Social Networks and Collaborative Filtering for Large-Scale Requirements Elicitation

Soo Ling Lim

A dissertation submitted in fulfilment

of the requirements for the degree of

Doctor of Philosophy

of the

University of New South Wales.

School of Computer Science and Engineering

THE UNIVERSITY OF NEW SOUTH WALES
SYDNEY • AUSTRALIA

August, 2010

Originality Statement

I hereby declare that this submission is my own work and to the best of my knowledge it contains no materials previously published or written by another person, or substantial proportions of material which have been accepted for the award of any other degree or diploma at UNSW or any other educational institution, except where due acknowledgment is made in the thesis. Any contribution made to the research by others, with whom I have worked at UNSW or elsewhere, is explicitly acknowledged in the thesis. I also declare that the intellectual content of this thesis is the product of my own work, except to the extent that assistance from others in the project's design and conception or in style, presentation and linguistic expression is acknowledged.

Soo Ling Lim
1st August 2010

Abstract

Within the field of software engineering, requirements elicitation is the activity in which stakeholder needs are understood. In large-scale software projects, requirements elicitation tends to be beset by three problems: information overload, inadequate stakeholder input, and biased prioritisation of requirements. The work described in this thesis addresses these problems using social networks and collaborative filtering.

The work has developed StakeNet, a novel method that uses social networks to identify and prioritise stakeholders. Using StakeNet, the requirements engineer asks an initial list of stakeholders to recommend other stakeholders and stakeholder roles, builds a social network with stakeholders as nodes and their recommendations as links, and prioritises the stakeholders using a variety of social network measures.

The work has also developed StakeRare, a novel method that uses social networks and collaborative filtering to identify and prioritise requirements. Using StakeRare, the requirements engineer asks the stakeholders identified by StakeNet to rate an initial list of requirements and suggest other requirements, recommends other relevant requirements to the stakeholders using collaborative filtering, and prioritises the requirements using the ratings and the stakeholders' priority from StakeNet.

Finally, to support the methods, this work has developed StakeSource, a novel software tool that automates the manual processes in StakeNet. StakeSource collects recommendations from stakeholders, builds the social network, and prioritises the stakeholders automatically.

The methods and tool have been evaluated using real large-scale software projects. The empirical evaluation of both StakeNet and StakeRare using a real large-scale software project demonstrates that the methods identify a highly complete set of stakeholders and their requirements, and prioritise the stakeholders and their requirements accurately. These methods outperform the existing methods used in the project, and require significantly less time from the stakeholders and requirements engineers. StakeSource has been evaluated with real large-scale projects by practitioners. The tool is now used in major software projects, and organisations are adopting it.

The methods, tool, and evaluation described in this thesis provide evidence that social networks and collaborative filtering can effectively support requirements elicitation in large-scale software projects.

Acknowledgement

I thank my supervisor, Anthony Finkelstein, for his advice and support. The two years of my PhD with him was pure adventure. I learned and did so much! Anthony made this two-year visit possible, by generously bearing the high costs of my overseas student fees and stipend at University College London (UCL). For that, I am eternally grateful. I also thank Anthony for providing me with the encouragement and freedom to pursue my research ideas.

My rather peculiar arrangement to be enrolled at the University of New South Wales (UNSW), but conduct my research at UCL, has worked very well for me. For that to happen, I thank my UNSW supervisors Paul Compton and Karl Cox, and at NICTA, Rod Belcher, Aruna Seneviratne, and Ross Jeffery.

My research internship at the National Institute of Informatics (NII) in Japan opened the door to my UCL visit. At NII, I thank Professor Shinichi Honiden for the memorable NII International Internship, and Eric Platon for providing me with the opportunity to present my work to Anthony, whose visit at NII happened to coincide with mine.

My work benefited from the discussions with experts from the fields of social networks, collaborative filtering, software engineering, machine learning, and survey research. At UCL, I thank Franco Raimondi, Emmanuel Letier, Daniele Quercia, Jun Wang, Neal Lathia, Licia Capra, and Jennifer (van Heerde) Hudson. At NII, I thank Fuyuki Ishikawa and Eric Platon. In Sydney, I thank Jason Lau for his contribution in the development of the StakeSource software described in this thesis.

Most importantly, I thank Peter Bentley for always being there to discuss my ideas and problems. Peter meticulously reviewed my papers and the many drafts of my thesis. His prompt feedback on each draft chapter enabled me to complete the thesis quickly. I thank him for making the final year of my PhD productive and fun at the same time!

I also thank the stakeholders of the UCL RALIC project for putting up with my countless surveys and interviews. It is through their participation, that I managed to conduct one of the largest empirical studies of stakeholders and requirements in the field. On top of that, I thank Eric Platon, Irene Halliwell, and John Bentley for their feedback on my thesis.

For financial support throughout my PhD, I thank the Australian Government and UNSW for the Australian Postgraduate Award and Postgraduate Research Student Support

Scheme, NICTA for the NICTA Research Project Award, NICTA and NII for the NII Internship Stipend, and Mandelbaum House, University of Sydney, for the Nate Zusman Scholarship.

Finally, I thank my examiners, Jane Cleland-Huang, Daniela Damian, and Neil Maiden, for their useful feedback and suggestions.

This thesis is dedicated to my parents.

1st August 2010

Contents

List of Figures

List of Tables

Chapter 1

Introduction

This chapter introduces the motivation for the thesis, describes the hypothesis, and lays out the objectives, main contributions, and publications of the work.

1.1 Motivation

Software systems are growing. The increase in size extends beyond mere lines of code or number of modules. A software system can now affect millions of people. In an ideal world, large software systems would always function as intended – users' needs would be met and customers would get value for their money. Projects to deliver the software systems would always be on time and under budget, regardless of the size of the software system. Current software development is far from ideal. Large projects are often late and over budget. They sometimes never deliver.

Today, projects to build large software systems involve vast numbers of stakeholders – the individuals or groups that can influence or be influenced by the success or failure of a software project (Nuseibeh and Easterbrook, 2000). These stakeholders include customers who pay for the system, users who interact with the system to get their work done, developers who design, build, and maintain the system, and legislators who impose rules on the development and operation of the system (Sharp et al., 1999, Nuseibeh and Easterbrook, 2000). In big projects, stakeholders can cut across divisions and organisations. They have diverse needs, which may conflict.

Requirements elicitation is the software engineering activity in which stakeholder needs are understood (Nuseibeh and Easterbrook, 2000). Requirements elicitation aims to identify the purpose for which the software system is intended (Zave, 1997). It involves identifying stakeholders and prioritising them based on their influence in the project. It also involves identifying requirements from these stakeholders and prioritising the requirements.

Existing methods for requirements elicitation require intensive interactions with the stakeholders, for example through face-to-face meetings, interviews, brainstorming sessions, and focus groups (Nuseibeh and Easterbrook, 2000). As such, the methods fail to scale to big projects with hundreds, thousands, or even hundreds of thousands of stakeholders (Cleland-Huang and Mobasher, 2008). Practitioners struggle to use these methods in large projects. Inevitably, stakeholders are omitted and their requirements overlooked. Users become frustrated when the software fails to meet their needs. Customers who pay for the project pay for the mistakes. As a result, billions of dollars are lost (Charette, 2005).

1.2 Problem Definition

The specific problems that beset large-scale requirements elicitation can be summarised as *information overload*, *inadequate stakeholder input*, and *biased prioritisation of requirements*.

Information overload is inevitable in big projects. A NASA engineer reported that the paperwork produced whilst eliciting the Space Station requirements was so extensive it could almost have been used to build a stairway all the way into space (Hooks and Farry, 2001). The requirements specification for the $170 million FBI Virtual Case File project was 800 pages long (Goldstein, 2005). In the presence of too much information, projects risk missing out important requirements. For example, in the FBI Virtual Case File project, the massive requirements specification failed to capture essential requirements, and the project was written off as a total failure (Goldstein, 2005).

Inadequate stakeholder input is a natural outcome of current practices. Existing stakeholder analysis methods are likely to overlook stakeholders (Alexander and Robertson, 2004). In addition, stakeholders are often sampled during requirements elicitation (Alexander, 2005). As requirements are elicited from stakeholders, omitting stakeholders results in missing requirements, which leads to the wrong product being built. Omitting stakeholders is one of the most common mistakes in software engineering (Gause and Weinberg, 1989). A disturbing study suggested that more than 60% of software projects fail every year, with lack of user input and incomplete requirements as the top two causes of failure (The Standish Group, 1994, The Standish Group, 2009). Due to missing requirements, Sydney Water Corporation, the largest water provider in Australia, had to abort their customer information and billing system project, after numerous change requests and significant added costs and delays (Charette, 2005). The failed project incurred a cost of AU $61 million (US $33.2 million) (Charette, 2005).

Biased prioritisation of requirements occurs because current prioritisation practices depend on individuals, who may not have a global perspective in large projects (Lehtola et al., 2004, Cleland-Huang and Mobasher, 2008). Although the literature suggests that prioritising from multiple stakeholders' viewpoints can reveal important requirements (Sommerville and Sawyer, 1997), the task is almost impossible to perform with many stakeholders and many requirements. As a result, important requirements known to only a few stakeholders can be lost in the sea of information. Those who attempted to get multiple viewpoints found it difficult to combine information from different sources (Lehtola et al., 2004). A study reveals that many practitioners resort to rough guesses on the requirements that might be important to customers and users, and most of the time make no effort at proper prioritisation (Lehtola et al., 2004). The Virtual Case File project, despite being late and over budget, had developed solutions to trivial requirements instead of essential ones (Charette, 2005).

Above all, the existing requirements elicitation literature mostly focuses on qualitative evaluation (Nuseibeh and Easterbrook, 2000, Cheng and Atlee, 2007). Without empirical evaluations using real projects, no-one can be certain how well one method performs against another, or indeed whether the methods work at all!

1.3 Hypothesis

To address these problems, this thesis proposes an open and inclusive method for requirements elicitation using social networks and collaborative filtering. An inherent feature in existing requirements elicitation methods is that they depend on a small number of experts such as the requirements engineers or the project team. These experts become a bottleneck in large-scale software projects where they have to process many requirements from many stakeholders. To remove the bottleneck, this work shifts the emphasis from requirements elicitation involving only the experts to a collaborative approach in which all stakeholders have a say.

More concisely, the hypothesis is:

Social networks and collaborative filtering provide effective support for requirements elicitation in large-scale software projects.

Social networks view social relationships in terms of network theory consisting of nodes and ties (Wasserman and Faust, 1994, Scott, 2000). Nodes represent actors in the networks and ties represent the relationships between the actors. In this work, the following social network techniques are employed: *snowball sampling*, *social network diagrams*, and *social network measures*. *Snowball sampling* is a process in which research samples are developed by asking existing study subjects to recruit future subjects such that the sample group grows like a rolling snowball. It is used in this work to identify stakeholders. *Social network diagrams*, which are graphical representations of the networks of nodes and ties, are used in this work to represent stakeholders and their relationships. Finally, *social network measures*, such as *betweenness centrality* and *degree centrality*[1], are metrics to analyse social networks. In this work, the measures are used to prioritise stakeholders.

Collaborative filtering is the process of filtering for information or patterns using techniques involving the collaboration among multiple users, viewpoints, and data sources (Schafer et al., 2007). The goal is to make automatic predictions about a user's interests by collecting information from many users. In this work, the following collaborative filtering techniques are employed: *user profiles* and *collaborative filtering algorithms*. A *user profile* is a collection of personal data associated with a specific user in the form of *user*, *item*, and *rating*. In this work, *user profiles* represent stakeholders and their requirements where *users* are the stakeholders, *items* are the requirements, and *ratings* are the stakeholders' ratings on the requirements. *Collaborative filtering algorithms*, such as *k*-nearest neighbour[2], are used to make predictions about a stakeholder's requirements based on the requirements from like-minded stakeholders.

As mentioned in the previous section, *requirements elicitation* is the activity in which stakeholder needs are understood (Nuseibeh and Easterbrook, 2000). It involves identifying stakeholders and prioritising them based on their influence in the project – a task also known as *stakeholder analysis* (Sharp et al., 1999). It also involves identifying requirements from these stakeholders and prioritising the requirements.

Effective support for requirements elicitation is defined as producing a complete and accurately prioritised list of stakeholders and requirements, while not imposing additional burdens on the requirements engineers or stakeholders, in terms of time spent and difficulty completing the task.

Large-scale software projects are software projects that have a large and diverse community of stakeholders with different needs. Stakeholders are used as the measure of scale as this work focuses on requirements elicitation. Specifically, this work considers large-scale software projects as those having more than 50 stakeholder groups and 10,000 users, where users are members of the stakeholder groups. For example, the FBI Virtual Case File project

---

[1] These measures are explained in Chapter 5.

[2] The algorithm is explained in Chapter 6.

which is widely cited as large-scale (Schaefer, 2006, Laurent et al., 2007, Schaefer, 2008, Cleland-Huang and Mobasher, 2008, Duan et al., 2009), has more than 50 stakeholder groups, comprising 23 divisions which previously had their own IT budget and systems, and the agents work out of 56 field offices (Goldstein, 2005). Among these stakeholder groups are the 12,400 agents who will use the software. The literature review in Chapter 2 will explore the rationale behind the definition and other ways to size a project, such as lines of code, function points, and number of developers.

The hypothesis is assessed by applying the proposed methods to a real large-scale software project. The resulting stakeholders and requirements are compared against the stakeholders and requirements produced by the existing methods used in the project and the *ground truth*, in terms of completeness and accuracy of prioritisation. The *ground truth* is the complete and prioritised list of stakeholders and requirements for the project obtained by analysing the stakeholders and requirements from the start of the project until after the system is deployed. After system deployment, stakeholders and requirements that were overlooked will be uncovered by change requests from stakeholders, and the actual importance of a requirement and the actual level of influence of a stakeholder will be revealed. In addition, the stakeholders are interviewed for qualitative feedback, and surveyed on the effort required, time spent, and difficulty in using the proposed methods.

1.4 Research Objectives

In order to provide evidence to support the hypothesis, the research is divided into the following objectives.

- To *review* the existing methods in stakeholder analysis and requirements elicitation, and the existing definitions of large-scale software projects.
- To *select* a large-scale software project to evaluate the work, *study* the project in detail, and *build* the ground truth and existing method lists of stakeholders and requirements to evaluate the methods developed in the work.
- To *review* the existing literature in social network analysis, *develop* a method that uses social networks in stakeholder analysis, and *evaluate* the method empirically.
- To *review* the existing literature in collaborative filtering, *develop* a method that uses social networks and collaborative filtering in requirements elicitation, and *evaluate* the method empirically.

- To *analyse* the bottlenecks in the proposed methods, *review* the existing tool support literature, *develop* a tool that reduces the bottlenecks, and *evaluate* the tool with real projects by practitioners.
- To *identify* the limitations in this work and *propose* future work to address the limitations.

Contributions

By achieving these objectives, the research makes the following contributions.

- A novel method to classify requirements into layers that change at different rates, and its application to analyse the requirements of the software project selected to evaluate the work.
- StakeNet, a novel method that uses social networks to identify and prioritise stakeholders.
- StakeRare, a novel method that uses social networks and collaborative filtering to identify and prioritise requirements.
- StakeSource, a novel web-based tool that automates the StakeNet method.
- The empirical evaluation of StakeNet and StakeRare using a real large-scale software project.
    - The empirical studies are the first of their kind in requirements elicitation.
    - The empirical studies are substantial, using post project knowledge to establish the ground truth of stakeholders and their requirements.
    - The evaluation provides clear evidence that the methods can identify a highly complete set of stakeholders and requirements, and prioritise them accurately. In addition, the methods are straightforward to use, and require less time from the requirements engineers and stakeholders compared to the existing method used in the project.
- The evaluation of StakeSource by practitioners in real projects.
    - Tool evaluation by practitioners is rare in requirements engineering research, but essential to provide confidence that the tool works in practice.
    - StakeSource is used by practitioners in a large-scale software project and a university-wide research project, and evaluated based on the feedback from the practitioners.

- The evaluation provides clear evidence that the tool provides effective support for stakeholder analysis in large-scale software projects.

Publications

In support of these contributions, the following papers have been published.

- Soo Ling Lim, and Anthony Finkelstein. (2011) Anticipating change in requirements engineering, *Relating Software Requirements and Architectures*. Editors: Paris Avgeriou, John Grundy, Jon G. Hall, Patricia Lago, and Ivan Mistrík. Springer-Verlag Computer Science Editorial (in press).
- Soo Ling Lim, Daniele Quercia, and Anthony Finkelstein. (2010) StakeNet: using social networks to analyse the stakeholders of large-scale software projects, in *Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering-Volume 1*. Association for Computing Machinery, New York. pp. 295-304.
- Soo Ling Lim, and Anthony Finkelstein. StakeRare: using social networks and collaborative filtering to identify and prioritise requirements for large-scale software projects, in *IEEE Transactions on Software Engineering* (in submission).
- Soo Ling Lim, Daniele Quercia, and Anthony Finkelstein. (2010) StakeSource: harnessing the power of crowdsourcing and social networks in stakeholder analysis, in *Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering-Volume 2*. Association for Computing Machinery, New York. pp. 239-242.

1.5 Thesis Structure

Chapter 1 has introduced the motivation for this thesis, described the hypothesis, and laid out the objectives, main contributions, and publications of the work.

The next chapter reviews the existing methods in stakeholder analysis and requirements elicitation, and the existing definitions of large-scale software projects.

Chapter 3 details the research methodology used in this work. It also describes the selection of a large-scale software project to evaluate the work.

Chapter 4 describes RALIC, the selected large-scale software project. It reviews RALIC's project documentation, reports the study of requirements change in RALIC, and details the construction of the existing method and ground truth lists of stakeholders and requirements for evaluating the work.

Chapter 5 reviews the existing literature in social network analysis, describes StakeNet, and reports the evaluation of StakeNet using the RALIC project.

Chapter 6 reviews the existing literature in collaborative filtering, describes StakeRare, and reports the evaluation of StakeRare using the RALIC project.

Chapter 7 reviews the bottlenecks in StakeNet and the literature on existing tool support for stakeholder analysis. It then describes StakeSource, and reports the evaluation of StakeSource using two real projects.

The final chapter summarises this work, discusses potential limitations, and puts forward a research agenda for the future.

Chapter 2

Literature Review

This chapter reviews the existing methods in stakeholder analysis and requirements elicitation, and examines the existing definitions of large-scale software projects.

Software engineering is a young discipline. Other engineering fields, such as civil and chemical, existed well before the 18th century, but 50 years ago, software engineering was non-existent (Shaw, 1990). The term "software engineering" was coined by Bauer in the 1968 NATO Software Engineering Conference[3] to provoke thought on the "software crisis" at the time (Naur and Randell, 1969, MacKenzie, 2004). Rapid increases in computer power and problem complexity had made it difficult to write computer programs that were correct, understandable and verifiable (Naur and Randell, 1969).

This software crisis manifested itself as projects that ran over-budget or over-time, software that did not meet requirements, and software that was low in quality, never delivered, and difficult to change or maintain (Naur and Randell, 1969). The NATO conference aimed to raise awareness about the crisis and discuss ways for it to be overcome (Naur and Randell, 1969). The conference was attended by an international group of leading computer scientists, computer manufacturers, software houses, and government and industrial organisations (Naur and Randell, 1969). Bauer's urge to "switch from home-made software to manufactured software, from tinkering to engineering," with a high degree of rapport from the conference attendees, marked the birth of software engineering (MacKenzie, 2004).

[3] http://homepages.cs.ncl.ac.uk/brian.randell/NATO/index.html

Software engineering begins by discovering the purpose for which a software system is intended. Widely known as requirements engineering (Sommerville and Sawyer, 1997, Zave, 1997, Kotonya and Sommerville, 1998, Nuseibeh and Easterbrook, 2000, Sommerville, 2004), this activity is concerned with the real world goals for, functions of, and constraints on software systems (Zave, 1997). Requirements describe necessary capabilities, characteristics, or qualities that a software system should possess, and serve as a primary measure of the success of the software system (Nuseibeh and Easterbrook, 2000). Requirements engineering involves eliciting, understanding, communicating, and agreeing requirements, and managing their change over time (Nuseibeh and Easterbrook, 2000). The output, a detailed technical description of the system known as the requirements specification (IEEE, 1998), is used in subsequent software engineering activities to design, build, and test the software system (Sommerville, 2004).

2.1 Stakeholder Analysis

Requirements elicitation involves a wide range of people. These people include customers or clients who pay for the system, users who interact with the system to get their work done, developers who design, construct, and maintain the system, and policy makers who impose rules on the development and operation of the software system (Sharp et al., 1999, Nuseibeh and Easterbrook, 2000). They have diverse backgrounds, expertise, interests, and personal goals (Zave, 1997). The identification and prioritisation of the individuals and groups that can influence or be influenced by the software project is known as stakeholder analysis. These stakeholders are the source of requirements during requirements elicitation (Nuseibeh and Easterbrook, 2000, Alexander, 2005).

Early practices in stakeholder analysis focused mainly on paying customers. Soon it was realised that the focus was too restrictive (Hood et al., 2007). Customers are not always the end-users of the product; end-users will make or break the software, affect or be affected by it, and decide on its usefulness (Gause and Weinberg, 1989). Nevertheless, merely considering customers and end-users was still insufficient, for other parties such as subject matter experts, policy makers, and developers can influence the success or failure of the project to build the software (Gause and Weinberg, 1989). Also, in addition to users who will benefit from the product, people who will lose from it should also be considered, as they may oppose the product (Gause and Weinberg, 1989, Alexander, 2005). As such, modern requirements elicitation broadens its scope to involve *stakeholders* – any individuals or groups that can influence or be influenced by the success or failure of a software project (Nuseibeh and Easterbrook, 2000, Cheng and Atlee, 2007, Glinz and Wieringa, 2007).

Stakeholder Identification

The task of identifying stakeholders is far from straightforward (Sharp et al., 1999). Information about stakeholders is not readily available and it is difficult to arrive at a complete list of stakeholders (Alexander and Robertson, 2004). Omitting stakeholders is reported as the most common mistake in development efforts (Gause and Weinberg, 1989). The majority of developers face problems finding the right stakeholders with adequate time, interest, and knowledge for the project (Alexander and Robertson, 2004). All too often developers omit stakeholders and the omission significantly impacts project success. For example, Gause and Weinberg (1989) reported a $20 million dollar project that overlooked a stakeholder from the auditor's office. The project had to be cancelled when the omission was discovered as the auditor's requirements were not met by the project.

Earlier approaches to identify stakeholders make use of heuristics. Gause and Weinberg (1989) proposed context-free questions to tease out information about stakeholders, such as: who is the customer, who should be on the team, whose problem does the product solve, who are the right people to ask these questions. Cockburn (2000) suggested identifying stakeholders by considering those who interact directly with the system (e.g., system users) and those who have interests in the system but do not interact directly with it (e.g., owners of the system or company, and regulatory bodies). The output of these approaches is a list of stakeholder names (e.g., Alice, Bob) or their roles in the project (e.g., students, vandals) (Gause and Weinberg, 1989, Cockburn, 2000). Heuristics provide a good starting point to identify stakeholders; however, requirements engineers are prone to omit stakeholders if they only consider broad stakeholder categories such as the parties interested in the system or the people whose problems are solved by the system.

Pouloudi and Whitley (1997) proposed a more systematic approach to stakeholder identification that involves interviewing stakeholders to identify more stakeholders. The approach starts by identifying obvious stakeholder roles. The individuals taking up these stakeholder roles are then interviewed to refine and enrich the initial stakeholder list. The interview includes questions such as: who are other stakeholders, what is their relation with the interviewee, what is the role and influence of the various stakeholders, and what are the politics underpinning the activities in the domain. The interview uncovers new stakeholders, who are interviewed in turn, and their perceptions integrated into the stakeholder list. Pouloudi and Whitley (1997) applied their approach to identify the stakeholders of information systems in the drug use management domain and the results are illustrated in Figure 2-1.

'Groups' of stakeholders	*Initial stage: the 'obvious' stakeholders*	*Second stage: after the literature review and first round of interviews*	*Third stage: conferences, further interviews*
Drug use management systems suppliers	(uncertain of whether specialised suppliers existed)	drug databases providers, hardware suppliers/software suppliers: for hospital systems for GP systems for pharmacies	+ EDI suppliers + telecommunications suppliers + IT consultants
Drug use management systems users	Hospitals	doctors pharmacists nurses user groups	
	GPs Pharmacies		
Other parties influencing the evolution of drug use management systems	'government'	PPA Department of Health Health Agencies	+ NHS Executive + CCTA
	Patients	+ Insurance companies	
	Pharmaceutical companies	+ Professional associations (e.g. BMA)	+ Medicines Control Agency + BCS

Figure 2-1: Expanding the list of stakeholders in the drug use management field (Pouloudi and Whitley, 1997) (reproduced with permission).

The interview method is thorough. The underlying principle is that stakeholders cannot be viewed in isolation. The interrelations between stakeholders are used to identify stakeholders who are otherwise likely to be overlooked. This principle serves as a foundation for subsequent work. Nevertheless, Pouloudi and Whitley (1997) pointed out two main problems with the approach. First, it is difficult to decide when to stop the identification process as the stakeholders who are interviewed may suggest new stakeholders who suggest other new stakeholders. As a result, there is a potential danger of identifying everyone as a stakeholder (Pouloudi and Whitley, 1997). Second, as more stakeholders are identified, it is more likely to have stakeholders with conflicting ideas. Without a method to prioritise these stakeholders, decision-making may be hindered (Pouloudi and Whitley, 1997).

Building on Pouloudi and Whitley's work, Sharp et al. (1999) proposed a search method that identifies stakeholders by considering their relationships. Sharp et al.'s method starts by finding initial stakeholder roles from users, developers, legislators, and decision-makers. These roles are called baseline roles as they are central to all software projects, and other stakeholders and their relationships can be identified from them. For each baseline role, the method identifies *supplier stakeholders* who provide information or supporting tasks to the baseline stakeholders, *client stakeholders* who process or inspect the products of the baseline stakeholders, and *satellite stakeholders* who interact or support the baseline stakeholders and vice versa (Figure 2-2). This step is repeated for each newly identified role and the outcome is added to the list of stakeholder roles (Sharp et al., 1999).

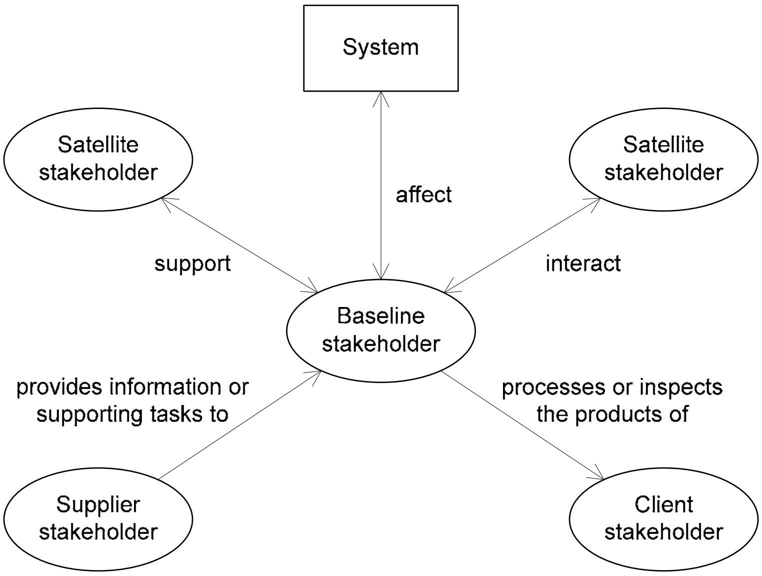


Figure 2-2: The main elements of stakeholder identification (Sharp et al., 1999) (reproduced with permission).

The search method produces a network of stakeholders where a stakeholder is a node and the link between two nodes represents the relationship between the two stakeholders (Sharp et al., 1999). Given this network of stakeholders, Sharp et al. (1999) suggested that a suitable network theory could be used to calculate the stakeholders' level of influence in the project and identify important stakeholders. They urged researchers to investigate network literature from other domains such as social network theory (Scott, 2000) and industrial networks (Axelsson and Easton, 1992). Sharp et al.'s work opened new doors for stakeholder analysis and provided inspiration for the work described in this thesis.

Similar to Pouloudi and Whitley's approach (1997), the search method faces the difficulty of knowing when to stop the identification process. Sharp et al. (1999) warned that their approach might generate too much data, which could include irrelevant parties or "non-stakeholders". Alexander (2005) pointed out that Sharp et al.'s approach may be time consuming and may only reveal the obvious stakeholders. In addition, the validation of Sharp et al.'s approach, either on an example case study or a real project, is needed to provide more concrete evidence of its benefits and shortcomings (Sharp et al., 1999).

Some recent approaches for stakeholder identification provide a checklist of generic stakeholder roles. Alexander and Robertson proposed the Onion Model (Alexander and Robertson, 2004, Alexander, 2005, Robertson and Robertson, 2006), which contains customisable slots of generic stakeholder roles in different layers, similar to the layers in an onion (Figure 2-3). Roles that directly interact with the system are close to the centre (e.g., normal operator); roles that are indirectly involved are further away from the centre (e.g., regulator). The model is used by asking stakeholders what their roles are and populating the model down to the contact details of the people filling each role. Any slots that remain unfilled are further investigated by asking who might fill the roles.

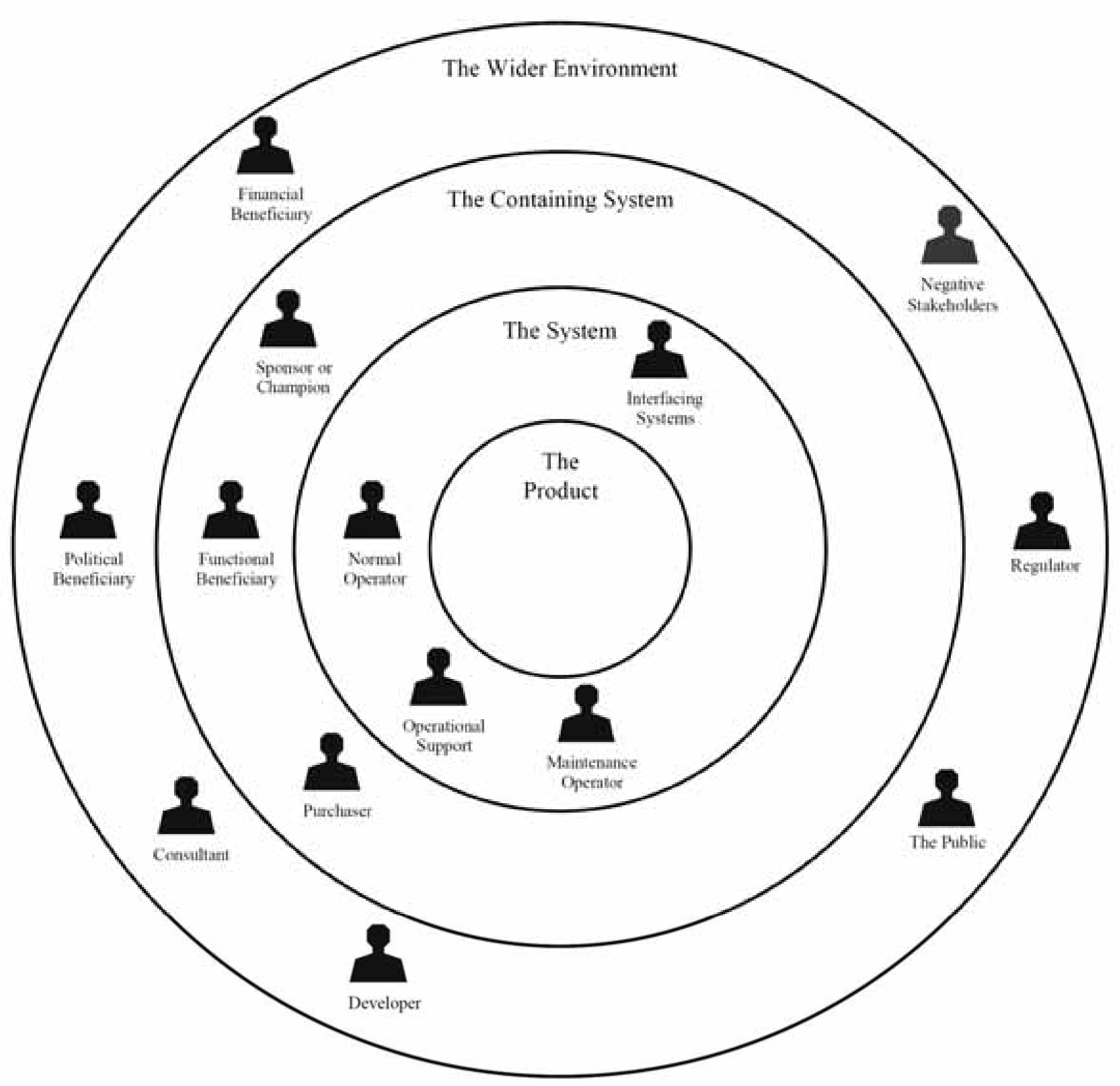


Figure 2-3: The Onion Model (Alexander, 2005) (reproduced with permission).

Another checklist-based approach is the Volere stakeholder analysis template[4] by Robertson and Robertson (Alexander and Robertson, 2004, Robertson and Robertson, 2006). The template provides a list of more than 70 stakeholder roles, such as business/subject experts, potential users, and sales specialists (Figure 2-4). Compared to the Onion Model, the template contains a larger variety of stakeholder roles. For example, the negative stakeholder role in the Onion Model corresponds to various stakeholder roles in the Volere template such as competitor,

---

[4] http://www.volere.co.uk

hacker, political party, and pressure group. The template is used by asking the types of knowledge required in a project, and identifying the individuals with the knowledge. The stakeholders' names and responsibilities are recorded in the template, which is useful when there are several different stakeholders concerned with the same knowledge or multiple stakeholders occupying the same role.

Stakeholder role	Stakeholder name	Necessary involvement	Classes of Knowledge						
			Goals	Business constraints	Technical constraints	Functionality	Look and feel	Usability	Performance
Client									
Customer(s)									
Business/subject experts									
Future idea specialist									
Current system specialist									
Clerical user									
Technical user									
Potential user									
Sales specialist									
Marketing specialist									
Asthetics specialist									
Graphics specialist									
Usability specialist									
Safety specialist									
Security specialist									
Cultural specialist									
Legal specialist									
Environmental specialist									
Maintenance specialist									
Packaging designer									
Manufacturer									
Product installer									

Figure 2-4: A partial Volere stakeholder analysis template (Alexander and Robertson, 2004) (reproduced with permission © The Atlantic Systems Guild). The complete template contains more stakeholder roles and knowledge classes.

Checklist-based approaches are not intended to provide exhaustive lists of stakeholders. Rather, they provide key stakeholder roles to reduce the likelihood of omitting important stakeholders (Alexander, 2005). As such, there is still the risk of omitting stakeholders, especially project specific stakeholders that do not appear on the checklist. For example, a requirements engineer, upon seeing the negative stakeholder role in the Onion Model, may not immediately list vandals and political parties as the negative stakeholders of a project. As such, Alexander and Robertson (2004) reported the Onion Model and the Volere template as being complementary as requirements engineers who have been using one model might overlook a role that the other model immediately suggests.

Stakeholder prioritisation

Different stakeholders have different levels of influence in the project. As well as identifying the stakeholders, there is also the need to prioritise them based on their influence (Gause and Weinberg, 1989). One of the earliest approaches considers the power and interest of different stakeholders (Freeman, 1984, Eden and Heijden, 1993). The Power Interest Grid (Figure 2-5) plots stakeholders on a matrix based on their level of power and interest in the project (Eden and Ackermann, 1998). Stakeholders with high power and interest are plotted on the top right corner of the matrix (e.g., Carl in Figure 2-5); stakeholders with low power and interest are plotted on the bottom left corner (e.g., Dave). The model allows a continuum of the level of power and interest. For example, in Figure 2-5, Bob has medium levels of power and interest, Alice has more power than Bob but less than Carl. The level of power and interest is judged from the requirements engineer's perspective, which is a simplistic view that ignores the effect of a "stakeholder's stakeholders" on the actual power and interest of the stakeholder in complex projects (Pouloudi and Whitley, 1997).

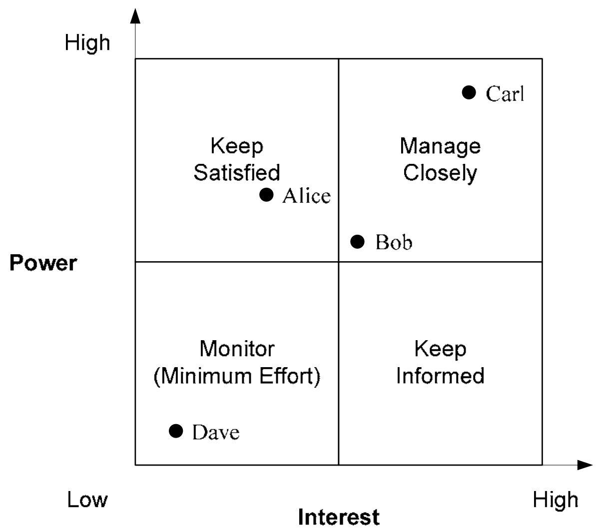


Figure 2-5: Example Power Interest Grid in use (MindTools[5]) (reproduced with permission).

The stakeholder power, legitimacy, and urgency model by Mitchell et al. (1997) is a seminal work in the field of business management. Mitchell et al. (1997) proposed that managers should prioritise stakeholders based on their possession of one or more of the three stakeholder attributes: power, legitimacy, and urgency (Figure 2-6). Legitimacy is the moral or legal claim a stakeholder possesses to influence a project; power is their capacity to influence the outcome of a given project; and urgency is the degree to which stakeholder claims call for immediate action. Entities with none of the stakeholder attributes are not stakeholders. Stakeholders are placed into different classes based on the number and type of attributes they

[5] http://www.mindtools.com/pages/article/newPPM_07.htm

possess. For example, stakeholders with all three stakeholder attributes – power, urgency, and legitimacy – are definitive stakeholders, and stakeholders with only power and urgency are dangerous stakeholders (Figure 2-6).

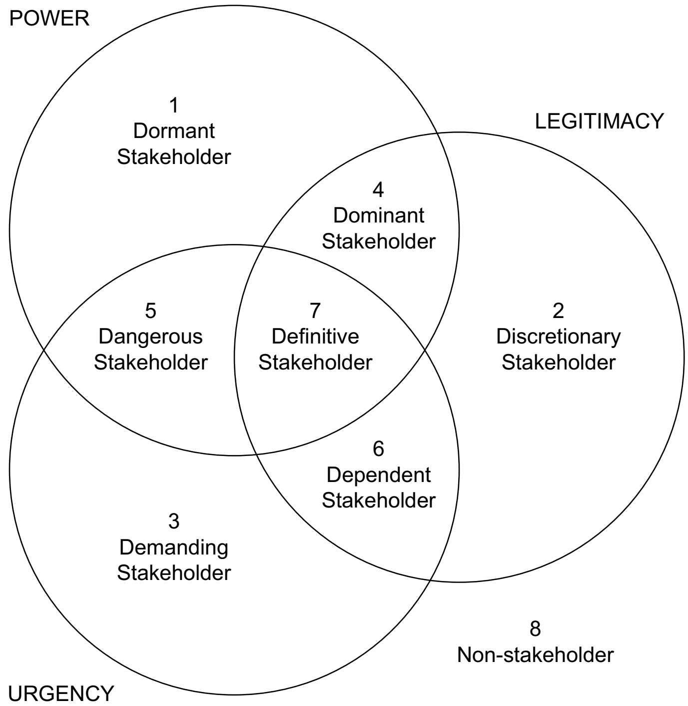


Figure 2-6: Stakeholder Power, Legitimacy, and Urgency (Mitchell et al., 1997) (reproduced with permission).

To prioritise stakeholders, Mitchell et al. (1997) introduced the concept of salience, defined as the degree to which managers give priority to competing stakeholder claims. Stakeholders with only one stakeholder attribute (areas 1, 2, and 3 in Figure 2-6) have low salience; stakeholders with two attributes (areas 4, 5, and 6) have moderate salience; and stakeholders with all three attributes (area 7) have high salience. Mitchell et al.'s model illustrates that stakeholder prioritisation is non-trivial: there are many "dimensions" to prioritise a stakeholder, and these "dimensions" may be interdependent. Nevertheless, the model treats each attribute as either present or absent while in reality they operate on a continuum; and the prioritisation is subjective from the manager's perspective (Mitchell et al., 1997).

In requirements engineering, Glinz and Wieringa (2007) propose to prioritise stakeholders by assessing the risk incurred from neglecting them. If the neglect causes the project to fail, then the stakeholder role is critical; if it causes a significant negative impact on the system, then the stakeholder has a major role; if it has marginal impact, then the stakeholder has a minor role. Glinz and Wieringa's approach classifies stakeholders into three broad categories for decision-makers to act on. However, the classification is subjective to the requirements engineers, as no concrete method is provided to assess the risk or measure the impact of neglect.

Woolridge et al. (2007) proposed a more concrete method for risk-based prioritisation in their Outcome-Based Stakeholder Risk Assessment Model (OBSRAM). OBSRAM identifies stakeholders using a checklist list of generic stakeholder roles, such as users, customers, special-interest stakeholders, both in the problem domain and in the software project. It then prioritises stakeholders using their risk scores. A risk score is calculated by multiplying two key elements in risk management plans: risk severity and probability (Boehm and DeMarco, 1997, Carbone and Tippett, 2004). It is then weighted by the number of outcomes the stakeholder can influence, and the scope of the stakeholder's influences. Stakeholders with influence at the organisation level have a higher scope of influence, followed by the problem domain level, and finally the project level. Woolridge et al. illustrated OBSRAM using a case study of a simulated airline-crew-scheduling system. An example of risk score calculation is in Figure 2-7.

Factor	Score	Rationale
Risk scope	2	This response could influence the whole fast-ground-turnaround initiative, not just the project's implementation.
Domain scope	1	Only one of the eight problem domain outcomes impacts the baggage-handling supervisor.
Risk severity	4	If the supervisor responds as predicted, the initiative could fail completely.
Risk probability	4	The supervisor will likely respond as predicted unless mitigation steps are taken.
Risk score	32	Risk scope (2) ∗ domain scope (1) ∗ severity (4) ∗ probability (4) = overall risk score (32)

Figure 2-7: OBSRAM risk score calculation for a baggage-handling supervisor (Woolridge et al., 2007) (reproduced with permission).

OBSRAM is rigorous and prioritises stakeholders at a fine level of granularity based on empirical calculations. For example, in the airline-crew-scheduling system case study, the ground crew director is ranked first as he has the highest risk score of 128, followed by the employee union with risk score of 36, baggage-handling supervisor with risk score of 32, analyst with risk score of 24, and so on (Woolridge et al., 2007). The prioritisation is more detailed than the broad categories of critical, major, and minor in Glinz and Wieringa's approach (2007). Nevertheless, similar to the other methods, the risk score calculation in OBSRAM depends on the requirements engineers which may be biased.

As well as identifying and prioritising stakeholder roles, stakeholder analysis also involves identifying and prioritising stakeholders to find suitable ones from which to elicit requirements (Glinz and Wieringa, 2007). Involving the wrong stakeholder representatives in requirements elicitation results in missing or wrong requirements, as the perceived needs by the stakeholder representatives may not reflect the actual needs of the stakeholders (Alexander, 2005). Some stakeholder roles comprise many stakeholders, but they may not be equally suitable for elicitation. For example, in an online library database project, thousands of individuals could assume the library user role, but some may have less time or interest to be involved in elicitation. For large stakeholder groups, exhaustive participation in requirements elicitation is seldom possible, and the usual way is to sample the population (Gause and Weinberg, 1989). Surrogacy is another type of representation, where an individual acts on behalf of a stakeholder role (Gause and Weinberg, 1989, Alexander, 2005).

Despite the centrality of involving suitable stakeholder representatives in requirements elicitation, the identification of suitable stakeholder representatives is under-researched. The methods previously discussed focus on identifying and prioritising stakeholder roles rather than stakeholders. Although Glinz and Wieringa (2007) mentioned the need to select stakeholder representatives for requirements elicitation, no method was provided. Mockus and Herbsleb (2002) proposed using data from change management systems to quantify development experience and suggest experts, but their focus is only on developers, who are a subset of stakeholders. A recent literature review by Alexander (2005) revealed that the issue of finding suitable stakeholder representatives is scarcely discussed and researched, and the few who mentioned the issue highlighted its importance but provided no solution. Alexander (2005) provided a detailed analysis of different types of representatives and their advantages and risks. For example, a statistical sample of a "typical consumer" may not be typical due to biased sampling, and a requirements engineer acting on behalf of the consumers of the product may not know their real needs (Alexander, 2005).

To summarise, the interview method and search method to identify stakeholder roles are less likely to omit stakeholders, but they are more likely to return "non-stakeholders" and can be time consuming for the requirements engineers. Checklist-based methods lessen the burden by providing a predefined list of stakeholders, but are more likely to omit stakeholders, especially in projects with many project-specific stakeholders. Different approaches can be used to prioritise stakeholder roles. However, these approaches prioritise from the perspective of the requirements engineers, which can be biased, especially in large projects where no individual has a global perspective (Cleland-Huang and Mobasher, 2008). Despite the importance of selecting suitable stakeholder representatives for requirements elicitation, methods to identify stakeholders to represent their roles are under-researched.

2.2 Requirements Elicitation

Once stakeholders and their roles are identified and prioritised, the requirements elicitation process commences. Requirements describe goals, functions, and constraints of a software system (Zave, 1997). The term “elicitation” is preferred to “capture”, to avoid the suggestion that requirements are out there to be collected simply by asking the right questions (Jirotka and Goguen, 1994). Rather, the data collected during requirements elicitation often has to be interpreted, analysed, modelled, and validated (Nuseibeh and Easterbrook, 2000). “Elicitation” is also referred to as “acquisition” in some literature (Dardenne et al., 1993, Maiden and Rugg, 1996, Davis et al., 2006).

Early requirements elicitation aimed towards specifying what the software system has to do (Zave and Jackson, 1997). Requirements were modelled in terms of information flow and system state (Nuseibeh and Easterbrook, 2000). In the 1990s, it was realised that focussing on the functionality of a new system was too restrictive. It constrained possible solutions to the stated functionality, while there might be better ways the software system can achieve its intended purpose (Zave and Jackson, 1997, Nuseibeh and Easterbrook, 2000). Requirements should describe the environment relevant to the software system, and the stakeholders’ desires concerning the system (Zave and Jackson, 1997). Doing so captures the system’s purpose, and allows the reasoning of whether a given design will meet that purpose (Nuseibeh and Easterbrook, 2000). As such, the turn of the century sees a shift towards modelling requirements in terms of stakeholders’ goals and scenarios that illustrate how goals can be achieved (Dardenne et al., 1993, Yu, 1997, Maiden, 1998, Nuseibeh and Easterbrook, 2000, Cockburn, 2000).

Requirements Identification

In requirements elicitation, traditional techniques, such as interviews and focus groups, form the basis of existing practice (Nuseibeh and Easterbrook, 2000, Cockburn, 2000, Robertson and Robertson, 2006, Davis et al., 2006). In interviews, the requirements engineers approach stakeholders with questions to gain information about their needs (Lauesen, 2002). Interviews are usually semi-structured based on a series of fixed questions with scope for the user to expand on their responses (Preece et al., 1994, Macaulay, 1996). Focus groups bring stakeholders together in a discussion group setting, where stakeholders are free to interact with other stakeholders. The general idea is that the participants stimulate ideas among one another through their discussions and the collective view is greater than the individual parts (Bruseberg and McDonagh-Philp, 2001). One criticism of focus group is that dominant participants may influence group disproportionately (Maguire and Bevan, 2002).

In these traditional techniques, the direct interaction between requirements engineers and stakeholders enables a better understanding of stakeholder needs. During interviews, requirements engineers can help stakeholders to articulate their requirements more clearly. The literature review on requirements elicitation by Davis et al. (2006) found interviews to be one of the most effective elicitation techniques. In focus groups, the requirements engineers observe the stakeholders interact and use team dynamics to come to a richer understanding of stakeholder needs (Nuseibeh and Easterbrook, 2000). Nevertheless, precisely due to the need for direct interaction, these techniques face difficulty when scaling to a large number of stakeholders.

To support elicitation, model-driven techniques provide a specific model of the type of information to be gathered, which is used by the requirements engineers to drive the interviews with stakeholders (Nuseibeh and Easterbrook, 2000). Examples of model-driven techniques include goal-based methods, such as KAOS (Dardenne et al., 1993, Van Lamsweerde, 2001) and *i** (Yu, 1997), and scenario-based methods, such as the use case method (Jacobson, 1991, Cockburn, 2000) and CREWS (Maiden, 1998). In goal-based methods, the requirements engineers elicit prescriptive statements of the purpose of the system or goals from the stakeholders (Dardenne et al., 1993). In use cases, stakeholders are prompted for possible sequences of interactions with the system (Cockburn, 2000). Model-driven techniques provide benefits such as improved structure and completeness of the elicited requirements, and allow further analysis of the requirements. However, these methods require direct interaction with the stakeholders, which means the stakeholders have to be sampled in large projects (Gause and Weinberg, 1989).

An elicitation technique that does not require direct interaction with the stakeholders is the survey method. Surveys involve administering a set of written questions in the form of questionnaires to a sample population of stakeholders (Nuseibeh and Easterbrook, 2000, Preece et al., 1994). The questionnaires usually consist of a mix of closed-ended questions with fixed responses and open-ended questions where the respondents have freedom in their answers. Surveys help to elicit quantitative and qualitative data about the needs of stakeholders, their current work practices, and attitudes to new system ideas (Preece et al., 1994). The requirements engineers need not meet stakeholders face-to-face to administer the questionnaires. As such, surveys are one of the few elicitation techniques that can be administered to a large number of stakeholders (Maguire and Bevan, 2002). However, the data quality depends on various factors such as the method of contact (e.g., telephone interviews, mail surveys, or online questionnaires), incentives, questionnaire length and content (Yu and Cooper, 1983, Kuniavsky, 2003).

In situations where there is a high degree of uncertainty about the requirements, prototypes are built and shown to stakeholders for feedback (Davis, 1992, Lichter et al., 1993).

The prototyping technique enables stakeholders to visualise an application that has not yet been built so that they can provide early feedback (Nuseibeh and Easterbrook, 2000, Hall, 2001). Similar to interviews, prototyping requires direct interaction with the stakeholders, hence is restricted to a limited number of stakeholders. Also, the use of prototypes focuses the discussion on the displayed artefact, which is often the user interfaces of the application, rather than help the discovery of requirements (Davis et al., 2006).

There is a plethora of advanced elicitation techniques such as card sorting, metaphors, persona, storyboards, and thinking aloud (summarised in Table 2-1). These techniques aim to improve the completeness and variety of the identified requirements by catalysing discussions and exploring the stakeholders' needs. Nevertheless, their main drawback is that they rely heavily on direct interaction between the requirements engineers and the stakeholders, which limits their applicability to large projects. In addition, there is no clear evidence that they perform better than traditional techniques. For example, Davis et al. (2006) reported that techniques such as card sorting and thinking aloud tend to be less effective than interviews.

Table 2-1: Advanced Elicitation Techniques

Technique	Description
Brainstorming (Gause and Weinberg, 1989)	The requirements engineers and stakeholders generate a large number of ideas by welcoming any suggestions, withholding criticisms, and building on one another's ideas, thus allowing freedom for creativity.
Card sorting (Nurmuliani et al., 2004)	The requirements engineers provide stakeholders with cards labelled with concepts. The stakeholders then cluster the cards to represent structures familiar to them. For example, card sort can be used to work out the organisation of a website (Maguire and Bevan, 2002). Stakeholders are given cards with the names of the intended web pages and asked to group the cards into related categories. By comparing the groupings from several stakeholders, requirements engineers can spot clear structures across many stakeholders.
Joint application development (JAD) workshop (Wood and Silver, 1995)	The workshop brings together representatives from various stakeholder roles, such as users, sponsors, analysts, designers, and developers, to elicit, analyse and achieve consensus on the requirements of the software system.
Metaphors (Potts, 2001)	The requirements engineers use analogies to help stakeholders to consider their requirements more deeply and be more precise about their requirements.

Technique	Description
Personas (Aoyama, 2005)	In domains where users are unknown (e.g., digital consumer products), the requirements engineers identify a rich contextual model of targeted users, called personas. Based on the requirements collected from real users, the requirements engineers use a set of techniques to identify the value and hot spots in the requirements by analysing the personas and the interactions between the users and the services.
Repertory grid (LaFrance, 1987)	The requirements engineers identify the ways that a stakeholder interprets his or her experience to provide information from which inferences about their needs are made.
Requirements invention (Maiden et al., 2005)	Stakeholders use creative techniques to invent requirements that result in more useful, usable and competitive products.
Storyboards (Andriole, 1989, Leffingwell and Widrig, 1999)	Storyboards are sequences of images that show the interaction between stakeholders and the software system. The requirements engineers hold interactive sessions to walk stakeholders through the storyboards.
Think-aloud protocol (Ericcson and Simon, 1993)	Stakeholders think aloud while performing a task, describing their thoughts, feelings, actions, and perceptions. The requirements engineers observe to gain insights into the cognitive processes used to perform the task.

Requirements Prioritisation

After requirements are identified, they also need to be prioritised. Projects often have more requirements than time, resource, and budget allow for. A function can always be added and the user interface enhanced. Although some requirements are critical for the success of the software system, others may merely be adornments (Karlsson, 1996). Hence, requirements should be prioritised so that the ones that are most likely to achieve customer satisfaction can be selected for implementation (Holbrook III, 1990, Davis, 1993, Karlsson, 1996, Duan et al., 2009).

A prioritisation technique commonly used in practice is the numeral assignment technique (Karlsson, 1996, Berander and Jonsson, 2006, Duan et al., 2009). In this technique, each requirement is assigned a value representing its perceived importance. For example, requirements can be classified as mandatory, desirable, or inessential (Karlsson, 1996). A variation of this technique is called the Planning Game in extreme programming, where customers distribute requirements into three groups: *those without which the system will not* *function*, *those that are less essential but provide significant business value*, and *those that would be nice to have* (Beck and Andres, 2004). A finer granularity of the scale of perceived importance can range from 1 to 5, where 5 indicates mandatory, 4 indicates very important, 3 indicates rather important, 2 indicates not important, and 1 indicates does not matter (Karlsson, 1996). Numeral assignment is straightforward, but a study by Karlsson (1996) found that numerical values are subjective, and the scoring system is often inconsistent as different people make use of different personal scales.

Similar to the numerical assignment technique, many existing approaches prioritise requirements from an individual's perspective. As prioritisations involve a small subset of stakeholders, the results are biased towards the perspective of those involved in the process (Cleland-Huang and Mobasher, 2008). Examples of these approaches include the pairwise comparison approach (Karlsson, 1996), the cost-value approach (Karlsson and Ryan, 1997), and the value-oriented prioritisation method (Azar et al., 2007).

In the pairwise comparison approach, requirements engineers compare two requirements to determine the more important requirement (Karlsson, 1996, Karlsson et al., 1998). For example, in Table 2-2, requirement R2 is more important than requirement R1, hence R2 is entered in the corresponding cell in the matrix[6]. The comparison is repeated for all requirements pairs such that the top half of the matrix is filled. If both requirements are equally important, then they both appear in the cell. Then, each requirement is ranked by the number of cells in the matrix that contain the requirement. For example, R3 is ranked first as two cells contain R3, followed by R2 with one cell, and R1 with no cells. Pairwise comparison is simple but does not scale to a large number of requirements (Karlsson, 1996). A matrix of order n requires $n \times (n-1)/2$ comparisons (Karlsson and Ryan, 1997, Karlsson et al., 1998). Hence, a project with 100 requirements would require approximately 5,000 comparisons.

Table 2-2: Example Pairwise Comparison Matrix

	R1	**R2**	**R3**
R1	–	R2	R3
R2	–	–	R3
R3	–	–	–

The cost-value approach is proposed by Karlsson and Ryan to prioritise requirements based on their relative value and implementation cost (Karlsson, 1996, Karlsson et al., 1998).

[6] http://deseng.ryerson.ca/~fil/t/pwisecomp.html

This approach is based on the Analytic Hierarchy Process (AHP) proposed by Saaty for decision making in situations where multiple objectives are present (Saaty, 1980). In the cost-value approach, the relative value of the candidate requirements is assessed followed by their relative cost. Using AHP, each candidate requirement's relative value and cost is calculated and plotted on a cost-value diagram (Figure 2-8). By not implementing requirements that have low contribution towards stakeholder satisfaction (R4 and R5 in Figure 2-8), the project can reduce its cost and duration of development. According to Karlsson and Ryan (1997), the pairwise comparison includes much redundancy and is thus less sensitive to judgmental errors common to techniques using absolute assignments. Since all unique pairs of requirements are to be compared, the required effort is substantial when there are many requirements (Karlsson et al., 1998).

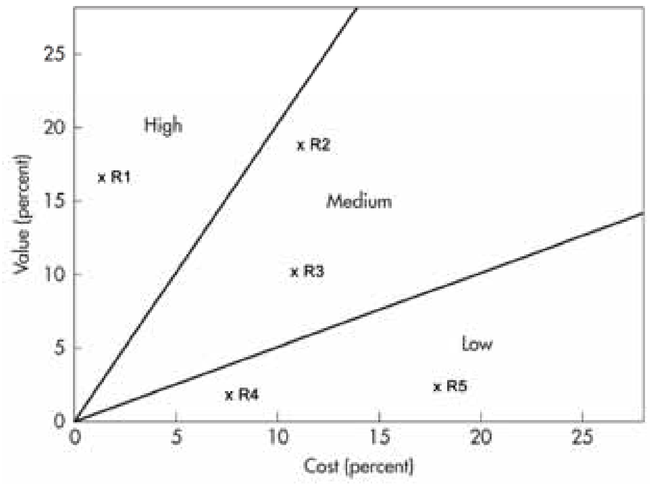


Figure 2-8: Cost-value diagram (Karlsson and Ryan, 1997) (reproduced with permission).

Value-oriented prioritisation method (VOP) by Azar et al. (2007) constructs a prioritisation matrix using core business values and risks. In the approach, the decision-makers identify core business values and risks, and use an ordinal scale to weight the importance of the business values and risks to the organisation. Figure 2-9 illustrates example business values, risks, and their weightings in bold, with the weighting scale of 0 (not important) to 10 (critical). Risks have negative weightings. Requirements are prioritised based on their contribution to the core business values and their perceived risks. For example, in Figure 2-9, the score of requirement r1, $Score_{r1} = 7(5) + 6(4) + 8(10) + 10(9) + 7(2) – 8(8) – 5(5) = 154$. In this example, r2 has a higher score than r1, hence it has more priority. VOP provides a documented visible process for requirements decisions that can be readily understood by stakeholders. However, the subset of stakeholders who set and give weightings to the core values may manipulate the results of the prioritisation.

	Core business values					Risks		
Requirement	Sales 7	Marketing 6	Competitive 8	Strategic 10	Customer retention 7	Technical −8	Business −5	Score
r_1	5	4	10	9	2	8	5	154
r_2	7	8	4	5	8	3	9	166

Figure 2-9: An example using the value-oriented prioritisation matrix (Azar et al., 2007) (reproduced with permission).

More sophisticated methods combine prioritisations from multiple stakeholders. In the 100-point test or cumulative voting, each stakeholder is given 100 points that they can distribute as they desire among the requirements (Leffingwell and Widrig, 2003). Requirements that are more important to a stakeholder are given more points. Requirements are then prioritised based on the total points allocated to them. 100-point test incorporates the concept of constraint in the stakeholder's prioritisation by giving each of them a limited number of points. One criticism of this approach is that this type of priority scheme can be easily manipulated by stakeholders seeking to accomplish their own objectives (Mead, 2006, Duan et al., 2009). For example, stakeholders may distribute their points based on how they think others will do it (Regnell et al., 2001). In addition, it is difficult for stakeholders to keep an overview of a large number of requirements (Berander and Jonsson, 2006).

Many existing prioritisation methods consider requirements to have a flat structure and be independent of one another (Herrmann and Daneva, 2008). However, requirements are often defined at different levels of abstraction (Dardenne et al., 1993, Van Lamsweerde, 2009). A high-level requirement can be refined into several specific requirements, and a specific requirement can be generalised into a higher-level requirement (Dardenne et al., 1993). Figure 2-10 illustrates a two-level hierarchy of requirements with high-level requirements (HLR) and low-level requirements (LLR).

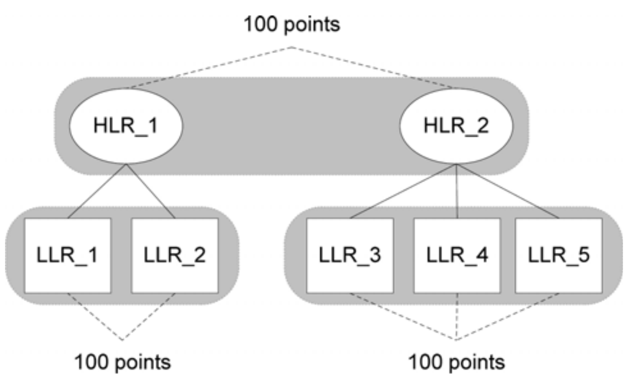


Figure 2-10: A hierarchy of requirements (Berander and Jonsson, 2006).

Hierarchical cumulative voting (HCV) proposed by Berander and Jönsson (2006) enables prioritisations to be performed at different levels of a hierarchy. Stakeholders perform prioritisation using 100-point test within each prioritisation block (grey area in Figure 2-10). The intermediate priorities for the requirements are calculated based on the characteristics of the requirements hierarchy. Final priorities are calculated for all requirements at the level of interest through normalisation. If several stakeholders have prioritised the requirements, their individual results are then weighted and combined. When doing so, different stakeholders may have different weights. Although the hierarchical prioritisation in HCV makes it easier for the stakeholders to keep an overview of all the requirements, the prioritisations need to be interpreted in a rational way as stakeholders can easily play around with the numbers (Berander and Jonsson, 2006).

Another method that involves multiple stakeholders is the value, cost, and risk method proposed by Wiegers (1999). In Wiegers' method, the customer representatives estimate the *value* of each requirement, which is the relative benefit each requirement provides to them and the relative penalty they suffer if the requirement is not included. The project team estimates the relative *cost* of implementing each requirement and the relative degree of *risk* associated with each requirement. The priority of each requirement is calculated from its value, cost, and risk such that requirements at the top of the list have the most favourable balance of the three elements. This method can be effectively applied to prioritise negotiable requirements. Nevertheless, it is limited by the individual's ability to determine the value, cost, and risk for each requirement (Wiegers, 1999).

In the requirements triage method, Davis (2003) proposed that stakeholders should be gathered in one location and group voting mechanisms used to prioritise requirements. One method to collect group vote is to use the show of fingers to indicate the stakeholders' enthusiasm for a requirement. For example, one finger up means the requirement should be included, two fingers up means the requirement is essential, and one finger down means the requirement should be excluded. Similar to Wiegers' approach (1999) and the 100-point test by Leffingwell and Widrig (2003), the relative priorities of requirements depend on the stakeholders who attended the prioritisation meeting, and dominant participants may influence the prioritisation (Duan et al., 2009).

In the win-win approach proposed by Boehm, stakeholders negotiate to resolve disagreements about candidate requirements (Boehm and Ross, 1989, Park et al., 1999). Using the win-win approach, each stakeholder ranks the requirements privately before negotiations start. They also consider the requirements they are willing to give up on. Stakeholders then work collaboratively to forge an agreement through identifying conflicts and negotiating a solution. Win-win negotiations encourage stakeholders to focus on their interest rather than positions, negotiate towards achieving mutual gain, and use objective criteria to prioritise requirements. Nevertheless, the win-win approach is labour intensive, particularly in projects with a large number of stakeholders or requirements (Mead, 2006).

The requirements prioritisation framework proposed by Moisiadis incorporates various aspects of requirements prioritisation from existing literature (Moisiadis, 2000, Moisiadis, 2002). The framework balances the various viewpoints and goals of the stakeholders, determines the value of each stakeholder's subjective opinion, and aligns the requirements to the business objectives of the systems development project. Although the framework is comprehensive and provides quantitative and qualitative requirements ratings, it is suitable for small to medium sized projects but is less feasible for large projects (Duan et al., 2009).

Other requirements prioritisation methods include multi-attribute utility theory (Keeney and Raiffa, 1993), top 10 requirements (Lauesen, 2002), outranking (Roy, 1996), minimal spanning tree (Karlsson et al., 1998), cost benefit analysis (Nas, 1996), and Quality Function Deployment (Akao, 2004). Many of these methods have similar shortcomings: significant effort is required when there are many requirements and the requirements' priorities are easy to manipulate (Regnell et al., 2001). For example, according to Moisiadis (2002), the Quality Function Deployment suggests the limit of 30 requirements. Minimal spanning tree requires much fewer comparisons between pairs of requirements but is more sensitive to judgemental errors (Karlsson et al., 1998). Cost benefit analysis relies on the type of costs included in the analysis by the decision-makers which may be biased due to their vested interest (Nas, 1996).

One of the few methods that can scale to a large number of requirements is the binary search tree (BST) (Ahl, 2005). In BST, a requirement from the set of requirements is selected as the root node. Then, a binary tree is constructed by inserting less important requirements to the left and more important ones to the right of the tree. A prioritised list of requirements is generated by traversing the BST in order. The output is a prioritised list of requirements with the most important requirements at the start of the list, and the least important ones at the end. This method is simple to implement but provides only a simple ranking of requirements as no priority values are assigned to the requirements (Duan et al., 2009).

For projects with many requirements, Laurent et al. (2007) and Duan et al. (2009) propose Pirogov, which uses data mining and machine learning techniques to support requirements prioritisation. Pirogov uses various clustering techniques to organise requirements into different categories (Figure 2-11). The requirements engineers then prioritise the clusters and determine the importance of each clustering technique. Using the information, Pirogov generates a list of prioritised requirements. By automatically clustering the requirements into different categories, Pirogov reduces the number of manual prioritisations required from the requirements engineers. The results of prioritisation depend on the requirements engineers' subjective prioritisation of the clusters and the clustering techniques.

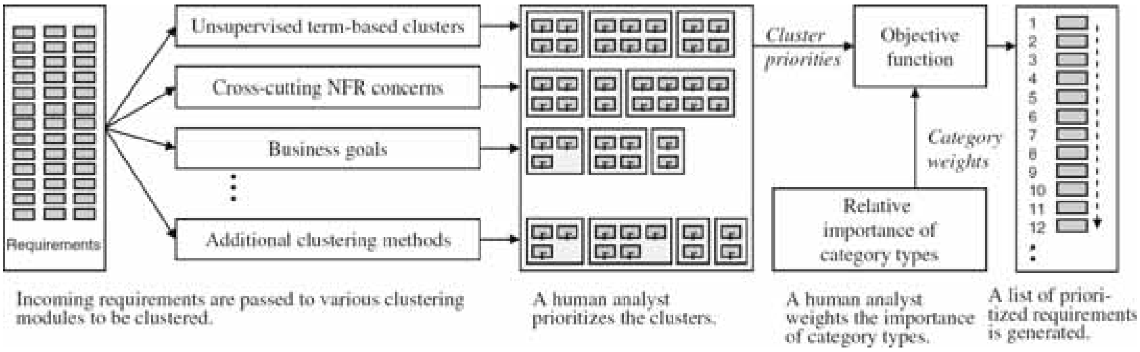


Figure 2-11: Pirogov (Laurent et al., 2007) (reproduced with permission).

In addition to having many requirements, large projects are also likely to have stakeholders in many different locations (Damian and Zowghi, 2003, Jones, 2008, Castro-Herrera et al., 2009a). To elicit requirements in these projects, many organisations are adopting online tools, such as wikis and forums, to capture the stakeholders' initial needs (Decker et al., 2007).

To facilitate online forum discussions, Castro-Herrera et al. proposed a method called Organiser and Promoter of Collaborative Ideas (OPCI) (Castro-Herrera et al., 2009a, Castro-Herrera et al., 2009b). OPCI uses clustering to automatically group the stakeholder's ideas to form an initial set of discussion forums (Figure 2-12). It then constructs a stakeholder profile for each stakeholder, and feeds these profiles to a collaborative filtering recommender system. The system returns stakeholders with similar interests, and this output is used by OPCI to suggest additional forums that might be of interest to the stakeholders. By recommending suitable forums to stakeholders, OPCI aims to encourage stakeholders to contribute to relevant forums and increase the quality of the elicited requirements.

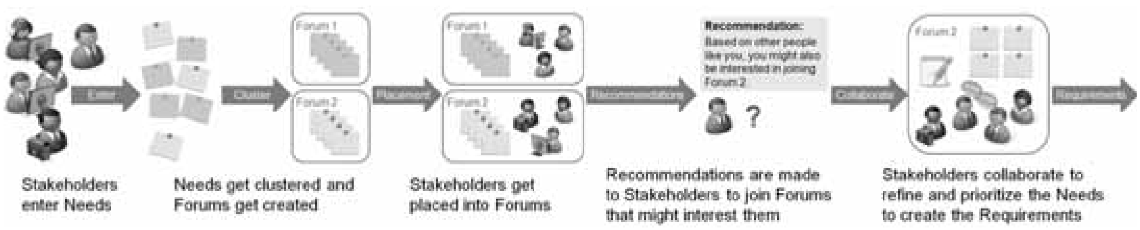


Figure 2-12: Organiser and Promoter of Collaborative Ideas (OPCI) (Castro-Herrera et al., 2009a) (reproduced with permission).

OPCI uses collaborative filtering to support early requirements identification by recommending forums of interest to stakeholders. It has inspired the work in this thesis to use collaborative filtering to support large-scale requirements elicitation by recommending requirements of interest to stakeholders. Recommending relevant requirements to stakeholders can reduce the number of requirements each stakeholder has to prioritise, while still ensuring they are aware of the requirements they may be interested in.

To summarise, existing requirements elicitation techniques do not scale to large projects with many stakeholders as they require direct interaction with the stakeholders. While OPCI and Pirogov are significant steps towards large-scale requirements elicitation, many existing requirements prioritisation methods require substantial efforts from the requirements engineers when there are many requirements. Furthermore, the priorities can be manipulated easily, and is likely to be biased towards the individuals doing the prioritisation.

2.3 Large-Scale Software Projects

As described in Chapter 1, this thesis focuses on requirements elicitation for large-scale software projects. However, there are a number of reasons and methods to size a project, leading to different views on what constitutes large-scale.

The earliest measure of project size is lines of code (LOC), which counts the number of non-blank, non-comment lines in the text of a software program’s source code (Fagan, 1976, Jeffery and Lawrence, 1979, Albrecht and Gaffney Jr, 1983, McConnell, 1996, McConnell, 2004). The calculation of LOC is straightforward, but it also has some drawbacks. For example, it is influenced by software design, programming style and language, and does not take into account auto-generated code, nor the functionality or complexity of the software (Jones, 2008).

Another popular measure is function points (FP) (Albrecht, 1979, Low and Jeffery, 1990, Jones, 1995, Kemerer, 1993, Galin, 2004, Jones, 2008). In FP analysis, size is determined by identifying the components of the system as seen by the end-user, such as the inputs, outputs, interfaces to other systems, and logical internal files. The components are classified as simple, average, or complex. All of these values are then scored and summed as crude function points (Figure 2-13). Complexity factors described by general systems characteristics, such as reusability, performance, and complexity of processing can be used to weight the crude function points. The output is a number that correlates to system size. Although FP does not correspond to an actual physical attribute of a software system such as the number of source code statements, it is a more accurate measure of program size compared to LOC (McConnell, 1996). Nevertheless, unlike LOC, FP requires manual calculation. In addition, the results in FP are subjective and accurate calculations require experience (Low and Jeffery, 1990, Kemerer, 1993).

Software system components	Complexity level									Total CFP
	Simple			Average			Complex			
	Count	Weight Factor	Points	Count	Weight Factor	Points	Count	Weight Factor	Points	
	A	B	C= AxB	D	E	F= DxE	G	H	I= GxH	
User inputs		3			4			6		
User outputs		4			5			7		
User online queries		3			4			6		
Logical files		7			10			15		
External interfaces		5			7			10		
Total CFP										

Figure 2-13: Crude function points (CFP) calculation form (Galin, 2004) (reproduced with permission © Pearson Education Limited).

Lines of code and function points have been used to indicate the relative size of projects (Table 2-3). For example, Jones defined a small project as having less than 2,000 LOC or less than 100 FP (Jones, 1995, Jones, 1998). Using the number of developers as a measure, Fischer and Gall (2004) classified Mozilla[7], which was maintained by 50 module owners, as a large software project. Rakos defined small projects to consist of 2-3 developers[8]. The numbers to indicate size are not absolute and may vary across different work. For example, McConnell (1996) considered small projects to have 2,500 LOC, but Kruchten (1995) considered them to have 10,000 LOC. McConnell (2004) considered projects with 500,000 LOC as very large, but Kruchten (1995) considered projects with 700,000 LOC as large.

Table 2-3: Project Size and Measures[9]

Project Size	Measure		
	Lines of Code	Function Points	Number of Developers
Small	< 2,000^	< 100*	< 5†
Large	> 500,000*•‡	> 5,000*	> 50‡∩
Ultra-large	1,000,000,000~	> 100,000▲	> 1,000⊥

[7] http://www.mozilla.org/

[8] Personal communication with the author

[9] Source: (Jones, 1995)*, (Jones, 1998)^, (Rakos, 1990)†, (McConnell, 1996)‡, (McConnell, 2004)•, (Fischer and Gall, 2004)∩, (Northrop et al., 2006)~, (Sauer et al., 2007)⊥, (Jones, 2008)▲

Other measures for project size include man-hour, budget, and duration (Brooks Jr, 1995, McConnell, 1996, Sauer et al., 2007). Man-hour is the amount of work performed by an average worker for an hour (Brooks Jr, 1995). Budget is the sum of money allocated to the project (McConnell, 1996, Sauer et al., 2007). Duration can be measured in terms of the number of months spent on the project (Sauer et al., 2007). These measures are more suitable for development (McConnell, 1996, McConnell, 2004) and less so for elicitation. Burstin and Ben-Bassat (1984) gave an example that a program that solves a complicated set of differential equations may be very large in terms of LOC or take a long time to implement, but may only have a small number of stakeholders. Although the project may be considered as large in terms of development effort, it is small in terms of elicitation effort.

In requirements elicitation, the number of stakeholders is used to size a project. From the requirements engineering perspective, a large software system is defined as "a software system that has a large and diversified community of users, and entails a variety of human, organisational, and automated activities, and various, sometimes conflicting, aspects of different parts of its environment" (Burstin and Ben-Bassat, 1984, page 133). According to Northrop et al. (2006), and Cheng and Atlee (2007), it is the human interaction element that makes requirements elicitation the most difficult activity to scale in software engineering. Large, complex projects have multiple stakeholder groups that cut across many different agencies, divisions, and even organisations (Cross, 2005). It is the complex interactions among these stakeholders that often cause difficulties in projects (Greenwood et al., 2010).

Using the number of stakeholders to indicate size, Cleland-Huang and Mobasher (2008) define ultra-large-scale projects to have thousands or even hundreds of thousands of stakeholders. The FBI Virtual Case File project, which is widely cited as large-scale (Schaefer, 2006, Laurent et al., 2007, Schaefer, 2008, Cleland-Huang and Mobasher, 2008, Duan et al., 2009) has 12,400 users – agents who will use the software. The project has more than 50 stakeholder groups, as the FBI consists of 23 divisions which previously had their own IT budget and systems, and the agents work out of 56 field offices (Goldstein, 2005).

For this thesis, a large-scale software project is thus defined as a software project with a large and diverse community of stakeholders with different needs. Based on the FBI Virtual Case File project, the numerical indication of large-scale is a project with more than 50 stakeholder groups and 10,000 users, where users are members of the stakeholder groups. Using this definition, projects with many similar users but few stakeholder groups are not large scale. For example, iStethoscope[10], a successful iPhone application that turns an Apple iPhone into a

---

[10] http://www.independent.co.uk/life-style/gadgets-and-tech/news/59p-stethoscope-on-iphone-proves-a-hit-1839885.html

stethoscope, has more than a million users but is not large-scale as it has less than five stakeholders[11]. Based on this definition, the case study used in this thesis, the RALIC project, is a large-scale software project, as it has more than 60 stakeholder groups and approximately 30,000 users.

2.4 Summary

In this chapter, the literature relevant to stakeholder analysis and requirement elicitation has been described and analysed. The key points are highlighted below.

- Existing methods in stakeholder analysis identify and prioritise stakeholder roles from an individual's perspective, which may be biased in large projects where no individual has the global perspective. These methods are likely to either omit stakeholder roles or return "non-stakeholders" and do not distinguish suitable stakeholders to be involved in requirements elicitation.
- Existing methods to identify and prioritise requirements do not scale to projects with many stakeholders and requirements. Most elicitation methods require face-to-face meetings with the stakeholders, hence is time consuming. Requirements prioritisation from an individual's perspective is likely to be biased, especially in large projects where no individual has the global perspective.
- In requirements elicitation, the number of stakeholder groups is an appropriate measure to size a project. In this thesis, a large-scale software project is defined as a software project with more than 50 stakeholder groups and 10,000 users, where users are members of the stakeholder groups. These stakeholders have differing and sometimes conflicting requirements.

An ideal method in requirements elicitation should identify and prioritise stakeholders and their requirements from a global perspective. It should be independent of the individual doing the analysis, and scalable to large projects. In doing so, it should not overload stakeholders with information or burden the requirements engineers.

The primary aim of this work, described in later chapters, is to develop such a method. The method builds on the existing literature, which suggested effective ways towards stakeholder analysis and requirements elicitation as follows.

---

[11] Personal communication with the developer

- The search method by Sharp et al. (1999), which produced a network of stakeholders, inspired the work in the thesis to use social networks to represent the relationships among stakeholders, and social network algorithms to calculate the priority of stakeholders.
- The survey method in requirements elicitation scales to large projects as they do not require direct interaction with the stakeholders (Preece et al., 1994, Nuseibeh and Easterbrook, 2000).
- In requirements prioritisation, multiple stakeholders should be involved in prioritisation to reduce bias (Cleland-Huang and Mobasher, 2008). Different stakeholders should be given different weights, based on their influence in the project.
- The OPCI method by Castro-Herrera et al. (2009a) inspired the work in this thesis to use collaborative filtering to support requirements prioritisation.

This chapter has focused on the literature review for *stakeholder analysis and requirements elicitation*. Chapter 5 will review the literature in *social networks* to inform the development of the StakeNet method proposed in this work, and Chapter 6 will review the literature in *collaborative filtering* to inform the development of the StakeRare method proposed in this work. Chapter 7 will review the literature on *existing tool support for stakeholder analysis* to inform the development of the StakeSource tool.

The next chapter will describe the research methodology used in this work.

Chapter 3

Research Methodology

This chapter describes the case study methodology used in this work, and the methodology used to develop and evaluate StakeNet, StakeRare, and StakeSource.

The literature review in the previous chapter highlighted the need for methods to identify and prioritise stakeholders and their requirements in large-scale software projects. This work aims to address the need. The hypothesis of this work, stated in Chapter 1, is that social networks and collaborative filtering provide effective support for requirements elicitation in large-scale software projects.

In order to provide evidence to support the hypothesis, it is necessary to show that a method that uses social networks and collaborative filtering can be used to elicit requirements in large-scale software projects. It is also necessary to show that this method produces a highly complete and accurately prioritised list of stakeholders and requirements, and requires less time and effort from the requirements engineers and stakeholders, as compared to the existing methods.

This work uses the case study methodology (Yin, 2008) to provide evidence to support the hypothesis (Figure 3-1). A method that uses social networks to identify and prioritise stakeholders is developed, and then a method that uses social networks and collaborative filtering to identify and prioritise the stakeholders' requirements is developed. The proposed methods are evaluated using a real large-scale software project. The resulting lists of prioritised stakeholders and requirements are empirically evaluated by comparing with the ground truth – the actual complete and prioritised lists of stakeholders and their requirements. The stakeholders are interviewed and surveyed on their effort and time spent using the proposed methods. The proposed methods are also compared to the existing methods used in the software project in terms of quality of the lists of stakeholders and requirements, and the time spent using the methods.

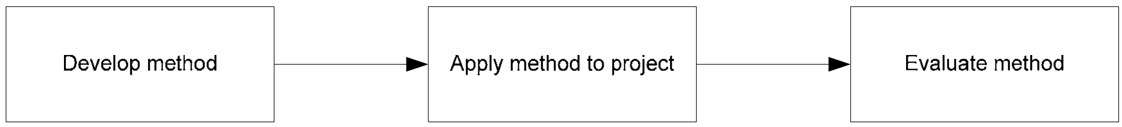


Figure 3-1: Case study research (Yin, 2008).

Developing and evaluating the methods incrementally increases the manageability of this work. Hence, the methodology in this work is divided into four parts:

1. select a software project and study the project from its initiation until after the system is deployed to identify the existing method and ground truth lists of stakeholders and requirements,
2. develop StakeNet, a method that uses social networks to identify and prioritise stakeholders, apply StakeNet to the project, and empirically evaluate the level of effective support provided by StakeNet,
3. develop StakeRare, a method that uses collaborative filtering to identify and prioritise requirements from the prioritised list of stakeholders provided by StakeNet, apply StakeRare to the project, and empirically evaluate the level of effective support provided by StakeRare, and
4. develop StakeSource, a software tool that supports the StakeNet method, apply StakeSource to real projects by having practitioners use it in their projects, and based on their feedback evaluate how well StakeSource improves the level of effective support. The purpose of StakeSource is to further improve the ability of StakeNet and StakeRare to provide effective support. StakeSource is used by practitioners in new projects beyond this evaluation, which provides further evidence to support the hypothesis.

The rest of this chapter details each part of the methodology (Figure 3-2) and explains its significance.

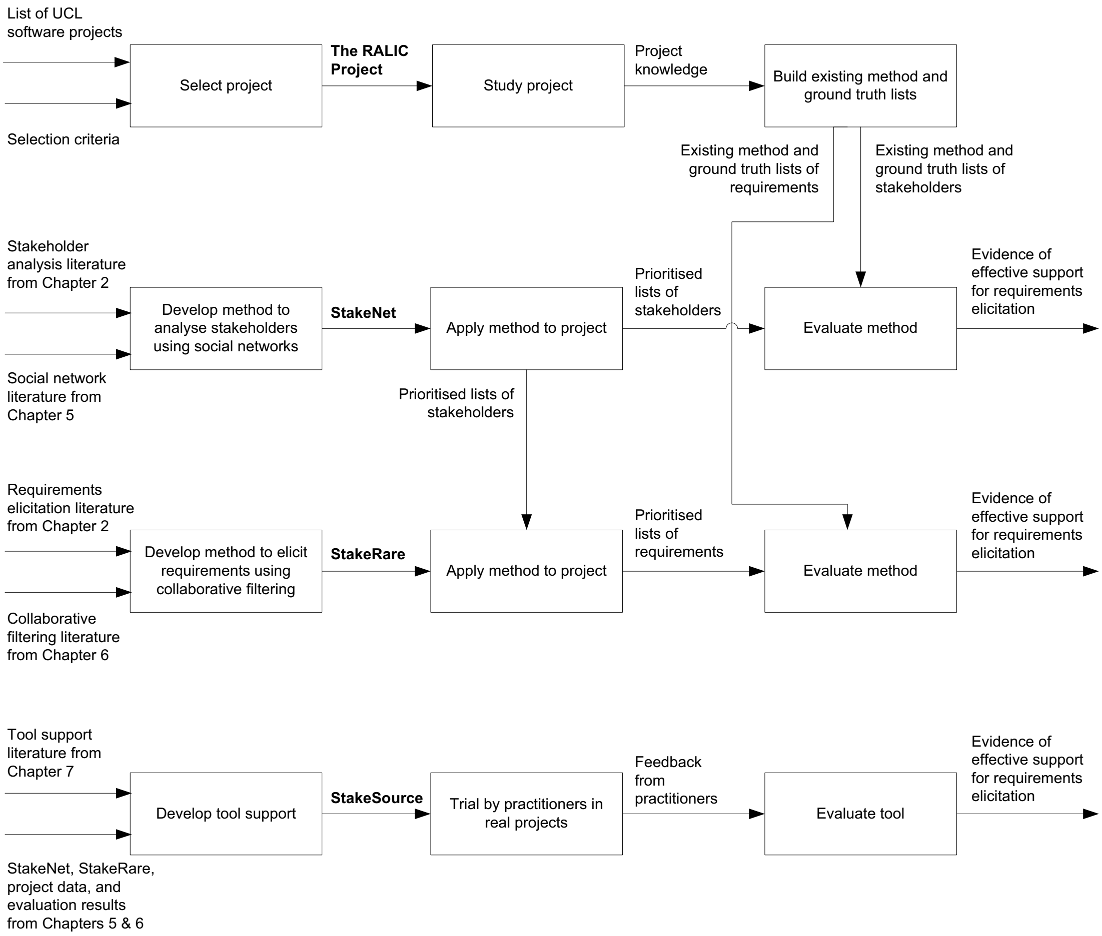


Figure 3-2: Research methodology.

3.1 The RALIC Project

Select Project

The case study project was selected from a list of software projects in University College London (UCL) provided by the Management Systems team within the Information Services Division at UCL (Table 3-1). Management Systems is responsible for the development, installation, maintenance, and support of UCL corporate information systems, such as financial information, human resources, payroll and admissions, and student information[12]. The work began with this subset of projects as the project documentation was accessible for this research and the stakeholders were more likely to be available for interviews compared to external projects. A single project was studied as detailed studies of large projects can be lengthy and

---

[12] http://www.ucl.ac.uk/isd/community/about_isd/management-systems

time-consuming. For example, in this work, approximately 200 face-to-face interviews were conducted with the project stakeholders, and the time for the interviews ranged from 30 minutes to 3 hours.

Table 3-1: List of UCL Software Projects

Project	Description
Advance	The development and population of the UCL Alumni Database which holds information about UCL alumni.
Adverts	The development of a system that provides information on UCL advertisements including the text, where the advertisement was placed, associated costs, and where the costs were charged.
CMIS/Timetabling	The procurement and integration of an off-the-shelf timetabling and room booking system. The system is used by staff involved in central and departmental room booking, and in the creation of departmental timetables.
Common Timetable	The development of a web-based front-end for UCL's departmental timetable to be accessed by UCL staff and students.
Departmental Admissions System (DAS)	DAS displays, stores, and produces statistics on postgraduate admissions information, and enable administrators to communicate with applicants.
Disability Office	The project provided a new IT system to support the Student Disability Services office.
Electronic Document & Records Management Project (EDRM)	The delivery of a software system to enable the capture, storage, and processing of documents and records in electronic format.
Email lists	The mailing lists system for UCL.
Experts System project (UEG)	The project created an online searchable database of UCL academics interested to engage with the media.
Facility Administration and Maintenance Information System (FAMIS)	The procurement and integration of a suite of off-the-shelf software systems for the management of space, capital projects, assets, maintenance, and operations in UCL.

Project	Description
Financial Information Systems (FIS)	The procurement and integration of an off-the-shelf financial system to support the management of purchase orders, general ledger, accounts payable and receivable, assets, grants, and inventory.
Graduate School	The graduate school system that interfaces with Portico, the off-the-shelf student and course management system.
HR	The procurement of a system to manage employee data such as personal histories, skills, salary, start and end date.
Info Office (HR)	The procurement and development of a system that produces human resource information such as statistical data, workforce profile information, and staffing information for management decision making.
Intranet Access	The maintenance of intranet access throughout UCL.
IS	The maintenance of UCL's central IT facilities, cluster rooms and network, together with a wide range of IT support activities.
KeySkills	The development of an online system that enables students to record their study, extra-curricular activities and employment experiences, and enables tutors to access those records. It also provides access to information about skills training courses and opportunities for extra-curricular activities within UCL.
LDAP	The development of a UCL directory service that provides the contact information of UCL staff.
Library e-Resources	The development of a system that provides UCL library members with access to e-journals, databases, and e-books.
Library Membership	The development of a system that manages the memberships for UCL libraries.
Medical School	The development of a student management system in the Medical School that interfaces with Portico, the off-the-shelf student and course management system.
Moodle	The migration of the UCL e-learning software from WebCT to Moodle (an open source e-learning software platform that enables educators to create online and interactive courses).

Project	Description
OnCite	The development or procurement of an online publications system that enables academics, faculty, and departmental administrators to manage publications.
Pensions (HR)	The procurement of the HR system to manage staff pensions.
pFACT	The procurement of, pFACT, a project financial appraisal and costing tool.
Portico/SITS	The procurement and integration of an off-the-shelf student and course management system.
Psychology	The development of a student management system in the Psychology Department that interfaces with Portico, the off-the-shelf student and course management system.
Records Office System (ROS)	ROS enables departments to request storage for and retrieval of archived materials.
Replacement Access, Library and ID Card (RALIC)	The project combined different UCL access control mechanisms into one, such as access to library and fitness centre, eliminating the need for a separate library registration process for UCL ID card holders.
Resource Management and Scheduling (RMS)	The project enabled the management of room reports, online timetables, and audio visual equipment.
Roles	This system enables the automated creation of user access privileges based on a business-level description of the user's role, such as staff or undergraduate students. All users who share the same role are managed together.
Salary Cost Analysis	The cost analysis tool enables administrators and heads of departments to modify or grant additional authorised access to the cost analysis reports for staff within their own departments.
Service in Partnership (SiP)	The system manages appointments, one-off payments, and leaver's notification.
Services Systems	The system enables departmental administrators and other departmental staff to request and revoke access to UCL services for members of their department including staff, visitors and, where appropriate, students.
SITS Fees Matrix	The development of a system that manages student fee information.

Project	Description
SITS Funding Management	The development of a system for more efficient processing of student funding.
Student Accounting Management (SAM)	The project provided a consolidated single student account for the major sources of student debt at UCL.
Student Residences System (SARS)	The development or procurement of a system that manages student residence data, such as applications, offers, and durations.
Study Link (SITS Admissions)	The development or procurement of a system that manages student applications and registrations. The system also links to the student admissions systems in other universities.
Tiger	Tiger is a call management system which holds the UCL directory database used by switchboard operators and is the basis for the UCL website telephone directory. The system also logs all calls made on the UCL telephone network to generate monthly telephone bills which are sent to departments.
UCL Person Identifier (UPI)	The project enables UCL systems with separate databases to communicate. Each UCL person is assigned a unique UPI which stays with them for the duration of their association with UCL. UPI also provides details of a person's entitlement to UCL services based on status and departmental associations.

To select the suitable project, this work used the information-oriented selection method in the case study methodology, where cases are selected on the basis of expectations about their information content (Figure 3-3). Within this selection method, the critical case selection method was used where a case that has strategic importance in relation to the general problem was selected. This selection enables the generalisation of the results to other large-scale projects (Flyvbjerg, 2006), i.e., if social networks and collaborative filtering provide effective support for requirements elicitation in this project, then they are likely to provide effective support for other projects that have similar characteristics to this project.

Type of Selection	Purpose
A. Random selection	To avoid systematic biases in the sample. The sample's size is decisive for generalization.
1. Random sample	To achieve a representative sample that allows for generalization for the entire population.
2. Stratified sample	To generalize for specially selected subgroups within the population.
B. Information-oriented selection	To maximize the utility of information from small samples and single cases. Cases are selected on the basis of expectations about their information content.
1. Extreme/deviant cases	To obtain information on unusual cases, which can be especially problematic or especially good in a more closely defined sense.
2. Maximum variation cases	To obtain information about the significance of various circumstances for case process and outcome (e.g., three to four cases that are very different on one dimension: size, form of organization, location, budget).
3. Critical cases	To achieve information that permits logical deductions of the type, "If this is (not) valid for this case, then it applies to all (no) cases."
4. Paradigmatic cases	To develop a metaphor or establish a school for the domain that the case concerns.

Figure 3-3: Case study research: Strategies for the selection of samples and cases (Flyvbjerg, 2006) (reproduced with permission).

The following selection criteria were used to select a suitable project from the list of UCL projects in Table 3-1.

- **Large-scale**. The project must be large-scale following the definition provided in the previous chapter. According to the definition, the project should have more than 50 stakeholder groups and 10,000 users, where users are members of the stakeholder groups, and the stakeholders have differing and sometimes conflicting requirements.
- **Well-documented**. The project has to be very well documented and the project documentation should be available to build the ground truth and existing method lists.
- **Available stakeholders**. The majority of stakeholders should be available for interviews. For stakeholders who are unavailable, other staff members should be available to take their roles.
- **Completed and deployed**. The project should be completed and the system should be deployed. Ideally, for the least biased evaluation, the proposed methods should be applied to a project when it was initiated and evaluated after the system is deployed, so that post-project knowledge does not influence the results. But it is impractical to do so because big projects often take longer than the three-year duration allocated for the

thesis[13]. Also, studies suggested that software projects are more likely to fail than complete successfully (The Standish Group, 1994, The Standish Group, 2009), hence applying the method to a project that has just started is risky because the project may fail before the ground truth can be built. To enable the evaluation of the hypothesis in a feasible timeframe, the timing criteria can thus be stated as follows.

- The project must be recent enough so that it is still relevant to the stakeholders and their environment. This also reduces the number of stakeholders who have already left their position at the time of study due to staff turnover. For example, projects completed more than ten years ago will no longer have stakeholders that identify with it and very few stakeholders will be available for interviews.
- The system must be deployed for more than a year to allow sufficient time for missing stakeholders and requirements to surface. Requirements elicitation and analysis activities at the start of the project often produce a "complete enough" set of requirements (Nuseibeh and Easterbrook, 2000). Stakeholders and requirements that are omitted during requirements phase are uncovered in later phases, such as design, development, and deployment. For example, one study described a project where all the change requests received during the first year the software was deployed were from stakeholder needs that were overlooked during the project (Cockburn, 2000).

To evaluate the list of projects in Table 3-1 based on the selection criteria, interviews were conducted with the directors and project managers to understand the projects. The evaluation revealed that most of the projects were not large-scale. For example, LDAP, the UCL directory project, involves only a small set of stakeholders with similar requirements, such as UCL staff whose information is found in the directory, and directory users. The large-scale criterion narrowed down the list to four high-profile large-scale projects in UCL: Common Timetable, KeySkills, RALIC, and UPI. The remaining criteria were then used to evaluate the four projects (Table 3-2).

RALIC was selected because it satisfied all four criteria (Table 3-2).

- **Large-scale**. RALIC had a complex stakeholder base with more than 60 stakeholder groups and 30,000 users. These stakeholders have different and sometimes conflicting requirements.

---

[13] A study of 214 software projects in Europe found the average project duration to be over 2 years (McManus and Wood-Harper, 2007). The study investigated projects of all sizes, and the duration for large-scale projects is likely to be above the average.

- **Well-documented**. RALIC was meticulously documented. In addition, the meeting minutes, project highlight reports, and post implementation report were documented by an external project support team to increase their objectiveness.
- **Available stakeholders**. Most of the stakeholders were available for interviews.
- **Completed and deployed**. The project has completed, and the system has been deployed in UCL since 2007, two years before this work commenced.

Although the stakeholders for the KeySkills project were equally available for interviews (more than 10 interviews were conducted with KeySkills stakeholders), the project was less suitable because it had just started. Common Timetable and UPI had insufficient project documentation to study change and build the ground truth.

The permission to use RALIC as a case study for this work was sought from the Director of Information Services Division, the Director of Management Systems, and the project manager for RALIC.

Study Selected Project

This stage involves interviewing project stakeholders and studying the RALIC documentation to provide the project knowledge required for building the ground truth and existing method lists in the next stage. The details are provided in Chapter 4.

The types of documentation available for RALIC include the project initiation document, business process analysis report, functional specification, business rules document, technical specification, version control export, project team meeting minutes, project board meeting minutes, workplans, risk log and issue log, project highlight reports, and post implementation report. Details of the documentation can be found in Chapter 4.

The documentation provided detailed information for the study of requirements change from the start of the project until after the system was deployed. To do that, a method to classify requirements was developed and used to classify the initial RALIC requirements signed off by the project board. The method and classification are described in Chapter 4. Then, all project documentation related to requirements, such as specifications, workplans, team and board meeting minutes, were studied for subsequent requirements changes. Care was taken not to consider the same changes more than once. Repeated documentation of the same changes may occur because changes discussed in team meetings can be subsequently reported in board meetings, reflected in functional specification, cascaded into technical specification and finally into workplans. Interviews were also conducted with the project team to understand the project context, clarify uncertainties or ambiguities in the documentation, and verify the findings.

Table 3-2: Project evaluation based on selection criteria[14]

Project	Description	Selection Criteria			
		Large-scale	**Well-documented**	**Available Stakeholders**	**Completed & Deployed**
Common Timetable	The development of a web-based front-end for UCL's departmental timetable to be accessed by UCL staff and students.	●	○	●	●
KeySkills	The development of an online system that enables students to record their study, extra-curricular activities and employment experiences, and enables tutors to access those records. It also provides access to information about skills training courses and opportunities for extra-curricular activities within UCL.	●	●	●	○
RALIC	The project combined different UCL access control mechanisms into one, such as access to library and fitness centre, eliminating the need for a separate library registration process for UCL ID card holders.	●	●	●	●
UPI	The project enables UCL systems with separate databases to communicate. Each UCL person is assigned a unique UPI which stays with them for the duration of their association with UCL. UPI also provides details of a person's entitlement to UCL services based on status and departmental associations.	●	○	●	●

[14] "○" means the criterion is not met and "●" means the criterion is met.

Build Existing Method and Ground Truth Lists

The knowledge gained from the study of requirements change was used to construct the existing method and ground truth lists of stakeholders and requirements.

The existing method list of stakeholders is the list of stakeholders produced by the project team at the start of the project using the existing methods. As RALIC was already completed, this list can be found in the project documentation. The time spent using the existing methods was derived from the number of hours the project team spent in stakeholder analysis.

The ground truth of stakeholders is the complete and prioritised list of stakeholders for the project obtained by analysing the stakeholders from the start of the project until after the system is deployed. To build the ground truth of stakeholders, the project documentation was analysed to identify RALIC stakeholders and their roles. Stakeholders were interviewed to learn about their past involvement in the project and observed on their present involvement. Each stakeholder was rated in terms of High, Medium, and Low for their involvement in the finance, management, development, and usage of the system. This rating assumed that the stakeholders' salience was reflected in their project involvement. Finally, the ratings were converted into numerical values (High = 3, Medium = 2, Low = 1) and the stakeholders were ranked by the sum of their ratings, from the highest to the lowest. The output was a prioritised list of stakeholders and their roles (Table 3-3).

Table 3-3: Example Ground Truth List of Stakeholders[15]

Stakeholder	Stakeholder Role	Priority
Alice	Director of Estates	1
Bob	Head of Security	2
Carl	Student	3

The existing method list of requirements is the requirements produced by the project team at the start of the project using existing methods. This list consists of the initial requirements signed off by the project board. The time spent using the existing methods was derived from the number of hours the project team spent in requirements elicitation until the sign-off date.

The ground truth of requirements is the complete and prioritised list of requirements for the project obtained by analysing the requirements from the start of the project until after the system is deployed. The ground truth of requirements was built using the output of the

[15] This example list of stakeholders is simplified to focus on the methodology.

requirements change study, which includes the initial requirements and subsequent changes. The resulting requirements were organised in a hierarchy starting with a list of project objectives, and within each project objective, a list of requirements, and within each requirement, a list of specific requirements. The requirements were prioritised using pairwise comparison described in the previous chapter as it is less sensitive to judgmental errors. Finally, each requirement was ranked by the number of cells in the matrix that contains the requirement, from the most to the least. The output was a prioritised list of requirements (Table 3-4).

The accuracy of the ground truth was assessed by interviewing management-level stakeholders and stakeholders who were involved in a major part of the project for feedback on its accuracy. The interviews were conducted after the StakeNet and StakeRare surveys described in the following sections. As StakeNet and StakeRare were evaluated by surveying the stakeholders, conducting the interviews after the surveys prevents the survey answers from being influenced by the interviews. The interviews took into account the stakeholders' past and present involvement in the project. Stakeholders who did not agree with the ranking had to provide justifications and their justifications were corroborated with other stakeholders' answers before the ground truth was revised. The assessment by these stakeholders increased the confidence that the ground truth is objective and accurate.

Table 3-4: Example Ground Truth List of Requirements[16]

Priority	Requirements
1	All in one card
2	Granting access rights
3	Faster card production

Significance

The study of requirements change has led to the development of a novel method to classify requirements based on their rate of change. Identifying volatile requirements from the start enables the design of the system such that architectural components that realise these volatile requirements are loosely coupled with the rest of the system (Sommerville and Sawyer, 1997).

The proposed method contributes to the area of requirements change management, an important but under-researched area in requirements engineering. According to Van Lamsweerde (2009), a well-known researcher in the field, "Surprisingly enough, the literature

[16] This example list of requirements is simplified to focus on the methodology.

on requirements evolution is inversely proportional to the importance of the subject. Many requirements engineering textbooks hardly mention the problem."

Very few methods classify requirements based on their rate of change. An exception is Harker et al.'s approach that classifies requirements into stable and changing (Harker et al., 1993). Changing requirements are further classified into mutable, emergent, consequential, adaptive, and migration (Table 3-5). Nevertheless, the proposed types of changing requirements lack consensus. For example, Sommerville felt that adaptive and migration requirements are closely related and merged them into compatibility requirements (Sommerville and Sawyer, 1997, Kotonya and Sommerville, 1998, Sommerville, 2004). In contrast, this work develops a more objective method of classification.

Table 3-5: Types of Requirements (Harker et al., 1993)

	Type of Requirement	Origins
Stable	Enduring	Technical core of the business
Changing	Mutable	Environmental turbulence
	Emergent	Stakeholder engagement in requirements elicitation
	Consequential	System use and user development
	Adaptive	Situated action and task variation
	Migration	Constraints of planned organisational development

The methodology for identifying the ground truth to evaluate the quality of elicited stakeholders and their requirements is novel. Most requirements engineering researchers evaluate their methods by reasoning about the merits of their methods on example projects (e.g., (Dardenne et al., 1993, Van Lamsweerde et al., 1995, Yu, 1997)). More rigorous evaluations involve inspecting the results produced by their methods (e.g., (Laurent et al., 2007)). In this work, the construction of a ground truth representing the ideal set of stakeholders and requirements based on post-project information is significant as it better enables an evaluation of the work in terms of how close it comes to a perfect solution, rather than simply improving on the existing methods. This methodology has been adopted from information retrieval research (van Rijsbergen, 1979), where the effectiveness of an information retrieval technique is empirically evaluated by comparing its output to the actual set of correct documents determined by human analysts.

3.2 StakeNet

Develop Method

StakeNet was the first method developed in this work to assess whether social networks and collaborative filtering provide effective support for requirements elicitation. StakeNet is detailed in Chapter 5. The method uses social networks to provide effective support for stakeholder analysis. It was developed based on the literature described in the previous chapter and the social network literature described in Chapter 5. To do so, the requirements for the method were correlated with techniques in the social network literature that can meet those requirements. These requirements, summarised from the previous chapter, are:

- The method should identify and prioritise stakeholders from a global perspective.
- The method should be independent of the individual doing the analysis.
- The method should not overload stakeholders with information or burden the requirements engineers.

To meet these requirements, the StakeNet method identifies an initial set of stakeholders and asks these stakeholders to recommend other stakeholders and stakeholder roles, builds a social network whose nodes are stakeholders and links are recommendations, and prioritise stakeholders using a variety of social network measures.

Apply Method to RALIC

StakeNet was applied to the selected software project by using a mixture of questionnaires and interviews with project stakeholders. The mixture of questionnaires and interviews is widely used in social network analysis research for data gathering (Wasserman and Faust, 1994, Scott, 2000). This work uses face-to-face surveys because elicitation involves interaction with stakeholders and StakeNet's effectiveness can be evaluated by observing the stakeholders while they complete their questionnaires. For example, in face-to-face surveys, stakeholders can provide direct feedback to the researcher if they found a question difficult, but in online surveys, the stakeholders may skip the question without providing feedback.

The stakeholders were surveyed separately to study their individual responses. The initial stakeholders were contacted by email. Each survey started with a description of the survey purpose which is to identify RALIC stakeholders, an introduction to StakeNet to familiarise the respondent with the method, the definition of stakeholder, and the possible types of stakeholders in order to prompt the respondent for recommendations. Each survey ended with an interview to ask the stakeholders for their feedback on StakeNet. The time spent by each stakeholder was recorded to compare with the time spent using the existing method. The data collected from the stakeholders were cleaned for consistency, for example, different names referring to the same person (e.g., Nic and Nicholas) are merged, and synonymous stakeholder roles (e.g., research students and PhD students) are also merged.

Evaluate Method

The prioritised lists of stakeholders produced by the various social network measures in StakeNet were compared against the ground truth and the existing method list. To add rigour to the evaluation, variations of the StakeNet method were created to produce different prioritised lists, such as different approaches to collect the survey data from stakeholders, and a combination of the social network measures. Empirical evaluation was used to provide concrete measures on the quality of the different lists. The lists were evaluated in terms of their completeness and the accuracy of prioritisation, using standard statistical measures from the information retrieval literature such as precision and recall (Herlocker et al., 2004). Precision measures the fraction of stakeholders returned by StakeNet that are actual stakeholders, and recall measures the fraction of the actual stakeholders that are successfully returned by StakeNet. The empirical results are analysed using project knowledge gained from interviewing the stakeholders and studying the project in detail.

Significance

The empirical evaluation of StakeNet is one of the first empirical studies of stakeholders in large software projects. In the existing stakeholder analysis literature, most evaluations are qualitative. For example, the Onion Model (Alexander, 2005) and the search method proposed by Sharp et al. (1999) introduced in the previous chapter were evaluated using knowledge gained from the literature and the researchers' experience using the solutions. This form of evaluation calls for further, more rigorous evaluation. For instance, Sharp et al. (1999) suggested that their search method requires further validation, either by using a fictitious case study, or even better, by applying it to a real project. Also, very few stakeholder analysis methods were evaluated using real projects. Among the methods discussed in the previous chapter, only the interview approach proposed by Pouloudi and Whitley (1997) was evaluated in the drug use management domain. Pouloudi and Whitley evaluated their method by interviewing actual stakeholders from the domain, and they gained an understanding of how their method works in practice. This work also interviews actual stakeholders.

While most methods proposed in the literature have been evaluated individually without comparing to other solutions, this work compares the proposed methods with the existing methods used in the project. In addition, while most methods in the literature have been qualitatively evaluated, this work uses empirical evaluation. The evaluation method in this work, which involves applying the proposed method to a real project, systematically comparing the proposed method with the existing methods, and producing empirical results from the study, provides one of the most convincing evidence to demonstrate the effectiveness of the proposed method (Zave, 1997).

3.3 StakeRare

Develop Method

StakeRare was the second method developed in this work to assess whether social networks and collaborative filtering provide effective support for requirements elicitation. StakeRare is detailed in Chapter 6. The first method, StakeNet, uses social networks to identify and prioritise stakeholders for such projects. To elicit requirements from these stakeholders, StakeRare asks the stakeholders to rate an initial list of requirements, recommends other relevant requirements to them using collaborative filtering, and prioritises their requirements using their ratings weighted by their project influence. The separation of the investigation into successive steps allowed StakeNet to be improved and re-evaluated if necessary, before StakeRare was developed and evaluated.

StakeRare was developed based on the literature in the previous chapter and the collaborative filtering literature described in Chapter 6. To do so, the requirements for the method were correlated with techniques in the collaborative filtering literature that can meet those requirements. These requirements, summarised from the previous chapter, are:

- The method should identify and prioritise requirements from a global perspective.
- The method should be independent of the individual doing the analysis.
- The method should not overload stakeholders with information or burden the requirements engineers.

Apply Method to RALIC

StakeRare was applied to RALIC using the same method of face-to-face survey as in StakeNet. The list of stakeholders identified by StakeNet was used as input to StakeRare. These stakeholders were contacted by email for a face-to-face survey. Face-to-face surveys were used as elicitation involves interaction with stakeholders and StakeRare's effectiveness can be evaluated by observing the stakeholders while they complete their questionnaires. The benefit of face-to-face surveys is that stakeholders can provide direct feedback to the researcher if they found that the questions do not effectively elicit their needs.

Each survey started with a description of the survey purpose which is to identify RALIC requirements, an introduction to StakeRare to familiarise the respondent with the method, the definition, and the possible types of requirements in order to prompt the respondent for input. Each survey ended with an interview to ask the stakeholders for their feedback on StakeRare. The time spent by each stakeholder was recorded to compare with the time spent using the existing method.

The data collected from the stakeholders were cleaned for consistency. For example, different descriptions of the same requirement (e.g., "all in one card" and "one card with multiple functionality") were merged. Statements containing more than one requirement were split into their respective requirements (e.g., "the card should be of a quality that lasts 5 or more years, and be easily read by our card readers" was split into "the card should be of a quality that lasts 5 or more years" and "the card should be easily read by our card readers").

Evaluate Method

The prioritised list of requirements produced by using StakeRare was compared against the ground truth and the existing method list. To add rigour to the evaluation, variations of the StakeRare method were created to produce different prioritised lists. For example, stakeholders were asked to use three different ways to provide their requirements and prioritise them. In addition, different collaborative filtering techniques were used. Empirical evaluation was used to provide concrete measures on the quality of the different lists. The lists were evaluated in terms of their completeness and the accuracy of prioritisation, using standard statistical measures from the information retrieval and collaborative filtering literature such as precision, recall, and mean absolute error (Herlocker et al., 2004). The empirical results were analysed using project knowledge gained from interviewing the stakeholders and studying the project in detail.

Significance

The evaluation of StakeRare is a substantial empirical study of requirements elicitation using a real software project. Very few requirements elicitation methods are evaluated empirically. Some exceptions are OPCI (Castro-Herrera et al., 2009a, Castro-Herrera et al., 2009b), the method to facilitate online requirements elicitation using collaborative filtering, and Pirogov (Laurent et al., 2007, Duan et al., 2009), the requirements prioritisation method using machine learning techniques, both introduced in the previous chapter. In Pirogov, Duan et al. (2009) reviewed discussion threads to come up with an answer set to compare with the prioritisation produced by their solution. The evaluation of StakeRare uses a similar method: the ground truth is constructed by interviewing stakeholders and reviewing project documentation, and then compared with the output from StakeRare. In OPCI, Castro-Herrera et al. empirically evaluated different variations of their approach, for example, they varied their approach by using different collaborative filtering techniques (Castro-Herrera et al., 2009a, Castro-Herrera et al., 2009b). StakeRare was evaluated by using different elicitation methods and different collaborative filtering techniques.

Most existing requirements elicitation methods are evaluated using exemplars. Exemplars are fictitious case studies, such as the library and lift problems (Marca and Harandi, 1987), the conference organisation system (Olle, 1982), and the meeting scheduler (Van Lamsweerde et al., 1995, Feather et al., 1997). Seminal work in requirements engineering, such as KAOS and i* (Dardenne et al., 1993, Yu, 1997, Van Lamsweerde et al., 1995), used exemplars as running examples to illustrate the merits of the proposed methods. Exemplars can be over-simplified to be representative of real-world requirements engineering tasks (Feather et al., 1997). To include real world problems such as multiple stakeholders from whom to elicit, and vague requirements statements, some exemplars are drawn from real life projects (Feather et al., 1997). For example, the London Ambulance System (LAS) (Finkelstein and Dowell, 1996) is widely used to evaluate requirements engineering research (Hunter and Nuseibeh, 1998, Maiden, 1998, van Lamsweerde and Letier, 2000, Letier and Van Lamsweerde, 2002, Letier and Van Lamsweerde, 2004, Alrajeh et al., 2009). Still, the use of exemplars removes direct interaction with project stakeholders, which is unrealistic in real projects.

Very few methods are evaluated using project stakeholders. Some exceptions are OPCI by Castro-Herrera et al. who evaluated their approach using simulated stakeholders consisting of the team members from their research laboratory (Castro-Herrera et al., 2009a). This work uses real project stakeholders.

3.4 StakeSource

Develop Tool Support

Although StakeNet and StakeRare provide effective support for requirements elicitation in large-scale software projects, these methods require the requirements engineers to manually collect recommendations and requirements from stakeholders. A software tool, StakeSource, was developed in this work to reduce the manual labour and increase the ability of the methods in providing effective support. StakeSource is detailed in Chapter 7. It was motivated by the tool support literature described in the same chapter, which shows that existing tools provide little support in the actual identification and prioritisation of stakeholders and their requirements; they only hold the data provided by the requirements engineers.

The evaluation results and lessons learnt from applying StakeNet and StakeRare to RALIC were used to identify key requirements for the implementation of StakeSource. For example, the StakeNet evaluation showed that closed-ended recommendations where stakeholders are provided with an existing list of stakeholder roles are easier to complete but return a less complete set of roles. Hence, a requirement for the tool was that it should be easy for stakeholders to make recommendations without compromising quality. These key requirements were used to inform the design decisions. For example, autocomplete was used rather than a drop-down list to enable stakeholders to make recommendations easily while not constraining their answers.

Using StakeSource, the requirements engineers only need to create the project, enter project details, and provide initial stakeholders. The tool automatically contacts the initial and newly recommended stakeholders for recommendations, and returns the complete and prioritised list of stakeholders.

To develop StakeSource within the timing constraints of the work and still maintain its quality and reliability, well-established software components were used whenever possible.

Trial by Practitioners in Projects

StakeSource was evaluated using real projects by approaching the practitioners to trial the tool in their projects. The trials started with UCL software projects before extending to software projects in other organisations.

To encourage the adoption of StakeSource in UCL projects, seminars were given to staff members of Management Systems and Information Services Division to disseminate the StakeNet and StakeRare methods, and demonstrate the StakeSource tool. Practitioners who expressed interest in trialling StakeSource would be provided with a StakeSource account so that they could use the tool for requirements elicitation in their projects. These practitioners were provided with training and technical support throughout the trial. They were also encouraged to provide feedback such as commenting on existing features or suggesting new features. This can be done verbally during meetings, via email, or directly through the bug/suggestion link in the tool. The feedback from the trials was used to improve the tool.

To encourage the adoption of StakeSource outside UCL, free trials were made publicly available from the StakeSource website[17]. Other on-going efforts include giving seminars to the broader practitioner community, for example, the British Computer Society[18], Australian Computer Society[19], and Association for Project Management[20].

Evaluate Tool

The tool was evaluated on its effectiveness in providing support for stakeholder analysis. The practitioners who used StakeSource in their projects were interviewed for feedback on their usage of the tool. Some of the questions include:

- What is your experience in using stakeholder analysis tools?
- How useful are the list of stakeholders identified by StakeSource?
- Which StakeSource features are the most and least useful for stakeholder analysis?

Work on StakeSource continues beyond the scope of the thesis. This includes the development of the portion of StakeSource that supports the StakeRare method, further trials of StakeSource in practice, and improvement of the tool based on practitioners' feedback.

The commercialisation of StakeSource is being investigated. Proof of concept funding to test the viability of StakeSource as a commercial product was granted by UCL Business[21], University College London's commercialisation group. Discussions with companies and research laboratories in information retrieval and requirements engineering about the potential integration of StakeSource with their tools are on-going.

Significance

Many tool developers in requirements engineering research aspire for their tools to be trialled in real projects to evaluate their effectiveness in practice (e.g., Seyff et al. (2010) with their tool iRequire). In software engineering, an effective way to evaluate the utility of a tool is to

---

[17] http://www.stakesource.co.uk/

[18] http://www.bcs.org/

[19] http://www.acs.org.au/

[20] http://www.apm.org.uk/

[21] UCL Business (http://www.uclb.com/) maximises the commercial potential of new research discoveries in University College London, by offering assistance to the technology development process, from consultancy through to collaborative research, IP licensing and the creation of spinout companies and joint ventures.

measure its use in real projects. For example, Expertise Browser by Mockus and Herbsleb (2002), a tool that uses data from change management systems to locate people with desired expertise, is used in real projects with their usage captured in logs. This work adopts a similar principle of evaluating StakeSource using real projects. Empirical evaluation is beyond the scope of this work as such evaluation can be lengthy and exceeds the timing constraints on this work. For example, the empirical evaluation of Expertise Browser on real projects took approximately two years.

3.5 Summary

This work is one of the first large-scale empirical studies on methods to support requirements elicitation. The research methodology has four parts:

- select the RALIC project and study the project,
- develop StakeNet, a method that identifies and prioritises stakeholders using social networks, apply StakeNet to RALIC, and evaluate StakeNet empirically,
- develop StakeRare, a method that identifies and prioritises requirements using social networks and collaborative filtering, apply StakeRare to RALIC, and evaluate StakeRare empirically, and
- develop StakeSource, a software tool that supports stakeholder analysis, apply StakeSource to real projects, and evaluate StakeSource based on the feedback from practitioners.

The results from all three evaluations provide evidence to support the hypothesis that social networks and collaborative filtering can provide effective support for requirements elicitation in large-scale software projects.

The remaining chapters of the thesis describe how each part of the methodology was carried out. The next chapter describes the RALIC project and the construction of the existing method and ground truth lists of stakeholders and requirements. Chapter 5 describes StakeNet, Chapter 6 describes StakeRare, and Chapter 7 describes StakeSource.

Chapter 4

The RALIC Project

This chapter describes the RALIC project, the project documentation, the study of the requirements change, and the construction of the existing method and ground truth lists of stakeholders and requirements for evaluating the work in this thesis.

In this work, the hypothesis was tested by applying the proposed methods to a software project. The project was selected using the following criteria detailed in the previous chapter.

- The project should be large-scale. It should have more than 50 stakeholder groups and 10,000 users, where users are members of the stakeholder groups and the stakeholders have differing and sometimes conflicting requirements.
- The project has to be well-documented so that the project documentation can be studied to build the ground truth and existing method lists.
- The project should be completed before the work commenced.

Based on these criteria, the RALIC project was chosen among the list of University College London (UCL) projects provided in Table 3-1 in the previous chapter.

RALIC stands for the Replacement Access, Library and ID Card project. It was a software project to enhance the existing access control system at University College London (UCL)[22]. Located in the central part of London, UCL is concerned with its security. Many UCL buildings require authorised access, such as the libraries, academic departments, and computer

[22] All RALIC related information in the thesis comes from personal communication with the stakeholders and RALIC project documentation, which are confidential.

clusters. In 2005, UCL had various methods of identification and access control, such as swipe cards, contactless cards, photo ID cards, library barcode, digital security code, and metal door keys. UCL staff and students had to use different mechanisms to access different buildings, which meant they had to carry various cards with them. Furthermore, some of the security systems were already obsolete; others would cease to be operable in a few years' time.

RALIC's aim was to replace the obsolete access control systems, consolidate the various existing access control mechanisms, and at the minimal, combine the photo ID card, access card, and library card. RALIC was a combination of development and customisation of an off-the-shelf system. The project started in 2005 and its duration was 2.5 years. The system has been deployed in UCL. The project scope is summarised in Table 4-1.

Table 4-1: RALIC Project Scope

Scope Item	Description
1	Replace swipe card readers with smart card readers
2	Source and install access card printers
3	Decide on card design and categories
4	Define user groups and default access rights
5	Provide a more accurate card holder database, save resources on manual data input, and facilitate automated provision and suspension of access and library borrowing rights
6	Issue new cards to staff, students, visitors and contractors
7	Replace the Library access control system
8	Use new cards at the Bloomsbury Fitness Centre

RALIC is a large-scale software project based on the definition in Chapter 2. It had more than 60 stakeholder groups and approximately 30,000 users. Some of the stakeholder groups included students, academic staff, short course and academic visitors, administrators from academic departments, security staff, developers, managers, and front line staff from supporting divisions such as the Estates and Facilities Division that manages UCL's physical estate, Human Resource Division that manages staff information, Registry that manages student information, Information Services Division, and Library Services. RALIC has approximately 30,000 students, staff, and visitors, who use the system to enter UCL buildings, borrow library resources, use the fitness centre, and gain IT access.

RALIC had a complex stakeholder base, with different stakeholders having conflicting requirements. For example, members of the UCL Development & Corporate Communications Office preferred the ID card to have UCL branding, but the security guards preferred otherwise for security reasons in case the cards were lost. Some administrators were worried that the new system, which promised to reduce manual labour, would threaten their job. The project involved many divisions in UCL, some of which had low stake in the project but were critical to its success. In particular, the project team found it difficult to engage with the divisions that manage the interfacing systems that supply data to RALIC, such as the Student Registry that provide student data, and Human Resources that provide staff data, because they had little stake in the project. Some representatives from these departments were often absent in project meetings.

This chapter is organised as follows. Section 4.1 describes the project documentation. Section 4.2 describes how this work uses the documentation to study requirements change in RALIC. This study helps to provide the project knowledge required to build the existing method lists of stakeholders and requirements (described in Section 4.3), and the ground truth lists of stakeholders and requirements (described in Section 4.4).

4.1 Project Documentation

RALIC was managed using the PRINCE2 method (Bentley, 2002), which is the project management method used in UCL to manage its software projects. PRINCE2 stands for PRojects IN Controlled Environments, and is a process-based approach for project management widely used in the United Kingdom[23]. RALIC's processes, project documentation, and vocabulary conformed to PRINCE2 conventions. RALIC consisted of a project board and a project team. The project board consisted of stakeholder representatives from the major stakeholder groups. The project team comprised a technical manager, business analysts, and developers. The maintenance team was involved when the system was deployed.

Throughout the lifetime of the project, substantial documentation was produced (Table 4-2). The project commenced in mid-2005 with the formulation of the project board and team. The project initiation phase involved the project board and team agreeing on project objectives and scope, business case, and project milestones. The output was the *Project Initiation Document*, which contains information such as the project scope, objectives, project requirements, stakeholders, project plans, budget, initial investigation of possible off-the-shelf access control systems, and constraints on their selection. It also contained a business analysis report, which was the result of the business process analysis on the existing processes for card production and card issue, and the proposed changes and their benefits.

[23] http://www.prince-officialsite.com/home/home.asp

Table 4-2: RALIC Documents and Their Description

Documentation	Content
Project Initiation Document	Project scope, objectives, project requirements, stakeholders, project plans, budget, initial investigation of possible off-the-shelf access control systems, constraints on their selection, and business process analysis report
Functional Specification	Software requirements for the customisation of the off-the-shelf access control system and its integration with other UCL information systems
Business Rules Document	The business rules imposed by other UCL information systems on RALIC
Technical Specification	Detailed requirements and high level design
AllChange Export	Information about change management, version control, release management, and source code control in RALIC
Project Team Meeting Minutes	Minutes for fortnightly team meetings
Project Board Meeting Minutes	Minutes for monthly board meetings
Workplans	Requirements change requests after project completion
Risk Log and Issue Log	Risks and their impact, likelihood, and mitigation, issues and the progress to resolve them
Project Highlight Reports	Quarterly summary of the project progress
Post Implementation Report	A review of the project against the objectives and business case in the Project Initiation Document, feedback from representatives of major stakeholder groups, and project statistics such as key resources deployed and total cost

Software requirements for the customisation of the off-the-shelf access control system and its integration with other UCL information systems were documented in a *Functional Specification*. These information systems impose business rules on RALIC; the rules were documented in the *Business Rules Document*. Detailed requirements and high level design were documented in a *Technical Specification*. The other source of documentation during software development and maintenance were the *AllChange*[24] configuration management system used for change management, version control, release management, and source code control in the project.

---

[24] http://www.intasoft.net/allchange_configuration_management.asp

Throughout the project, the project team met every fortnight and the project board every month. Both *Board Meeting Minutes* and *Team Meeting Minutes* were documented in detail by an external project assurance. Meeting minutes were an important source of documentation for RALIC as they contained project decisions and discussions that led to the decisions (Figure 4-1). The majority of requirements change requests were raised and approved in meetings, which were then documented in the minutes. Only the minor changes were reflected directly in a document and noted in the version control of the document. Requirements change requests after project completion are detailed in *Workplans* by the maintenance team.

Item No.		Action	Target Date
3.6	Item 3.12 mtg 14/07/05 - ***Design of new combined card & scope of information to be printed on new card - to be future agreed & approved by the Project Board.*** *Action:* *Project team to set up initial meeting with P*[redacted] *Ch*[redacted] *to discuss card design.* Update 26/09/05 Final design and layout of card still to be agreed (see draft layouts in revised PID). Only senior staff and a small number of other managers (e.g. Head of Safety, etc) will have job titles printed, as staffs' job titles change frequently. A meeting with P[redacted] Ch[redacted] (Development & Corporate Communications) has been held and initial layouts agreed. The barcode may have to be printed on the back of the card as there were issues with barcode recognition by the library scanners with the barcode printed on the front (i.e. there was insufficient white space around the barcode which confused the scanners). **Round the table discussions resulted in the following further agreements;**		
	1. Forename & surname to be printed on separate lines.		
	2. Title not to be printed i.e. Dr., Prof., Mr., Mrs., Miss etc.	MRP	
	3.Remove Job title (print only for senior staff & special officers), as these change frequently	MMc	
	4. Departmental name to be printed on card.		
	5. Remove the statement "London's Global University" from back of card.	MRP	
	6. Modify "return address" details i.e. "Freepost UCL" statement and postcode only (i.e. minimal information).		
	7. Decision required from Student Union to print "Member of NUS" on back of card.		
	8. Employ "The Partners" (UCL corporate ID external consultants) to work up & propose final design (i.e. font / colours / "watermark" / logos etc).	MRP/ PC	

Figure 4-1: Excerpt of RALIC meeting minutes (Project board meeting 29 September 2005).

The project progress was monitored by the external project assurance team. The output documents were *Risk Logs*, *Issue Logs*, and *Project Highlight Reports*. Risk Logs identifies project risks, impact, likelihood, and mitigation; Issue Logs describes the issues raised during the project, and the progress to resolve the issue. Project Highlight Reports provides a quarterly summary of the project progress. The final Project Highlight Report in October 2007 marked the completion of the project. Seven months later, the project assurance team produced a *Post Implementation Report* to formally evaluate the project. The report reviewed the project against the objectives and business case in the Project Initiation Document, and included feedback from representatives of major stakeholder groups, and project statistics such as key resources deployed and total cost.

RALIC's documentation provides a rich source of data for the study of requirements change described in the following section.

4.2 Requirements Change

To gain sufficient knowledge about RALIC to build the existing method lists and ground truth lists, the requirements for RALIC were studied from when the project started in June 2005 until March 2009, two years after the system went live (Figure 4-2). As illustrated later in this section, the changes in requirements stabilised towards the end of the study period, which means that any missing requirements would have surfaced during the study period. This provides the confidence that the complete set of requirements for the ground truth can be built.

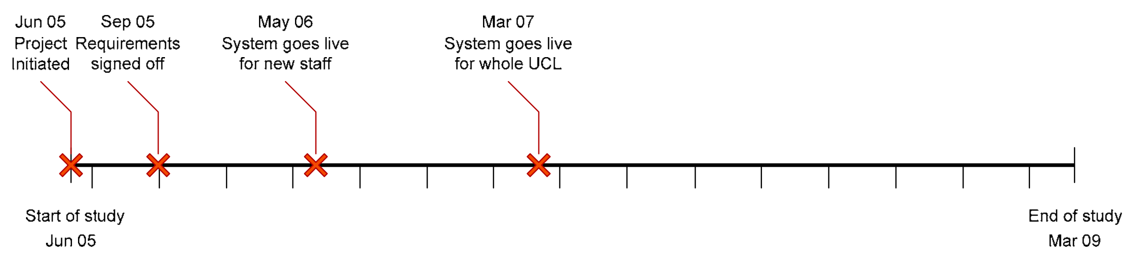


Figure 4-2: Timeline for the study of RALIC's requirements change[25].

The Shearing Layers

To study change, this work developed a method to classify requirements into layers that change at different rates[26, 27]. The idea is adopted from the concept of shearing layers from building

---

[25] The dates for the RALIC project are taken from the RALIC high level plan version 1.10.

[26] This method has been published as Soo Ling Lim, and Anthony Finkelstein. (2011) Anticipating change in requirements engineering, *Relating Software Requirements and Architectures*. Editors: Paris

architecture, created by British architect Frank Duffy who refers to buildings as composed of several layers of change[28] (Brand, 1995). The layers, from the most stable to most volatile, are site, structure, skin, services, space plan, and "stuff" or furniture (Figure 4-3). For example, services (the wiring, plumbing, and heating) evolve faster than skin (the exterior surface), which evolves faster than structure (the foundation). The concept was elaborated by Brand (1995), who observed that buildings that are more adaptable to change allow the "slippage" of layers, such that faster layers are not obstructed by slower ones. The concept is simple: designers avoid building furniture into the walls because they expect tenants to move and change furniture frequently. Designers also avoid solving a five-minute problem with a fifty-year solution, and vice versa.

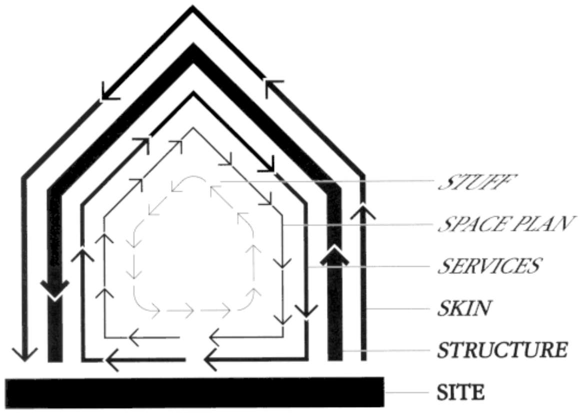


Figure 4-3: The shearing layers of architecture (Brand, 1995) (reproduced with permission).

The shearing layer concept is based on the work of ecologists (O'Neill, 1986) and systems theorists (Salthe, 1993) that some processes in nature operate in different timescales and as a result there is little or no exchange of energy or mass or information between them. The concept has already been adopted in various areas in software engineering. For example, in software architecture, Foote and Yoder (2000) and Mens and Galal (2002) factored artefacts that change at similar rates together. In human computer interaction, Papantoniou et al. (2003) proposed using the shearing layers to support evolving design. In information systems design,

---

Avgeriou, John Grundy, Jon G. Hall, Patricia Lago, and Ivan Mistrík. Springer-Verlag Computer Science Editorial (in press).

[27] The method has been used in the UCL Software Database Project (http://www.ucl.ac.uk/isd/community/projects/azlist-projects).

[28] http://www.predesign.org/shearing.html

Simmonds and Ing (2000) proposed using rate of change as the primary criterion for the separation of concerns.

Similar to the elements of a building, some requirements are more likely to change; others are more likely to remain the same over time. Hence, one way to study requirements change is to first classify requirements into layers, with a clear demarcation between parts that should change at different rates. These layers have different volatility and cause of change. From the most stable to the most volatile, the layers are: patterns, functional constraints, non-functional constraints, and business policies and rules (Figure 4-4).

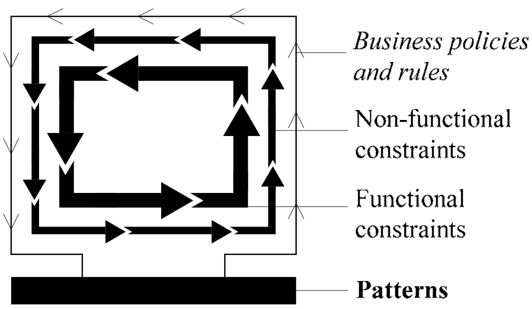


Figure 4-4: The shearing layers of requirements.

- **Patterns.** A pattern is the largest combined essential functionality in any variation of a software component that achieves the same goal. In other words, every software component that achieves the same goal should provide the functionality captured in a pattern. This functionality is core to the components, and hence remains unchanged over time unless the goal is no longer needed. For example, one of the goals of RALIC is to provide the information of a UCL person to security staff. It can be achieved by the `Person` pattern illustrated in Figure 4-5 (a) with functionalities such as `get person name` and `get gender`. These functionalities have existed long before software systems and are likely to remain unchanged. Different patterns can be found in different domains, e.g., patterns in the medical domain revolve around patients, doctors, patient records (Sommerville, 2004) and patterns in the business domain revolve around products, customers, inventory (Arlow and Neustadt, 2003). In the business domain, Arlow and Neustadt (2003) developed a set of patterns which they named enterprise archetypes as the patterns are universal and pervasive in enterprises[29]. Their catalogue of patterns consists of various business related pattern, including the ones in Figure 4-5.

---

[29] In this chapter, the word "archetype" is used when referring specifically to the patterns by Arlow and Neustadt (2003).

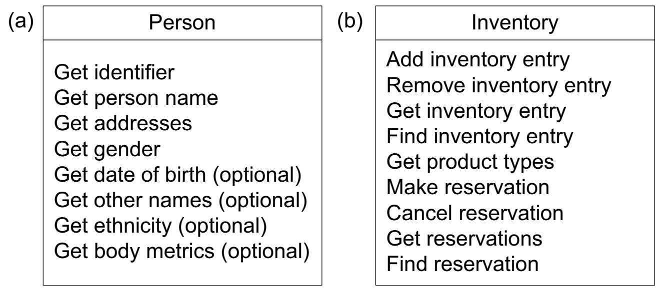


Figure 4-5: Example patterns: (a) `Person` pattern (b) `Inventory` pattern (Arlow and Neustadt, 2003).

- **Functional constraints.** Patterns allow freedom for different instantiations of software components that achieve the same goals. In contrast, functional constraints are specific requirements on the behaviour of the system that limit the acceptable instantiations. As such, they are more volatile than patterns. Functional constraints are needed to support the stakeholders in their tasks, and hence remain unchanged unless the stakeholders change their way of working. For example, RALIC's main goal is to provide access control. The pattern assigned to this goal is the `PartyAuthentication` archetype that represents an agreed and trusted way to confirm that a party is who they say they are (Arlow and Neustadt, 2003). A functional constraint on the achievement of this goal is that the system must display the digital photo of the cardholder when the card is scanned, in order to allow security guards to do visual checks.
- **Non-functional constraints.** A non-functional constraint is a restriction on the quality characteristics of the software component, such as its usability, and reliability (Chung et al., 2000). For example, the ISO/IEC 9126 Software Product Quality standard[30] (ISO, 2001) identifies non-functional constraints as a set of characteristics (e.g., reliability) with sub-characteristics (e.g., maturity, fault tolerance) and their measurable criteria (e.g., mean time between failures). Changes in non-functional constraints are independent of the functionality of the system and occur when the component can no longer meet increasing quality expectation. For example, in RALIC, a person's information has to be up-to-date within an hour of modification. The constraint remains unchanged until the system can no longer support the increasing student load, and a faster service is needed.
- **Business policies and rules.** A business policy is an instruction that provides broad governance or guidance to the enterprise (Berenbach et al., 2009, Object Management

[30] http://www.iso.org/iso/catalogue_detail.htm?csnumber=22749

Group, 2006). A business rule is a specific implementation of the business policies (Berenbach et al., 2009, Object Management Group, 2006). Policies and rules are an essential source of requirements specific to the enterprise that the system operates in (Ross, 2003, Berenbach et al., 2009). They are the most volatile (Berenbach et al., 2009), as they are related to how the enterprise decides to react to changes in the environment (Object Management Group, 2006). For example, a UCL business policy states that access rights for students should correspond to their course duration. The rule based on the policy is: a student's access rights should expire 6 months after their expected course end date. For better security, the expiration date was shortened from 6 months to 3 months after the students' course end dates.

Classifying Initial Requirements

The RALIC requirements signed off at the end of September 2005 (Figure 4-2) were classified into the shearing layers of requirements. To do so, this work adopted goal modelling methods, which are well-researched methods to model requirements (Anton, 1996, Darimont and Van Lamsweerde, 1996, Yu, 1997, Rolland et al., 1998, Van Lamsweerde, 2001, Letier and Van Lamsweerde, 2002, Liu and Yu, 2004, Yu et al., 2004). Goal models capture the intent of the system as goals, which are incrementally refined into a goal-subgoal structure. For example, the RALIC system had a goal *to control access to university buildings and resources*. The study used goal refinements to classify each requirement into one of the four layers using the following steps (Figure 4-6).

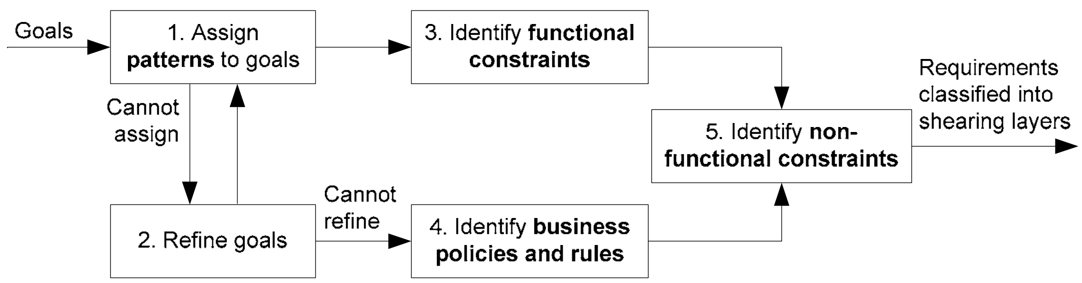


Figure 4-6: Classifying RALIC requirements into the shearing layers.

- **Step 1: Assign patterns to goals.** This step checks if there is a pattern for each goal. A pattern can be assigned to a goal if and only if the operation(s) in the pattern is capable of achieving the goal. There are two ways for this to happen. First, the goal is a direct match to a functionality in the pattern. For example, the goal of searching for a person by name can be directly mapped to the functionality *to find a person by ID or name* in the `PartyManager` archetype (Arlow and Neustadt, 2003). Second, the goal can be refined into subgoals that form a subset of the operations in the pattern. For example, the goal in RALIC *to manage people information centrally* can be refined into subgoals such as *to add or delete a person*, and *to find a person by ID or name*. These subgoals are a subset of the operations in the `PartyManager` archetype. If no patterns can be assigned to the goal, proceed to Step 2 with the goal. Otherwise, proceed to Step 3.

- **Step 2: Refine goals.** This step refines high-level goals into subgoals and repeats Step 1 for each subgoal. To refine a goal, the KAOS goal refinement strategy is used: a goal is refined if achieving a subgoal and possibly other subgoals is among the alternative ways of achieving the goal (Dardenne et al., 1993).
    - For a complete refinement, the subgoals must be distinct and disjoint and together they must reach the target condition in the parent goal. For example, the goal *to control access to university buildings and resources* is refined into three subgoals: *to maintain up-to-date and accurate person information*, *assign access rights to staff, students, and visitors*, and *verify the identity of a person requesting access*. If these three subgoals are met, then their parent goal is met.
    - As the refinement aims towards mapping the subgoals to archetypes, the patterns are used to guide the refinement. For example, the leaf goal[31] *to maintain up-to-date and accurate person information* is partly met by the `PartyManager` archetype that manages a collection of people. Hence, the leaf goal is refined into two subgoals: *to manage people information centrally*, and *to automate entries and updates of person information*.
    - A goal cannot be refined if there are no patterns for its subgoals even if it is refined. For example, the goal *to assign access rights to staff, students, and visitors* has no matching patterns as access rights are business specific. In that case, proceed to Step 4.
- **Step 3: Identify functional constraints.** For each pattern that is assigned to a goal, this step identifies functional constraints on the achievement of the goal. This involves asking users of the system about the tasks they depend on the system to carry out, also known as task dependency in i* (Yu, 1997). These tasks should be significant enough to warrant attention. For example, one of the security guard's tasks is to compare the cardholders' appearance with their digital photos as they scan their cards. This feature

---

[31] A leaf goal is a goal without subgoals.

constrains acceptable implementations of the `PartyAuthentication` archetype to those that enable visual checks.

- **Step 4: Identify business policies and rules.** The goals that cannot be further refined are assigned to business policies and rules. This involves searching for policies and rules in the organisation that support the achievement of the goal (Object Management Group, 2006). For example, the goal *to assign access rights to staff, students, and visitors* is supported by UCL access policies for these user categories. These policies form the basis for access rules that specify the buildings and access times for each of these user categories and their subcategories. For example, undergraduates and postgraduates have different access rights to university resources.
- **Step 5: Identify non-functional constraints.** The final step involves identifying non-functional constraints for all the goals. If a goal is annotated with a non-functional constraint, all its subgoals are also subjected to the same constraint. As such, to avoid annotating a goal and its subgoal with the same constraint, higher-level goals are considered first. For example, the RALIC system takes people data from other UCL systems, such as the student system and human resource system. As such, for the goal *to maintain up-to-date and accurate person information*, these systems impose data compatibility constraints on the access control system.

The output is a list of requirements that are classified into the four shearing layers. A visual representation of its output is illustrated in Figure 4-7. This representation is adopted from the KAOS (Dardenne et al., 1993) and i* methods (Yu, 1997). For example, the goal refinement link means the three subgoals should together achieve the parent goal, and the means-end link means that the element (functional, non-functional, or pattern) is a means to achieve the goal.

Classifying Subsequent Changes

To study requirements change, modifications to the requirements documentation after requirements sign-off were considered as a change. There are three types of changes.

- **Addition**. A requirement is introduced.
- **Deletion**. An existing requirement is removed.
- **Modification**. An existing requirement is modified due to changes in stakeholder needs. Corrections, clarifications, and improvements to the documentation are not considered as changes.

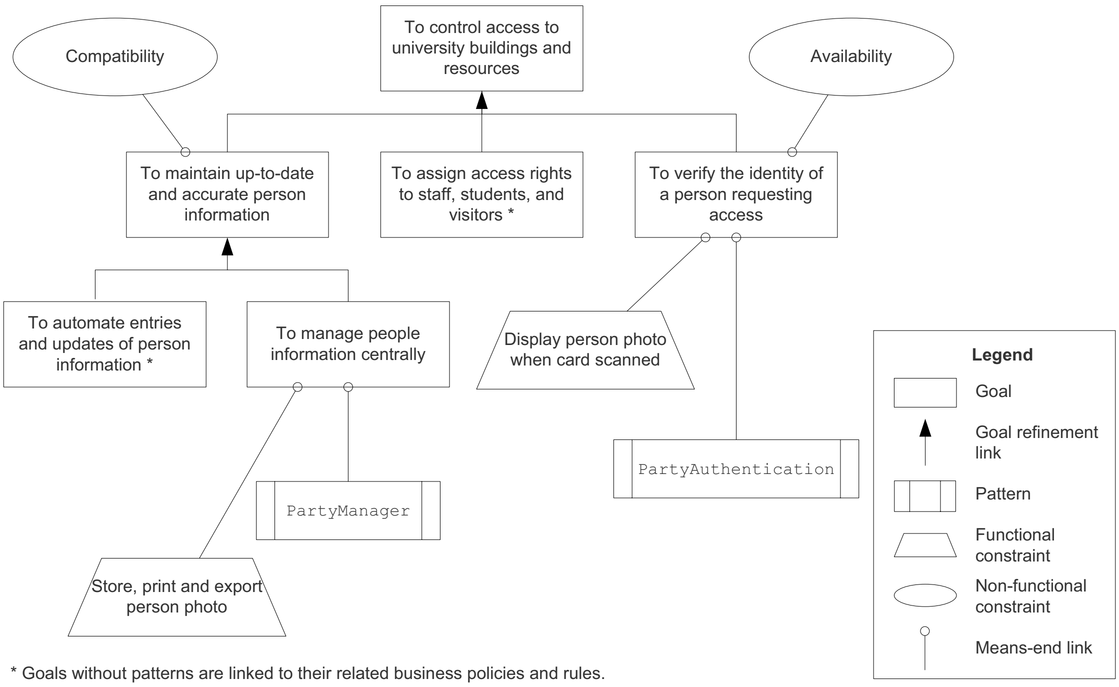


Figure 4-7: A model of the partial initial requirements.

The following procedure was used to analyse the project documentation and record changes.

- All project documentation related to requirements, such as specifications, workplans, team and board meeting minutes, were studied, as changes may be dispersed in different locations.
- Care was taken not to consider the same changes more than once by analysing the content of change. Repeated documentation of the same changes occurred because changes discussed in team meetings can be subsequently reported in board meetings, reflected in functional specification, cascaded into technical specification and finally into workplans.
- Interviews were conducted with the project team to understand the project context, clarify uncertainties or ambiguities in the documentation, and verify the findings.
- Some statements extracted from the documentation belong to more than one layer. For example, the statement "for identification and access control using a single combined card" consists of two patterns (i.e., `Person` and `PartyAuthentication`) and a functional constraint (i.e., combined card). In such cases, the statements are split into their respective layers.

Although the difference between pattern, functional constraint, and non-functional constraint is clear cut, policies and rules can sometimes be difficult to distinguish. This is because high-level policies can be composed of several lower-level policies (Object Management Group, 2006, Berenbach et al., 2009). For example, the statement "Access Systems and Library staff shall require leaver reports to identify people who will be leaving on a particular day" is a policy rather than a rule, because it describes the purpose of the leaver reports but not how the reports should be generated. Sometimes, a statement can consist of both rules and policies. For example, "HR has changed the staff organisation structure; changes were made from level 60 to 65". Interviews with the stakeholders revealed that UCL has structured the departments for two faculties from a two tier to a three tier hierarchy. This is a UCL policy change, which has affected the specific rule for RALIC, which is to display department titles from level 65 of the hierarchy onwards.

Each change was recorded by the date it was approved, a description, the type of change, and the shearing layer of requirements. Table 4-3 illustrates the change records. There were a total of 97 changes and all requirements can be exclusively classified into one of the four layers for this project.

Table 4-3: Partial Change Records[32]

Date	Description	Type	Layer
6 Oct 05	The frequency of data import from other UCL systems is one hour (changed from 2 hours).	Modification	Non-functional Constraints
6 Oct 05	The access rights for students expire 3 months after their expected course end date (changed from 6 months).	Modification	Business Rules
18 Oct 05	End date from the Staff and Visitor systems and Student Status from the Student system is used to determine whether a person is an active card holder.	Addition	Business Rules
16 Nov 05	Expired cards must be periodically deleted.	Addition	Business Policies
30 Nov 05	Access card printer should be able to print security logos within the protective coating.	Addition	Functional Constraints

[32] The complete change records and project data are not provided in the thesis as they contain sensitive information related to the security and access control of University College London.

Date	Description	Type	Layer
31 Mar 06	The main appointment of a staff member is identified in the following order. 1. A current appointment is preferred to a future appointment; a future appointment is preferred to a past appointment. 2. Between two future appointments, the one with the earlier start date is preferred. 3. Between two past appointments, the one with the later end date is preferred.	Addition	Business Rules
8 May 06	The highest level department name at departmental level 60 should be printed on the card.	Addition	Business Rules
17 Jan 07	The frequency of data import from other systems is 2 minutes (changed from 5 minutes).	Modification	Non-functional Constraints
2 Apr 07	Replace existing library access control system that uses barcode with the new access control system.	Deletion	Business Policies
1 Jul 08	Programme code and name, route code and name, and faculty name from the Student system is used to determined their access on the basis of courses.	Addition	Business Rules
15 Aug 08	The highest level department name at departmental level 65 should be printed on the card (changed from 60).	Modification	Business Rules
1 Jan 09	Introduce access control policies to the Malet Place Engineering Building.	Addition	Business Policies

To compare the volatility of RALIC requirements to other systems, the volatility ratio formula from Stark et al. (1999) is used (Equation 4-1).

$$volatility = \frac{Added + Deleted + Modified}{Total}, \qquad (4\text{-}1)$$

where *Added* is the number of added requirements, *Deleted* is the number of deleted requirements, *Modified* is the number of modified requirements, and *Total* is the total number of initial requirements for the system. Volatility is greater than 1 when there are more changes than initial requirements. In Stark et al.'s study of 44 software releases of seven products in maintenance, the average volatility was 0.48, with a release having the highest volatility of 6. RALIC requirements have a total volatility of 3.73. However, care needs to be taken when comparing the volatility among these systems because Stark et al.'s study focused on requirements change during system maintenance, while RALIC's requirements change study started from development until system maintenance. Also, the granularity of a requirement can affect the volatility ratio, for example, a pattern is a collection of many requirements, hence counting it as one requirement reduces the total number of requirements.

Using Equation 4-1 to calculate the volatility for each layer enables the comparison of their relative volatility. Patterns are the most stable, with no changes over 3.5 years. This is followed by functional constraints with a volatility ratio of 0.6, non-functional constraints with a volatility ratio of 2.0, and business policies and rules with a volatility ratio of 6.4. Business policies and business rules have similar volatility when considered separately: policies have a volatility ratio of 6.40 and rules 6.44.

To understand when the changes occur, the number of quarterly changes for each layer is plotted over the duration of the requirements change study (Figure 4-8). The number of requirements changes was high at the start of the study period, and decreased to one or no changes per quarter one year after the system was deployed. A closer inspection revealed that the requirements changes towards the end of the study were not from missing requirements, but due to changes in business policies and rules in UCL. This provides confidence that the complete set of requirements can be built for this work.

The quarter Oct-Dec 05 has the highest number of changes for functional constraints, non-functional constraints, business policies and rules because the requirements elicitation and documentation were still in progress. The project board had signed off the high-level requirements, but the details surrounding access rights and card processing were still under progress. Many of the changes are due to better understanding of the project and to improve the completeness of the requirements.

Consistent with the existing literature (e.g., (Cockburn, 2000)), missing requirements surfaced from change requests after the system was deployed. The system went live first for new staff in May 06 and then for the whole of UCL in March 07. Each time it went live, the number of requirements change increased in the following quarters.

A rise in policy change in quarters Oct-Dec 05 and Jan-Mar 07 was followed by a rise in rule change in the following quarters, because business rules are based on business policies. As more than one rule can be based on the same policy, the number of changes in rules is naturally higher than that of policies. Nevertheless, after the system went live, policy changes did not always cascade into rule changes. For example, application of the access control policy to new buildings required only the reapplication of existing rules.

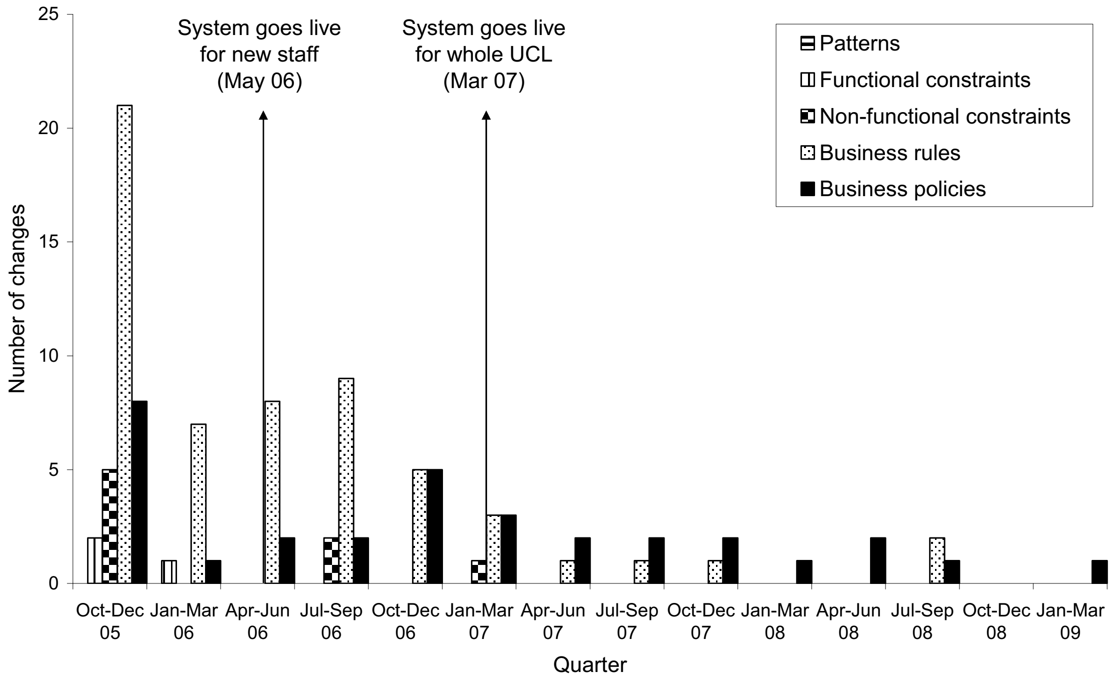


Figure 4-8: Quarterly requirements changes for each layer.

Interestingly, the quarterly changes for business rules resemble an inverse exponential function, as the number of changes was initially large but rapidly decreased. In contrast, the quarterly changes for business policies shows signs of continuous change into the future. Rules suffered from a high number of changes to start with, as the various UCL divisions were still formulating and modifying the rules for the new access control system. After the system went live, the changes reduced to one per quarter for three quarters, and none thereafter. One exception is in quarter Jul-Sep 08, where UCL faculty restructuring had caused the business processes to change, which affected the rules. Nevertheless, these changes were due to the environment of the system rather than missing requirements.

In summary, the study of requirements change in RALIC equipped this researcher with the project knowledge to build the existing method and ground truth lists of stakeholders and requirements. The analysis of all project documentation informed the construction of the stakeholder lists to focus on the documentation that describes stakeholders, their roles, and involvement in the project. In addition, knowledge about the RALIC project structure and UCL organisation structure provides the global perspective to build the ground truth of stakeholders objectively. The study showed that all the missing requirements during the RALIC project had been discovered, providing confidence that the ground truth of requirements can be built. The initial requirements and subsequent changes served as input to build the existing method and ground truth lists of requirements.

4.3 Stakeholder Lists

StakeNet was evaluated by comparing the list of stakeholders produced by StakeNet and the list of stakeholders produced by the existing method used in RALIC with the ground truth of stakeholders. The existing method and ground truth lists of stakeholders were built using the project documentation described in Section 4.1 (page 75). The requirements change study in the previous section revealed the project documentation that contained stakeholders and their roles (Figure 4-9).

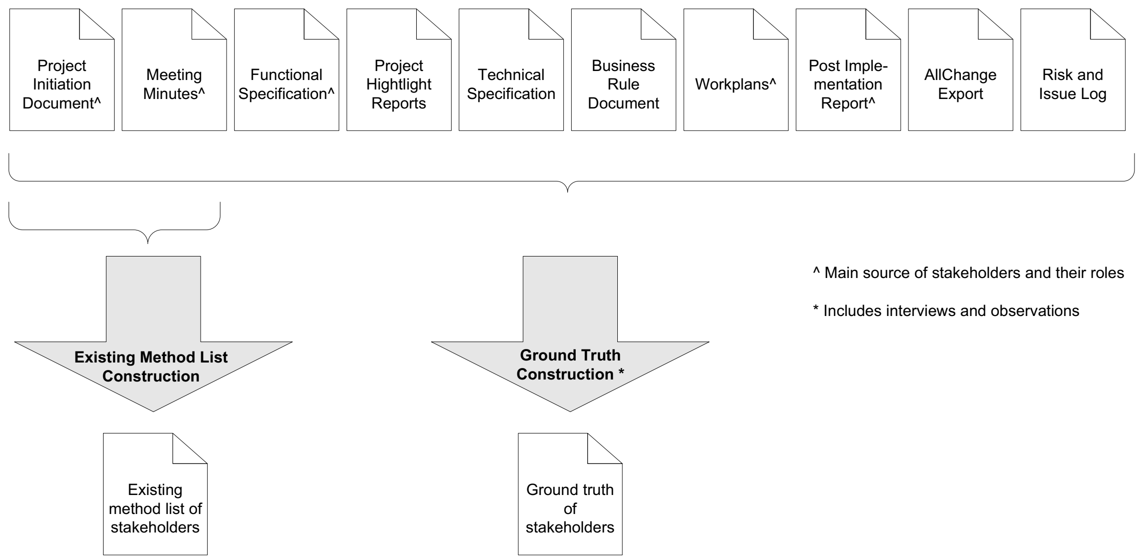


Figure 4-9: Project documentation used to produce the stakeholder lists (only the first two documents were used for existing method list construction).

Existing Method List

The existing method list of stakeholders was elicited by the project team using the existing methods discussed in Chapter 2 (Section 2.2). Two methods were used: the heuristic-based approach and the checklist-based approach. For example, the project team mapped generic stakeholders in the PRINCE2 method (Bentley, 2002), such as sponsors and users, to project-specific stakeholders such as Facilities and Estates Division represented by Fuller, and Access and Security Systems represented by Kyle and Dawson. The project team also conducted a workshop to discuss possible stakeholders of the project. Stakeholders discovered after elicitation were excluded from the lists, as they were not the result of elicitation. Specifically, the existing method list consists of the stakeholders that were identified from the start of the project until the end of September 2005, when the requirements were signed off by the project board.

The outcome of the elicitation was documented in the Communications Plan section in the Project Initiation Document (Figure 4-10) and in the meeting minutes of the RALIC workshop (Figure 4-11). The Communications Plan contained high-level stakeholder groups (e.g., the project board) rather than its members (e.g., Martin). As such, other parts of the document were used to enumerate the members. For example, the Project Organisation Structure section of the Project Initiation Document (Figure 4-12) was used in the enumeration of the project board members.

5 Communications Plan

5.1 Stakeholders

Parties with an interest in the project are as follows:

- Estates and Facilities Division (Security and Access Systems Section)
- The RALIC Project Board.
- The RALIC Project Team.
- Library Services.
- UCL Faculties, Departments and Institutes.
- Student Union

Email distribution lists for the above sets of people are to be set up to aid communication.

5.2 Communications Planning

Stakeholder Group	Meeting	Report	Bulletin / Email
Programme / Corporate Board		3 Monthly	
Project Board	Monthly	Monthly	As Req.
Project Assurance	Monthly	Monthly	As Req.
Planning and Implementation Group	Fortnightly	As Req.	As Req.
UCL Community		As Req.	As Req.
ISC	Quarterly	As Req.	As Req.
ADSSC	Quarterly	As Req.	As Req.

Figure 4-10: Communications plan (Project Initiation Document).

EFFICIENCY IN PROCESSING
- Multiple Cards (library / student union / medical students / various clubs & societies)
- Future Opportunities (Allow for the future introduction of additional functionality to the same card)
- ID Information on Cardax ("harbour savings" in the process of not having to support 2 or more cards)
- Staff Nos (Planned Future Reductions), consequential reduction in "security / ID" resources (i.e. less manpower required)
- Photographs (Digital storing / printing /retrieving of photos)

6. HOW MANY PEOPLE ARE AFFECTED?

STAFF – 7,700 (current level)

STUDENTS – 20,000 (current level)

CARDS - 17,000 / annum 7,000 of which are issued in week 1 (w/c 23rd September), long queuing issues – possible option to prior issue cards by "Post".

Figure 4-11: Partial meeting minutes (Stakeholder Analysis Workshop, June 2005).

4 Project Organisation Structure

Terms used below are taken from PRINCE2 project management methodology.

4.1 Project Board

J. R[redacted] Fu[redacted] (Director EFD)	Executive
Prof. R[redacted] Ro[redacted] (Director EISD)	Senior Supplier
R[redacted] C[redacted] (Director IS)	Senior Supplier
W[redacted] Mi[redacted] (Director MS)	Senior Supplier
K[redacted] Le[redacted] (MSD)	Supplier
B[redacted] W[redacted] (Registrars)	Senior Users
N[redacted] Ak[redacted]e (HR)	Senior Users
N[redacted] Ky[redacted] (Security and Access Systems, EFD)	Senior Users
M[redacted] Da[redacted] (Access Systems EFD)	Senior Users
J[redacted] Pe[redacted] (Library Services)	Senior Users

Figure 4-12: Partial board members list[33] (Project Initiation Document).

The existing method list of stakeholders is an unprioritised list of 18 stakeholders and 28 stakeholder roles (Table 4-4). In Table 4-4, stakeholder roles with blank stakeholder fields are roles without specific stakeholders. In this project, stakeholder roles include divisions (e.g., Security and Access Systems, and Estates and Facilities Division), teams within a division (e.g., Estates and Facilities Division: Project Assurance), positions (e.g., Heads of Departments), groups (e.g., Students), and organisations (e.g., Hospitals).

[33] Names have been made anonymous for reasons of privacy.

Table 4-4: Partial Existing Method List of Stakeholders[34]

Stakeholder[35]	Stakeholder Role
Kyle	Security and Access Systems
Dawson	Security and Access Systems
Fuller	Estates and Facilities Division
Crowe	Library Services
Niche	Registry
Bates	Estates and Facilities Division: Project Assurance
	Students
	Clubs and Societies
	Hospitals
	Heads of Departments
	Security Staff

The project team spent about 24 hours to produce the existing method list. This number is an approximation calculated from the total number of hours the stakeholders spent in the stakeholder analysis workshop. The workshop duration was 2 hours according to the post implementation report, and 12 stakeholders attended the workshop according to the meeting minutes.

Ground Truth

The ground truth of stakeholders is the actual and prioritised list of stakeholders for the RALIC project. It was built based on the project documentation illustrated in Figure 4-9 (page 90), using the following steps.

- **Step 1: Derive stakeholder subtypes.** This step derived subtypes of stakeholders relevant for RALIC based on the types of stakeholders defined by Alexander and Robertson (2004). Their work has defined stakeholders as those who finance the system (type 1), make decision about the development of the system (type 2), develop the system (type 3), impose rules on the development or operation of the system (type 4), use the system or its output (type 5), or threaten the success of the system (type 6) (Alexander and Robertson, 2004). For example, in RALIC, for stakeholders who

[34] The complete existing method list of stakeholders is available in Appendix A.

[35] Names have been changed for reasons of privacy.

finance the system (type 1), the subtypes of stakeholders were stakeholders who *finance the human resources* (subtype 1), *finance the hardware and software* (subtype 2), and *allocate server space* (subtype 3). The output of this step was 38 subtypes of stakeholders which were assumed to be discrete and complete for RALIC.

- **Step 2: Find actual stakeholders and their roles.** For each subtype, this step identified actual stakeholders and their roles from the project documentation. A stakeholder can have more than one role and there can be more than one stakeholder for each role. If a stakeholder role was not specifically represented during the project, the stakeholder for the role was left empty.
  - In this step, the stakeholders' present involvement in the project was observed and their past involvements were learnt from interviews. For example, in RALIC, for the subtype *finance the human resources*, the meeting minutes revealed that "Miles[36] confirmed Management Systems will provide long term support using existing permanent resources" and "approval for additional resource granted by Fuller, Estates." Hence, Miles and Fuller were stakeholders, and their roles were Management Systems and Estates, respectively. For *finance the hardware and software*, the meeting minutes revealed that "it was desirable to procure the servers ASAP subject to Fuller's approval on funding." Again, Fuller was a stakeholder from Estates. For *allocate server space*, the meeting minutes revealed that "servers are due to be delivered & installed into Kathleen Lonsdale Building & Foster Court server rooms." The Kathleen Lonsdale Building was Clarke's responsibility from Information Systems, and Foster Court was Fuller's responsibility from Estates. Hence, Clarke and Fuller were stakeholders from Information Systems and Estates respectively.
  - If a stakeholder left and was replaced by another stakeholder with the same role in RALIC, then both stakeholders' names were included on the list as *previous stakeholder name → current stakeholder name*. For example, Rosen the Director of Information Services Division was replaced by Randall, hence the stakeholder was written as Rosen → Randall.
- **Step 3: Rate stakeholder involvement.** In this step, each stakeholder was rated in terms of their involvement in each subtype as High, Medium, or Low. By doing so, the step assumed that the stakeholders' salience was reflected in their project involvement.

---

[36] Names have been changed for reasons of privacy.

For stakeholder roles without stakeholder representation, the roles were rated. Stakeholders were rated across four types of involvement.

- **Finance**: a stakeholder who paid more received a higher rating. For example, Fuller allocated the highest budget for human resources and hardware, hence he was rated High for both the subtypes *finance human resource* and *finance hardware and software*. Miles allocated approximately half of Fuller's budget for human resources; hence he was rated Medium for the subtype *finance human resource*. Clarke allocated the least amount of resources to host the servers and maintain connectivity; hence he was rated Low for the subtype *allocate server space*.
- **Management**: a stakeholder who was more accountable received a higher rating. For example, Payne from Estates managed the whole project, Fuller chaired the project board, Lester from Management Systems managed the implementation, and Bates from Estates monitored the project progress. Payne and Fuller were rated High, Lester was rated Medium, and Bates was rated Low.
- **Development**: a stakeholder with more responsibilities received a higher rating. For example, Hicks from Management Systems was the interface developer, Wade was the supplier representative for the access control system, and Skinner was the technical contact for the system interface between library and student records. Hicks was rated High, Wade Medium, and Skinner Low.
- **Usage**: a stakeholder who used the system more frequently and was more affected by the system received a higher rating. For example, Dawson from Security Services used the system on a daily basis and was responsible for the provision of access control, Crowe from Library Services used the barcode output, and Cates from Security Services issues cards. Dawson was rated High, Crowe Medium, and Cates Low.

- **Step 4: Sum and rank.** The previous step produced a list of stakeholders and their ratings for different involvements. As stakeholders were prioritised based on their total involvement in the project, Step 4 derived the stakeholders' total involvement based on their ratings in different involvements from Step 3. To do so, Step 4 converted the qualitative ratings of High, Medium and Low into numerical ratings (High = 3, Medium = 2, Low = 1) and summed up the numerical ratings for each stakeholder, by assuming that the different types of involvements contribute equally to the project. Stakeholders were then ranked by the sum of their ratings, from the highest to the lowest. For example, Fuller received two High ratings and a Medium rating, so he has the score of

2(3) + 1(2) = 8, and Miles received a Medium rating and a Low rating, his score is 1(2) + 1(1) = 3. Based on the score, Fuller was ranked higher than Miles. The output of Step 4 is a ranked list of 85 stakeholders and 62 roles shown partially in Table 4-5.

- **Step 5: Prioritise stakeholders by their roles**. This step produced the ground truth of stakeholders, which consists of a prioritised list of stakeholder roles, and within each role, a prioritised list of stakeholders (Table 4-6). To do so, the stakeholders were grouped according to their roles. Within each role, stakeholders with higher total ratings were prioritised first. Then, the roles were prioritised based on the rating of their highest priority stakeholder. Roles without stakeholders were prioritised based on their rating. Fractional ranking or "1 2.5 2.5 4" ranking (Triola, 1992) was used when ranking stakeholders and their roles. For example, in Table 4-6, the roles Information Strategy Committee and Information Services Division have tied ranks because their highest priority stakeholder has the same rating. Fractional ranking finds the mean of the ranks involved in the tie, which is (6 + 7) / 2 = 6.5, and then assigns this mean rank to each of the tied items, which is why the role priority is 6.5 for both.

Table 4-5: Stakeholders and Total Rating

Stakeholder	Stakeholder Role	Total Rating
Dawson	Access and Security Services	31
Fuller	Estates and Facilities	24
Payne	Estates and Facilities	22
Crowe	Library Services	19
Cook	Student Registry	15
Lester	Management Systems	14
Rosen → Randall	Information Strategy Committee	10
Rosen → Randall	Information Services Division	10
Clarke	Information Systems	9
Akins	Human Resources Division	9
Reed	Library Services	7
Ortis	Security and Access Systems	7
	Students[37]	7

[37] The stakeholder for the Students role is empty because the role was not represented during the project.

Table 4-6: Partial Ground Truth of Stakeholders (based on Table 4-5)[38]

Stakeholder Role	Stakeholder
(1) [39] Access and Security Services	(1) Dawson (2) Ortis
(2) Estates and Facilities	(1) Fuller (2) Payne
(3) Library Services	(1) Crowe (2) Reed
(4) Student Registry	Cook
(5) Management Systems	Lester
(6.5) Information Strategy Committee	Rosen → Randall
(6.5) Information Services Division	Rosen → Randall
(8) Information Systems	Clarke
(9) Human Resources Division	Akins
(10) Student	

Throughout this work, fractional ranking was used to prioritise stakeholders, their roles and requirements. This fractional ranking method has the statistical property that the average rank of *N* items is always the same. Hence, it is widely used in rank-order methods (Riffenburgh, 2005, Utts and Heckard, 2005).

The ground truth of stakeholders was validated by interviewing management-level stakeholders and stakeholders who were involved in a major part of the project. The interviews increased the confidence that the ground truth is objective and accurate, and is representative of the actual stakeholders and their involvement in RALIC. The stakeholders involved in the interviews were the Vice-Provost, the Director of Information Systems, the Director of Information Services Division, the Director of Management Systems, RALIC Project Manager, RALIC Technical Manager, RALIC Business Analyst, and the Manager of Access and Security Systems. The director of Estates and Facilities Division was not included because he left after the survey, and the new director was not involved in RALIC. Interviews were conducted with these stakeholders after StakeNet was applied to RALIC. As StakeNet was evaluated by surveying the stakeholders, conducting the interviews after the surveys prevents the survey answers from being influenced by the interviews.

[38] The complete ground truth of stakeholders is available in Appendix A.

[39] The ranks are provided in brackets. Fractional ranking or "1 2.5 2.5 4" ranking (Triola, 1992) is used.

During the interviews, the stakeholders were provided with a description of the RALIC project and reminded about the purpose of the study, which was to identify and prioritise stakeholders for RALIC. The stakeholders were also provided with the ground truth, and the purpose of the ground truth to evaluate StakeNet's output was explained to them. The stakeholders were then asked to inspect the ground truth and were presented with the following questions:

- Are there any stakeholders or roles that are missing from the ground truth? If so, what was their involvement in the project?
- Are there any stakeholders or roles that should not be included in the ground truth?
- Are there any stakeholders that are incorrectly prioritised? If so, why?

The feedback based on the questions was used to amend the ground truth. For example, if the management-level stakeholders pointed out missing stakeholders who were involved in the past, the involvement of those stakeholders was checked with project documentation and other stakeholders. If the stakeholders were available, they were contacted to confirm their involvement. Missing stakeholders that were confirmed by the project documentation and stakeholders were added to the ground truth. Many stakeholders in the interview remembered only the stakeholders that were heavily involved in the project. Stakeholders marginally involved in the project were sometimes mistakenly identified as not a stakeholder. The method to amend prioritisations was similar to that for amending missing stakeholders. Disagreements in the prioritisations were confirmed with the other stakeholders and justified before the ground truth was amended.

The interviews were also used to confirm stakeholders in the documentation whose involvement in the project was unclear. For example, the name Neena Goland[40] appeared in the Functional Specification as a footnote for one of the interfacing systems to RALIC, but no where else in the project documentation. The stakeholder revealed that she was not involved in the project. This was confirmed with the management-level stakeholders before her name was removed from the ground truth.

To summarise, the existing method list of stakeholders is an unprioritised list of stakeholders identified by the project team at the start of the project using existing methods. It consists of 18 stakeholders and 28 roles. The ground truth of stakeholders is the actual list of stakeholders identified after the system was deployed, and is prioritised by the stakeholders' involvement in the project. The ground truth consists of 85 stakeholders and 62 roles. Some stakeholders and roles in the existing method list are not in the ground truth, and vice versa.

[40] The name has been changed for reasons of privacy.

4.4 Requirements Lists

StakeRare is evaluated by comparing its output to the list of requirements produced by the existing method in the project, and with the ground truth of requirements. The existing method and ground truth lists of requirements were built based on the requirements change study described in Section 4.2 (Figure 4-13). The requirements change study analysed all the project documentation in order to produce the initial requirements for RALIC, and subsequent additions, modifications, and deletions to the requirements. The initial requirements produced by the project team were used to build the existing method lists of requirements. The initial requirements and subsequent additions, modifications, and deletions to the requirements were used to build the ground truth of requirements.

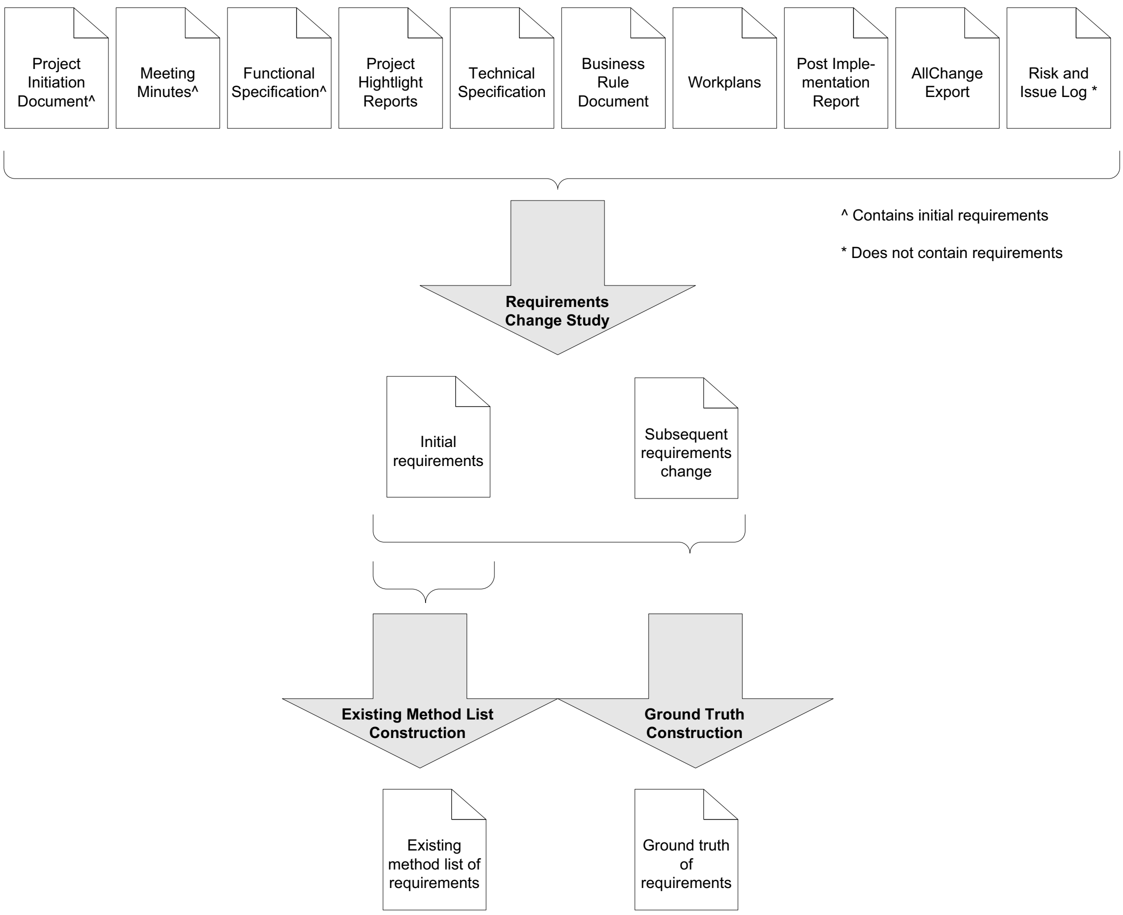


Figure 4-13: Requirements change study informing the construction of the existing method and ground truth lists of requirements (only the initial requirements are used in the existing method list construction).

Existing Method List

The existing method list of requirements was elicited by the project team using the existing methods discussed in Chapter 2. Traditional elicitation techniques were used, which included meetings and interviews with key stakeholders determined by the project board. Requirements discovered after this initial elicitation were excluded from the lists, as they were not the result of elicitation. Specifically, the existing method list consists of requirements that were identified from the start of the project until the end of September 2005, when the requirements were signed off by the project board.

The requirements change study identified the initial requirements and their source in the project documentation. Documents that contain requirements are the Project Initiation Document, team and board meeting minutes, and functional specification. For example, the requirement “The database platform must support Microsoft SQL Server and/or Oracle Server” is extracted from the list of constraints in the Project Initiation Document (Figure 4-14). The requirement “The PRN (student number) will be used and displayed on the new card” is extracted from the Meeting Minutes (Figure 4-15). The requirement “Reports (e.g., leavers’ reports) should be developed for Access Systems and Library staff” is extracted from the Functional Specification (Figure 4-16). The technical specification and business rules document were excluded as they were done after the initial requirements were signed off.

The chosen system must conform to the following minimum requirements (but not limited to):-

- Be modular in design to enable additional doors/functions to be added in the future.
- The communications between the Host Server and the field controllers should be capable of both TCP/IP (Transmission Control Protocol and Internet Protocol) and PSTN (Public Service Telephone Network) Modem.
- Capable of multiple Access Site Locations/Workstation Locations via the above mentioned Comms Networks.
- Capable of ODBC (Open DataBase Connectivity) to third party Databases (HR/Registrars etc.).
- Photo ID Pass Software must be an embedded feature of the Access Control Software and only require software/licence upgrades.
- The system MUST support Smart Card technology, and this technology must not be proprietary to the system manufacturer.
- The system manufacturer MUST be a Microsoft™ Certified Partner.
- The system MUST utilise Microsoft™ Windows 2000 and/or XP Operating System.
- The Database platform MUST support Microsoft™ SQL Server and/or Oracle Server.
- The chosen manufacturer must have a proven tracker record within Institutions with Access Control, ID Pass Production, ODBC, Smart Card technologies.
- Have an expected Life Cycle and Product Support of NOT less than 10 years.

Figure 4-14: Constraints on off-the-shelf solutions (Project Initiation Document).

Update 3/11/05
Return Address – Steve Shine to confirm address.
Card Design – CC confirmed that the current SITS system has no facility to look up UPI, therefore the PRN ("student No") will be used & displayed on the new card.
KL confirmed that this requirement is accounted for in the approved middleware spec.

Figure 4-15: Excerpt of requirements (Meeting Minutes).

Card disabled

There may be occasions where a card is immediately disabled by staff in Access Systems, this action will take place on the Cardax system directly and, if necessary the Library Membership staff will be contacted and informed that a card had been disabled.

1.6.5 Reports

It will be necessary to develop some reports for Access Systems and Library staff to use, for example leaver reports to enable Access Systems and Library staff to identify people who will be leaving on a particular day.

1.7 Specification

Develop a means to:
Phase I

- Select all current (or due to start within 14 days) students from MIRUCL or Portico;
- Select all current (or due to start within 14 days) staff from ResourceLink;
- Select all current (or due to start within 14 days) visitors from the Services system;
- Read the start date or student status to determine whether the Global Authority flag (that activates the card) in Cardax should be active or in-active

Figure 4-16: Excerpt of requirements (Functional Specification).

The existing method list of requirements is an unprioritised list of 99 requirements extracted from project documentation (Table 4-7). The project team spent about 127 hours to produce the existing method list. This number is an approximation calculated from the total number of hours the stakeholders spent in meetings until the requirements were signed off (Table 4-8). The first meeting was not included as it was the stakeholder analysis workshop.

Table 4-7: Partial Existing Method List of Requirements[41]

Requirement
Control access to departments
Control access to libraries
Control access to computer clusters

[41] The complete existing method list of requirements is available in Appendix B.

Requirement
Be compatible with the National Health Service system
Be compatible with current network infrastructure
Card design to include card type and user status
Card to include UCL branding
Lifecycle of the off-the-shelf system is at least five years
Card is capable of being directly printed on both sides
The PRN (student number) will be used and displayed on the new card
Reports (e.g., leavers' reports) should be developed for Access Systems and Library staff
The database platform must support Microsoft SQL Server and/or Oracle Server

Table 4-8: Time Spent Eliciting Requirements using Existing Methods

Meetings before Sign-off	Number of Stakeholders[42]	Hours[43]	Total Hours
Project board meeting (2 Jun 05)	12	2	24 (excluded)
Project team meeting (29 Jun 05)	7	1.5	10.5
Project team meeting (7 Jul 05)	5	1.5	7.5
Project board meeting (14 Jul 05)	11	2	22
Project team meeting (21 Jul 05)	7	1.5	10.5
Project team meeting (3 Aug 05)	7	1.5	10.5
Project team meeting (10 Aug 05)	7	1.5	10.5
Project team meeting (18 Aug 05)	7	1.5	10.5
Project team meeting (6 Sep 05)	6	1.5	9
Project team meeting (22 Sep 05)	8	1.5	12
Project board meeting (26 Sep 05)	12	2	24
Total Man Hours			127

[42] The names of stakeholders who attended the meetings were recorded in the meeting minutes.

[43] According to the post implementation report, project board meetings were approximately 2 hours and project team meetings were approximately 1.5 hours.

Ground Truth

The ground truth of requirements is the actual and prioritised list of requirements in the RALIC project. It was built using the following steps.

- **Step 1: Identify requirements.** The initial requirements and subsequent changes from the requirements change study were used as input to this step. The study identified all the project requirements and their source in the documentation. For example, the project plan revealed that a project objective was "to improve security." A requirement to achieve the project objective was "to enable security/reception staff to validate the cardholder's identity." Two specific requirements were "to enable security/reception staff to check that the appearance of the cardholder matches the digitally stored photo" and "to enable security/reception staff to check the cardholder's role."
    - RALIC requirements were organised into three levels of hierarchy, similar to the hierarchical structure of requirements illustrated in Figure 2-10 (page 42). The three levels of hierarchy are: project objectives, requirements, and specific requirements. A requirement that contributed towards a project objective was placed under the project objective, and a specific requirement that contributed towards the requirement was placed under the requirement (Table 4-9).
    - When placing requirements and specific requirements in the hierarchy, the assumption was made that a requirement contributes to only one project objective, and similarly, a specific requirement contributes to only one requirement.

Table 4-9: Hierarchy for RALIC Requirements

Project Objective	Requirement	Specific Requirement
to improve security	to enable security/reception staff to validate the cardholder's identity	to enable them to check that the appearance of the cardholder matches the digitally stored photo
		to enable them to check the cardholder's role

- **Step 2: Pairwise comparison.** This step uses pairwise comparison to prioritise the project objectives, requirements, and specific requirements from Step 1. The pairwise comparison method discussed in Section 2.2 was used as it can be less sensitive to judgmental errors (Karlsson and Ryan, 1997). The requirements from each level were considered separately.

- **Project objectives**: The project objectives were arranged in an $N \times N$ matrix where N is the total number of project objectives. For each row, the objective in the row was compared with respect to each objective in the rest of the row in terms of their importance to the project. The project objective that contributes more to the success of the project is more important. For example, in RALIC, the objective "to improve security and access control in UCL" (labelled as Security in Table 4-10) was more important compared to the objective "to design the access card" (labelled as Card design in Table 4-10). The objective considered to be more important in each pairwise comparison was placed in the corresponding cell of the matrix (Table 4-10). If the two project objectives were equally important, they were both placed in the cell. For example, the objective "to design the access card" was equally important with the objective "to reduce cost" (labelled as Cost). Hence, in Table 4-10, they both appear in the corresponding cell of the matrix.

Table 4-10: 3×3 Matrix for Project Objectives

	Security	Card design	Cost
Security	–	Security	Security
Card design	–	–	Cost, Card design
Cost	–	–	–

- **Requirements**: Requirements were prioritised the same way as project objectives. A requirement was more important if it contributed more towards the project objectives. For example, in RALIC, between the requirements "granting access rights" and "cashless vending," "granting access rights" was more important as it contributed highly towards the project objectives "to improve security" and "to improve processes," but "cashless vending" only contributed towards "extensible future features."
- **Specific requirements:** Specific requirements were prioritised the same way as requirements. A specific requirement was more important if it contributed more towards the requirements.

- **Step 3: Prioritise requirements by their project objectives.** This step produced the ground truth of requirements, which consists of a prioritised list of project objectives, and within each project objective, a prioritised list of requirements, and within each requirement, a prioritised list of specific requirements (Table 4-11). To produce the ground truth, project objectives were ranked by the number of cells in the matrix that contains the project objectives, from the most to the least. For each project objective, the requirements were prioritised from the requirements that appeared in the most cells to the least, and for each requirement, the specific requirements are prioritised from the specific requirements that appear in the most cells to the least.

The ground truth of requirements was validated the same way as the ground truth of stakeholders. Management-level stakeholders and stakeholders who were involved in a major part of the project, such as the Vice-Provost, the Director of Information Systems, the Director of Information Services Division, the Director of Management Systems, RALIC Project Manager, RALIC Technical Manager, RALIC Business Analyst, and the Manager of Access and Security Systems, were interviewed to validate its completeness and accuracy in prioritisation. The interviews were conducted after StakeRare was applied to RALIC. As StakeRare was evaluated by surveying the stakeholders, conducting the interviews after the surveys prevents the survey answers from being influenced by the interviews.

Table 4-11: Partial Ground Truth of Requirements[44]

Project Objective	Requirement	Specific Requirement
(1) [45] better user experience	(1) all in 1 card	(1.5) combine ID card and session card (1.5) combine library card (3) combine Bloomsbury fitness card (4) the combine card should not have too many features
(2) to improve security and access control in UCL	(1) ensure appropriate access for each individual	Information about the access rights for each UCL person type is excluded here as it contains sensitive information related to UCL's security.

[44] The complete ground truth of requirements is available in Appendix B.

[45] The ranks are provided in brackets. Fractional ranking or "1 2.5 2.5 4" ranking (Triola, 1992) is used.

Project Objective	Requirement	Specific Requirement
	(2) control access to UCL buildings	(1) control access to departments (2) control access to library (3) control access to Bloomsbury (4) control access to computer cluster (5) control access to high hazard area (7) control access to access Kathleen Lonsdale (7) control access to private offices (7) control access to rooms
	(3) increase access control to buildings	easy to install new readers
	(4) enable visual checking	(1) enable photo visual checks (2) visual checking cardholder’s role
	(5) access control to include movement tracking/logs	(1) movement tracking/logs in the library (2) movement tracking in buildings other than library (3) use card to mark attendance

During the interviews, the stakeholders were provided with the description of the RALIC project and reminded about the purpose of the study, which was to identify and prioritise requirements. The stakeholders were also provided with the ground truth, and the purpose of the ground truth to evaluate StakeRare's output was explained to them. The stakeholders were asked to inspect the ground truth and were presented with the following questions:

- Are there any project objectives, requirements, and specific requirements that are missing from the ground truth?
- Are there any project objectives, requirements, and specific requirements that should not be included in the ground truth?
- Are any of requirements incorrectly prioritised? If so, why?

The feedback based on the questions was used to amend the ground truth. Missing requirements that were pointed out were confirmed with project documentation as this work considers only documented requirements. The interviews revealed that the ground truth of requirements was complete. However, some stakeholders pointed out that as the project was completed a while ago, they may not have remembered all the requirements, and the best way to check for completeness would be to consult the project documentation.

Disagreements in the prioritisations were confirmed with the other stakeholders and justified before amendments were made to the ground truth. For example, the original ground truth listed the project objective "compatibility with existing UCL systems" as equally important as the objective "better data quality." But according to the stakeholders, compatibility with existing UCL systems was *desirable* when selecting the off-the-shelf access control system, but improving the quality of the UCL people data was *highly crucial* to the project. Hence, the objective "compatibility with existing UCL systems" was adjusted to have less priority compared to the objective "better data quality."

The interviews increased the confidence that the ground truth is objective and accurate, and is representative of the actual requirements and their prioritisations in RALIC.

To summarise, the existing method list of requirements is an unprioritised list of requirements identified by the project team at the start of the project using existing methods. It consists of 10 project objectives, 43 requirements, and 56 specific requirements. The ground truth of requirements is the actual list of requirements identified after the system was deployed, prioritised based on their importance in the project. The ground truth consists of 10 project objectives, 43 requirements, and 80 specific requirements. Some requirements in the existing method list are not in the ground truth, and vice versa.

4.5 Summary

This chapter studies the RALIC project to produce the knowledge and data necessary to evaluate the methods developed in this work. The output is:

- the list of stakeholders produced from the existing methods used in the project,
- the ground truth of stakeholders,
- the list of requirements produced from the existing methods used in the project, and
- the ground truth of requirements.

The stakeholder lists are used to evaluate StakeNet described in the next chapter, and the requirements lists are used to evaluate StakeRare described in Chapter 6.

Chapter 5

StakeNet

This chapter reviews the existing literature in social network analysis, describes the application of social networks to requirements elicitation in StakeNet, and reports the evaluation of StakeNet using the RALIC project.

Identifying and prioritising stakeholders and their requirements in large-scale projects are far from trivial. This work aims to develop a method to identify and prioritise stakeholders and their requirements in large-scale software projects. The research methodology described in Chapter 3 separates the work into a method to identify and prioritise stakeholders, a method to identify and prioritise requirements from these stakeholders, and a software tool that supports the two methods. To identify and prioritise stakeholders, this work has developed StakeNet[46], a method that asks stakeholders to recommend other stakeholders, builds a social network with stakeholders as nodes and their recommendations as links, and prioritises stakeholders using various social network measures. The idea behind StakeNet is to be open and inclusive, so that each stakeholder participates in the stakeholder analysis process. As stakeholders are socially related to one another, StakeNet identifies and prioritises them using their relations.

---

[46] StakeNet has been published as Soo Ling Lim, Daniele Quercia, and Anthony Finkelstein. (2010) StakeNet: using social networks to analyse the stakeholders of large-scale software projects, in *Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering-Volume 1*. Association for Computing Machinery, New York. pp. 295-304.

This chapter reviews the existing literature in social network analysis that informs the development of StakeNet, describes StakeNet, and reports its evaluation using the RALIC project described in the previous chapter.

5.1 Social Network Analysis

Social network analysis is the application of methods to understand the relationships among actors, and on the patterns and implications of the relationships (Wasserman and Faust, 1994). A social network is a structure that consists of actors and the relation(s) defined on them (Wasserman and Faust, 1994, Scott, 2000). Actors are discrete individuals, corporate, or collective social units, such as employees within a department, departments within a corporation, and private companies in a city (Wasserman and Faust, 1994). These actors are linked to one another by relational or social ties. The kind of ties is extensive, such as evaluation of one person by another (e.g., friendship, liking, or respect), transfers of material resources (e.g., business transaction), association or affiliation (e.g., belonging to the same social club), and formal relations (e.g., authority) (Wasserman and Faust, 1994).

Social Network Data

Social network data consists of actors and their relations. For example, a network of interaction relation among four people in a social event consists of the names of each person in the network, and the other people in the network with whom the actor has interacted. This network can be represented in a matrix (Table 5-1): Alice interacted with Bob, Bob interacted with Carl, and Dave interacted with Alice and Carl.

Table 5-1: Data for Interaction Network

	Alice	Bob	Carl	Dave
Alice	–	1	0	1
Bob	–	–	1	0
Carl	–	–	–	1
Dave	–	–	–	–

Relations can be binary or valued, undirected or directed. The simplest relational data is binary and undirected (Scott, 2000), such as the previous interaction example. In binary relations, the relations either exist between the pairs of actors or not at all. However, the relations in social networks are often valued such that the relations have varying strength or intensity (Wasserman and Faust, 1994). Examples of valued relations are the frequency of interaction among pairs of people, or the rating of friendship between people in a group. Many relations are also directional, with the ties orienting from one actor to another (Wasserman and Faust, 1994). An example of a directional relation is the import or export of goods from one nation to another (Wasserman and Faust, 1994). Some relations are both valued and directional, such as the dollar amount of goods exported from one country to another (Wasserman and Faust, 1994). Country *A* may export a different amount to country *B* than country *B* to country *A*.

A social network is often depicted as a graph in which the actors are represented as nodes and the relationships among the pairs of actors are represented by lines linking the corresponding nodes (Wasserman and Faust, 1994, Scott, 2000). Figure 5-1 (a) illustrates a binary undirected graph. Directional relations are represented as a directed graph (Figure 5-1 (b)), and valued and directional relations are represented as a weighted directed graph, whereby each line on the network has a value or magnitude attached to it (Figure 5-1 (c)). Finally, Figure 5-1 (d) illustrates a weighted undirected graph. Using graph structures to represent social networks enables large sets of social network data to be visualised (e.g., Figure 5-2).

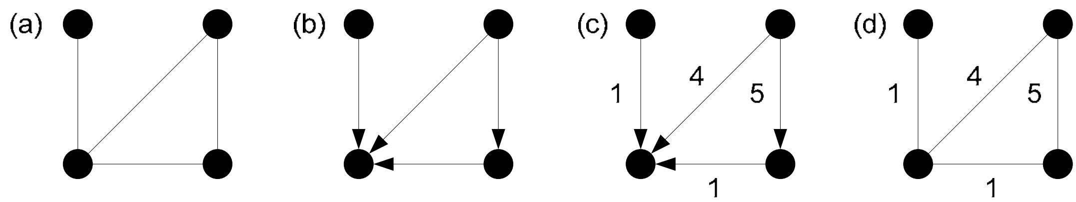


Figure 5-1: (a) Binary undirected graph, (b) binary directed graph, (c) weighted directed graph, and (d) weighted undirected graph.

Data Collection

Questionnaire is the most common data collection method, especially when the actors are people (Wasserman and Faust, 1994). The questionnaire usually contains questions about the respondent's ties to the other actors. For example, respondents can be asked to report on the people they like, respect, or seek advice from. Three different question formats can be used in a questionnaire (Wasserman and Faust, 1994).

- **Roster vs. free recall**. Roster is where each respondent is presented with a complete list of the other actors in the actor set. Rosters can only be provided when all the actors are known prior to data gathering. However, in many network designs, it is not possible to know all the actors beforehand. In free recall, the question asks respondents to "name the people with whom you (fill in specific tie)," and the respondents are responsible to generate the list of names (Wasserman and Faust, 1994).

- **Fixed vs. free choice**. Fixed choice is where respondents are told how many other actors to nominate on a questionnaire. In contrast, free choice is where respondents are not given any constraints on the number of nominations to make (Wasserman and Faust, 1994).

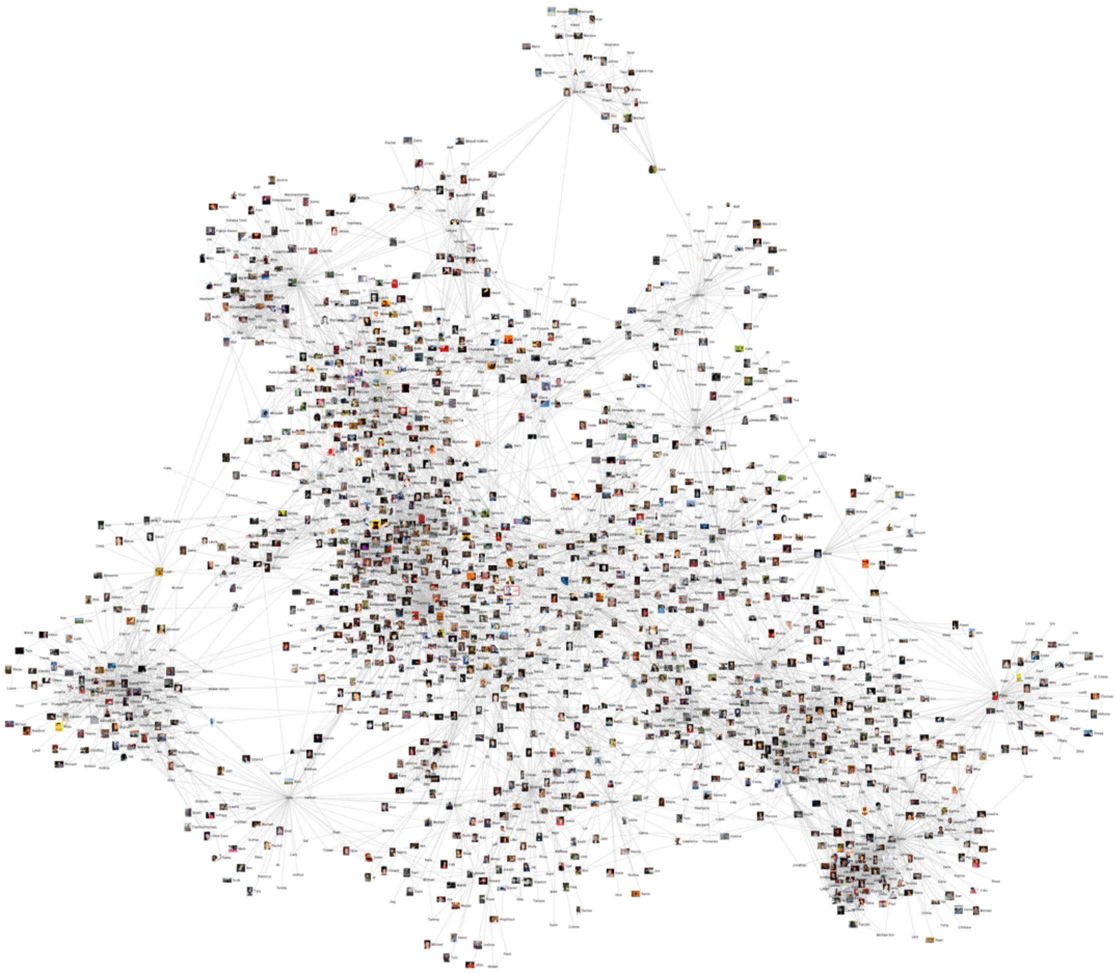


Figure 5-2: Large social network[47] (Heer and Boyd, 2005) (reproduced with permission).

- **Complete rankings vs. ratings**. In complete rankings, respondents are asked to rank order their ties to all other actors in the network. In ratings, respondents are asked to assign a value or rating to each tie. These responses produce valued relations. Studies with binary relations only require respondents to provide the ties without rankings or ratings (Wasserman and Faust, 1994).

---

[47] A sample of the Friendster social networking service (http://www.friendster.com/) visualised by Vizster (http://hci.stanford.edu/jheer/projects/vizster/), a visualisation tool for online social networks.

In some situations, questionnaires are infeasible. Interviews, either face-to-face or over the telephone, can also be used to collect network data (Wasserman and Faust, 1994). Some studies use observations, where the interactions among actors are observed (Wasserman and Faust, 1994). This method is useful in situations where actors are unable to respond to questionnaires or interviews, and is widely used to study small groups of people who have face-to-face interactions with one another. To reconstruct ties that existed in the past, such as previously published citations of one scholar by another, archival records can be used (Wasserman and Faust, 1994).

Snowball Sampling

Many network studies focus on small collectives, such as classrooms, offices, where the set of actors and their boundary is clearly defined. However, in some studies, the boundary is unknown. In such situations, the snowball sampling technique proposed by Goodman (1961) is used to define the boundary of the actor set. Snowball sampling is also used when it is not possible to take measurements on all the actors in the relevant actor set, for example, in very large social networks (Wasserman and Faust, 1994, Scott, 2000). It is also used to track down "special" or "hidden" populations, such as business contact networks, community elites, and deviant sub-cultures (Hanneman and Riddle, 2005).

Snowball sampling begins with a set of actors (Wasserman and Faust, 1994, Scott, 2000, Hanneman and Riddle, 2005). Each of these actors is asked to nominate other actors for the study. Then, new actors who are not part of the original list are similarly asked to nominate other actors for the study. As the process continues, the group of actors under study builds up like a snowball rolled down a hill, which results in a well-connected network (Scott, 2000). The process continues until no new actors are identified, time or resources have run out, or when the new actors being named are very marginal to the actor set under study (Hanneman and Riddle, 2005). When using snowball sampling, thought should be given to the selection of the initial actors. Starting with the wrong initial actors risks missing out the whole subset of actors who are connected to one another but not with the initial actors (Hanneman and Riddle, 2005).

Social Network Measures

The centrality of actors in their social networks is of great interest to social network analysts (Scott, 2000). Actors that are more central have a more favourable position in the network (Hanneman and Riddle, 2005). For example, in a friendship network, an actor who is connected to many actors in the network is popular. In a business contact network, an actor that sits in between clusters of networks has high influence on the information that passes between the clusters. A number of different social network measures have been developed to measure the centrality of social network actors, each with their own definition of centrality (Wasserman and Faust, 1994, Scott, 2000, Hanneman and Riddle, 2005).

In degree centrality, actors who have more ties to other actors have advantaged positions (Scott, 2000). With undirected relations, actors differ from one another in the number of connections they have. With directed relations, actors can be measured based on their in-degree and out-degree centrality (Wasserman and Faust, 1994). The in-degree of a node is the number of nodes that point to it. In-degree can measure receptivity or popularity. For example, in a friendship relation, an actor who is nominated by many actors as friends has a high in-degree and is popular, but an actor who is nominated by only a few people has a lower in-degree and is less popular. The out-degree of a node is the number of nodes that it points to. Out-degree can measure expansiveness of a node. For example, in a friendship relation, an actor who nominates many people as friends has a high out-degree and enjoys company, but an actor who nominates very few people as friends has a low out-degree and is less sociable.

Degree centrality considers only direct connections between a node and its immediate nodes (Scott, 2000). Other social network measures, such as closeness centrality and betweenness centrality, consider the overall structure of the network (Scott, 2000). Closeness centrality considers an actor to have a central position if the distance of an actor to all others in the network is short (Scott, 2000). Betweenness centrality measures the extent to which a node sits between other nodes in the network (Brandes, 2001). This measure takes into account the connectivity of the node's neighbours, giving a higher value for nodes that bridge clusters of the network.

There are numerous other measures used to analyse social networks. In load centrality, a data packet (or any commodity) is transmitted from a node to each other node in the network. Starting from the source, the data packet is always passed to the adjacent node closest to the target, and if there is more than one such node, the data packet is divided equally among them. The load centrality of a node is then the total amount of the packets that pass through the node during all the data exchanges (Goh et al., 2001, Brandes, 2008). Another popular social network measure is PageRank (Page et al., 1998, Brin and Page, 1998), used by Google[48] to rank pages that contain authoritative information on the Internet. In essence, PageRank interprets a link from page *A* to page *B* as a vote by page *A* for page *B*. To rank the pages, PageRank considers more than the sheer number of links a page receives; it also analyses the page that casts the vote. Votes cast by pages that are authoritative weigh more heavily. Similar to closeness centrality

[48] http://www.google.com

and betweenness centrality, both load centrality and PageRank consider the whole network in their analysis.

Applications in Software Engineering

Social network analysis has been used in software engineering. Lopez-Fernandez et al. (2004) applied social network analysis to the information in software revision control repositories. In their work, two weighted undirected networks were built. In one network, the nodes were the developers who committed a software module (also known as committer). Two nodes were linked if the committers contributed to at least one common module, and the weight of the link was the number of commits performed by both developers to all common modules. In another network, the nodes were the software modules in the project. Two modules were linked when there was at least one committer who contributed to both of them. The links were weighted by the total number of commits performed by committers common to both modules. The networks were then characterised using social network measures, such as degree centrality, closeness centrality, and betweenness centrality. Their analysis of the top modules and developers for each measure provided insight into the internal structure of the projects under study.

Social network analysis has also been used to predict software failure. For example, Zimmermann and Nagappan (2008) used social networks to predict central programs that are more likely to have defects. In their work, nodes are the binary files in a software system and the links are the dependencies between the binary files. They empirically evaluated their method using measurements including precision, recall, and Pearson's correlation coefficient. Wolf et al. (2009) used social network analysis to study the communication structures of software project teams. They combined communication structure measures to predict whether a software integration will fail. Meneely et al. (2008) modelled how developers collaborate using social networks and showed that it can help to predict software failures at the file level.

To study the collaboration and coordination in distributed teams, Sarma et al. (2009) visualised the socio-technical relationships in software development as social networks. Damian et al. used social network analysis to study collaboration, communication, and awareness among project team members (Damian et al., 2007, Damian et al., 2010). In their work, the nodes were members of the development team who are working on, assigned to, or communicating about the requirements in the project. Social network measures, such as degree centrality and betweenness centrality, were used to analyse the collaboration behaviour. For example, degree centrality indicated active members and betweenness centrality indicated members who control interactions between other members.

Finally, social networks have also been used for stakeholder analysis in the domain of natural resource management (Prell et al., 2009). In Prell et al.'s work, the stakeholders of a national park project were identified using focus groups and interviews. Then, a subset of the stakeholders was studied using social network analysis. Each stakeholder in this subset was provided with the names of all the other stakeholders in the subset and asked to rate their communication with these other stakeholders between 1 (not often) and 5 (very often). The data was used to build a social network, and social network measures such as betweenness centrality and degree centrality were used to analyse the network.

To summarise, social network analysis studies the relationships among actors, the patterns and the implications of the relationships. Social network data consists of actors and their relations, which can be binary or valued, directed or undirected. Social network data is often collected using questionnaires. The snowballing method is used to sample social network data for large networks where the boundary is unknown. A social network can be depicted as a graph with actors as nodes and their relations as links. If the relations are directed, then the links have direction and if the relations are valued, the links have weights attached to them. Social network measures are used to analyse an actor's position in the network. Some measures consider direct connections between a node and its immediate nodes; others consider the overall structure of the network.

5.2 StakeNet

This work hypothesises that social networks can be used to provide effective support for stakeholder analysis in large-scale software projects. To test the hypothesis, a method that uses social networks to analyse stakeholders, StakeNet, has been developed. StakeNet uses the snowball sampling technique described in the previous section by asking stakeholders to recommend other stakeholders. It also uses questionnaires to collect the recommendations, which consist of the stakeholders' names, their roles and the level of influence the stakeholders have on the project. A social network is built with stakeholders as nodes and their recommendations as links weighted by the level of influence. Finally, StakeNet prioritises the stakeholders using a variety of social network measures. StakeNet uses the existing stakeholder analysis concepts described in Chapter 2. The concepts are summarised in Table 5-2.

StakeNet identifies and prioritises stakeholders using the following steps (Figure 5-3).

Figure 5-3: StakeNet steps.

Table 5-2: StakeNet Concepts

Concept	Definition
Scope	The work required for completing the project successfully (Robertson and Robertson, 2006).
Stakeholder	An individual or a group who can influence or be influenced by the success or failure of a project (Nuseibeh and Easterbrook, 2000).
Stakeholder role	The stakeholder's position or customary function in the project (Sharp et al., 1999).
Stake	An interest, investment, share, or involvement in the project, as in hope of gain[49].
Salience	The level of influence a stakeholder has on the project (Mitchell et al., 1997). Stakeholders with high salience are crucial to project success; stakeholders with low salience have marginal impact.

Step 1: Define Scope

This step determines the project scope, which is a preparatory step adopted from the existing requirements engineering literature, whereby requirements elicitation starts with the identification of project scope (Robertson and Robertson, 2006, Van Lamsweerde, 2009). Scope describes the boundary of the project so that the stakeholders who should be involved can be identified. For example, the scope of the RALIC project (Table 4-1, page 74) included installing new card readers throughout the university but excluded changing the existing systems in student residences. Hence, the Estates director was a stakeholder but the Student Residences director was not.

Step 2: Identify Roles

Based on the project scope from the previous step, Step 2 identifies initial stakeholder roles from the predefined categories of users, developers, legislators, and decision-makers. These predefined categories of stakeholder roles are adopted from the search method by Sharp et al. (1999) described in Section 2.1 (page 29). The quality of the data resulting from the snowball sampling technique depends on the initial set of actors. As such, the use of established categories in this step increases the coverage of the resulting network. For example, in the

---

[49] http://dictionary.reference.com/browse/stake

RALIC project, users included students, staff, and security guards; developers included software vendor, and interface developer; legislators included data protection officer; and decision-makers included the director of Estates.

Step 3: Find Stakeholders

In Step 2, only the roles of the stakeholders are identified. Step 3 identifies the actual stakeholders for each role. If an individual role is suggested (e.g., director of Estates), the stakeholder is the person taking up the role (e.g., Alice), unless she nominates someone else. If a group is suggested, the default representatives of the group are used if they already exist. For example, in the RALIC project, the group "staff" was represented by the staff union representatives. If no default representatives exist, the people who hold the role are asked to nominate a representative. For example, in RALIC, for the group "security guards", the security guards were asked to nominate their colleagues.

Step 4: Get Recommendations

This step collects the stake and recommendations from each stakeholder. The stake explains the particular way the stakeholder influences the project, or is influenced by it. For example, in RALIC, students depended on the system to access university buildings and library resources, and the funding director determined the project budget.

In this step, the stakeholders are asked to recommend other stakeholders in the project. A recommendation is a triple

<*stakeholder*, *stakeholder role*, *salience*>,

where salience (the influence of a stakeholder in the project) is a number on an ordinal scale (e.g., 1 – 5 where 1 indicates low salience and 5 indicates high salience). For example, if Alice believes Bob from the Library to be a salient stakeholder, Alice can make a recommendation

<Bob, Library, 4>.

To have a broad coverage of stakeholders and their roles, the snowball sampling technique described in the previous section is used. To do so, Step 4 is repeated for each new stakeholder, so that recommended stakeholders are, in turn, asked for further recommendations. For example, Bob makes a recommendation

<Carl, Students, 1>,

Carl then makes a recommendation

<Dave, Students, 5>,

and so on. The group of identified stakeholders builds up like a snowball rolled down a hill. Eventually, few additional stakeholder roles are identified in each round of interviews. The snowballing stops when no new stakeholder roles are identified in one round of interviews.

Stakeholders may make an incomplete recommendation

<*stakeholder role*, *salience*>

if they are unaware of actual stakeholders. If the role has existing stakeholders, then the recommendation is connected to *all* existing stakeholders. For example, Alice makes a recommendation

<Students, 2>.

Since Carl and Dave are recommended as students, they are linked to Alice's recommendation. This means that Alice is assumed to make the two recommendations

<Carl, Students, 2>, and <Dave, Students, 2>.

If the role does not have existing stakeholders, return to Step 3 to find stakeholders.

Step 5: Build Network

This step builds a social network with the stakeholders as nodes, and their recommendations as weighted directed links such that stakeholder *A* links to stakeholder *B* if *A* believes *B* to be a stakeholder, and the weights are determined by the salience values that come with the recommendations. The weights of the links are either the *salience* or the *reversed order of salience*, depending on the social network measure used in Step 6.

Social network measures that interpret link values directly as strength of recommendation (e.g., degree centrality) use salience as the weights of the links. Social network measures that interpret link values as lengths (e.g., betweenness centrality) use the reversed order of salience. By interpreting link values as lengths, *lower link values* correspond to *shorter distances* between nodes, which imply *stronger ties* and higher salience. Hence, the *reverse order of salience* is used as weights, where high salience is reflected as low link value, and low salience as high link value (Brandes, 2008).

The *reversed order of salience* is calculated by subtracting the salience from the upper bound of *maximum salience + 1* (Brandes, 2008). Figure 5-4 illustrates an example stakeholder network where Alice recommends Bob as salience 4 and Carl as salience 2; Bob recommends Alice as salience 5 and Carl as salience 1; Carl recommends Dave as salience 5; and Dave does not recommend anyone. The values in brackets are the *reversed order of salience* where the *maximum salience* is 5.

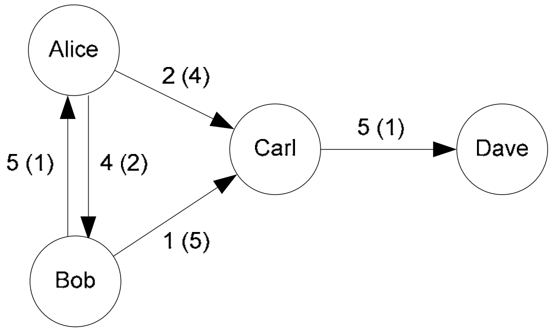


Figure 5-4: A network of stakeholders.

Step 6: Prioritise Stakeholders

Given the social network in Step 5, this step applies various social network measures to prioritise the stakeholders. The social network measures mentioned in the previous section are used: betweenness centrality, closeness centrality, load centrality, degree centrality, in-degree centrality, out-degree centrality, and PageRank.

The input for the social network measures is the stakeholders and their recommendations. PageRank, degree centrality, in-degree centrality, and out-degree centrality use salience as link weights. The input for these measures for the stakeholder network in Figure 5-4 is illustrated in Table 5-3. Betweenness centrality, load centrality, and closeness centrality use the reversed order of salience as link weights. The input for these measures for the stakeholder network in Figure 5-4 is illustrated in Table 5-4.

Table 5-3: Input for PageRank, Degree, In-degree, and Out-degree for the Stakeholder Network in Figure 5-4

Stakeholder	Recommend	Salience
Alice	Bob	4
Alice	Carl	2
Bob	Alice	5
Bob	Carl	1
Carl	Dave	5

Table 5-4: Input for Betweenness, Load, and Closeness for the Stakeholder Network in Figure 5-4

Stakeholder	Recommend	Reversed Order of Salience
Alice	Bob	2
Alice	Carl	4
Bob	Alice	1
Bob	Carl	5
Carl	Dave	1

Each measure prioritises different kinds of stakeholders as follows.

- **Betweenness centrality** (Brandes, 2001). This measure ranks stakeholder *S* based on *S*'s ability to act as a broker between disparate groups of stakeholders. This measure sums the number of shortest paths between other pairs of stakeholders that pass through *S*. In Figure 5-4, Carl is ranked the highest because Alice and Bob both need to go through him to get to Dave. He is followed by Alice, as Bob can get to Carl directly or go through Alice, with equal distance of 5. Bob and Dave share the lowest rank as they do not appear between the shortest paths of other nodes. The notion is that stakeholders who play powerful roles in connecting the network are salient stakeholders. When interpreting high betweenness centrality as good brokers, this work assumes that stakeholders recommend other stakeholders whom they interact with.
- **Load centrality** (Brandes, 2008). This measure ranks stakeholder *S* based on *S*'s influence over the flow of information between every pair of stakeholders. Each stakeholder sends a unit of information to each other stakeholder. Starting from the source stakeholder, the information is always passed to the adjacent stakeholder closest to the target, and if there is more than one such stakeholder, the information is divided equally among them. The load of *S* is the total amount of information passing through *S* during all these exchanges. In Figure 5-4, Carl has the highest rank as he has two units of information passing through him from Alice and Bob to Dave. All the others share the lowest rank because no information passes through them. The notion is stakeholders who have control over information are salient stakeholders. This assumes stakeholders recommend other stakeholders whom they interact with.
- **Closeness centrality** (Scott, 2000). This measure ranks stakeholder *S* based on the inverse average shortest-path distance from *S* to all other reachable stakeholders. This measure prioritises stakeholders who reach others in the network quickly. In Figure 5-4,

Carl ranks the highest because he reaches Dave with a high inverse average distance. He is followed by Alice with the inverse average distance of $\frac{3}{2+4+5}$, Bob with $\frac{3}{1+5+6}$, and Dave with zero. The notion is that stakeholders who can access others in the network quickly, are salient stakeholders. Again, this assumes that stakeholders recommend other stakeholders whom they interact with.

- **PageRank** (Page et al., 1998, Brin and Page, 1998). This measure ranks stakeholder *S* in terms of *S*'s relative importance to all other stakeholders. This measure is recursive in that stakeholders who are strongly recommended by many salient stakeholders are salient, and the recommendations of a highly salient stakeholder deserve more weight, which, in turn, makes their recommended stakeholders salient. In Figure 5-4, Alice and Dave both have a recommendation of 5, but Alice ranks higher as she is recommended by Bob, who ranks higher than Carl. Carl has the lowest rank due to the low salience recommendations from Alice and Bob.

- **Degree centrality** (Scott, 2000). This measure ranks stakeholder *S* based on the number of incoming and outgoing recommendations *S* has and the weight of the recommendations. In Figure 5-4, Alice ranks the highest as she has the most connections with most weight 5 + 4 + 2, followed by Bob with 5 + 4 + 1, Carl with 1 + 2 + 5, and Dave with 5. The notion is that stakeholders who have a high number of direct connections with others are active and hence salient stakeholders.

- **In-degree centrality** (Scott, 2000). This measure ranks stakeholder *S* based on the number of stakeholders that recommend *S* and the recommendation weights. In Figure 5-4, Dave and Alice rank the highest as they have a recommendation of weight 5, followed by Bob with a recommendation of weight 4, and Carl with two recommendations of weights 1 and 2. The notion is that stakeholders that are strongly recommended by many, are salient stakeholders.

- **Out-degree centrality** (Scott, 2000). This measure ranks stakeholder *S* based on the number of recommendation *S* makes and the weights of the recommendations. In Figure 5-4, Alice and Bob rank the highest as they recommend two other stakeholders with a total weight of 6, followed by Carl with a total weight of 5, and Dave with zero. The notion is that stakeholders who strongly recommend many are concerned or knowledgeable about the project and hence are salient stakeholders.

Each measure produces a list of all the stakeholders in the network and their corresponding scores (e.g., Table 5-5). The stakeholders in the list are grouped according to their roles. Within each role, stakeholders who have a higher score are prioritised first. Then, the roles are prioritised based on the score of their highest priority stakeholder. Fractional ranking or “1 2.5 2.5 4” ranking (Triola, 1992) is used to rank the stakeholders and their roles. The final output for each measure is a prioritised list of stakeholder roles, and within each role, a prioritised list of stakeholders (Table 5-6).

Table 5-5: Output by PageRank

Stakeholder	Score
Alice	0.27172082011782839
Dave	0.27158937866369132
Bob	0.24918787616346233
Carl	0.20750192505501802

Table 5-6: Final Output[50] for PageRank Based on Table 5-5

Prioritised Stakeholder Roles	Prioritised Stakeholders
(1) Estates	Alice
(2) Students	(1) Dave
	(2) Carl
(3) Library	Bob

5.3 Evaluation

The goal of StakeNet is to identify and prioritise stakeholders and their roles. StakeNet identifies stakeholders and their roles using snowball sampling and prioritises the stakeholders using various social network measures. To evaluate StakeNet, the methodology described in Section 3.2 (page 65) was used to apply StakeNet to the RALIC project described in the previous chapter.

Applying StakeNet to RALIC

Using Step 1 of StakeNet, the project scope for RALIC (Table 4-1, page 74) were listed. For example, Scope 1 was to replace magnetic swipe card readers with proximity readers to improve usability and reliability of the access control system. Scope 2 was to source and install access

[50] The ranks are provided in brackets. Fractional ranking or “1 2.5 2.5 4” ranking (Triola, 1992) is used.

card printers that could reliably print digital photos, person information, library bar codes and encode smart card chips.

Using Step 2, the initial stakeholder roles were identified. The users were students, visitors, library, and Security Services. The developers were project manager, interface developer, maintenance team, and access control system vendor. The legislators were data protection officer and Development & Corporate Communications Office, and the decision-makers were the Vice Provost and the directors of Information Services Division, Estates and Facilities Division, and Management Systems Division. This step identified 15 stakeholder roles.

Using Step 3, the stakeholders for the initial stakeholder roles were then identified. Steele[51] was identified to be a stakeholder representing students, Johnson representing medical students, Dawson and Ortiz representing Access and Security Systems. Step 3 was repeated for all the initial stakeholder roles to produce 22 initial stakeholders. Some stakeholder roles had more than one stakeholder. The initial stakeholders and their roles were identified before the ground truth was constructed[52] to avoid knowledge about the stakeholders from affecting the determination of the initial stakeholders, which can influence the quality of the final set of stakeholders.

In Step 4, the stakeholders identified in Step 3 were contacted separately via email for a survey (Figure 5-5). This survey was separate from the interviews conducted to validate the ground truth described in the previous chapter (Section 4.3, page 93). Those interviews were conducted after the survey, so that the stakeholders' answers were not influenced by the interviews for the ground truth. If the stakeholder's response was positive (e.g., Figure 5-6(a) and (b)), a time and place would be arranged for a face-to-face survey. If the stakeholder's response was negative (e.g., Figure 5-6(c)), the stakeholder would not be surveyed. For stakeholders with no response, a call was made to check if they received the email and to determine if they wanted to participate in the survey.

Each survey took an hour on average. At the start of each survey, the respondent was provided with a cover sheet describing the survey purpose to identify RALIC stakeholders (Figure 5-7). Then, StakeNet was introduced using a set of slides (Figure 5-8). To prompt the respondent for recommendations, the respondent was provided with the definitions of stakeholder, role, and salience, as well as possible types of stakeholders and examples (Figure 5-9). Then, the respondent was provided with a summary of the RALIC project scope (Figure 5-10), and the background for the RALIC project was explained to familiarise the respondent with the project.

---

[51] Names have been made anonymous for reasons of privacy.

[52] For details about the ground truth construction, refer to Section 4.3, page 93.

From: <S.Lim@cs.ucl.ac.uk>
To: [redacted]
Sent: Thursday, April 23, 2009 9:51 PM
Subject: RALIC Project - Identification of Stakeholders

Dear D[redacted],

I am a PhD student from the Department of Computer Science, working with Professor Anthony Finkelstein. My research is on identifying stakeholders for a software project. I have developed an approach to find and rank stakeholders and I am currently using the RALIC project to test it out, with M[redacted]'s permission.

Can I organise a meeting with you to briefly explain my work and conduct a survey? It should take about 20 minutes.

Thank you!

Regards,
Soo Ling

Figure 5-5: Email to stakeholder for survey.

(a)

From: "D[redacted]
To: <S.Lim@cs.ucl.ac.uk>
Cc: [redacted]; [redacted]
Sent: Friday, April 24, 2009 9:20 AM
Subject: Re: RALIC Project - Identification of Stakeholders

Hi Soo,

that is fine and happy to meet. Please contact my PA R[redacted] cc'd above to arrange the meeting. I think it would also be useful for our IT Manager I[redacted] to attend and he is cc'd as well. I hope this is ok by you.

Best regards,

D[redacted]

D[redacted]
General Manager
UCL Union
25 Gordon Street
London
WC1H 0AY

(b)

From: "A[redacted]
To: "S.Lim" <S.Lim@cs.ucl.ac.uk>
Sent: Friday, April 24, 2009 9:24 AM
Subject: RE: RALIC Project - Identification of Stakeholders

Dear Soo,

I would be happy to help with your research.

I work at 51 Gordon Square. We could meet there.

Times when I am available next week:
Monday 27th 11.30 - 12.30
Wednesday 29th All mmorning
Thursday 30th All morning

Please pick a time in these periods. If none are convenient for you, please let me know and I will suggest others.

Regards,
A[redacted]

(c)

From: "V[redacted]
To: "Soo Ling Lim" <s.lim@cs.ucl.ac.uk>
Sent: Monday, April 27, 2009 1:54 PM
Subject: RE: RALIC Project - Identification of Stakeholders

Sorry to disappoint you, but I have no involvement with the RALIC project.

V[redacted]

Figure 5-6: Responses from stakeholders.

Stakeholder Identification Survey

As part of our research at the Department of Computer Science, we have developed a method to identify the stakeholders of a software project.

The survey aims to collect project data for testing the method. It should take less than 30 minutes to complete.

Your name and answers are confidential and will be used strictly for research.

Thank you for your participation.

Regards,

Soo Ling Lim
Dr. Daniele Quercia
Professor Anthony Finkelstein

Figure 5-7: Survey cover sheet.

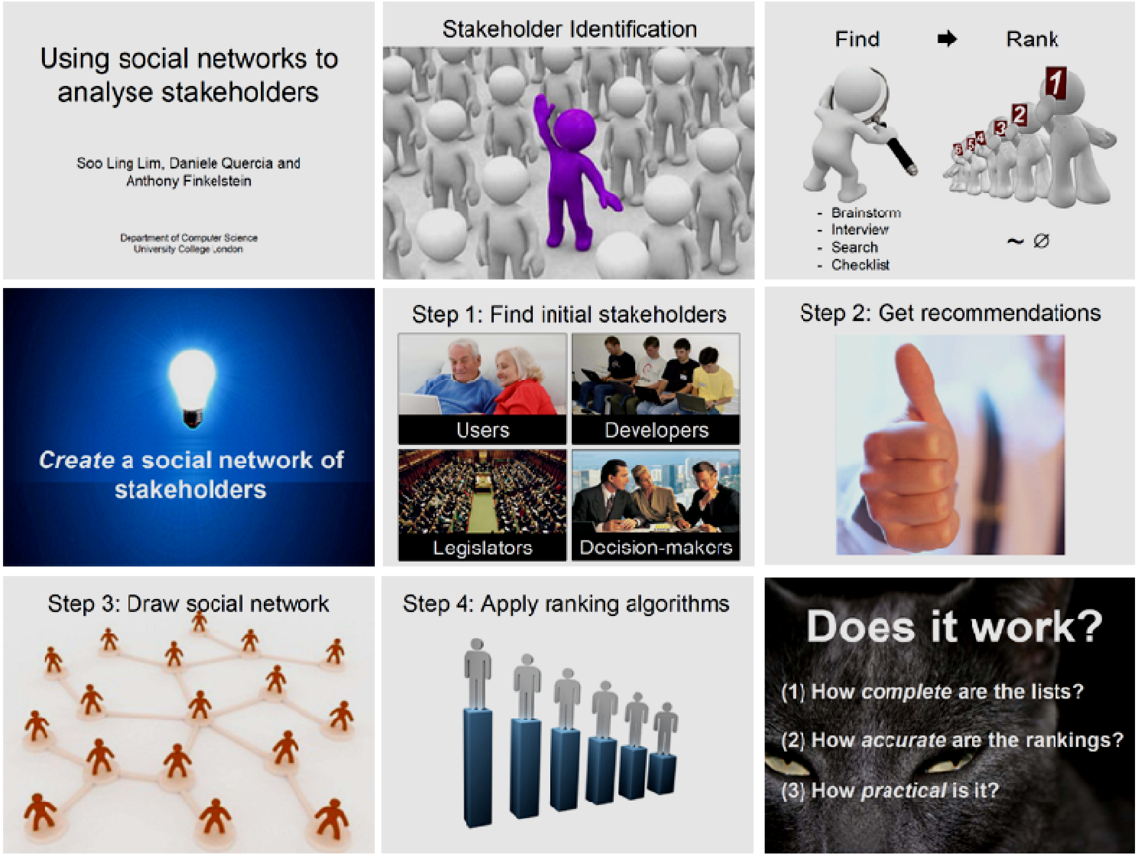


Figure 5-8: Slides to introduce StakeNet.

Stakeholders and their Salience

A **stakeholder** is a person or group who *can affect* or *is affected by* the *success* or *failure* of a software system.

A stakeholder can be someone who:
- *finances* or *makes decision on* the development of the system;
- *develops* the system;
- *imposes rules* on the development or operation of the system;
- *uses* the system or its output; or
- *threatens* the success of the system.

Examples of stakeholders and their roles are John Doe (Developer), Jane Doe (Student).

Salience is the *level of influence* a stakeholder has on the system.

For example:
- A stakeholder with high salience plays a crucial role in the success of the system.
- A stakeholder with lower salience has less impact on the system.
- A person with no salience is not a stakeholder.

Figure 5-9: Definitions and types of stakeholders[53].

[53] The types of stakeholders are adopted from Alexander and Robertson (2004).

Below is a summarised scope for the RALIC project.

1. Replace magnetic swipe card readers with smart card readers
2. Source and install access card printers
3. Decide on card design and categories
4. Define user groups and default access rights
5. Provide a more accurate card holder database, save resources on manual data input, and facilitate automated provision and suspension of access and library borrowing rights
6. Issue new cards to staff, students, visitors and contractors
7. Replace the Library access control system
8. Use new cards at the Bloomsbury Fitness Centre

Figure 5-10: RALIC project scope.

During the survey, the respondents' recommendations were collected using a questionnaire that consists of the following parts[54].

- **Stakeholder details**. Respondents are requested to provide their name, position, department, and role in the project (Figure 5-11(a)). Respondents with informal roles are asked to describe their stake in RALIC (Figure 5-11(b)).
- **Open-ended recommendations (OpenR)**. For each item in the RALIC project scope (Figure 5-10), respondents are requested to make recommendations in the form of *<stakeholder, stakeholder role, salience>* (Figure 5-11(c)). OpenR must be completed before moving on to the closed-ended recommendations.
- **Closed-ended recommendations (ClosedR)**. Given the project scope, respondents are requested to select stakeholders from a checklist of names and circle their salience (Figure 5-11(d)). The names in the checklist belong to the stakeholders with the initial stakeholder roles. The names of other UCL staff are included in the list to introduce noise. An option is provided for the respondents to check "others" and suggest stakeholders not in the checklist (Figure 5-11(e)). It was emphasised to the respondents that OpenR and ClosedR are separate questionnaires, and once they start on ClosedR, they cannot return to OpenR. Two distinct questionnaires were administered to measure the effect of different survey methods on the results. Open-ended ones were expected to be tedious to complete and closed-ended ones to be restrictive (Babbie, 1973).
- **Individual prioritisations**. Respondents are requested to provide a prioritised list of who they think are the twenty most salient stakeholders (Figure 5-11(f)). These lists enable the comparison of individual prioritisations against the collective prioritisation from StakeNet.

---

[54] The complete questionnaire is available in Appendix C.

(a)

Q1. Please complete the following information about yourself.

Name: K[redacted] LE[redacted]

Position: PROGRAMME MANAGER

Department: ISD

Q2. What is your role in the RALIC project?

TECHNICAL PROJECT MANAGER

(b)

Q1. Please complete the following information about yourself.

Name: K[redacted] NI[redacted]

Position: DIRECTOR, REGISTRY INFORMATION + DATA SERVICES

Department: REGISTRY

Q2. What is your role in the RALIC project?

OWNER OF STUDENT DATA.

(c)

Scope 3: Decide on card design and categories

Name of Stakeholder and Role; or only Name of Role if Stakeholder unknown	Please circle the level of salience.				
	High		Medium		Low
ACCESS SYSTEMS - M[redacted] DA[redacted] +TEAM	5	4	3	2	1
UCL LIBRARY - M RE[redacted] +TEAM	5	4	3	2	1
N[redacted] KY[redacted] - HEAD OF SECURITY	5	4	3	2	1
REGISTRY - C[redacted] COLLSON	5	4	3	2	1
HR - N[redacted] A[redacted]	5	4	3	2	1
SERVICES SYSTEM - T[redacted] PU[redacted]	5	4	3	2	1
OTHER HEIS	5	4	3	2	1
UCL AFFIL NHS TRUSTS.	5	4	3	2	1
ALL UCL ACADEMIC + SERVICE DEPTS	5	4	3	2	1
EQUIPMENT PROVIDERS	5	4	3	2	1
UCL SECURITY STAFF	5	4	3	2	1
LIBRARY SECURITY STAFF	5	4	3	2	1

M[redacted] PA[redacted] 5

CORPORATE COMMUNICATIONS DIVISION 4

(d)

Q1: Who are the stakeholders for the RALIC project?

The following is a list of names in alphabetical order.
Check all that apply and **circle** their level of salience.

Name		←	High salience						Low salience		→
		10	9	8	7	6	5	4	3	2	1
A[redacted] To[redacted]	X	10	9	8	7	6	5	4	3	2	1
A[redacted] Hi[redacted]	X	10	9	8	7	6	5	4	3	2	1
A[redacted] Wi[redacted]	X	10	9	8	7	6	5	4	3	2	1
A[redacted] Ri[redacted]		10	9	8	7	6	5	4	3	2	1
B[redacted] Bo[redacted]	X	10	9	8	7	6	5	4	3	2	1
C[redacted] Co[redacted]	X	10	9	8	7	6	5	4	3	2	1
D[redacted] Sq[redacted]		10	9	8	7	6	5	4	3	2	1
E[redacted] St[redacted]		10	9	8	7	6	5	4	3	2	1
G[redacted] Jo[redacted]		10	9	8	7	6	5	4	3	2	1
J[redacted] Cr[redacted]	X	10	9	8	7	6	5	4	3	2	1
J[redacted] Pe[redacted]	X	10	9	8	7	6	5	4	3	2	1
J[redacted] Or[redacted]	X	10	9	8	7	6	5	4	3	2	1
J[redacted] Mi[redacted]		10	9	8	7	6	5	4	3	2	1

(e)

If you checked others, please **write** the names and roles of the other stakeholders below and **circle** their salience.

Stakeholder	←	High salience						Low salience		→
Name: Role: students + visitors	10	9	8	7	6	5	4	3	2	1
Name: Role: C[redacted] Ha[redacted]	10	9	8	7	6	5	4	3	2	1
Name: Role: V[redacted] Ma[redacted]	10	9	8	7	6	5	4	3	2	1
Name: Dept administrators Role: G. K[redacted] Mi[redacted]	10	9	8	7	6	5	4	3	2	1
Name: Role:	10	9	8	7	6	5	4	3	2	1

(f)

Q2: For all the stakeholders that you have checked in Q1, please rank them by their order of salience (1 being the most salient).

1. S[redacted] Ay[redacted] / R[redacted] F[redacted]
2. J[redacted] Pe[redacted], M[redacted] Da[redacted]
3. N[redacted] Ky[redacted], M[redacted] Pa[redacted],
4. R[redacted] Wi[redacted]
5. M[redacted] Ak[redacted]
6. P[redacted] Ch[redacted]
7. V[redacted] M[redacted]
8. N[redacted] Mc[redacted]/D[redacted] Sq[redacted]
9. J[redacted] Cr[redacted]
10. Ka[redacted] Le[redacted]
11. R[redacted] Cu[redacted]
12. M[redacted] Ba[redacted]
13. J[redacted] Po[redacted], R[redacted] Ba[redacted]
14. K[redacted] P[redacted]
15. R[redacted] Ro[redacted]
16. K[redacted] Ga[redacted]
17. Staff, Students
18. Visitors/Contractors
19. A[redacted] Ri[redacted].
20. Je[redacted] Mi[redacted] / We[redacted] Ri[redacted].

Figure 5-11: StakeNet survey questionnaire.

At the end of the survey, the respondents were interviewed for their survey experience and the rationale behind their answers. Some questions included:

- What do you think about the StakeNet method?
- Who is the person you recommended?
- How is the person involved in the project or affected by it?
- How confident are you in your answers?

The interviews were semi-structured, allowing the questions to be modified and new questions to be brought up depending on what the respondents say (Lindlof and Taylor, 2002). For example, a respondent was keen for StakeNet to be used in his projects, hence the interview focused on exploring the possibilities. Also, while answering the questionnaires, some respondents explained who they recommended, and why those people were stakeholders, hence answering some of the questions before being interviewed.

Each new stakeholder who had just been recommended in the first round was contacted similarly via email for a face-to-face survey. Then each new stakeholder who had just been recommended in the second round was contacted similarly, and so on. For the fourth round, no additional stakeholder roles were identified. At this point, the snowballing should stop. Nevertheless, for evaluation purposes, some of the newly identified stakeholders in that round were surveyed. A total of 68 stakeholders were surveyed. A breakdown of the types of stakeholders involved in the survey is illustrated in Figure 5-12. Table 5-7 summarises the amount of data collected from the survey. OpenR identified 127 stakeholders and 70 stakeholder roles, and ClosedR identified 76 stakeholders and 39 stakeholder roles.

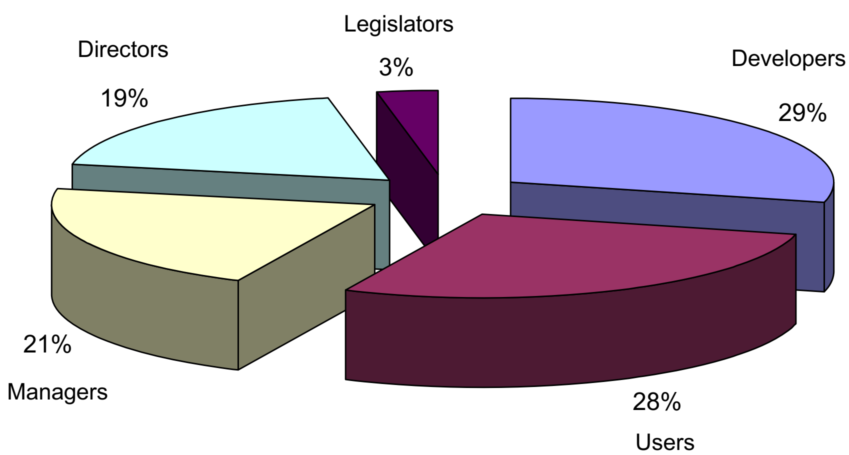


Figure 5-12: Proportion of the kinds of stakeholders surveyed.

Table 5-7: Data Collected from 68 Respondents

Data	Amount
Stakeholder details	68 sets of details
Open-ended recommendations (OpenR)	1,789 recommendations
Closed-ended recommendations (ClosedR)	839 recommendations
Individual prioritisations[55]	57 prioritised lists

The data collected from the survey was processed and cleaned. As ClosedR used a predefined checklist, little cleaning was required. Data cleaning focused on OpenR as follows.

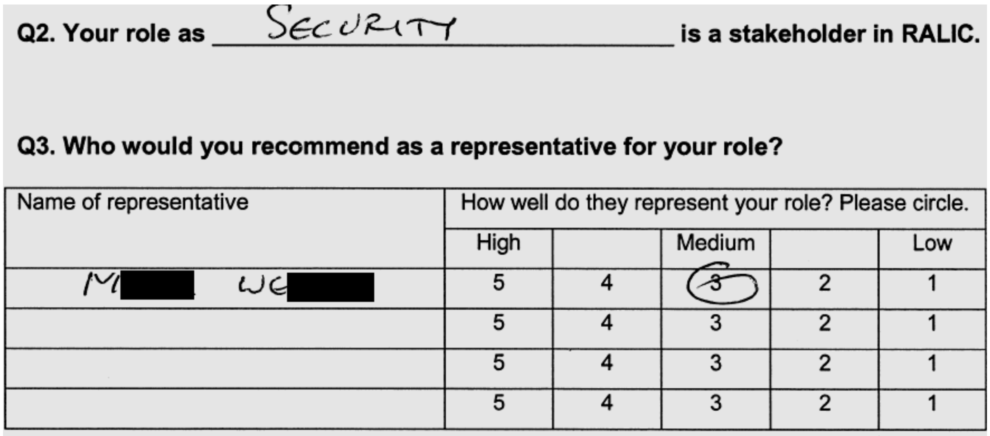
- **Inconsistent stakeholder roles.** Synonymous stakeholder roles (e.g., PhD students and research students) were merged. Some recommendations referred to the same stakeholders with slightly different roles. The more commonly recommended role was kept. For example, some people recommended Richard representing the role Director of Estates, while others recommended Richard representing Estates. Richard representing Estates was used as it appeared more frequently in the recommendations.
- **Inconsistent stakeholder names.** Different names referring to the same person were merged, and the official name in the UCL Directory[56] was used. For example, Nicholas was sometimes recommended as Nic or Nick, and data cleaning made all recommendations to Nicholas refer to his official name in the directory.
- **Duplicate recommendations.** If a stakeholder was recommended more than once in the same scope, only the recommendation with the highest salience was kept.
- **Missing fields.** Valid recommendations are *<stakeholder, stakeholder role, salience>* or *<stakeholder role, salience>*.
    - Recommendations without a salience value were removed.
    - 32% of the recommendations were stakeholder and salience, without the role. Many respondents omitted the role because the project was internal to UCL and the role of a stakeholder was the stakeholder's position or division, which was widely known (e.g., a stakeholder's division is searchable from the UCL Directory). Names without role were filled with their roles provided by other

[55] Some respondents chose not to list down the twenty most salient stakeholders in the project as they do not know the project well enough.

[56] http://www.ucl.ac.uk/directory/

recommendations, but if no role was provided, the UCL directory was searched and their division was entered as roles.

Step 4 requires incomplete recommendations without stakeholder names to be expanded such that it is connected to all existing stakeholders of the same role. In OpenR, this role expansion resulted in a total of 4463 recommendations. As ClosedR provided a predefined list of stakeholder names, many stakeholders did not recommend additional stakeholders. Only 21 respondents suggested additional stakeholders, with an average of less than 3 suggestions per person, and the suggestions were mostly stakeholder names. Hence, there were very few role expansions in ClosedR. Step 3 was revisited if there are no existing stakeholders of that role. For example, the group "security guards" did not have default representatives, hence individual security guards were approached to nominate their colleagues as representatives (Figure 5-13).



Q2. Your role as SECURITY **is a stakeholder in RALIC.**

Q3. Who would you recommend as a representative for your role?

Name of representative	How well do they represent your role? Please circle.				
	High		Medium		Low
M[redacted] WE[redacted]	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1

Figure 5-13: Nomination for representatives.

Using Step 5, two networks were built, one from the OpenR data (Figure 5-14) and one from the ClosedR data (Figure 5-15). As OpenR collected recommendations for each of the scope items separately, the recommendations were combined to build a network for the whole project as follows. If stakeholder *A* recommended stakeholder *B* in *N* number of scope items, a combined recommendation was thus stakeholder *A* recommended stakeholder *B* as salience *N*. The maximum salience was 8 because there were eight scope items. Combining the recommendations this way assumed the scope items had equal importance in the project.

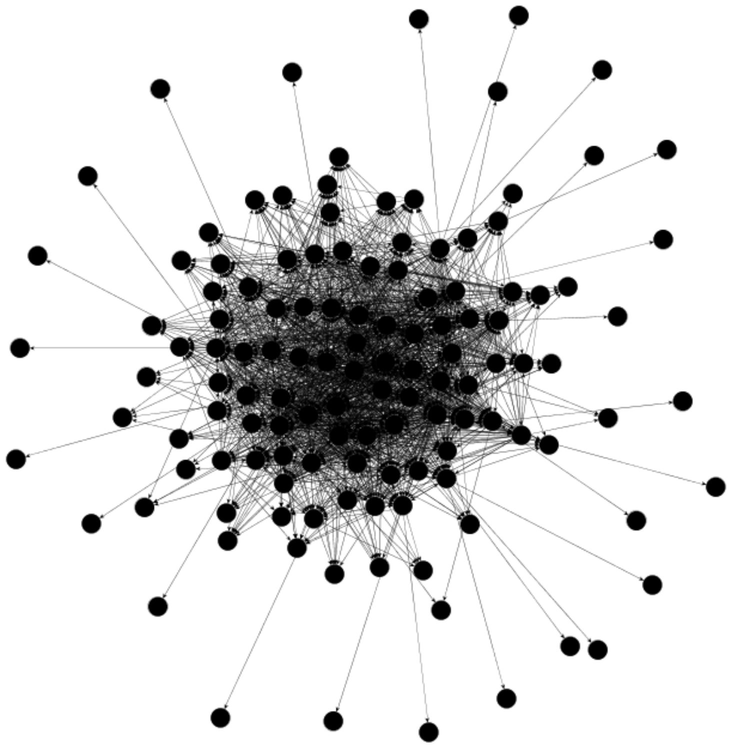


Figure 5-14: OpenR network[57].

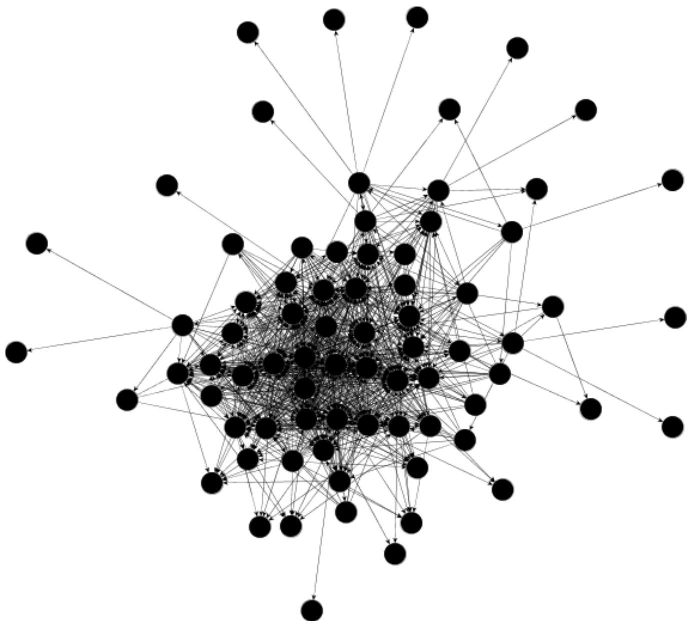


Figure 5-15: ClosedR network.

[57] The network diagrams are produced using yFiles for Java (http://www.yworks.com/en/products_yfiles_about.html) and displayed using the yEd Graph Editor (http://www.yworks.com/en/products_yed_about.html). Only the original recommendations are shown, edges formed by role expansions are hidden for better visualisation.

A partial dataset for OpenR is illustrated in Table 5-8. The complete OpenR and ClosedR datasets are available in Appendix D.

Table 5-8: Partial OpenR Dataset

Stakeholder	Recommend	Salience
Aaron Toms	Derek Pack	3
Aaron Toms	Martin Payne	7
Aaron Toms	Diana Cates	1
Aaron Toms	Mike Dawson	6
Alison Crane	Derek Pack	1

Interestingly, when plotting the number of recommendations against the stakeholders, the result resembles a power-law distribution (Figure 5-16), with a few dominating stakeholders to the left receiving many recommendations and a long tail to the right with many stakeholders receiving a few recommendations. This may indicate that the network is scale-free (Barabási and Albert, 1999). A power law graph emerges when there is a large population of stakeholders, a large number of recommendations, and a high freedom of choice (Anderson, 2008). Hence, a scale-free network suggests that OpenR is able to build a complete picture of the social network of stakeholders. In contrast, the network resulting from ClosedR is not scale-free (Figure 5-17), the distribution of the number of edges shows a long tail but is not a power law. This suggests that ClosedR builds only a partial view of the network of stakeholders.

Finally, using Step 6, each social network measure discussed in the StakeNet method was applied to the OpenR and ClosedR networks (Figure 5-18). NetworkX[58], an existing software tool implementing the social network measures, was used to produce the list of stakeholders and their scores. The stakeholders in each list were then prioritised to produce a final prioritised list of stakeholders and their roles.

---

[58] http://networkx.lanl.gov/ (NetworkX version 0.99 was used for all the measures except PageRank as during the time of the study, June/July 2009, Version 1.0 which introduced PageRank was not yet released. Version 1.0 released in Aug 2009 was used for PageRank.)

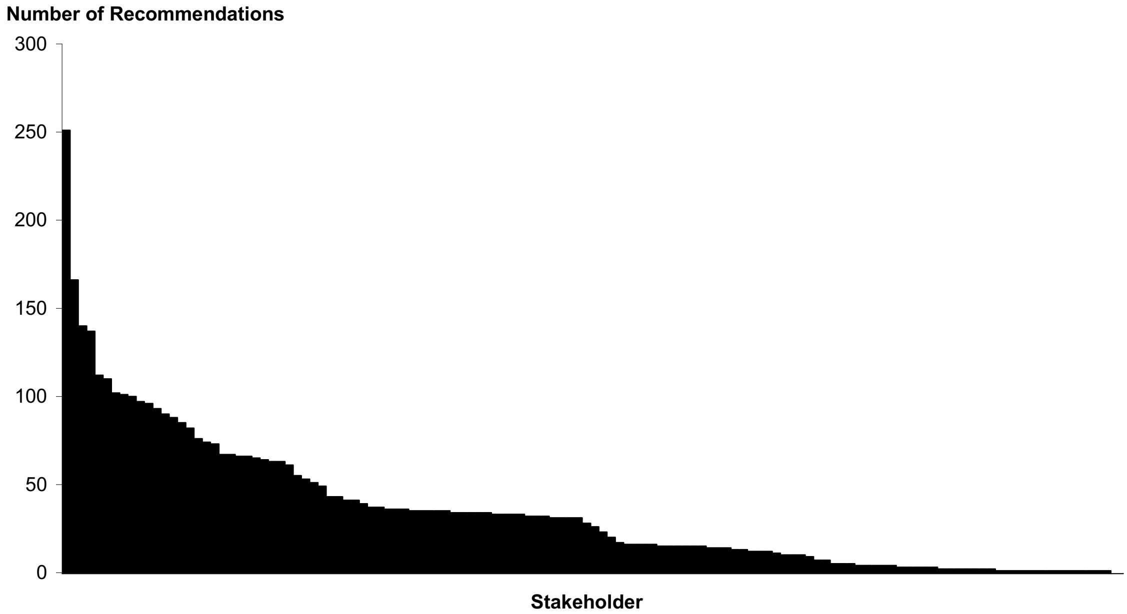


Figure 5-16: OpenR: Number of recommendations per stakeholder.

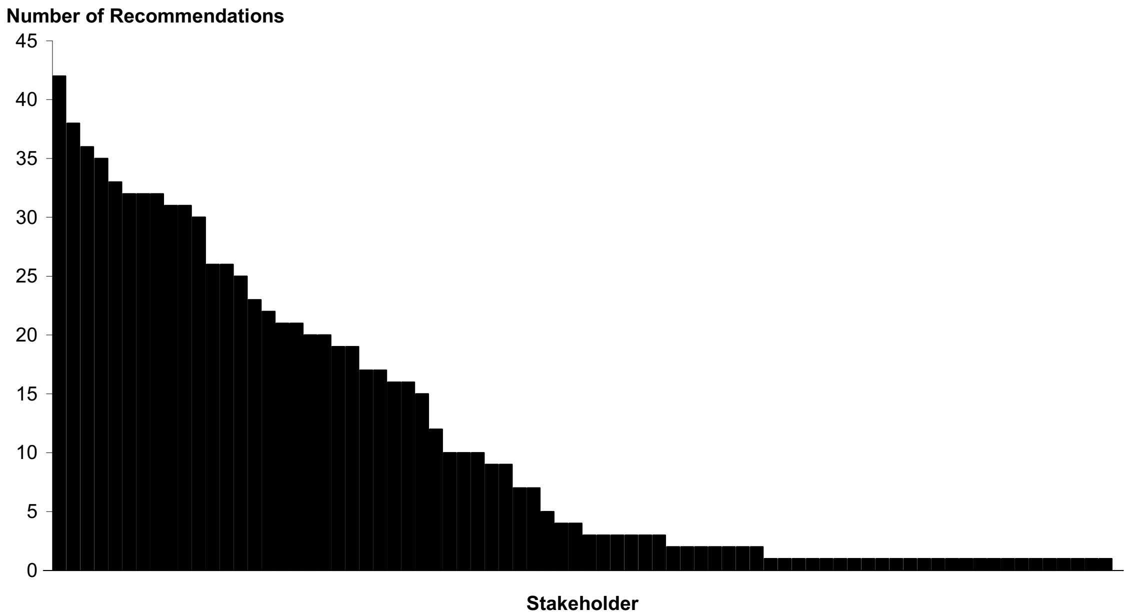


Figure 5-17: ClosedR: Number of recommendations per stakeholder.

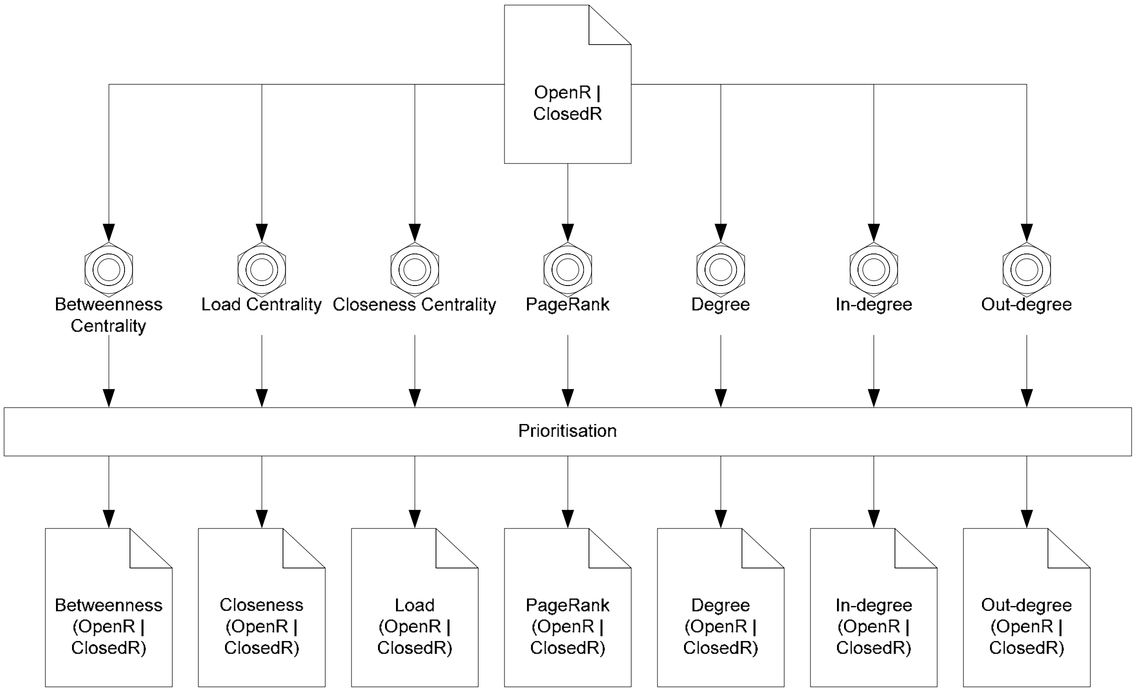


Figure 5-18: Producing the prioritised stakeholder lists for OpenR and ClosedR.

Research Questions

To evaluate the effectiveness of StakeNet in supporting stakeholder analysis, the following research questions were asked. To answer these research questions, the stakeholder lists produced by StakeNet were compared with the existing method and the ground truth lists of stakeholders described in the previous chapter (Section 4.3, page 90).

RQ1. Identifying stakeholder roles. Many existing methods in stakeholder analysis described in Chapter 2 (Section 2.1, page 26) focus on identifying stakeholder roles. The following research questions assess how well StakeNet identifies stakeholder roles as compared to the existing method used in the project.

- How many stakeholder roles identified by StakeNet are actual stakeholder roles as compared to the ground truth?
- How many of all the actual stakeholder roles in the ground truth does StakeNet identify?

RQ2. Prioritising stakeholder roles. In large projects, many stakeholder roles are involved, and different roles have different levels of influence in the project. This research question asks:

- How accurately do StakeNet's social network measures prioritise stakeholder roles?

RQ3. **Prioritising stakeholder roles: combining measures**. StakeNet uses different social network measures, such as betweenness centrality, degree centrality, and PageRank, to prioritise stakeholder roles. This research question asks:

- Does the combination of StakeNet's social network measures improve its accuracy in prioritising stakeholder roles?

RQ4. **Prioritising stakeholder roles: StakeNet vs. individuals**. The existing stakeholder prioritisation methods described in Chapter 2 (Section 2.1, page 26) involve a small subset of stakeholders or individual stakeholders such as the project board, project team, or project manager. In contrast, StakeNet involves all the identified stakeholders. This research question asks:

- In prioritising stakeholder roles, how well do the individual stakeholders perform as compared to StakeNet?

RQ5. **Identifying stakeholders**. In addition to identifying and prioritising stakeholder roles, the actual stakeholders for each role have to be identified from whom to elicit requirements. This research question asks:

- For each stakeholder role, how many of all the actual stakeholders are identified by StakeNet?

RQ6. **Prioritising stakeholders**. Many stakeholder roles consist of more than one stakeholder with different levels of influence. This research question asks:

- For each stakeholder role with more than one stakeholder, how accurately does StakeNet prioritise the stakeholders?

RQ7. **OpenR vs. ClosedR**. StakeNet uses open-ended recommendations (OpenR), where stakeholders provide recommendations without a predefined list. During the survey, stakeholders were also provided with a predefined list of stakeholders to help with their recommendations (ClosedR). This research question asks:

- What are the results for identifying and prioritising stakeholders and their roles if ClosedR were used instead of OpenR?

RQ8. **Survey response and time spent**. The quality of the stakeholders returned by StakeNet depends on the stakeholders' motivation to participate. Also, to provide effective support in stakeholder analysis, StakeNet should take less time than existing methods. This research question asks:

- Are stakeholders motivated to provide recommendations for StakeNet?

- How much time did stakeholders spend on StakeNet as compared to the existing method in the project?

Method and Results

The method to evaluate each research question and the results are described as follows.

RQ1: Identifying Stakeholder Roles

The first research question asks:

- How many stakeholder roles identified by StakeNet are actual stakeholder roles as compared to the ground truth?
- How many of all the actual stakeholder roles in the ground truth does StakeNet identify?

Method

The stakeholder roles returned by StakeNet and the existing method were compared against the ground truth, in terms of precision and recall (Herlocker et al., 2004). The precision of identified stakeholder roles is the number of actual stakeholder roles in the set of identified stakeholder roles divided by the total number of identified stakeholder roles (Equation 5-1).

$$precision = \frac{\left|\{X\} \cap \{GroundTruth\}\right|}{\left|\{X\}\right|}, \qquad (5\text{-}1)$$

where X is the set of stakeholder roles identified by StakeNet or the existing method, and *GroundTruth* is the set of stakeholder roles in the ground truth.

The recall of identified stakeholder roles is the number of actual stakeholder roles in the set of identified stakeholder roles divided by the total number of actual stakeholder roles (Equation 5-2).

$$recall = \frac{\left|\{X\} \cap \{GroundTruth\}\right|}{\left|\{GroundTruth\}\right|}, \qquad (5\text{-}2)$$

with X and *GroundTruth* same as for precision.

Both precision and recall range from 0 to 1. Precision of 1 means all the identified roles are actual stakeholder roles. Recall of 1 means all the actual stakeholder roles are identified. For example, the ground truth has 62 stakeholder roles and the existing method list has 28 stakeholder roles. The number of stakeholder roles in the existing method list that matches the stakeholder roles in the ground truth is 25. Hence, $precision = \frac{25}{28} = 0.893$ and $recall = \frac{25}{62} = 0.403$.

The stakeholder roles returned by the methods can be at a finer, equal, or coarser grain compared to the ground truth. If the returned stakeholder roles were at a finer grain, then the results were considered a match. For example, if ground truth returned students, and StakeNet returned graduates, undergraduates, and medical students, then it was considered that StakeNet returned a stakeholder role that matched the ground truth. Otherwise, if the returned stakeholder roles were at a coarser grain than the ground truth, then the results were considered not a match. If they were of equal grain, then each stakeholder role was considered individually. For example, for Security Services, ground truth returned the subgroup card issuer. StakeNet returned the subgroups card issuer and photographers. Photographers were considered as an error.

Results

StakeNet identified most of the stakeholder roles in the ground truth with very few errors. StakeNet showed a recall of 90%, which was 50% higher than the existing method used in the project, and maintained a high precision of 90% (Figure 5-19). Although StakeNet had a higher false positive compared to the existing method, it had a much lower false negative (Table 5-9).

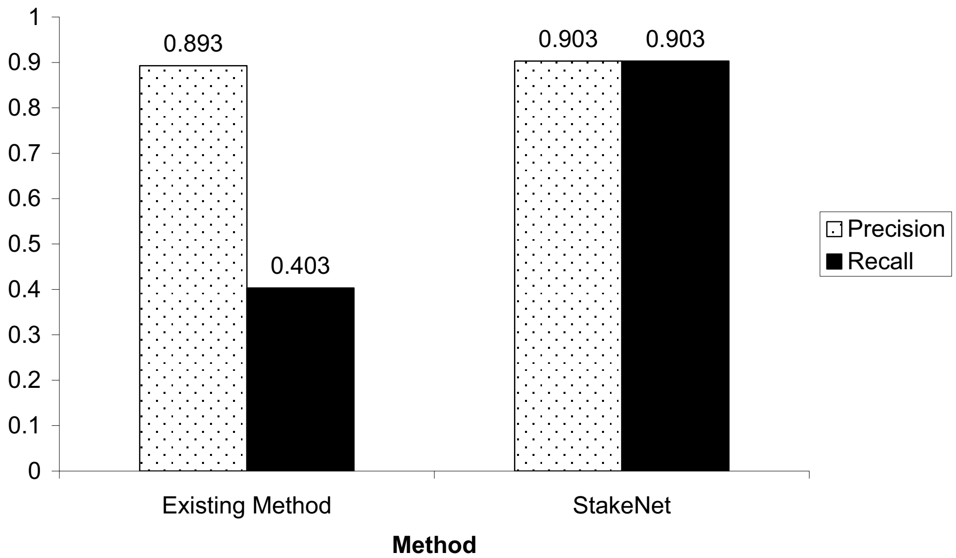


Figure 5-19: Precision and recall.

Table 5-9: Identifying Stakeholder Roles: Precision and Recall

Method	Stakeholders Returned[59]	False Positives	False Negatives
Existing Method	28	3	37
StakeNet	62	6	6

By using the existing method, the project team was only able to determine a limited number of stakeholder roles. As a result, they overlooked stakeholder roles, such as, the UCL Development & Corporate Communications Office that influenced the access card design, the network team who provided network connectivity to the access control system, the access card vendor, short course students, external library users (library members not in other UCL systems), and the maintenance team. In contrast, by combining individual views of all stakeholders, StakeNet came up with a more complete picture. It also successfully identified the previously mentioned stakeholder roles, which were overlooked by the project team.

The external library users role, which was overlooked by using the existing method, had high influence on RALIC. Overlooking this role during the project impacted RALIC's success. According to the post implementation report, "it was established that there were some 17,000 'external' library members who would consequently require new cards if the existing Library access control system were to be de-commissioned. The Board decided that this objective should be removed from the Project scope as the associated costs and complications of issuing such a high number of cards to non UCL members far outweighed the benefits" (Figure 5-20). Had StakeNet been used, the project team would not have needed to wait until the end to find that they had overlooked external library users and caused the library to stay with the old access control system.

In StakeNet, the snowballing process stops when no new stakeholder roles are identified in one round of surveys. However, as mentioned in the previous section, the surveys for RALIC continued past that round for evaluation purposes. A graph of precision and recall is plotted to observe the trade-off between precision and recall as the snowball progresses (Figure 5-21). According to the graph, the recall increases quickly at the start and then stabilises, and the precision lowers consistently throughout. As the snowball progressed towards the boundary of the network, fewer additional stakeholder roles were identified in each round of interviews. StakeNet terminated after Round 4 of surveys. But after that, new stakeholder roles can still be

[59] Although 70 different stakeholder roles were returned by StakeNet, some roles were subtypes of other roles (e.g., the head of department for speech and language sciences was a subtype of the role heads of department), so they were counted as one.

identified, only at a slower rate. The increase in recall at the end was from an initial stakeholder who was unavailable to make recommendations at the start of the survey.

7.1. The Project was "signed off" by the RALIC Board in Q3 2007 as successfully completed (at the final RALIC Board meeting held on 9th October 2007).

7.2. The Board concluded that all Phase 1 & 2 objectives had been met.

7.3. There was one exception in Phase 3, this being the Library. Following review (March 2007) with representatives of Library Services, it was established that there were some 17,000 "external" library members who would consequently require new cards if the Library turnstiles were to be controlled by Cardax and the existing Library Sentry Access control system were to be de-commissioned. The Board decided that this objective should be removed from the Project scope as the associated costs and complications of issuing such a high number of cards to non UCL members far outweighed the benefits.

Figure 5-20: Excerpt of post implementation report.

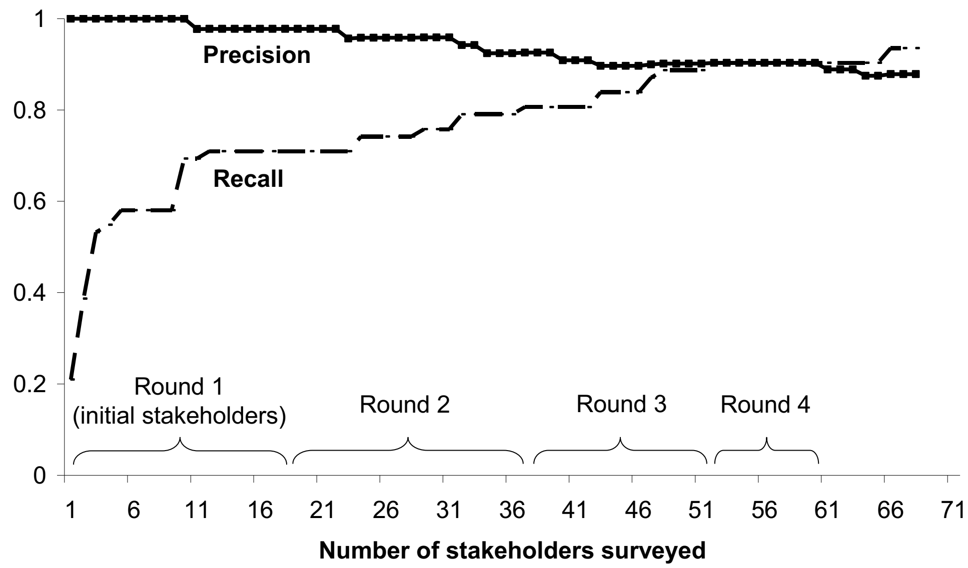


Figure 5-21: Precision and recall as the snowball rolls.

It is difficult to identify *all* the stakeholders for a project. Stakeholders who were identified can be connected to networks that were not currently mapped, but the stakeholders in those networks can indirectly affect the project. For example, RALIC was delayed due to problems with the access card printers supplied by the stakeholder Cardax UK, which depended on their counterpart in New Zealand. Although the counterpart was not considered as a RALIC stakeholder, its delay in supplying parts to Cardax UK affected RALIC. Also, within a group, there are subgroups with different stake (Pouloudi and Whitley, 1997, Nuseibeh and Easterbrook, 2000). For example, within the role of students, graduate students needed more flexible access hours than undergraduates, and medical students needed their card design to be consistent with their National Health Service[60] badges.

The decision of when to stop looking for stakeholders is a trade-off between project constraints and the risk of overlooking a stakeholder. In projects where the consequence of overlooking stakeholders is dire, it is better to identify superfluous ones than to fail to find them all (Robertson and Robertson, 2006). Hence, these projects can extend their snowball sampling process to get a higher recall, but should also expect a lower precision.

RQ2: Prioritising Stakeholder Roles

The second research question asks: How accurately do StakeNet's social network measures prioritise stakeholder roles?

Method

The StakeNet lists were compared against the ground truth, but not against the existing method list, as the existing method list was unprioritised. The accuracy of stakeholder role prioritisation is the similarity between the prioritisation of the identified stakeholder roles and the prioritisation in the ground truth. Pearson's correlation coefficient, ρ, was used to determine this similarity (Equation 5-3). The computation of ρ requires the lists to be of the same size. Therefore, the measurement takes the intersection between the lists: each list is intersected with the other, and fractional ranking (Triola, 1992) is reapplied to the remaining elements in that list.

$$\rho = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}, \qquad (5\text{-}3)$$

where n is the total number of roles in the intersection between the ground truth and the StakeNet list, x_i is the rank for role i in the StakeNet list and y_i is the rank for role i in the ground truth. When Pearson's correlation coefficient is used to determine the agreement between ranks, it is equivalent to Spearman's rank correlation coefficient (Myers and Well, 2003).

ρ is widely used as a measure of the strength of linear dependence between two variables (Rodgers and Nicewander, 1988, Herlocker et al., 2004). Values of ρ range from +1 (perfect correlation), through 0 (no correlation), to –1 (perfect negative correlation). A positive ρ means that high priorities in the ground truth list are associated with high priorities in the list

---

[60] http://www.nhs.uk/

of identified stakeholders. The closer the values are to −1 or +1, the stronger the correlation. In this work, the statistics software by Wessa[61] was used to calculate ρ.

Results

StakeNet prioritised stakeholder roles with high accuracy (Figure 5-22). Measures that consider the whole network (e.g., betweenness centrality, load centrality, and PageRank) had a higher accuracy in prioritising stakeholder roles than measures that consider direct connections. Betweenness and load centralities had the highest accuracy, followed by PageRank. Betweenness and load centralities limit closed communities of stakeholders who recommended one another (e.g., a team of developers) from gaining disproportional influence in the prioritisation. This is because these two measures prioritise based on network connectivity, and recommendations in a closed community tend to create poorly connected networks. PageRank gives more weight to recommendations from salient stakeholders. As such, for salient stakeholders who were recommended by a small number of stakeholders, using PageRank minimises the extent of these stakeholders losing importance in the ranking if they were recommended by salient stakeholders.

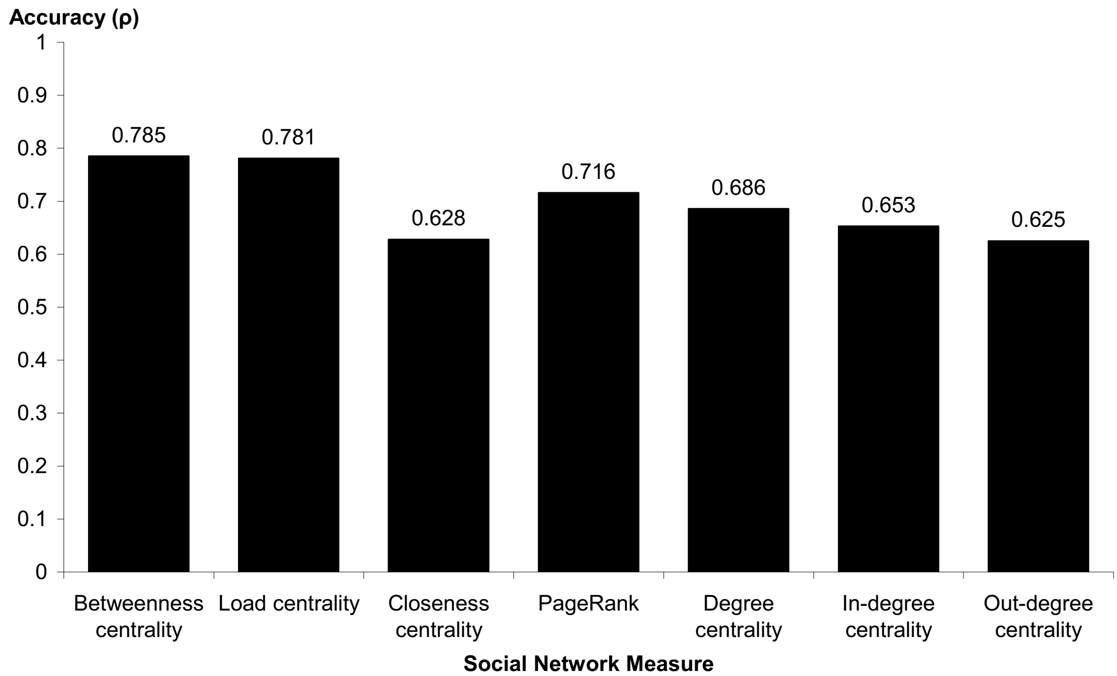


Figure 5-22: Prioritising stakeholder roles.

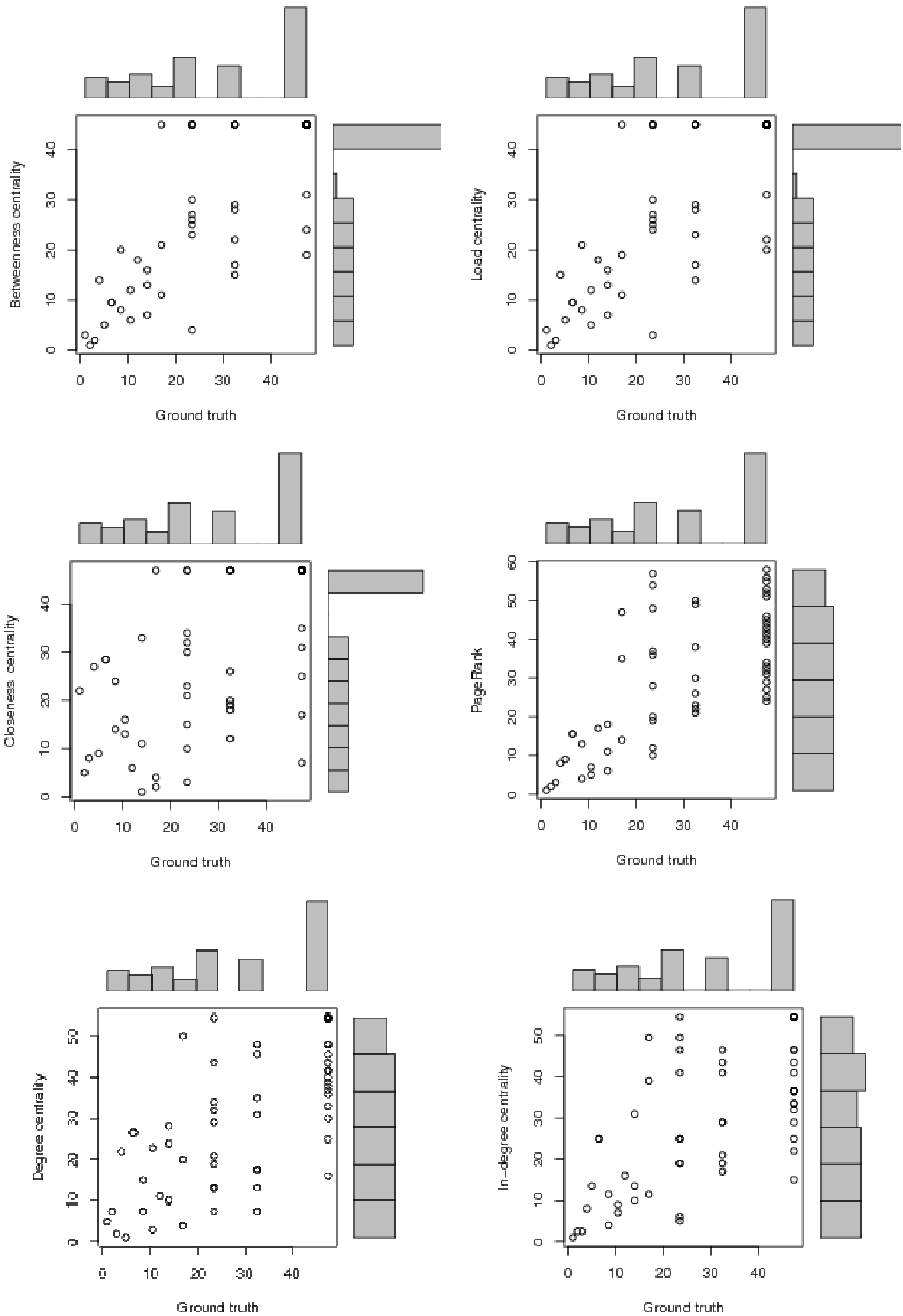
[61] Wessa, P. (2009) Free Statistics Software, Office for Research Development and Education, version 1.1.23-r4, URL http://www.wessa.net/.

Out-degree centrality had the lowest accuracy, as stakeholders who made a lot of recommendations were not necessarily salient stakeholders. In-degree centrality had a higher accuracy than out-degree centrality because other stakeholders' recommendations were a more reliable indication of salience than the enthusiasm to recommend. Degree centrality performed better than in-degree and out-degree centralities, as a stakeholder who was both highly recommended and enthusiastic to recommend, was more likely to be salient. Measuring the correlation between the lists produced by degree centrality and betweenness centrality revealed that degree centrality correlates strongly with betweenness centrality with $\rho = 0.831$, a feature common to social networks (Newman, 2005).

Betweenness centrality and load centrality prioritised stakeholders that were crucial to RALIC, such as the project manager, developers, and student registry that provided student data to RALIC. PageRank and in-degree centrality prioritised stakeholders that were highly influenced by the project such as security service owner, students, and security guards. The difference in their accuracy was because betweenness considered brokerage position as an indication of salience, but load considered the amount of information that passes through a stakeholder. For example, betweenness correctly prioritised security service owner over card issuer, but load centrality prioritised card issuer as they were at the centre of information flow, issuing cards to the UCL community.

Closeness centrality revealed stakeholders whose position in the network allowed them to access other stakeholders quickly. These stakeholders included the Vice Provost who ensured that all the relevant divisions supported RALIC and reported to her, project assurance who documented meeting minutes and updated other stakeholders on project progress, and the access card issuer. These stakeholders had the best visibility to the activities in the network but were not salient stakeholders, hence closeness had low accuracy in prioritising stakeholders.

The scatter plots of the output of different measures against the ground truth show that all the measures produce output that is positively correlated with the ground truth. Betweenness centrality, load centrality, and PageRank show high correlation with the ground truth in prioritising stakeholder roles, especially within the top 20 ranks (Figure 5-23). Closeness centrality and out-degree centrality has the most random relationship with the ground truth.


Betweenness centrality
Ground truth
Load centrality
Ground truth
Closeness centrality
Ground truth
PageRank
Ground truth
Degree centrality
Ground truth
In-degree centrality
Ground truth

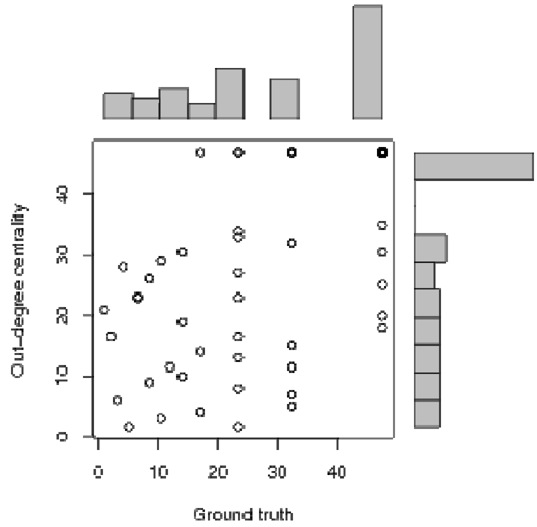


Figure 5-23: Scatter plots. Each scatter plot plots the priority of the stakeholder role in the ground truth (x-axis) against its priority in the social network measure (y-axis).

Two StakeNet features influenced the accuracy of prioritisation. First, StakeNet prioritised stakeholder roles based on the highest rank of the stakeholders with that role, which produced inaccurate prioritisation when a stakeholder had more than one role. For example, a stakeholder with two roles received a recommendation every time either role was recommended. Hence, both roles received higher prioritisation than if different stakeholders played the two roles. Second, the expansion of role recommendations into existing stakeholders with the same role also affected the accuracy, because respondents who recommended roles appeared to make many recommendations. For example, the new data protection officer was ranked first by out-degree centrality as he was unfamiliar with actual stakeholders and suggested many roles.

RQ3: Prioritising Stakeholder Roles: Combining Measures

The third research question asks: Does the combination of StakeNet's social network measures improve its accuracy in prioritising stakeholder roles?

Method

A preliminary study was performed to combine different social network measures to produce more accurate prioritisation. The study investigated the use of decision trees (Quinlan, 1986) to predict the suitable measure for each stakeholder role. Each role had two Boolean attributes gathered from interviews: `is_confident` and `is_community`. `is_confident` indicates whether the stakeholder expressed a lack of confidence in his or her recommendations. `is_community` indicates whether the stakeholder belonged to any cliques within the organisation. These attributes were chosen because stakeholders who are not confident in their recommendations may be more likely to provide inaccurate recommendations, and stakeholders in cliques may recommend one another more frequently and skew the results. A C4.5 (J48) decision tree classifier (Witten and Frank, 2005) was trained to find the measure that produced the closest result to the ground truth for each stakeholder role from the three most accurate and diverse measures: betweenness centrality, in-degree centrality, and PageRank.

10-fold cross-validation was used to evaluate the results (Witten and Frank, 2005). This technique is commonly used in machine learning research for assessing how the results of a statistical analysis will generalise to an independent dataset (Zhang, 1993, Kohavi, 1995, Braga-Neto and Dougherty, 2004). Using 10-fold cross-validation, the original sample is randomly partitioned into ten subsamples. Of the ten subsamples, a single subsample is retained as the validation data for testing the model, and the remaining nine subsamples are used as training data (Witten and Frank, 2005). The cross-validation process is then repeated ten times (the folds), with each of the ten subsamples used exactly once as the validation data. The ten results from the folds are then averaged to produce a single estimation. The advantage of this method over repeated random sub-sampling is that all observations are used for both training and validation, and each observation is used for validation exactly once (Witten and Frank, 2005, Alag, 2008). The Weka[62] data mining software was used.

Results

The decision tree produced more accurate prioritisation than the most accurate individual measure, which was betweenness centrality with $\rho = 0.785$. The overall prioritisation from the measures selected by the decision tree had an accuracy of $\rho = 0.812$ when compared to the ground truth. The decision tree correctly predicted the suitable measure 95% of the time. Figure 5-24 shows the learned decision tree. Betweenness centrality avoids stakeholder communities who highly recommended one another from gaining disproportional influence, PageRank avoids salient stakeholders recommended only by a few salient stakeholders from losing influence, and in-degree centrality avoids salient stakeholders who were not confident with their recommendations to be penalised.

The preliminary study showed that taking into account how the various measures prioritise stakeholders can improve the accuracy of prioritisation. Nevertheless, further studies are needed to investigate other attributes, and whether the results can be generalised to other projects and organisations.

[62] Weka version 3.6 http://www.cs.waikato.ac.nz/ml/weka/

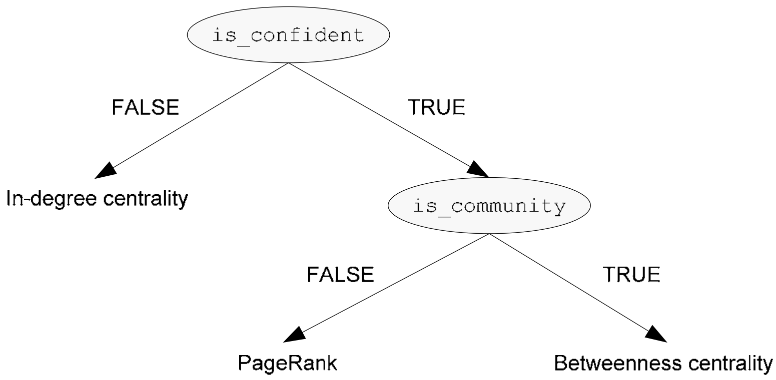


Figure 5-24: Decision tree classifier.

RQ4: Prioritising Stakeholder Roles: StakeNet vs. Individuals

The fourth research question asks: In prioritising stakeholder roles, how well do individual stakeholders perform as compared to StakeNet?

Method

The individual prioritisations collected during the surveys were compared against the ground truth, in terms of accuracy in prioritising stakeholder roles. Entries that consisted of stakeholder names were converted to their respective roles for comparison. As in RQ2 (Equation 5-3), the intersection between the lists was used to produce lists of the same size for the calculation of accuracy using Pearson's correlation coefficient. Each list was intersected with the other, and fractional ranking (Triola, 1992) was reapplied to the remaining elements in that list.

In the previous section describing the RALIC survey, the respondents were grouped into their generic roles of directors, managers, developers, users, and legislators to produce a breakdown of the types of stakeholders involved in the survey (Figure 5-12). For an overview of the accuracy of individual prioritisations, the average accuracy for each generic role was calculated by taking the mean of accuracy values for all members of that role. The standard deviation for the average was calculated.

Results

Prioritisations by individual stakeholders were less accurate compared to the collective prioritisation by StakeNet. Managers had the highest accuracy, followed by directors, developers, users, and then legislators (Figure 5-25). The individual prioritisations had an average accuracy of $\rho = 0.360$, less than half compared to StakeNet's most accurate prioritisation from betweenness centrality with $\rho = 0.785$. The prioritisations were biased by local perspective. For many respondents, the majority of the stakeholders in their list were from the same divisions as the respondents.

Developers often prioritised their immediate managers and other developers; managers often prioritised other managers. For example, a developer provided a prioritised list of six stakeholders which included his direct superior and five other developers; a manager provided a list of eleven stakeholders, all of which were managers. Finally, a stakeholder with the role of card user, was unsure about the prioritisation, and provided a prioritised list of UCL directors instead. All these prioritisations had low accuracy as compared to the ground truth.

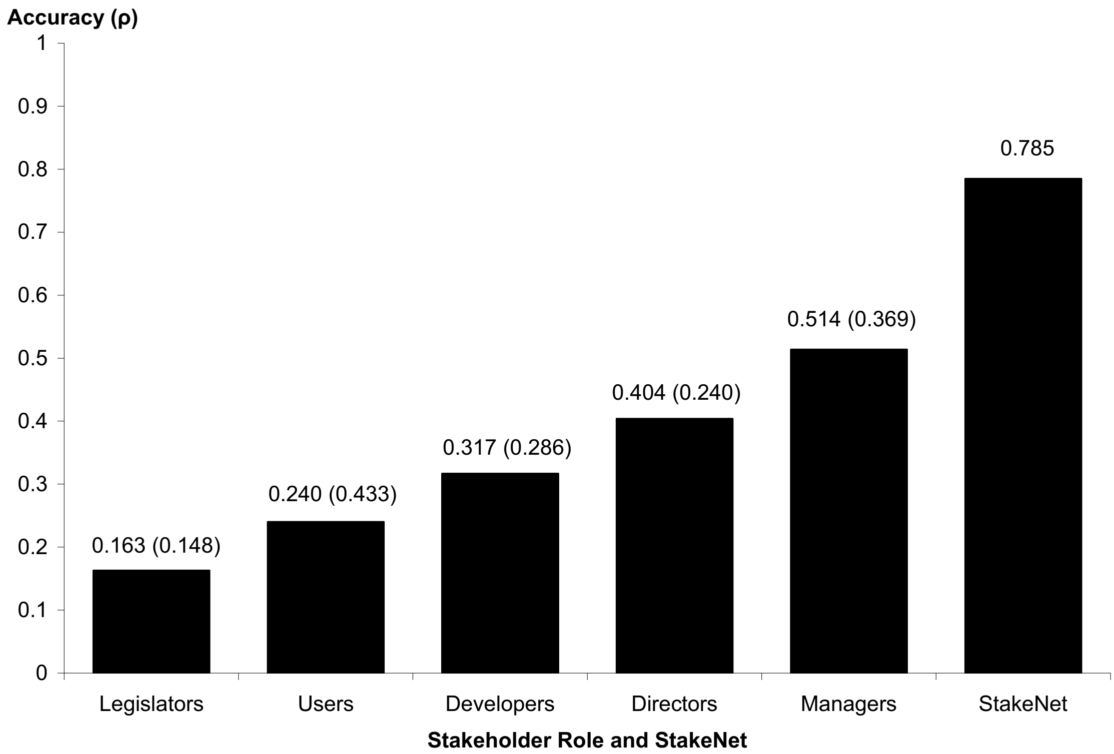


Figure 5-25: StakeNet vs. Stakeholders (standard deviation in parentheses).

RQ5: Identifying Stakeholders

The fifth research question asks: For each stakeholder role, how many of all the actual stakeholders are identified by StakeNet?

Method

The lists of stakeholders returned by StakeNet and the existing method list were compared against the ground truth in terms of recall. The recall of identified stakeholders is the number of actual stakeholders identified, divided by the total number of stakeholders in the ground truth, for each stakeholder role that appears in both lists, with the following rule. If the ground truth has *N* stakeholders with the same role, then only the first *N* stakeholders returned by the method are considered. For example, for the stakeholder role Management Systems, closeness centrality suggested Holmes, Lester, and then Miles. As the ground truth considered only two representatives, Miles was not considered when calculating the recall for closeness centrality. This is because if the project consulted one stakeholder and the method returned the correct stakeholder after two incorrect ones, the project would have consulted the less suitable stakeholder. The recall formula (Equation 5-4) is used as follows.

$$recall = \frac{\left|\{X\} \cap \{GroundTruth\}\right|}{\left|\{GroundTruth\}\right|}, \qquad (5\text{-}4)$$

where X is the set of stakeholders identified by StakeNet or the existing method, and *GroundTruth* as the set of stakeholders in the ground truth.

Results

StakeNet identified stakeholders with high recall. Betweenness centrality and load centrality had the highest recall in identifying stakeholders, 45% more than the existing method (Figure 5-26). In line with the literature, these measures prioritised stakeholders whose positions in the network allowed them to connect with different groups and have more knowledge, which are the characteristics of influential individuals (Scott, 2000). PageRank had a lower recall than all the other measures. This was because in situations where there were two representatives who were almost equally recommended, the one that was available to make recommendation ranked lower if he or she recommended the other.

In the existing method list, many stakeholder roles were identified without actual stakeholders, explaining the low recall. Some stakeholder roles, such as the software vendor, need not have predefined stakeholders, because any representative of the software vendor may suffice. However, for stakeholder roles whose stakeholders are involved in requirements elicitation, involving unsuitable stakeholders can adversely influence the outcome of the project (Gause and Weinberg, 1989, Alexander, 2005). If representatives not from the stakeholder group are used (e.g., a developer acting on behalf of a card issuer), the perceived needs may not reflect the actual needs, and there is the risk of eliciting the wrong requirements.

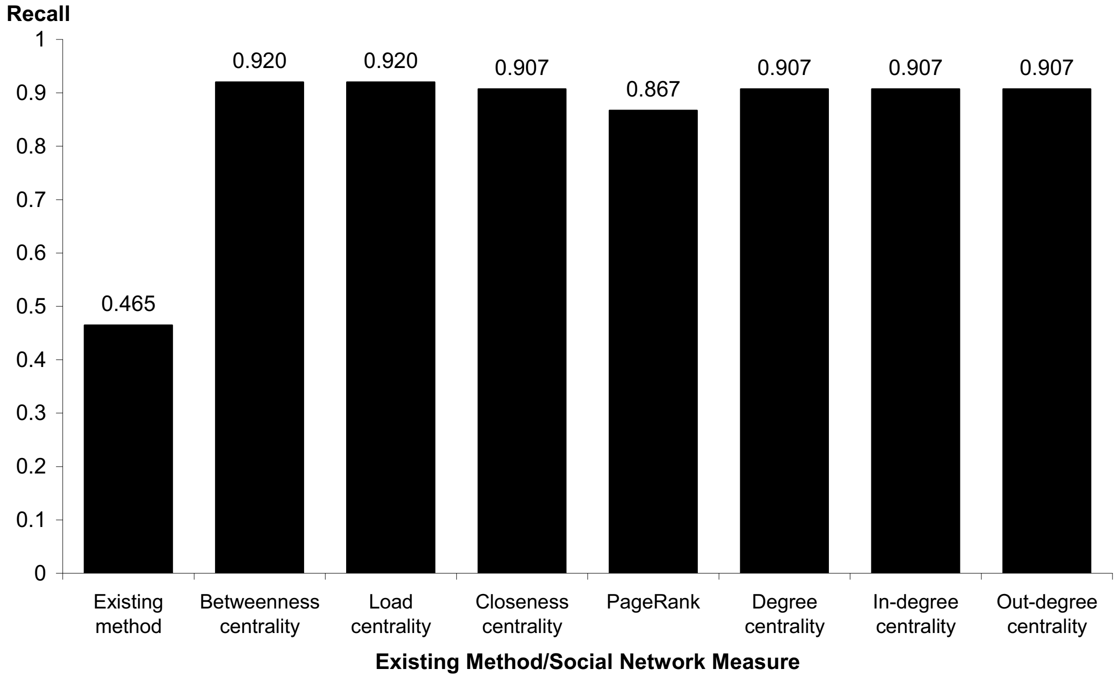


Figure 5-26: Identifying stakeholders.

RQ6: Prioritising Stakeholders

The sixth research question asks: For each stakeholder role with more than one stakeholder, how accurately does StakeNet prioritise the stakeholders?

Method

In StakeNet, for stakeholder roles with more than one stakeholder, the stakeholders are also prioritised according to their suitability to represent the role. The accuracy of stakeholder prioritisation is the similarity between the ordering of the identified stakeholder and their actual ordering in the ground truth. Pearson's correlation coefficient, ρ (Herlocker et al., 2004), is used to measure accuracy in prioritising stakeholders for each stakeholder role with more than one stakeholder (Equation 5-5). As in the previous research questions on prioritisation accuracy, the measurement of ρ takes the intersection between the lists: each list is intersected with the other, and fractional ranking (Triola, 1992) is reapplied to the remaining elements in that list.

$$\rho = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}, \qquad (5\text{-}5)$$

where n is the total number of stakeholders in the intersection between the ground truth and the StakeNet list for the stakeholder role, x_i is the rank for stakeholder i in the StakeNet list and y_i is the rank for stakeholder *i* in the ground truth. The final accuracy is the average accuracy for all such roles, and the standard deviation is calculated for each average. For accuracy in prioritising stakeholders, only the StakeNet lists were considered as the existing method list was unprioritised.

Results

StakeNet prioritised the stakeholders accurately. PageRank had the highest accuracy in prioritising stakeholders (Figure 5-27). StakeNet produced a high accuracy in prioritising stakeholders as it prioritised them based on their relations with other stakeholders rather than their formal positions. Just from looking at the organisational chart for Security Services (Figure 5-28), one may assume that the Head of Security Services would be the most suitable stakeholder to approach about RALIC. Nevertheless, the manager was more suitable as he was more involved in RALIC and connected to the other stakeholders. StakeNet correctly identified this. In contrast to high accuracy in prioritising stakeholder roles, measures considering network connectivity had low accuracy in prioritising stakeholders. A close inspection revealed that their accuracy was low for roles with recent turnover, as the new stakeholders did not share the same ties in the network as the old.

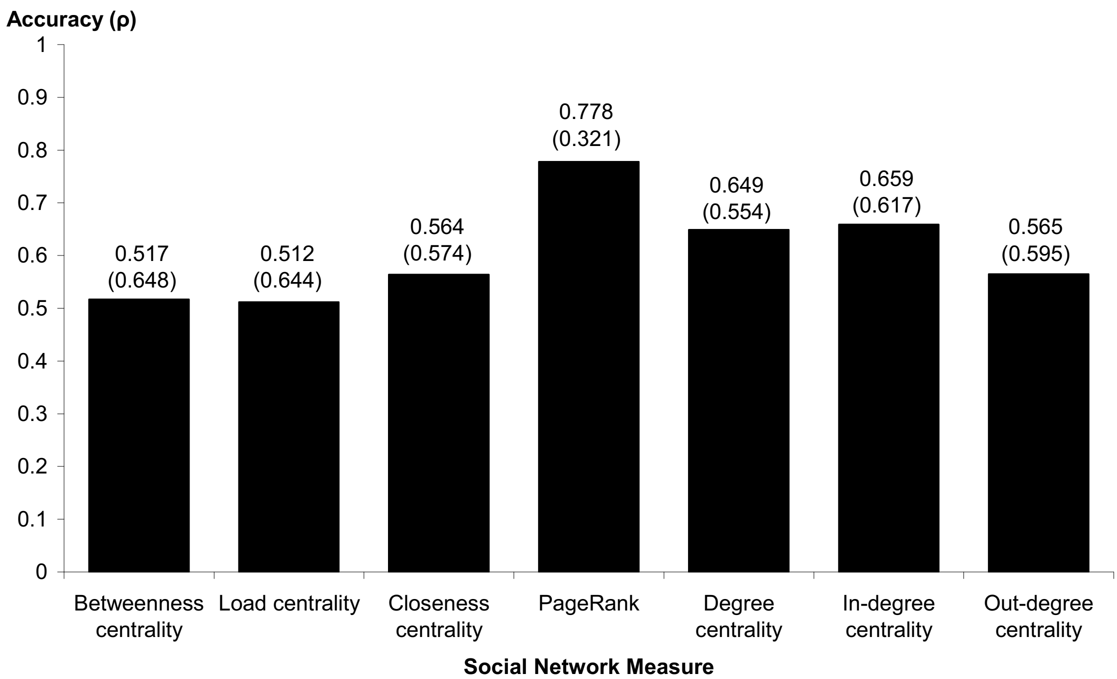


Figure 5-27: Prioritising stakeholders (standard deviation in parentheses).

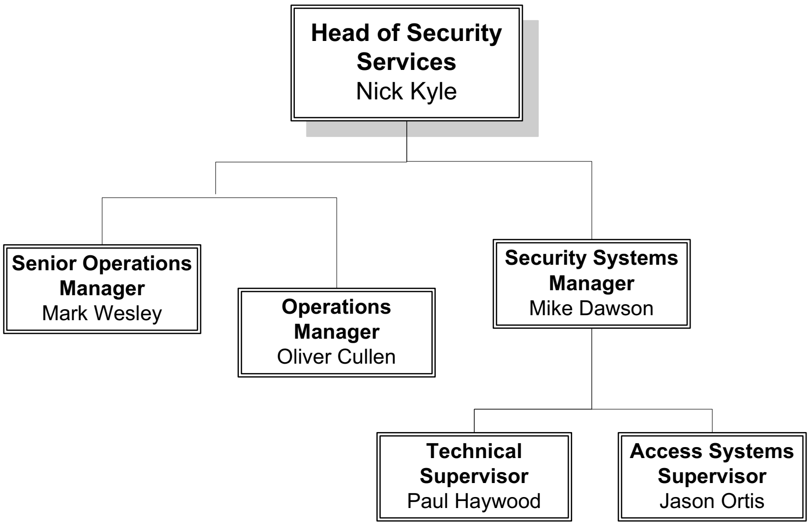


Figure 5-28: Partial organisational chart for Security and Access Systems[63].

As well as knowing who the suitable stakeholders are, it is also useful to know about potential problems with a stakeholder's involvement as it enables the impact to be mitigated. Inspired by the social network literature (Newman, 2005), comparisons between different measures that are strongly correlated may reveal problems related to a stakeholder's involvement in the project. First, stakeholders who have a high rank in degree centrality but low rank in betweenness centrality may have high influence but low involvement. In RALIC, an example was the Head of Security Services – many security issues discussed in meetings required his input but he was absent. Second, stakeholders who have a high rank in betweenness centrality but low rank in closeness centrality may be salient stakeholders who are often out of the loop. An example from RALIC was the stakeholders from Bloomsbury Fitness Centre, who pointed out that they were often not updated with the project progress.

RQ7: OpenR vs. ClosedR

StakeNet uses OpenR where stakeholders provide recommendations without a predefined list. The seventh research question asks: What are the results for identifying and prioritising stakeholders and their roles if ClosedR (where respondents were provided with a predefined list of stakeholders) were used instead of OpenR?

---

[63] Names have been changed for reasons of privacy.

Method

The lists produced from ClosedR were compared against the ground truth, using precision, recall, and accuracy as before. Then, the results from ClosedR were compared with the results from OpenR.

Results

In identifying stakeholders and their roles, OpenR performed better compared to ClosedR. OpenR had 30% more recall in identifying stakeholder roles (Figure 5-29), and an average of 8% more in identifying stakeholders (Figure 5-30). Checklists limited the discovery of project-specific stakeholder roles as they constrained survey outcomes around the given options. Although respondents were encouraged to recommend stakeholders not in the checklist, only 34% of them did so, with an average of less than three recommendations each.

As fewer new suggestions reduced the likelihood of error, ClosedR had 5% more precision than OpenR in identifying stakeholder roles (Figure 5-29). This finding was consistent with the literature in survey research on the weakness of closed-ended surveys: when provided with a predefined list, respondents tend to rely on the given list, which constrains the outcome around the list provided by the researcher (Babbie, 1973). Several respondents commented that they had not thought of some stakeholders in the open-ended questionnaire and were reminded when their names appeared in the checklist.

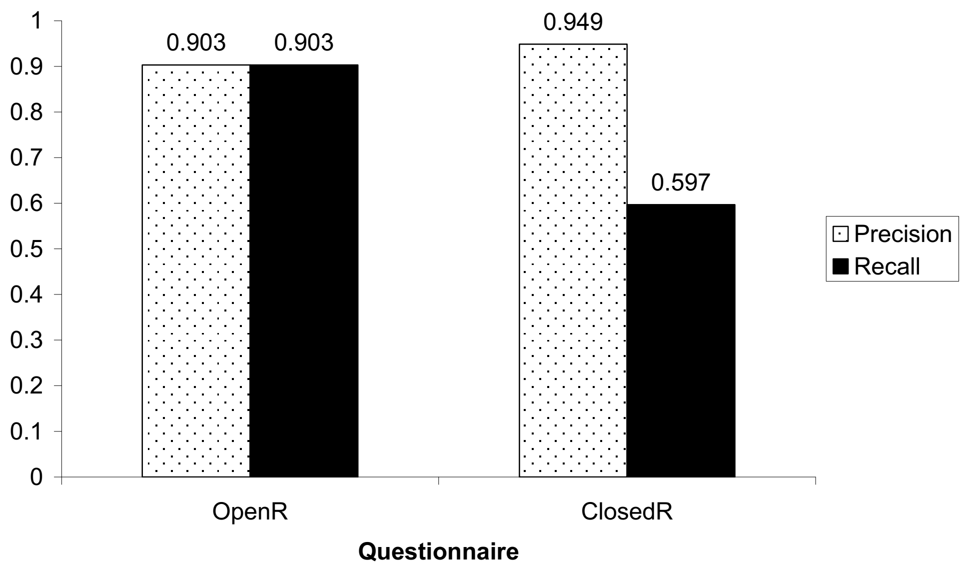


Figure 5-29: OpenR vs. ClosedR: Identifying stakeholder roles.

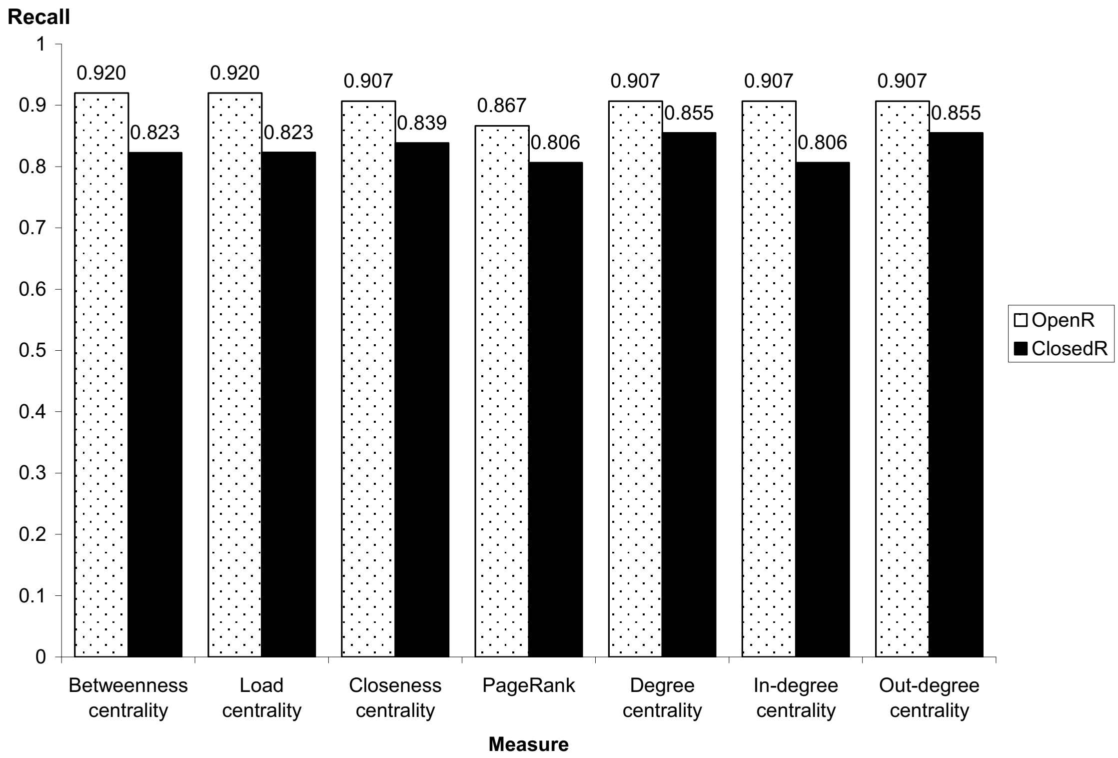


Figure 5-30: OpenR vs. ClosedR: Identifying stakeholders.

In prioritising stakeholder roles (Figure 5-31) and prioritising stakeholders (Figure 5-32), degree centrality had the highest accuracy in ClosedR, followed by in-degree centrality and then PageRank. In ClosedR, recommendations revolved around the names in the checklist rather than from the respondents' interactions with the stakeholders. In OpenR, respondents who lacked confidence recommended stakeholder roles rather than stakeholders, but in ClosedR, they selected the names of division heads and provosts. As a result, most measures in ClosedR returned these names as globally high ranked stakeholders. For example, the stakeholder ranked first in betweenness centrality and load centrality was the Vice Provost, and the stakeholders ranked first in degree centrality, in-degree centrality, and PageRank were all division heads.

RQ8: Survey Response and Time Spent

The final research question asks:

- Are stakeholders motivated to provide recommendations for StakeNet?
- How much time did stakeholders spend on StakeNet as compared to the existing method in the project?

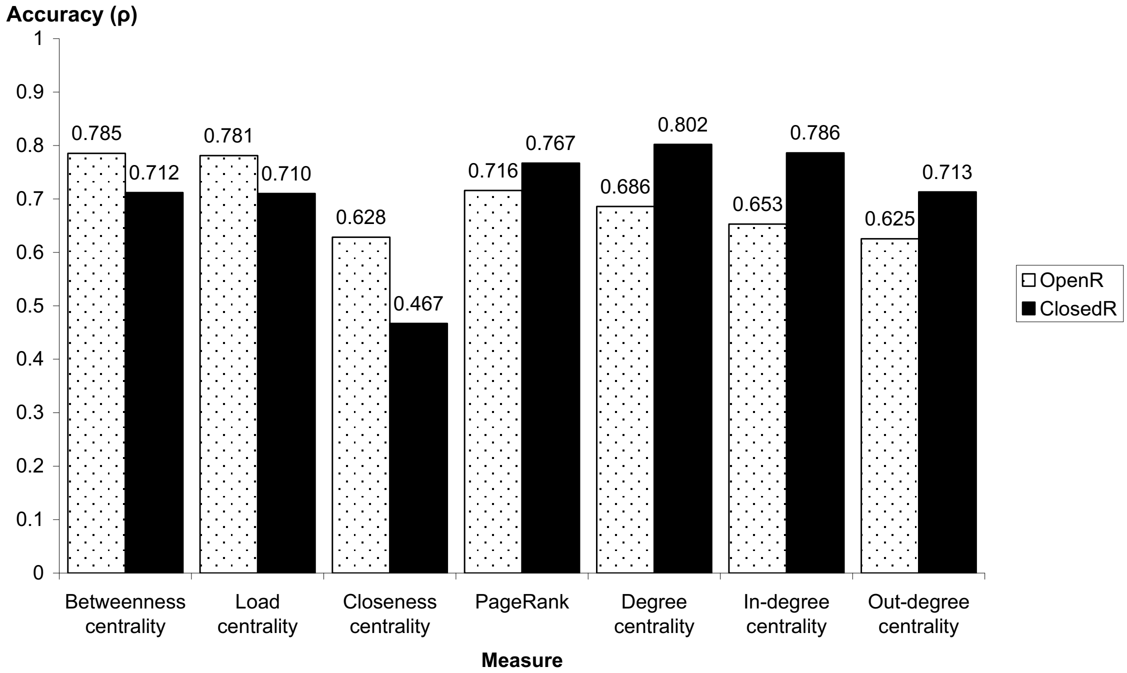


Figure 5-31: OpenR vs. ClosedR: Prioritising stakeholder roles.

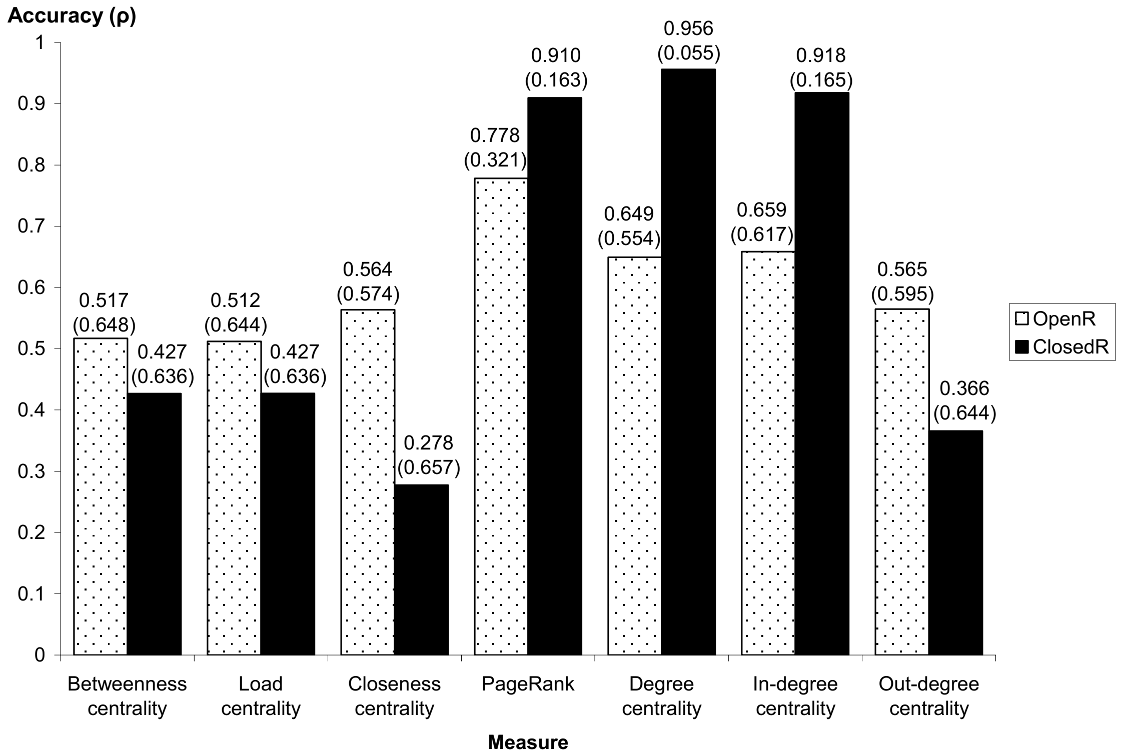


Figure 5-32: OpenR vs. ClosedR: Prioritising stakeholders.

Method

The response rate of the survey was calculated as the number of stakeholders who responded, over the total number of stakeholders contacted, expressed as a percentage. This response rate was compared to the weighted average response rates for surveys from Yu and Cooper (1983). In Yu and Cooper's study, the response rates for a total of 497 survey studies were analysed (1983). The sample sizes of these survey studies ranged from 12 to 14,785. Because of this variability, the average response rate reported in their results was weighted by the number of contacts underlying the response rate.

Without regard to technique (e.g., mail surveys, telephone surveys, personal interviews), Yu and Cooper (1983) reported the weighted average response rate to be 48.8%. With regard to technique, Yu and Cooper (1983) found personal interviews to be most effective in generating responses (81.7%), followed by telephone surveys (72.3%), and then mail surveys (47.3%). The rate without regard to technique was used as comparison, because the respondents for StakeNet were contacted by email and some were reminded with a phone call, and then they were all surveyed in person.

The time spent using StakeNet was calculated as the total time spent answering the questionnaire divided by 3. The total time spent answering the questionnaire is the total survey time minus the time spent introducing StakeNet and interviewing the respondents after the survey, which was about 15 minutes per respondent. This is divided by 3 because each respondent was required to complete three questions (OpenR, ClosedR, and individual prioritisations) but only OpenR was used in StakeNet to build the social network (ClosedR and individual prioritisations were used to evaluate StakeNet). Only the respondents' time spent is calculated, as this researcher's presence while the respondents were completing the questionnaires was just to observe them for research purposes. The calculation is an approximation because open-ended recommendations often took longer than closed-ended recommendations, and individual prioritisations. The time spent using StakeNet was compared with the time spent using the existing method in the project, which was 24 hours, as reported in the previous chapter (Section 4.3, page 90).

Results

Stakeholders were motivated to recommend other stakeholders. The survey response rate was 81%, which is 30% higher than Yu and Cooper's weighed average response rate without regard to technique (Yu and Cooper, 1983). Of the 81% of stakeholders who participated in the survey, 70% of them responded to the initial email contact, and 11% responded to the reminder (Figure 5-33). Those who did not respond to both the initial emails and the subsequent reminders were mostly away or not stakeholders. Of the 6% who did not respond but were still at UCL, only one stakeholder was salient in the project. Interviews revealed that this stakeholder had delegated his responsibilities to another stakeholder, who had responded.

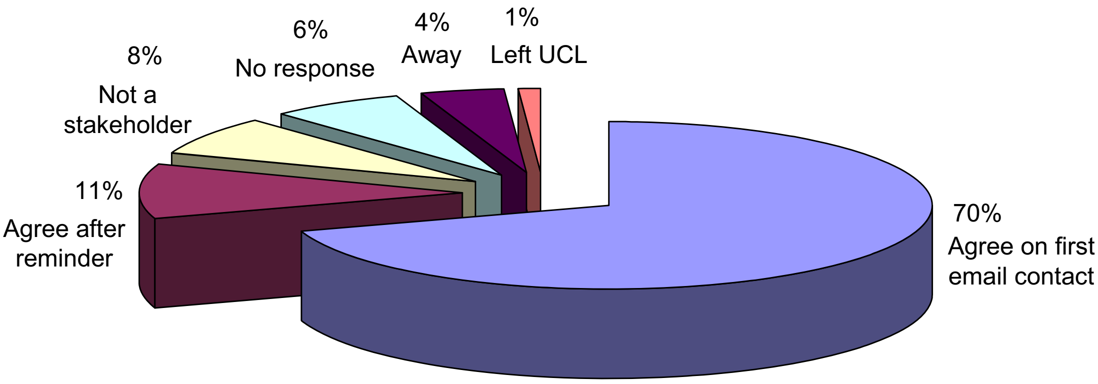
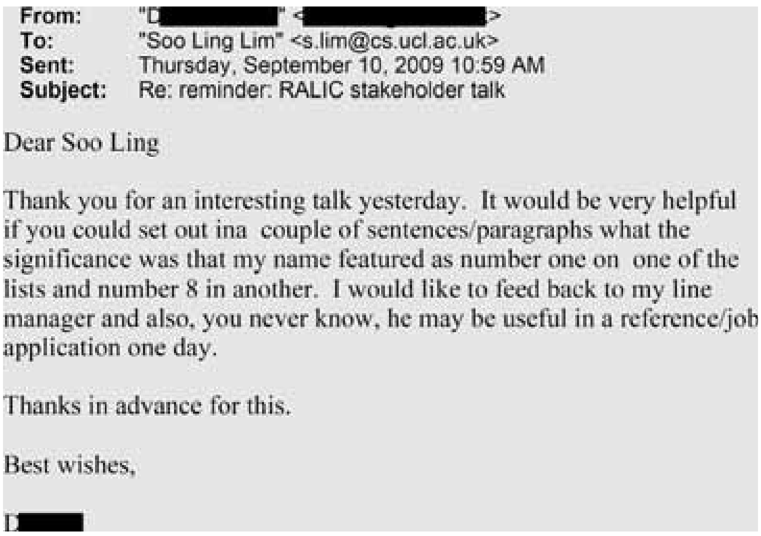


Figure 5-33: Stakeholders' response.

Stakeholders were pleased when they were ranked high, which suggests that their ranking may motivate them to make recommendations. For example, after the survey, a presentation about the evaluation results was given to the stakeholders who participated. A stakeholder who was prioritised highly by two social network measures requested for the prioritisation and the meaning they convey to be shared with his line manager (Figure 5-34). This stakeholder was also keen to participate in the StakeRare survey described in the next chapter, despite suffering from illness.



From: "[redacted]" <[redacted]>
To: "Soo Ling Lim" <s.lim@cs.ucl.ac.uk>
Sent: Thursday, September 10, 2009 10:59 AM
Subject: Re: reminder: RALIC stakeholder talk

Dear Soo Ling

Thank you for an interesting talk yesterday. It would be very helpful if you could set out ina couple of sentences/paragraphs what the significance was that my name featured as number one on one of the lists and number 8 in another. I would like to feed back to my line manager and also, you never know, he may be useful in a reference/job application one day.

Thanks in advance for this.

Best wishes,

[redacted]

Figure 5-34: Stakeholder's email on survey results.

The time spent using StakeNet was 17 hours, seven hours less than the time spent using the existing method in the project. While the existing method in the project returned an unprioritised list of stakeholders and their roles, StakeNet's list of stakeholders and their roles was accurately prioritised and highly complete, as shown in the previous research questions.

Respondents involved in software projects were keen to use StakeNet in their work. During the survey, a system support asked eagerly, "Will UCL use StakeNet?" He explained that many of the change requests he received can be avoided if stakeholders were identified initially. A director recommended StakeNet to be used in his division. He added, "Managers often think in terms of systems and organisation. When we have a function, we only look at the layer in the organisation affected by the function. This limited view often gives us problems in the long run!"

5.4 Summary

StakeNet is a stakeholder analysis method that uses social networks to identify and prioritise stakeholders for large-scale software projects. The evaluation results provide clear evidence that StakeNet provides effective support for stakeholder analysis as follows.

- StakeNet identifies a highly complete set of stakeholders and their roles compared to the existing method used in the project.
- StakeNet prioritises stakeholders and their roles accurately. Different social network measures prioritise different kinds of stakeholders. Combining the measures can improve the accuracy of prioritisation.
- Compared to individual stakeholders, StakeNet is more accurate in prioritising stakeholder roles.
- Open-ended questionnaires are more effective than closed-ended questionnaires in collecting recommendations.
- Stakeholders are motivated to recommend other stakeholders using StakeNet. StakeNet requires less time from the requirements engineers and the stakeholders as compared to the existing method used in the project.

The next chapter describes StakeRare, a method that identifies and prioritises requirements from the stakeholders identified by StakeNet.

Chapter 6

StakeRare

This chapter reviews the existing literature in collaborative filtering, describes the application of collaborative filtering to requirements elicitation in StakeRare, and reports the evaluation of StakeRare using the RALIC project.

As described in the previous chapter, social networks provide effective support for stakeholder analysis in large-scale software projects. However, the aim of this work is to develop a method that provides effective support for requirements elicitation in large-scale software projects, which involves identifying and prioritising both stakeholders and their requirements. This chapter describes StakeRare[64], a method that uses social networks and collaborative filtering to identify and prioritise stakeholders and their requirements. The goal of StakeRare is to identify and prioritise requirements from the global perspective and avoid overloading stakeholders with information or burdening the requirements engineers. StakeRare (Stakeholder- and Recommender-assisted method for requirements elicitation) uses StakeNet to identify and prioritise stakeholders and their roles, asks the stakeholders to rate an initial list of requirements, recommends other relevant requirements to them using collaborative filtering, and prioritises their requirements using their ratings weighted by their project influence. StakeRare shares the same principle with StakeNet: to be open and inclusive so that each stakeholder participates in requirements elicitation.

---

[64] StakeRare has been submitted to the *IEEE Transactions on Software Engineering* as Soo Ling Lim, and Anthony Finkelstein. StakeRare: using social networks and collaborative filtering to identify and prioritise requirements for large-scale software projects.

This chapter reviews the existing literature in collaborative filtering that informs the development of StakeRare, describes StakeRare, and reports its evaluation using the RALIC project described in Chapter 4.

6.1 Collaborative Filtering

Opinion sharing is not new to humans. In Schafer et al.'s words, "For years, people have stood over the back fence or in the office break room and discussed books they have read, restaurants they have tried, and movies they have seen – then used these discussions to form opinions. For example, when enough of Amy's colleagues say they liked the latest release from Hollywood, she might decide that she also should see it. Similarly, if many of them found it a disaster, she might decide to spend her money elsewhere. Better yet, Amy might observe that Matt recommends the types of films that she finds enjoyable, Paul has a history of recommending films that she despises, and Margaret just seems to recommend everything. Over time, she learns whose opinions she should listen to and how these opinions can be applied to help her determine the quality of an item" (Schafer et al., 2007, pages 291-292).

With the Internet, the opinions of thousands can now be considered. Opinions from a large community of users can be gathered and filtered for information and patterns, a process known as collaborative filtering (Goldberg et al., 1992). The users' opinions on an item are expressed as ratings. Collaborative filtering mines patterns within these ratings in order to forecast each user's preference for unrated items (Lathia, 2008). Hence, as well as being able to determine what a much larger community thinks of an item, collaborative filtering can also develop a personalised view of an item using the opinions most appropriate (Schafer et al., 2007). The underlying assumption is that those with similar opinions in the past will continue to share similar tastes in the future (Lathia, 2008).

Collaborative filtering is used to support decision-making involving large amounts of information. For example, Amazon[65] uses collaborative filtering to recommend books (e.g., Figure 6-1), and MovieLens[66] uses it to recommend movies (Linden et al., 2003, Schafer et al., 2007).

[65] http://www.amazon.com/

[66] http://www.movielens.org/

Figure 6-1: Amazon's recommendations for this researcher.

User, Item, and Ratings

Collaborative filtering recommender systems produce recommendations for a given user on one or more items (Lathia, 2008). To do so, they take a set of ratings from the user community as input, use this set of ratings to predict missing ratings, and use the predictions to create a list of items that is personalised for each user, which are then presented to the user as recommendations (Figure 6-2).

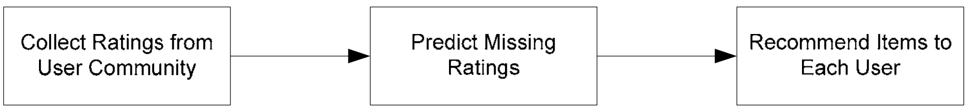


Figure 6-2: Generating recommendations.

In collaborative filtering, users are the individuals who provide ratings to a system and receive recommendations from the system. The entire set of users is thus the user community. Items can consist of anything for which ratings can be provided, such as art, books, songs, movies, vacation destinations, and jokes (Segaran, 2007). A rating is a numerical representation of a user's preference for an item. Profile is the set of ratings that a particular user has provided to the system. Take MovieLens[67] for example. Each user is required to provide a profile of more than 15 movie ratings. The ratings range from 1 to 5 stars, where 1 is "Awful" and 5 is "Must See". MovieLens then uses the ratings from the user community to predict the particular user's

---

[67] http://www.movielens.org/

ratings on movies that the user has not yet watched, and recommend movies that user might be interested in (Figure 6-3).

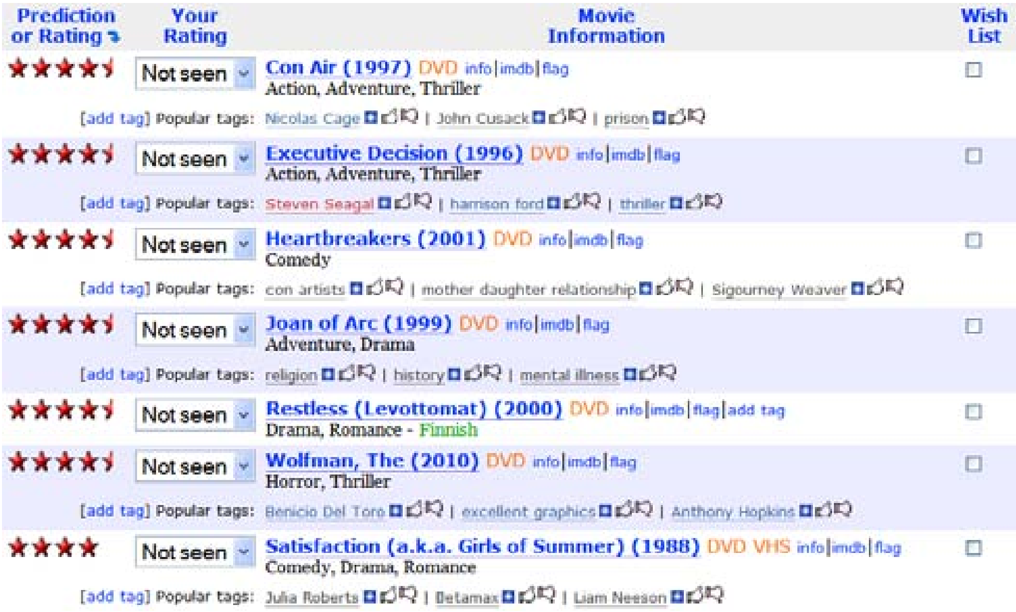


Figure 6-3: MovieLens predicts that this researcher is likely to rate the movie "Con Air" as 4.5 stars and the movie "Satisfaction" as 4 stars.

Predicting Ratings

To produce predictions, collaborative filtering systems use a variety of algorithms. One of the most well-known algorithms is the *k*-Nearest Neighbour (*k*NN) algorithm (Herlocker et al., 1999, Schafer et al., 2007, Bell and Koren, 2007). *k*NN is a simple machine learning algorithm that classifies an object by the majority vote of its neighbours (Witten and Frank, 2005). The object is assigned to the class most common amongst its *k* nearest neighbours, where *k* is a positive and typically small integer.

*k*NN is used in collaborative filtering to identify like-minded users with similar rating histories, in order to predict ratings for unobserved users-item pairs (Bell and Koren, 2007). First, *k*NN finds a unique subset of the community for each user by identifying those with similar interests. To do so, every pair of user profiles is compared to measure the degree of similarity. A popular method to measure similarity is Pearson's correlation coefficient, which measures the degree of linearity between the intersection of the pair of users' profiles.

The formula provided by Schafer et al. (2007) for measuring similarity between user *u* and user *n* is as follows.

$$userSim(u,n) = \frac{\sum_{i \in CR_{u,n}} (r_{ui} - \bar{r}_u)(r_{ni} - \bar{r}_n)}{\sqrt{\sum_{i \in CR_{u,n}} (r_{ui} - \bar{r}_u)^2} \sqrt{\sum_{i \in CR_{u,n}} (r_{ni} - \bar{r}_n)^2}}, \quad (6\text{-}1)$$

where $CR_{u,n}$ is the set of items both rated by u and n, r_{ni} is the rating user n provides on item i, r_{ui} is the rating user u provides on item i, and $\bar{r}_n$ is the average rating provided by user n. The output ranges between –1 and +1, where users in perfect agreement score +1, and users in perfect disagreement score –1. When the similarity between each pair of user profiles is computed, a neighbourhood is created for each user by selecting the k most similar users. As every dataset exhibits different characteristics, the optimal neighbourhood size k varies for each dataset. This optimal k can be determined via cross-validation (Witten and Frank, 2005).

The similarity between each pair of user profiles, *userSim(u,n)*, is used to compute predicted ratings. The formula provided by Schafer et al. (2007) to predict user *u*'s ratings on item *i* is as follows.

$$pred(u,i) = \bar{r}_u + \frac{\sum_{n \in neighbours(u)} userSim(u,n) \cdot (r_{ni} - \bar{r}_n)}{\sum_{n \in neighbours(u)} userSim(u,n)}, \quad (6\text{-}2)$$

where *neighbours(u)* is the set of users similar to u, r_{ni} is the rating user n provides on item i, and $\bar{r}_n$ is the average rating provided by user n. As users may vary in their use of rating scales, this computation compensates for the difference, by considering how much ratings deviate from each recommender's mean rather than the rating itself. The predicted ratings for the items are sorted according to the predicted value, and finally, the top-N items are proposed to the user as recommendations, where N is the number of items recommended to the user.

Applications in Software Engineering

In software engineering, Ohira et al. (2005) uses collaborative filtering to identify similar developers and similar projects, so that the developers in one project can seek help from the developers in other projects. Using collaborative filtering, if developer *i* and developer *j* join the same projects many times, the similarity among the two developers is rated highly. If there are many developers who are working together for project *m* and project *n*, the similarity among the two projects is rated highly. The similarity is used to define and visualise the relationships among developers and projects. For example, the relations among developers and projects with low similarities are not visualised for simplicity.

In requirements engineering, Castro-Herrera et al. uses collaborative filtering to facilitate online discussions for requirements identification (Castro-Herrera et al., 2009a, Castro-Herrera et al., 2009b). Their method, also discussed in Chapter 2 (Section 2.2, page 45), uses clustering to group the stakeholder's ideas into an initial set of discussion forums and construct a stakeholder profile for each stakeholder. These profiles are used by the *k*NN algorithm to identify stakeholders with similar interests and suggest additional forums that might be of interest to the stakeholders. Castro-Herrera et al.'s work demonstrates that collaborative filtering can be used to support requirements elicitation. Their work, which uses collaborative filtering to recommend forums of interest to stakeholders, has inspired the work in this thesis to use collaborative filtering to recommend requirements of interest to stakeholders, in order to support large-scale requirements elicitation. Recommending relevant requirements to stakeholders can reduce the number of requirements each stakeholder has to identify and prioritise, while still ensuring they are aware of the requirements they may be interested in.

To summarise, collaborative filtering is a technique used to filter large sets of data for information and patterns. It is used to make predictions about the interests of a user by collecting taste information from many users. The underlying assumption is that users who have had similar taste in the past will share similar taste in the future. Collaborative filtering takes as input a set of ratings from the user community, uses this set of ratings to predict missing ratings, and uses the predictions to create a list of items that is personalised for each user, which are then presented to the user as recommendations. To predict users' ratings on items that they have not rated, collaborative filtering algorithms are used. A popular collaborative filtering algorithm is the *k*-Nearest Neighbour algorithm, which identifies like-minded users with a similar rating history to predict ratings for unobserved users-item pairs.

6.2 StakeRare

This work hypothesises that collaborative filtering can be used to provide effective support for requirements elicitation in large-scale software projects. To test the hypothesis, a method that uses collaborative filtering to identify and prioritise requirements, StakeRare, is developed.

Large projects often have many requirements. Involving all stakeholders in requirements elicitation results in a large volume of stakeholder requests (Cleland-Huang and Mobasher, 2008, Duan et al., 2009). To avoid overloading stakeholders with information, StakeRare uses collaborative filtering to present only the requirements that are relevant to them. StakeRare asks each stakeholder to rate an initial list of requirements, and based on the list, identifies a neighbourhood of similar stakeholders for each stakeholder. Then, it predicts other relevant requirements for the stakeholder based on the requirements provided by similar stakeholders. These predictions are presented to the stakeholder to be approved and added into their set of ratings. Finally, StakeRare produces a prioritised list of requirements based on each stakeholder's ratings and their influence in the project. StakeRare uses the existing requirements elicitation concepts described in Chapter 2 and collaborative filtering concepts described in the previous section. The concepts are summarised in Table 6-1.

Table 6-1: StakeRare Concepts

Concept	Definition
Scope	The work required for completing the project successfully (Robertson and Robertson, 2006).
Stakeholder	An individual or a group who can influence or be influenced by the success or failure of a project (Nuseibeh and Easterbrook, 2000).
Stakeholder role	The stakeholder's position or customary function in the project (Sharp et al., 1999).
Requirement	The real-world goals for, functions of, and constraints on software systems (Zave, 1997).
Rating	Numerical importance of a requirement to the stakeholder (Schafer et al., 2007).
Profile	The set of requirements and their ratings provided by a stakeholder (Schafer et al., 2007).

StakeRare identifies and prioritises requirements using the following steps (Figure 6-4).

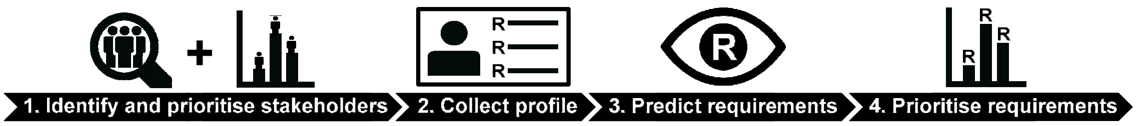


Figure 6-4: StakeRare's four steps.

Step 1: Identify and Prioritise Stakeholders

This step identifies and prioritises the stakeholders based on their influence in the project. Stakeholders have to be identified as they are the source of requirements. They have to be prioritised as their level of influence in the project affects the priority of their requirements. The output is a prioritised list of stakeholder roles and for each role, a prioritised list of stakeholders. A stakeholder analysis method that produces such an output is StakeNet, described in the previous chapter. StakeNet identifies stakeholders and asks them to recommend other stakeholders and stakeholder roles, builds a social network whose nodes are stakeholders and links are recommendations, and prioritises the stakeholders using social network measures. An example output from StakeNet for the RALIC project is illustrated in Table 6-2.

Table 6-2: StakeNet's Prioritised Stakeholder List

Prioritised Stakeholder Roles	Prioritised Stakeholders
(1) Estates	Alice
(2) Students	(1) Dave
	(2) Carl
(3) Library	Bob

As mentioned in the previous chapter (Section 5.2, page 116), the stakeholder roles are prioritised based on their influence in the project (e.g., Estates: Rank 1, Students: Rank 2, Library: Rank 3). Fractional ranking or "1 2.5 2.5 4" ranking (Triola, 1992) is used such that if a tie in ranks occurs, the mean of the ranks involved is assigned to each of the tied items. For example, if Estates and Students have the same level of influence, then the ranks become Estates: Rank 1.5, Students: Rank 1.5, Library: Rank 3.

Step 2: Collect Profile

This step collects a profile from each stakeholder identified in Step 1. Existing elicitation methods in Chapter 2, such as interviews with a subset of stakeholders or focus groups, is used to identify an initial list of requirements. For example, in the RALIC project, an interview with Alice from Estates revealed that one of the project objectives is to provide "better user experience." Bob representing the library reveals that his requirement is "to combine library card with access card," student Dave's requirement is "to combine access card with bank card," and Alice, representing the Estates, requests for "all in one card."

The requirements are organised into a hierarchy of three levels: project objective, requirement, and specific requirement. As mentioned in Chapter 2 (Section 2.2, page 42), requirements can be defined at different levels of abstraction (Dardenne et al., 1993, Van Lamsweerde, 2009). A high-level requirement can be refined into several specific requirements (Dardenne et al., 1993). Achieving all the specific requirements means that the parent requirement is achieved, and achieving all the parent requirements means that the project objective is achieved. For example, the requirement "all in one card" falls under the project objective "better user experience," as it is easier to carry one card for all purposes (Figure 6-5). Then, combining the various cards are specific requirements under "all in one card."

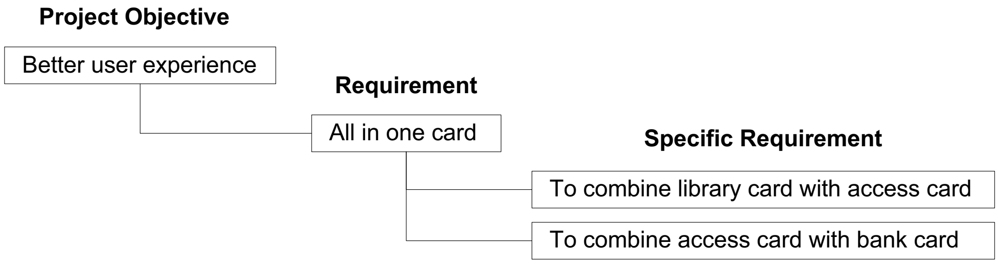


Figure 6-5: The hierarchy of requirements.

The stakeholders identified in Step 1 are asked to provide their preferences on the initial requirements. A preference is a triple

<*stakeholder*, *requirement*, *rating*>,

where rating is a number on an ordinal scale (e.g., 0 – 5) reflecting the importance of the requirement to the stakeholder (e.g., 0 is unimportant and 5 is very important). For example, Alice provides a preference

<Alice, To combine library card with access card, 5>.

Stakeholders can also indicate requirements that they actively do not want (e.g., by rating the requirement an X). For example, Bob provides

<Bob, To combine access card with bank card, X>.

Stakeholders can also rate requirements not in the list by adding their own requirements. The requirements added are then available to be rated by other stakeholders. If a stakeholder rates a high-level requirement but does not rate the lower-level requirements in the hierarchy, then his rating propagates down to all the existing lower-level requirements for that requirement to ensure there are no missing values in the lower-level data. For example, Carl provides a preference

<Carl, All in one card, 4>.

Since Bob and Dave provided specific requirements for this requirement, Carl then implicitly provides two other preferences

<Carl, To combine library card and access card, 4>, and

<Carl, To combine access card with bank card, 4>.

Similarly, if a stakeholder rates a lower-level requirement but does not rate the high-level requirement, then his rating propagates up to the high-level requirement to ensure there are no missing values in the high-level data. By doing so, the assumption is that if someone cares about a specific requirement, they would care equally about the parent requirement. This enables StakeRare to make prioritisations and predictions at different levels of detail. Nevertheless, it is noted that if there is a high-level requirement rated with X (actively do not want), it means that the stakeholder does not want a specific requirement related to that requirement, rather than he does not want the high-level requirement. In such propagation, in the case of duplicate ratings, the maximum rating is kept. For example, if a stakeholder gives 3 and X on two specific requirements with the same high-level requirement, it is assumed that he rates 3 on the high-level requirement. Finally, if a requirement provided by a stakeholder does not have any specific requirements, specific requirements can be identified using existing elicitation methods (e.g., interviews) and added to the list to be rated.

Step 3: Predict Requirements

Based on the stakeholders' profile, this step uses collaborative filtering to predict other requirements that each stakeholder needs or actively does not want. StakeRare uses the *k*-Nearest Neighbour (*k*NN) algorithm described in the previous section. Cross-validation is used to find the optimal value for *k*. *k*NN finds similar stakeholders by measuring the similarity between the stakeholders' profiles. Then, it generates the predicted level of interest that a stakeholder will have in a requirement which he has not yet rated. StakeRare returns requirements that may be relevant to the stakeholder as recommendations at all three levels (e.g., Figure 6-6). Recommendations that are approved by the stakeholders are added to their profiles, which are used in the next step to prioritise requirements.

StakeRare recommends the following requirements to you:

1. Card to have features to prevent sharing
2. To combine access card with fitness centre card

The recommendations are based on the requirements you have rated:

★★★★★ To combine library card with access card

★★★★ To combine ID card with session card

Figure 6-6: StakeRare's output for Alice at the specific requirements level.

Step 4: Prioritise Requirements

For the final step, StakeRare aggregates all the stakeholders' profiles into a prioritised list of requirements. The ratings from the stakeholders' profiles, and the priority of the stakeholders and their roles from Step 1 are used to prioritise requirements. Negative ratings (from a stakeholder actively not wanting a requirement) are excluded in the calculation, as their purpose is to highlight conflicts to the requirements engineers, rather than to prioritise the requirements. To calculate the importance of a requirement in a project, the influence of the stakeholder's role in the project is determined, and then the influence of the stakeholders in their roles is determined as follows.

The influence of stakeholder *i*'s role in the project is calculated using Equation 6-3.

$$Influence_{role(i)} = \frac{RRmax + 1 - rank(role(i))}{\sum_{j=1}^{n}(RRmax + 1 - rank(role(j)))}, \qquad (6\text{-}3)$$

where *role(i)* is stakeholder *i*'s role in the project[68], *RRmax* is the maximum rank of the roles in the list, *rank(role(j))* is the fractional rank of role *j*, and *n* is the total number of roles in the list. Roles where none of the stakeholders provide ratings are excluded. As lower rank values correspond to higher influence, this calculation inverts the rank value by subtracting it from the upper bound of $maxrank_{Role}$ + 1. The calculation also normalises the influence of a role by dividing it with the sum of all role influences. An example prioritised list of stakeholder roles is Estates: Rank 1.5, Students: Rank 1.5, and Library: Rank 3 (fractional ranking is used where Estates and Students have the same rank). Using this example, Estates' influence is $\frac{(3+1)-1.5}{2.5+2.5+1} = 0.42$, Students' influence is the same as Estates' and Library's influence is $\frac{(3+1)-3}{2.5+2.5+1} = 0.17$.

The influence of stakeholder *i* in the role is calculated the same way using Equation 6-4.

$$Influence_{i} = \frac{RSmax + 1 - rank(i)}{\sum_{k=1}^{n}(RSmax + 1 - rank(k))}, \qquad (6\text{-}4)$$

where *RSmax* is the maximum rank of all stakeholders with the same role, *rank(i)* is the fractional rank of stakeholder *i*, and *n* is the total number of stakeholders with the same role. Stakeholders who do not provide any ratings are excluded. Again, as lower rank values correspond to higher influence, this calculation inverts the rank value by subtracting it from the upper bound of $maxrank_s$ + 1, then it normalises the influence by dividing it with the sum of all the influences of stakeholders with the same role. For roles with one stakeholder, the stakeholder's influence is its role's influence. For example, Alice's influence is 1 as she is the

[68] See Table 6-2 for examples of stakeholders and their roles.

only stakeholder for the Estates role. The Student role has two stakeholders Dave and Carl. Dave's influence is $\frac{(2+1)-1}{2+1} = 0.67$ and Carl's influence in his role is $\frac{(2+1)-2}{2+1} = 0.33$.

The influence of stakeholder *i* in a project is calculated using Equation 6-5 as follows.

$$ProjectInfluence_i = Influence_{role(i)} \times Influence_i \,, \qquad (6\text{-}5)$$

where $Influence_{role(i)}$ is the influence of the stakeholder's role in the project (Equation 6-3), and $Influence_i$ is the influence of the stakeholder in the role (Equation 6-4). From the previous example, Carl's influence in the Student role is 0.33, and the Student role's influence in the project is 0.42. Hence, Carl's influence in the project is 0.33 × 0.42 = 0.1386.

The importance of a requirement is calculated using Equation 6-6 as follows.

$$Importance_R = \sum_{i=1}^{n} ProjectInfluence_i \times r_i \,, \qquad (6\text{-}6)$$

where $ProjectInfluence_i$ is the stakeholder *i*'s influence in the project (Equation 6-5), r_i is the rating provided by stakeholder *i* on requirement *R*, and *n* is the total number of stakeholders who rated on requirement *R*. If a stakeholder has more than one role, only the position in the role that gives him the highest weight is considered. Following the previous example, the requirement "To combine library card with access card" is rated 5 by Alice and 4 by Carl. Alice's influence in the project is 0.42, and Carl's influence in the project is 0.1386, hence the requirement's importance is (0.42 × 5) + (0.1386 × 4) = 2.6544.

Finally, the requirements are prioritised based on their importance, where requirements with higher importance values are ranked higher. The requirements are prioritised within their hierarchy, so that the output is a ranked list of project objectives, for each project objective, a ranked list of requirements, and for each requirement, a ranked list of specific requirements (Table 6-3). This list is StakeRare's output for the requirements engineers.

Table 6-3: StakeRare's Output[69]

Project Objective	Requirement	Specific Requirement
(1) better user experience	(1) all in 1 card	(1) combine library card with access card (2) combine access card with bank card
(2) to improve security and access control in UCL	(1) enable visual checking	enable photo visual checks
	(2) control access to UCL buildings	(1.5) control access to departments (1.5) control access to computer cluster

6.3 Evaluation

The goal of StakeRare is to identify and prioritise requirements from the global perspective and avoid overloading stakeholders with information or burdening the requirements engineers. StakeRare identifies requirements by asking all the stakeholders to rate an initial list of requirements and recommending other relevant requirements to them using collaborative filtering, and prioritises their requirements using the stakeholders' ratings on the requirements weighted by their project influence. To evaluate StakeRare, the methodology described in Chapter 3 (Section 3.3, page 67) was used to apply StakeRare to the RALIC project described in Chapter 4.

Applying StakeRare to RALIC

Using Step 1 of StakeRare, the stakeholders and roles for the RALIC project were identified and prioritised. This step is described in the previous chapter where StakeNet was used in RALIC to identify and prioritise stakeholders and their roles. A total of 127 stakeholders and 70 roles were identified by StakeNet. In that chapter, StakeNet was empirically evaluated and the results showed that StakeNet identified a highly complete set of stakeholders and prioritised them accurately. The list of stakeholders and their roles identified by StakeNet served as input to Step 2 of StakeRare to collect stakeholder's profile.

Step 2 of StakeRare uses existing elicitation methods to identify an initial list of requirements. As mentioned in Chapter 4 (Section 4.2, page 78), the RALIC project commenced in June 2005 and the requirements were signed off at the end of September 2005. The initial list of requirements for Step 2 was taken from the first draft requirements (dated 8 August 2005)

[69] The ranks are provided in brackets. Fractional ranking or "1 2.5 2.5 4" ranking (Triola, 1992) is used.

produced by the project team. This initial list consists of 3 project objectives, 12 requirements, and 11 specific requirements (Table 6-4).

Table 6-4: Initial Requirements for RALIC

Project Objective	Requirement	Specific Requirement
Better user experience	Access cards that are easier to use with more accurate scanning	
	For library entrance, remove the need to put card in exact location for barcode scanning	
	All in one card	ID card and session card
		Library card
		Bloomsbury fitness
		Club and societies
		Cashless vending
		Time and attendance
		Computer Logon
Improve processes (reduce manual data entry and improve efficiency for access control and library processes)	Library barcode generated together with card (less 1 library queue)	
	Import photos from registry for advance card production (save queuing time for students)	
	Centralised management of access and identification information	
	Card issue available anywhere within the UCL campus	
	Digitally storing, printing and exporting photographs to other systems	Staff photograph
		Student photograph

Project Objective	Requirement	Specific Requirement
Improved security	Enable security/reception staff to check that the appearance of the card user matches the digitally stored photo	
	More locations to be controlled by smart card access readers	
	Enable the reliable removal / suspension of access rights and library borrowing privileges	
	Enable the gathering and retrieval of the time which individuals enter and leave buildings	Library
		Other buildings

Once the initial list of requirements was prepared, a survey was conducted to collect the profile of RALIC stakeholders. To do so, all the stakeholders identified in Step 1 were contacted separately via email for a survey. This survey was separate from the interviews conducted to validate the ground truth described in Chapter 4 (Section 4.4, page 103). Those interviews were conducted after this survey, so that the stakeholders' survey answers were not influenced by the interviews about the ground truth[70]. Two email templates were prepared, one for stakeholders previously surveyed in StakeNet (Figure 6-7 (a)), and one for stakeholders not yet surveyed (Figure 6-7 (b)). These stakeholders were either unavailable during the StakeNet survey period, or they were identified after Round 4 of the StakeNet survey.

If the stakeholder's response was positive (e.g., Figure 6-8 (a) and (b)), a time and place would be arranged for a face-to-face survey. If the stakeholder's response was negative (e.g., Figure 6-8 (c) and (d)), the stakeholder would not be surveyed. For stakeholders with no response, a reminder phone call was made to check if they received the email and to determine if they wanted to participate in the survey.

[70] For details about the ground truth construction, refer to Section 4.4, page 103.

(a)

From: "Soo Ling Lim" <s.lim@cs.ucl.ac.uk>
To: "M[redacted]" <[redacted]>
Sent: Thursday, October 22, 2009 12:26 PM
Subject: RALIC project - Identifying requirements

Dear M[redacted].

How are you?

Thank you for helping me in the RALIC survey in May.

I am conducting another survey on the RALIC project, this time to identify the requirements. This should be the final survey that I need to do for my PhD.

Would you have time for the survey next week? It should take about 30 minutes.

Thank you!

Soo Ling

(b)

From: "Soo Ling Lim" <s.lim@cs.ucl.ac.uk>
To: <[redacted]>
Sent: Thursday, October 22, 2009 3:52 PM
Subject: RALIC project - Identifying requirements

Dear D[redacted].

I am a PhD student from the Department of Computer Science, working with Professor Anthony Finkelstein. My research is on identifying requirements for a software project. I am currently using the UCL access card project to test out my method, with the project manager Martin Paul's permission.

I contacted you sometime in May but had not got around to the survey. Would you have time for a survey next week or the week after?

Thank you!

Regards,
Soo Ling

Figure 6-7: Email to stakeholder for survey.

(a)

From: "J[redacted]" <[redacted]>
To: "Soo Ling Lim" <s.lim@cs.ucl.ac.uk>
Sent: Thursday, October 22, 2009 1:59 PM
Subject: Re: UCL access card project - Identifying requirements

Hello Soo Ling

Happy to help if you think I have the knowledge.

It might be worth including K[redacted], who you spoke to before. K[redacted] is currently off with a badly sprained ankle and I'm not sure when he'll be able to walk/come back to work. Why don't you and I agree a time and if K[redacted] is here he can come to the meeting.

When would suit you best? Tuesday looks good, or Wednesday morning. Just let me know.

J[redacted]

(b)

From: "M[redacted]" <[redacted]>
To: "Soo Ling Lim" <s.lim@cs.ucl.ac.uk>
Cc: "M[redacted]" <[redacted]>
Sent: Monday, October 26, 2009 10:05 AM
Subject: Re: UCL access card project - Identifying requirements

Hi Soo,

> Thank you for helping me in the RALIC survey in May.
>

Pleasure - and I was impressed and intrigues at your summation talk.

> I am conducting another survey on the RALIC project, this time to
> identify the requirements. This should be the final survey that I
> need to do for my PhD.
>
> Would you have time for the survey next week? It should take about
> 30 minutes.

This week's rather busy for me - can we do it next? I have a few meetings, but could meet Mon 2 (except 10-11), Tue 3 (except <11 and 1-2) or Wed 4 (up to 3).

M[redacted]

(c)

From: "S[redacted]" <[redacted]>
To: "Soo Ling Lim" <s.lim@cs.ucl.ac.uk>
Sent: Friday, October 23, 2009 3:01 PM
Subject: RE: RALIC project - Identifying requirements

Dear Soo

I'm sorry but I do not think I can help you with your project.

Regards

S[redacted]

(d)

From: "A[redacted]" <[redacted]>
To: "Soo Ling Lim" <s.lim@cs.ucl.ac.uk>
Sent: Friday, October 30, 2009 12:13 PM
Subject: Re: UCL access card project (RALIC)

Soo Ling

Given I have no knowledge of the project, access control has not yet been anywhere near my agenda and hence I have not yet thought about goals, let alone preferences and requirements and its a complex area with many stakeholders, I really don't believe I can add any value.

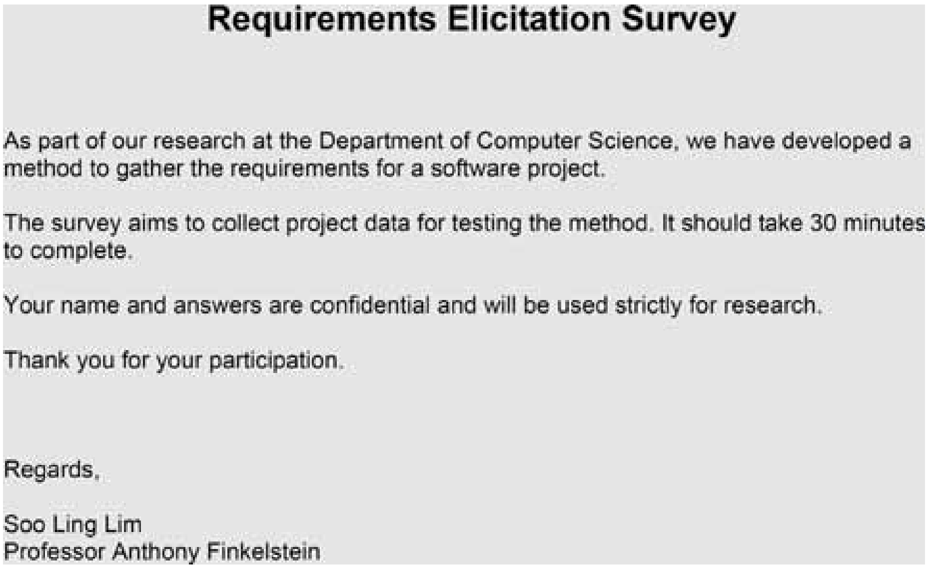
Sorry.

A[redacted]

Figure 6-8: Response from stakeholders[71].

[71] The stakeholder in (a) was referring to a talk given as part of this work to the RALIC stakeholders who participated in the StakeNet survey to tell them about the results of the study.

Each session took 30 minutes on average. At the start of each survey, the respondent was provided with a cover sheet describing the survey purpose to elicit RALIC requirements (Figure 6-9). Then, StakeRare was introduced using a set of slides (Figure 6-10). After that, the respondent was provided with a description of RALIC and its project scope (Figure 6-11) to familiarise the respondent with the project. The respondent was also asked to put themselves in the situation before RALIC was initiated (as described in Figure 6-11) when providing requirements. To prompt the respondent for recommendations, the respondent was provided with the definition of requirements, as well as the different types of requirements (Figure 6-12), examples for each type of requirement, and a template to guide the free text provided by the respondent (Figure 6-13).



Requirements Elicitation Survey

As part of our research at the Department of Computer Science, we have developed a method to gather the requirements for a software project.

The survey aims to collect project data for testing the method. It should take 30 minutes to complete.

Your name and answers are confidential and will be used strictly for research.

Thank you for your participation.

Regards,

Soo Ling Lim
Professor Anthony Finkelstein

Figure 6-9: Survey cover sheet.

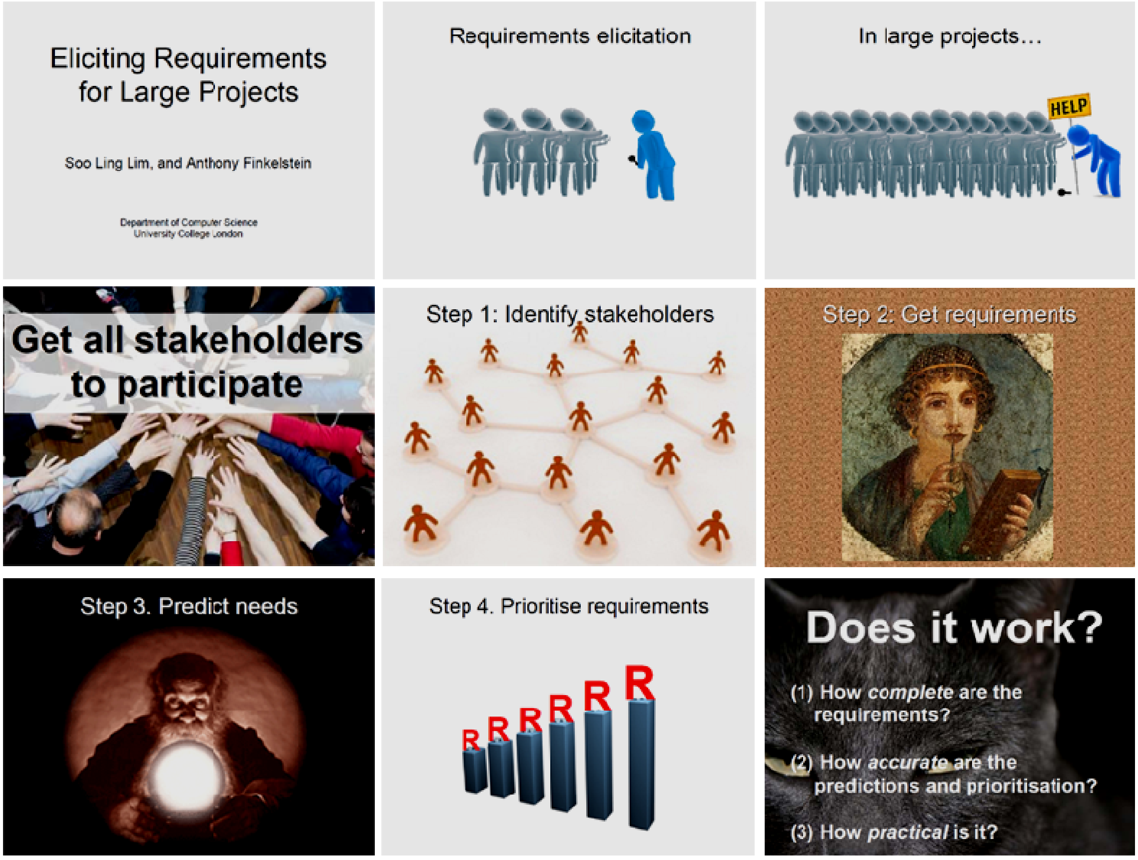


Figure 6-10: Slides to introduce StakeRare.

The RALIC Project

In 2005, UCL had a variety of access and security systems. As a result, identification and access control methods varied from building to building.

Staff, students, and visitors had to use two or more of the following access control measures:

- Magnetic strip swipe card
- Contactless Smart Card
- Photo ID Card
- Library Barcode
- Philips "Black key"
- Digital Security Code
- Metal door keys
- Session Card
- Bloomsbury Fitness Centre Card

The RALIC project was initiated to provide one card that replaces all of the above measures.

Below is the summarised scope of the RALIC project.

1. Replace magnetic swipe card readers with smart card readers
2. Source and install access card printers
3. Decide on card design and categories
4. Define user groups and default access rights
5. Provide a more accurate card holder database, save resources on manual data input, and facilitate automated provision and suspension of access and library borrowing rights
6. Issue new cards to staff, students, visitors and contractors
7. Replace the Library access control system
8. Use new cards at the Bloomsbury Fitness Centre

Figure 6-11: RALIC description and project scope.

Types of Requirements

A requirement can be:

- A **Business Goal**: a state or target that the enterprise intends to achieve or maintain with the system.
- An **Objective**: a quantitatively measurable and specific state or target that the enterprise intends to achieve or maintain with the system.
- A **System Goal**: a state or target that you intend to achieve or maintain by using the system.
- A **Capability Constraint**: a restriction on how the system achieves your goal.
- A **Quality of Service Constraint**: a quality restriction on the behaviour of the system.
- A **Business Policy**: a directive from the enterprise that defines what can be done and what must not be done, and may indicate or set limits on how it should be done.
- A **Business Rule**: a directive from the enterprise that provides specific and discrete governance or guidance to implement Business Policies.

Figure 6-12: Types of requirements.

Requirements

A requirement is a statement that identifies a necessary attribute, capability, characteristic, or quality of a system in order for it to have value and utility to a stakeholder.

Examples	Template
• To reduce the time a student spends queuing for access cards (provided by student registry). • To borrow library books (provided by students).	To <a goal you want to achieve by using the system>.
• To control access to university buildings.	To <a goal the enterprise should achieve from the system in operation>.
• Per annum, save 9000 pounds on purchase of access cards (provided by director of Estates).	By / Within / Per annum <a measurable criteria to know if the enterprise's goal is achieved>.
• Security guards should be able to view cardholder photos (provided by security guard).	<subject> should [not] be able to <action> (by using the system).
• An individual without an access card must not enter the Computer Science building (provided by Computer Science department admin). • The identification card must display the UCL logo.	<subject> must / should [not] <action> [if/while <condition>].
• The system must be compatible with other UCL systems. • The system should have an expected Life Cycle and Product Support of more than 10 years.	The system must / should [not] <performance criteria>. Examples of performance criteria: • Compliance • Time behaviour • Fault tolerance

Figure 6-13: Definition of requirements, examples and templates.

Step 2 of StakeRare collects stakeholders' profiles by asking them to rate a predefined list of requirements (the initial requirements) and provide other requirements not in the list. In addition to this elicitation method, the work also tested two other methods: (1) without a predefined list, stakeholders provide a list of requirements and assign numeric ranks to the requirements based on their perceived importance (Karlsson, 1996), and (2) 100-point test, where each stakeholder is given 100 points that they can distribute as they desire among the requirements (Herrmann and Daneva, 2008). In order to gather these different forms of information, a questionnaire comprising the following parts [72] was used to gather the stakeholders' profile.

- **Stakeholder details**. Respondents provide their name, position, department, and role in the project (Figure 6-14(a)).
- **Ranked profile (RankP)**. Respondents provide their requirements with numeric priorities (1 for most important) and X for requirements they actively do not want (Figure 6-14(b)). Then, respondents provide feedback on the elicitation method in terms of three criteria: (1) level of difficulty, (2) effort required, and (3) time spent, by rating each criterion High, Medium or Low (Figure 6-14(c)). The respondents are required to complete this question before proceeding to the next to avoid the predefined list of requirements in the next question from influencing their answers.
- **Rated profile (RateP)**. Respondents rate a predefined list of requirements, from 0 (not important) to 5 (very important), and –1 for requirements they actively do not want (Figure 6-14(d)). The predefined list consists of the initial requirements in Table 6-4, to reflect the actual initial requirements in RALIC. One extra requirement was added to the list, which is combining Santander Bank Card with UCL access card (Figure 6-14(d), Item 1.3.8). This requirement was being considered at the time of the survey and it was an opportunity to use the survey to elicit the stakeholders' views on the requirement. Respondents are asked to add requirements not in the predefined list and rate those requirements (Figure 6-14(e)). Once they start on RateP, they cannot return to RankP. As before, respondents provide feedback on the elicitation method after they have completed the question.
- **Point test profile (PointP)**. Respondents are allocated 100 points each to distribute among the requirements they want from RateP (Figure 6-14(f)). The requirements include both the predefined ones and the additional ones they provide. Respondents are asked to allocate more points to the requirements that are more important to them. Again, respondents provide feedback on the elicitation method.
- **Interest and comments**. Finally, respondents reveal their interest in the RALIC project in terms of "not at all", "a little", "so so", or "a lot" (Figure 6-14(g)). Respondents also provide any other comments they have on the study (Figure 6-14(h)).

[72] The complete questionnaire is available in Appendix E.

(a)

Q1. Please complete the following information about yourself.

Name: [redacted] [redacted]

Position: Staffing and HR Team Manager

Department: Biosciences, Faculty of Life Sciences

Q2. What stakeholder do you represent in the RALIC project?

User

Departmental Administrator
- responsible for setting up staff appointments on ResourceLink (SIPS); if appointments not on ResourceLink, Access Systems cannot issue a staff access card.

(b)

Question 1

Please **write your requirements for RALIC** in the space below following the template we provided.

Then, **rank the requirements** based on their importance to you in the right-hand column (1 being the most important).

Finally, **write requirements that you actively do not want**, and **put an X** in the right-hand column.

Requirement	Rank/X
Provide a combined card to give cardholders all functions on one card. ID + access control card + library card.	1
To populate access control system with personal data for central data bases. Enable validity to be controlled by this data (expire when HR or Registry record expires)	2
Provide a card that can be produced in one process of printing + encoding smart-card chip with data.	3

(c)

How did you find Question 1?

Please **circle** the appropriate answer.

Level of difficulty	Low	Medium	High
Effort required	Low	Medium	High
Time spent	Low	Medium	High

(d)

Question 2

Below is a list of requirements for RALIC.

Rate them from 0 (not important to you) to 5 (very important to you).

Circle -1 for requirements that you **actively do not want** in the system.

Requirements	**Increasing importance →**						
1. Better user experience	-1	0	1	2	3	4	5
1.1 Access cards that are easier to use with more accurate scanning	-1	0	1	2	3	4	5
1.2 For library entrance, remove the need to put card in exact location for barcode scanning	-1	0	1	2	3	4	5
1.3 All in one card	-1	0	1	2	3	4	5
1.3.1 ID card and session card	-1	0	1	2	3	4	5
1.3.2 Library card	-1	0	1	2	3	4	5
1.3.3 Bloomsbury fitness	-1	0	1	2	3	4	5
1.3.4 Club and societies	-1	0	1	2	3	4	5
1.3.5 Cashless vending	-1	0	1	2	3	4	5
1.3.6 Time and attendance	-1	0	1	2	3	4	5
1.3.7 Computer Logon	-1	0	1	2	3	4	5
1.3.8 Santander Bank Card	-1	0	1	2	3	4	5
2. Improve processes (reduce manual data entry and improve efficiency for access control and library processes)	-1	0	1	2	3	4	5
2.1 Library barcode generated together with card (less 1 library queue)	-1	0	1	2	3	4	5
2.2 Import photos from registry for advance card production (save queuing time for students)	-1	0	1	2	3	4	5

(e)

Write other requirements you have or actively do not want following the template we provided. Please also **rate** the requirements.

Requirements	Increasing importance →						
Sturdy/robust	-1	0	1	2	3	4	5
Attractive	-1	0	1	2	3	4	5
paper/cardboard	-1	0	1	2	3	4	5

(f)

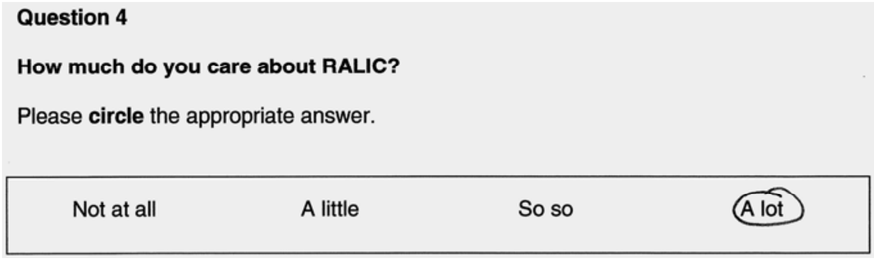
Question 3

You are given 100 points.

Please **distribute the points** among the requirements you want in **Question 2**. Allocate *more* points to requirements that are more important to you.

Requirement	Points
ACCESS CARDS EASY TO USE	10
ALL IN ONE ID + SESSION CARD	15
LIBRARY BARCODE GENERATED ON ID CARD	20
IMPORT PHOTOS FROM REGISTRY IN ADVANCE FOR ID PRODUCTION	40
SUSPENSION OF ACCESS ON CARDS IF REQUIRED	5
TO CREATE ACCESS REPORTS FOR SECURITY REASONS	5
TO ENSURE USER PROGRAMMING MISTAKES ARE KEPT TO A MINIMUM	5

(g)



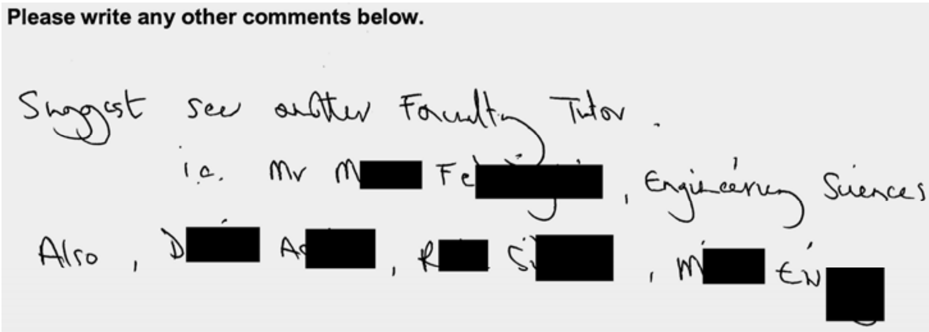
Question 4

How much do you care about RALIC?

Please **circle** the appropriate answer.

Not at all	A little	So so	A lot

(h)



Please write any other comments below.

Suggest see another Faculty Tutor.
i.e. Mr [redacted], Engineering Sciences
Also, [redacted], [redacted], [redacted]

Figure 6-14: StakeRare survey questionnaire.

At the end of the survey, the respondents were interviewed for their survey experience and the rationale behind their answers. Similar to the interviews in the StakeNet survey, these interviews were semi-structured, allowing the questions to be modified and new questions to be brought up depending on what the respondents say (Lindlof and Taylor, 2002). Some questions include:

- What do you think about the StakeRare method?
- Why is requirement *R* bad? (If the respondent actively does not want a requirement.)
- Why is requirement *R* important to you? (If the respondent allocated many points to a particular requirement.)
- Which elicitation method do you prefer and why?

A total of 87 stakeholders were surveyed. Table 6-5 summarises the amount of data collected from the survey. RateP received the most input, followed by PointP, and then RankP. The predefined list in RateP has the advantage of suggesting requirements that the respondents are unaware of, but has the disadvantage of enabling respondents to rate as many requirements as they like. PointP has fewer ratings than RateP, as the limitation of points encouraged the stakeholders to rate only the requirements that they needed most.

Table 6-5: Data Collected from 87 Respondents

Data	Amount
Stakeholder details	87 sets of details
Rank profile (RankP)	415 ratings
Rate profile (RateP)	2,396 ratings
Point allocated profile (PointP)	699 ratings
Feedback on elicitation method	783 ratings
Interest in RALIC	79 ratings

The data collected from the survey was processed and cleaned. The survey revealed that although all stakeholders provided short statements of their requirements (e.g., short clauses, or one to two sentences per requirement), very few stakeholders adhere to the requirements template provided to them at the start of the survey (Figure 6-13). A respondent experienced in business analysis advised that in requesting input from stakeholders, restrictions and templates should be kept to a minimum to encourage response, and the requirements engineers should process the data after collection. As RateP and PointP used a predefined list of requirements, less cleaning was required. Data cleaning focused on RankP as follows.

- **Same requirement different wording**. Different statements describing the same requirement were merged. For example, “all in one card” was the same requirement as “one card with multiple functionality.”
- **Same requirement different perspective**. Stakeholders with different perspective may express the same requirement in a different way, hence these requirements were merged. For example, Library Systems had the requirement “to import barcode from Access Systems,” but Access Systems had the requirement “to export barcode to Library Systems.”
- **One statement many requirements**. Statements containing more than one requirement were split into their respective requirements. For example, a statement “the card should be of a quality that lasts 5 or more years, and be easily read by our card readers” consisted of two requirements: “the card should be of a quality that lasts 5 or more years” and “the card should be easily read by our card readers.”
- **Classification into the requirements hierarchy**. The requirements were grouped under their respective project objectives. For example, the requirement “the card can be extended for future requirements, such as a digital certificate” was placed under the project objective “extensible for future features.” Specific requirements were classified into their respective requirements. For example, the requirement “does not interface

with HR directly" was a specific requirement for the requirement "minimal impact to other UCL systems," hence it was classified accordingly.

- **Duplicate entries.** If a stakeholder provided a requirement more than once in the same question, only the requirement with the highest rank (i.e., assigned with the smallest number) was kept.
- **Missing fields.** A valid preference is in the form of *<stakeholder, requirement, rating>*. Many stakeholders who provided only one requirement did not rank their requirement. The rank of 1 was assigned to such requirements, because if the stakeholder provided one requirement, then that requirement was assumed to be the most important to the stakeholder.
- **Tied ranks**. Some respondents provided tied ranks for their requirements (e.g., R1 is assigned rank 1, R2 is also assigned rank 1, R3 is assigned rank 2). Fractional ranking was used to handle tied ranks (e.g., R1: rank 1.5, R2: rank 1.5, R3: rank 3) and the ranks were normalised such that the sum of all the ranks from a stakeholder adds up to 1 (e.g., R1: rank 0.25, R2: rank 0.25, R3: rank 0.5). Using the ranking method (RankP), the range of the ranking depends on the number of requirements provided by the stakeholders, and this variability affects the prediction and prioritisation. Hence, normalisation was done to ensure that all rankings were within the same range of 0 to 1 for each stakeholder. The rating for "actively do not want" was converted to 0.

In RateP, if the respondents entered additional requirements, then the requirements were cleaned the same way as they were in RankP for the items "same requirement different wording", "same requirement different perspective", and "one statement many requirements". When providing additional requirements in RateP, some respondents indicated which project objective in the predefined list the requirements belong to, hence reducing the need for classification into project objectives. For duplicate entries in RateP, the requirement with the highest rating was kept.

For PointP, the ratings were normalised such that each stakeholder's allocated points added up to 100 to remove arithmetic errors during the survey. For duplicate entries in PointP, the requirement with the most points was kept.

Step 2 of StakeRare involves propagating the ratings up and down the hierarchy. If a stakeholder rates a lower-level requirement but does not rate the high-level requirement, then StakeRare assumes the stakeholder provides the same rating to the high-level requirement. If a stakeholder rates a requirement but not its specific requirements, then StakeRare assumes the stakeholder provides the same rating to all the specific requirements. This propagation expanded requirements into their corresponding specific requirements, resulting in a total of 1109 ratings on specific requirements for RankP, 3113 for RateP, and 1219 for PointP. The complete RankP, RateP, and PointP datasets are available in Appendix F.

When plotting the specific requirements in RankP against the number of positive ratings, the result resembles a power-law distribution (Figure 6-15), with a few dominating requirements to the left receiving many ratings and a long tail to the right with many requirements receiving a few ratings (Anderson, 2008). A power law graph emerges when there is a large population of stakeholders, a large number of requirements, and a high freedom of choice (Anderson, 2008). The graph for RateP has a large number of dominating requirements due to the predefined list (Figure 6-16) and the graph for PointP has a long tail but does not have clear dominating requirements because of its point restriction (Figure 6-17).

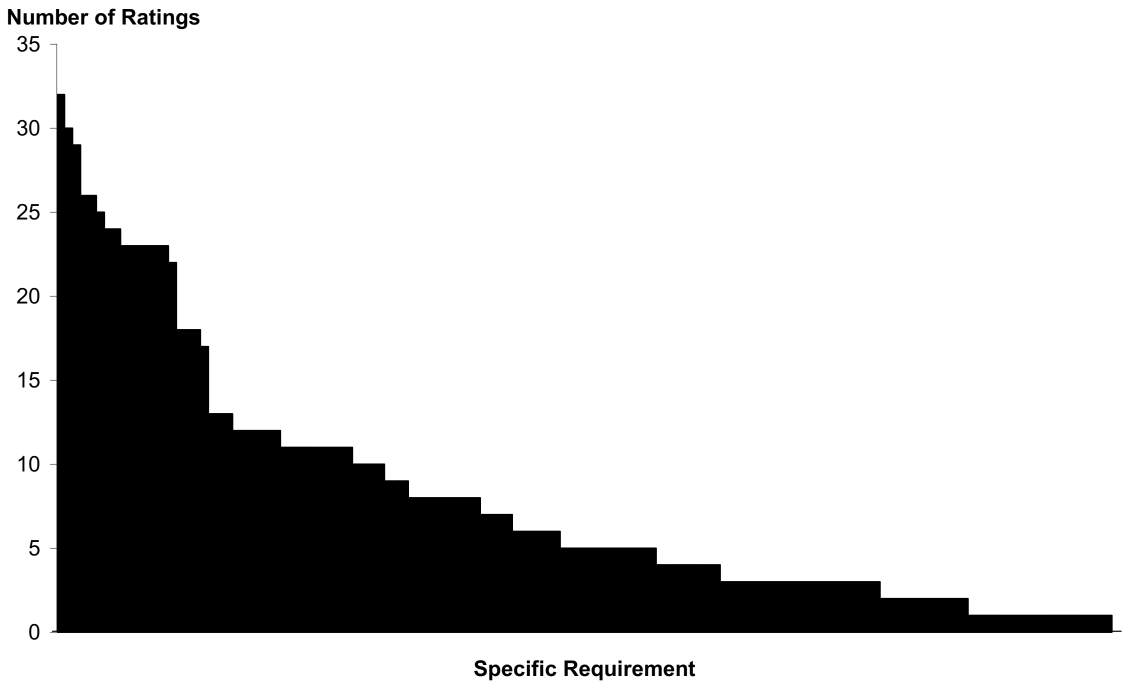


Figure 6-15: RankP: Specific requirement vs. number of ratings.

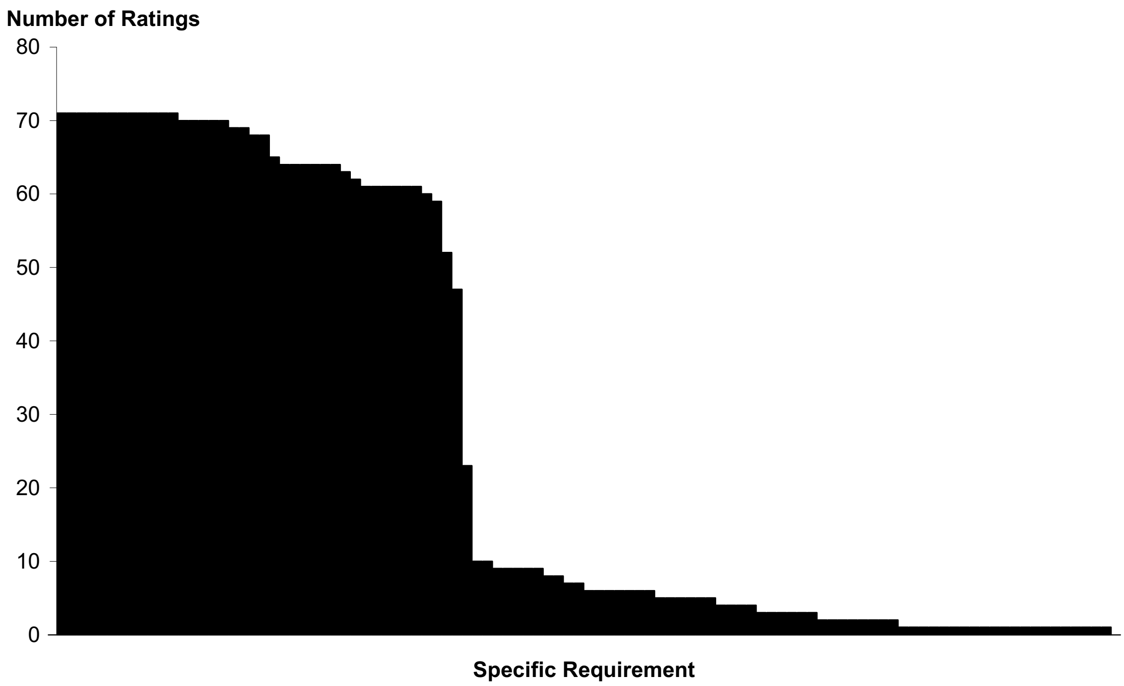


Figure 6-16: RateP: Specific requirement vs. number of ratings.

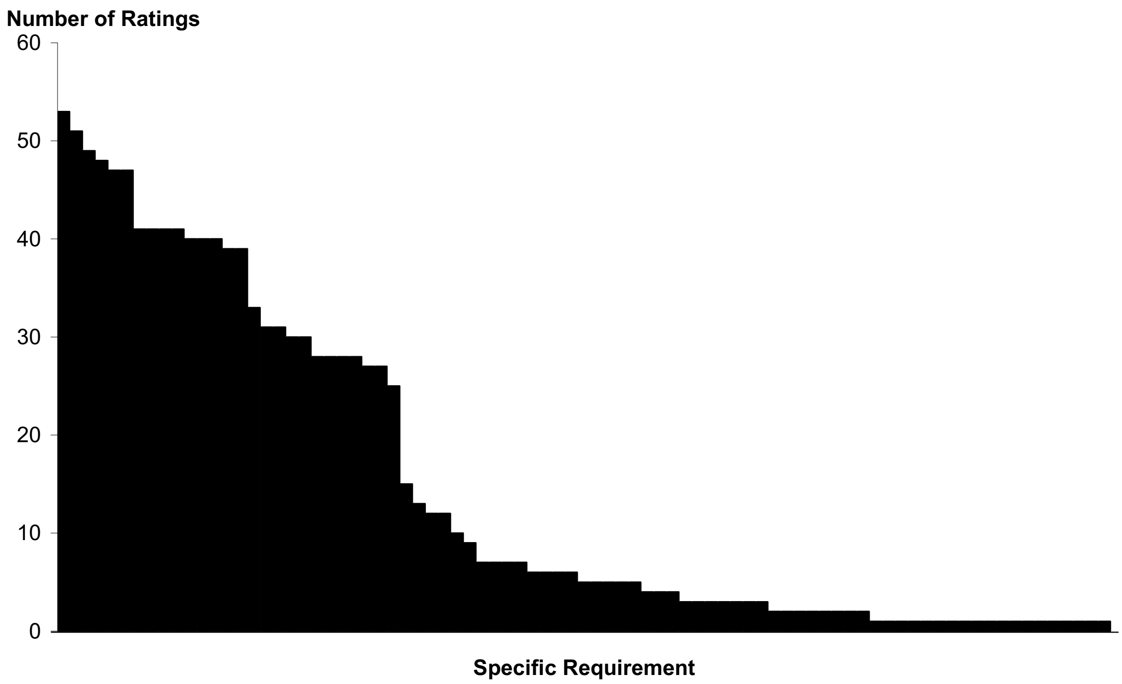


Figure 6-17: PointP: Specific requirement vs. number of ratings.

In Step 3, collaborative filtering is used to predict other requirements a stakeholder may need based on the profile they provide in Step 2. This step was evaluated using the standard evaluation method in the collaborative filtering literature (Herlocker et al., 2004, Schafer et al., 2007, Lathia, 2008). The evaluation partitioned the stakeholders' profiles into two subsets. The first subset was the training set, which the collaborative filtering algorithm learnt from. The second subset was the test set, with rating values that were hidden from the algorithm. For the evaluation, the algorithm's task was to make predictions on all the items in the test set. The predictions were then compared to the actual hidden rating values. Using this method of evaluation, no additional input was required from the stakeholders. An alternative method to evaluate this step was to make predictions based on the stakeholders' complete profiles and approach the stakeholders to approve the recommended requirements by getting them to rate the recommended requirements. This option was not selected as not all stakeholders were available to be interviewed more than once.

The fourth and final step of StakeRare gathers all the stakeholders' initial ratings in Step 2 and their approved ratings from Step 3 to prioritise all the requirements for the project. This step uses the priority of stakeholders and their roles from Step 1. For this priority, the StakeNet list produced by the betweenness centrality measure was used, because the evaluation from the previous chapter found the list to be the most accurate compared to the lists produced by the other social network measures (Section 5.3). As three datasets, RankP, RateP, and PointP, were collected during the survey, three prioritised lists of requirements were produced.

Research Questions

Step 1 of StakeRare identifies and prioritises the stakeholders and their roles for RALIC. The evaluation of this step is described in the previous chapter about StakeNet. The rest of this section describes the evaluation of the other StakeRare steps.

To evaluate the effectiveness of StakeRare in supporting requirements elicitation, the following research questions were asked. To answer these research questions, the requirements lists produced by StakeRare are compared with the existing method and the ground truth lists of requirements from Chapter 4 (Section 4.4, page 99).

RQ1. **Identifying requirements**. The existing requirements elicitation methods described in Chapter 2 (Section 2.2) involve a subset of stakeholders. In contrast, StakeRare involves all the identified stakeholders. This research question assesses how well StakeRare identifies requirements as compared to the existing method used in the project by asking:

- How many requirements identified by StakeRare are actual requirements as compared to the ground truth?
- How many of all the actual requirements in the ground truth does StakeRare identify?

RQ2. **Prioritising requirements**. StakeRare prioritises stakeholders using social network measures, and then uses the output to prioritise requirements. This research question asks:

- How accurately does StakeRare prioritise requirements as compared to the ground truth?

RQ3. **Effective support for requirements elicitation**. StakeRare aims to provide effective support for requirements elicitation, by providing a predefined list of requirements for the stakeholders to rate (RateP). During the survey, two other elicitation methods were administered to explore the effectiveness of different methods. RankP asks stakeholders to enter their requirements without providing an initial list of requirements, and PointP asks stakeholders to allocate 100 points to the requirements they want in the same predefined list. In RateP and PointP, stakeholders can suggest additional requirements. This research question explores what kinds of support are effective for the requirements engineer and stakeholders by asking the following questions.

- Between the three elicitation methods RankP, RateP, and PointP, which produces the most complete list of requirements and most accurate prioritisation for the requirements engineer?
- Between the three elicitation methods RankP, RateP, and PointP, which do the stakeholders prefer?
- If stakeholders are provided with a list of all the requirements in the project, how prepared are they to rate them all?

RQ4. **Predicting requirements**. To recommend requirements that may be of interest to the stakeholders, StakeRare uses the *k*NN algorithm in collaborative filtering to identify similar stakeholders and predict their requirements. This research question asks:

- How accurately can collaborative filtering predict stakeholder requirements?
- Are the results consistent regardless of the elicitation method used?

RQ5. **Predicting requirements: enhanced profiles**. In Castro-Herrera et al.'s work in recommending forums to stakeholders, the stakeholders' profiles are enhanced with stakeholder information, such as their roles in the project and their interest in different aspects of the system, to produce more accurate predictions of the stakeholders' interest in forums (Castro-Herrera et al., 2009a). This research question asks:

- Does enhancing stakeholder profile by adding stakeholder information improve the accuracy of predicting stakeholder interest in requirements?
- Are the results consistent regardless of the elicitation method used?

RQ6. **Predicting requirements: other algorithms**. As mentioned in the previous section (Section 6.1), *k*NN is a simple machine learning algorithm. Other machine learning algorithms can also be used to predict stakeholders' interest (Witten and Frank, 2005). This research question asks:

- Does using other algorithms and combinations of algorithms improve the prediction accuracy?
- Are the results consistent regardless of the elicitation method used?

RQ7. **Survey response and time spent**. The quality of the requirements returned by StakeRare depends on the stakeholders' motivation to participate. Also, to provide effective support in requirements elicitation, StakeRare should take less time than existing methods. The previous chapter shows that the first step of StakeRare identifies and prioritises stakeholders using less time compared to the existing method used in the project. This research question asks:

- Are stakeholders motivated to provide requirements for StakeRare?
- How much time did stakeholders spend in identifying and prioritising requirements as compared to the existing method in the project?

Method and Results

The method to evaluate each research question and the results are described as follows.

RQ1: Identifying Requirements

The first research question asks:

- How many requirements identified by StakeRare are actual requirements as compared to the ground truth?
- How many of all the actual requirements in the ground truth does StakeRare identify?

Method

The list of requirements identified by StakeRare and the existing method were compared against the ground truth, in terms of precision and recall, the two metrics widely used in the information retrieval literature (Herlocker et al., 2004).

The precision of identified requirements is the number of actual requirements in the set of identified requirements divided by the total number of identified requirements (Equation 6-7).

$$precision = \frac{\left|\{X\} \cap \{GroundTruth\}\right|}{\left|\{X\}\right|}, \qquad (6\text{-}7)$$

where X is the set of requirements identified by StakeRare or the existing method, and *GroundTruth* is the set of requirements in the ground truth.

The recall of identified requirements is the number of actual requirements in the set of identified requirements divided by the total number of actual requirements (Equation 6-8).

$$recall = \frac{\left|\{X\} \cap \{GroundTruth\}\right|}{\left|\{GroundTruth\}\right|}, \qquad (6\text{-}8)$$

with X and *GroundTruth* same as for precision. Both precision and recall range from 0 to 1. A precision of 1 means all the identified requirements are actual requirements. A recall of 1 means all the actual requirements are identified (i.e., the list of requirements is complete).

As explained in the StakeRare method, the requirements in StakeRare are organised into a hierarchy of project objectives, requirements, and specific requirements. To measure the precision and recall of the identified requirements, both the requirements and specific requirements were considered. Project objectives were not considered because the different methods share the same project objectives. If the requirements identified by StakeRare matched the ones in the ground truth but their exact details differ, they were still considered a match, because in an actual project, the details could be amended during the project as long as the requirement was identified. For example, a stakeholder provided the requirement "a minimum of 5 years support from the software vendor," but the actual requirement in the ground truth was a minimum of ten years support rather than five. This requirement was considered a match with the ground truth.

Results

StakeRare identified the requirements in RALIC with a high level of completeness, with a 10% higher recall compared to the existing method used in the project (Figure 6-18). As the existing method mainly involved decision-makers, the list omitted process related requirements such as "enable visual checking of cardholders' roles" and "ease of installing new card readers." In the StakeRare list, these requirements were identified by stakeholders who were involved in the process. Hence, StakeRare's approach of asking stakeholders with different perspectives increased the completeness of the elicited requirements, which is critical to build a system that meets the stakeholders' needs. The majority of the requirements missing in the StakeRare list were technical constraints such as "the database platform must support Microsoft SQL Server and/or Oracle Server" and "the system manufacturer must be a Microsoft Certified Partner."

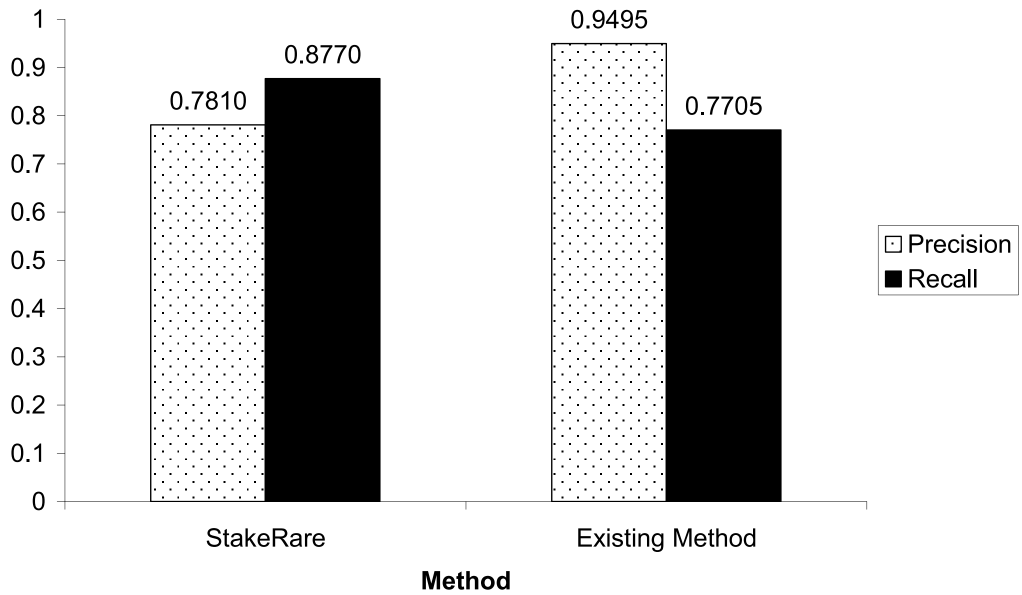


Figure 6-18: Identifying requirements.

StakeRare had a lower precision compared to the existing method. This is because in StakeRare, stakeholders are free to suggest requirements, which may not always be implemented. For example, some RALIC stakeholders wanted to replace the existing access control system with thumb readers, but this requirement was not implemented, hence lowering the precision. Nevertheless, in requirements elicitation, it is better to be *more complete* but *less precise* (identify extra requirements which are not implemented), rather than to be precise (identify only the requirements that are implemented) but miss out requirements (Nuseibeh and Easterbrook, 2000, Robertson and Robertson, 2006).

Not all stakeholders had requirements. For example, some developers who had not provided any requirements explained that their job was to implement the requirements given to them; others highlighted prerequisites for their job. For example, when completing the survey, the maintenance team entered technical documentation as their requirement. The StakeRare lists were less precise partly due to these requirements, as they were not in the ground truth.

By asking stakeholders to indicate requirements they actively did not want, StakeRare uncovered conflicts. For example, security guards preferred not to have UCL's logo on the ID card, for security reasons had the card been lost. Fitness centre users preferred not to have too many features on the ID card, as they had to exchange their cards for their locker keys for the duration they use the gym lockers. If the ID card had also served as a cash or bank card, then the fitness centre users would prefer using a separate gym card to exchange for locker keys, which meant that the requirement “all in one card” would not be achieved.

Stakeholders recommended for a role may provide requirements for another role, as it is common for a stakeholder to have more than one role in a project. For example, a RALIC developer was also a user of the access cards. According to one such stakeholder, “as a developer I only care about system requirements. But as a member of staff, I want to be able to access required buildings, and by rating these [access related] requirements, I am answering the questionnaire as a member of staff.”

During the surveys, some respondents recommended other stakeholders to be surveyed regarding a specific requirement (e.g., the comment in Figure 6-14(h)). This suggests that the stakeholder analysis step should overlap with the requirements elicitation step to improve the quality of the stakeholder list and requirement list. This finding is consistent with the existing requirements engineering literature. For example, according to Robertson and Robertson (2006), the identifications of scope, stakeholders, and requirements are dependent on one another, and should be iterated until the deliverables have stabilised.

Stakeholders supported StakeRare’s idea of being open and inclusive in requirements elicitation. When asked to represent all UCL students in RALIC, the student representative clarified that “I do not represent all 20 thousand students, even though they voted for me. Their views on data management, for example, can be very different from mine,” and suggested a wider body of students to be surveyed using StakeRare to ensure a more representative view. A management-level stakeholder commented that StakeRare provides the opportunity to elicit different views from a large number of stakeholders, which can increase stakeholder buy-in, a vital element for project success.

RQ2: Prioritising Requirements

The second research question asks: How accurately does StakeRare prioritise requirements as compared to the ground truth?

Method

StakeRare’s output for the requirements engineers was measured against the ground truth of requirements in Chapter 4 (Section 4.4, page 103), in terms of accuracy of prioritisation. The accuracy of prioritisation for project objectives is the similarity between the prioritisation of the project objectives by StakeRare and the prioritisation in the ground truth. Pearson’s correlation coefficient, ρ, was used to determine the similarity (Herlocker et al., 2004). Values of ρ range from +1 (perfect correlation), through 0 (no correlation), to –1 (perfect negative correlation). A positive ρ means that high priorities in the ground truth list are associated with high priorities in the list of identified requirements. The closer the values are to −1 or +1, the stronger the correlation. The statistics software by Wessa[73] is used to calculate ρ in this work.

The computation of ρ requires the lists to be of the same size. Therefore, the measurement of ρ takes the intersection between the lists: each list is intersected with the other, and fractional ranking (Triola, 1992) is reapplied to the remaining elements in that list. Missing requirements and additional requirements in the StakeRare list were accounted for when answering RQ1 on the completeness of the returned requirements. For requirements, ρ was measured for each list of requirements per project objective and the results were averaged, and the standard deviation was calculated for each average. The same was done for specific requirements, by measuring ρ for each list of specific requirements per requirement, averaging the results and calculating the standard deviation for each average.

As a control, prioritised lists were produced using unweighted stakeholders (referred to as Unweighted in the results), i.e., each stakeholder's weight is 1. The existing method list was not compared as it is unprioritised.

Results

StakeRare prioritised requirements accurately compared to the ground truth (Figure 6-19). In prioritising project objectives and requirements, StakeRare had a high correlation with the ground truth (ρ = 0.8 and ρ = 0.7 respectively). It was less accurate in prioritising specific requirements (ρ = 0.5). Weighting stakeholders by their influence increased the accuracy of prioritising project objectives and requirements by over 10%, but not for specific requirements. This influence is produced by applying social network measures to the stakeholder network. As such, the results show that using social networks generally improves the accuracy of prioritising requirements. StakeRare's output was presented to interested stakeholders after this work was completed. The director of Information Systems, who was experienced in options rankings for major decisions, commended StakeRare's prioritisation as "surprisingly accurate."

---

[73] Wessa, P. (2009) Free Statistics Software, Office for Research Development and Education, version 1.1.23-r4, URL http://www.wessa.net/.

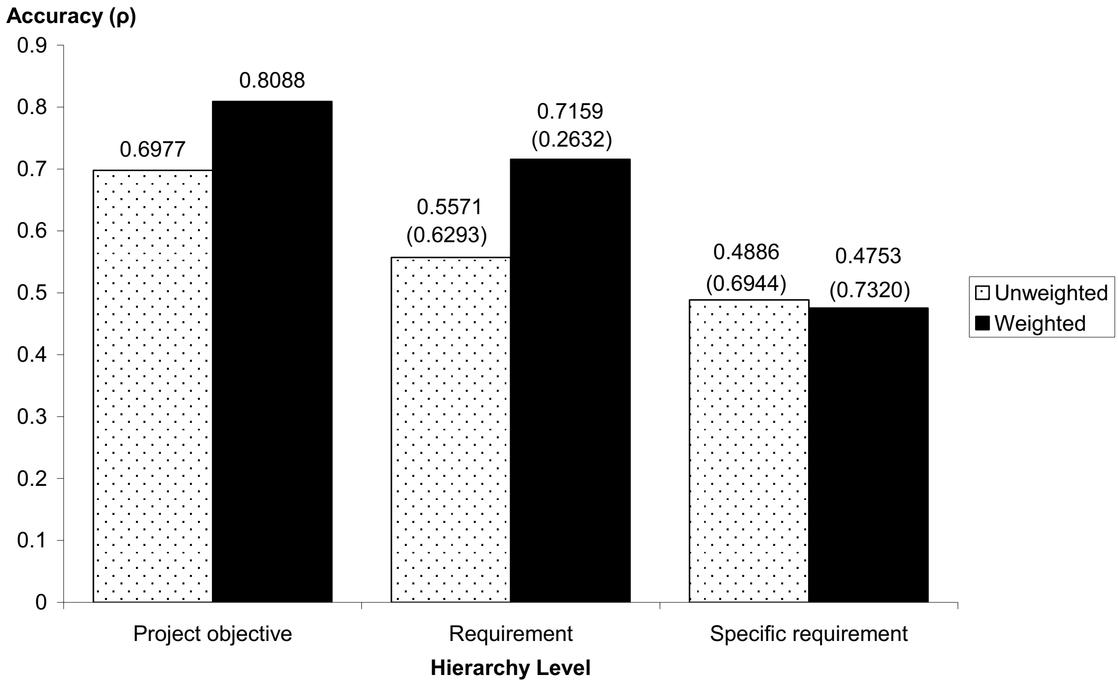


Figure 6-19: Prioritising requirements (standard deviation in parentheses).

Interestingly, analysis of the meeting minutes and post implementation report revealed that the project team spent a disproportionate amount of time discussing less important requirements during project meetings. According to the minutes and interviews with the stakeholders, a significant amount of time was spent discussing card design. However, the project objectives "better user experience" and "improve processes" have a higher priority than "card design" in the ground truth. The post implementation report identified a key area relating to user experience and processes that was not given adequate attention. According to the report, "A student's first experience of UCL should not be spent all day in a queue. …the queuing arrangements should be revised and a more joined up approach with Registry taken. Last year the queue for the RALIC card meant students were queuing outside – we were fortunate with the weather."

StakeRare accurately prioritised the project objectives "better user experience" and "improve processes" as having higher priority than "card design." Had StakeRare been used, the project team would have realised that "card design" had a lower priority compared to the other two project objectives, and might have spent less time discussing card design and more time discussing various ways to improve processes and user experience.

RQ3: Effective Support for Requirements Elicitation

StakeRare's default elicitation method is RateP, but the evaluation administered two other elicitation methods, RankP and PointP, to explore the effectiveness of different methods. The third research question asks:

- **Best elicitation method**. Between the three elicitation methods RankP, RateP, and PointP, which produces the most complete list of requirements and most accurate prioritisation for the requirements engineer?
- **Stakeholders' preference**. Between the three elicitation methods RankP, RateP, and PointP, which do the stakeholders prefer?
- **Rating all requirements**. If stakeholders are provided with a list of all the requirements in the project, how prepared are they to rate them all?

Method

Best elicitation method. Three elicitation methods were administered to explore the effectiveness of different methods. In RankP, stakeholders were asked to enter their requirements without providing an initial list of requirements. In RateP, stakeholders were asked to rate a predefined list of requirements and provide additional requirements. In PointP, stakeholders were asked to allocate 100 points to the requirements they want in the same predefined list as RateP. To evaluate the different elicitation methods, the lists produced from RankP and PointP were compared against the ground truth, and RQ1 and RQ2 were answered using precision, recall, and accuracy as described previously. Then, the results from RankP and PointP were compared with the results from RateP.

Stakeholders' preference. To determine the elicitation method preferred by the stakeholders, the respondents' feedback on the elicitation methods was investigated. During the survey, each respondent rated RankP, RateP, and PointP in terms of the criteria: level of difficulty, effort required, and time spent. Each criterion was rated High, Medium, or Low. The ratings were converted into numeric values (High = 3, Medium = 2, Low = 1) to be averaged. The average rating on each criterion for each elicitation method and the standard deviation for each average were calculated for RankP, RateP, and PointP. The interviews conducted with stakeholders after the surveys provided the rationale behind the stakeholders' preference.

Rating all requirements. To determine how prepared stakeholders were to rate all the requirements, an alternative RateP questionnaire, which consisted of the predefined list of requirements and requirements provided by other stakeholders, was prepared (Figure 6-20). This alternative questionnaire had 64 requirements. An experiment was conducted with four stakeholders to rate this alternative questionnaire. The initial plan to involve more stakeholders in the experiment fell through as the stakeholders were reluctant to rate a long list of requirements.

to minimise impact on Portico	0
QoS: Software application needs to be able to switch to standby system in the event	5
Rule: Entire live system must perform network backup to off-site backup server	3
Rule: Access to administer the system needs to be strictly controlled (limited to certain ip addresses and/or users via vpn)	5
Rule: system is situated in central machine room(s) with redundant and backup power supplies and adequate air con.	5
The UCL shop provides a service as to where students & staff can purchase a	0
UCL branding according to visual identity guidelines Design approved by DCCO	5
colour coded for type of user	3
Alumni version for library access inc online journals - in combination with alumni	~~[illegible]~~ -1
Maybe - use instead of event badges so should have large clear name & job title &	3
Maybe use as cashless purchase card (like oyster) to buy merchandise at events.	0
Not easily copied	5
Allow late access to buildings for events staff	4
Use to book out equipment. Eg laptops, AV equipment OR files from central records	3
Monitor alumni use, eg library use, shop, fitness etc - helps to understand alumni	2
Use at public events to create attendance events. Help to monitor staff, student,	1

Figure 6-20: Partial list of requirements[74].

Results

Best elicitation method. In identifying requirements (RQ1), RateP had the best overall results, RankP had the highest recall, and PointP had the highest precision (Figure 6-21). RankP had the lowest precision because stakeholders were free to express what they want. PointP had the highest precision as limited points encouraged stakeholders to only suggest requirements they really needed.

In prioritising requirements (RQ2), RateP produced the most accurate prioritisation for project objectives and requirements (Figure 6-22). The results in all three datasets showed that weighting stakeholders generally increased the accuracy of prioritisation. The most significant improvement was RateP requirements with an increase of 16 percentage points. Only for RankP requirements and RateP specific requirements was there no improvement.

[74] The complete questionnaire is available in Appendix G.

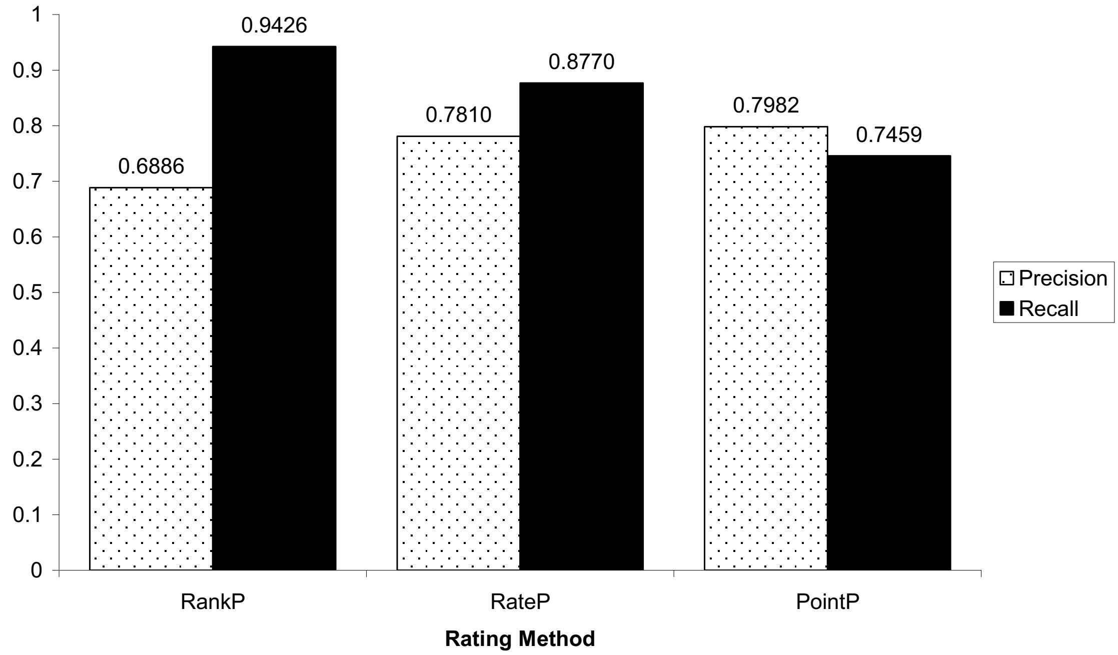


Figure 6-21: Identifying requirements: RankP, RateP, and PointP.

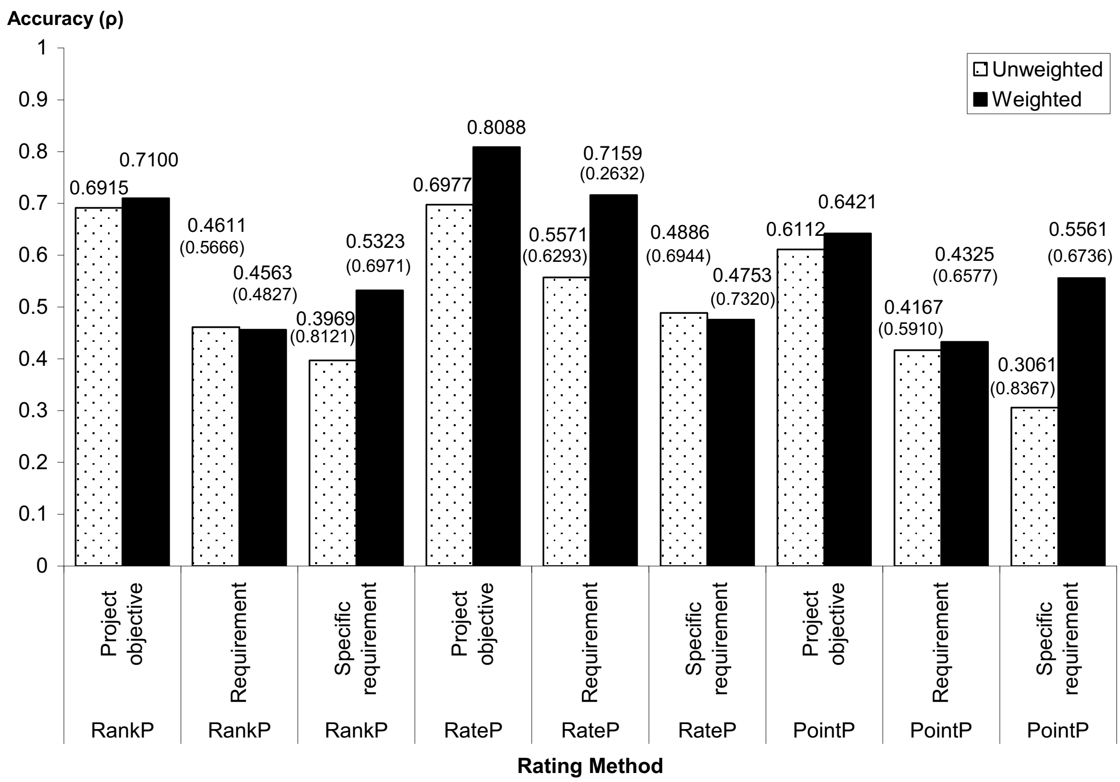


Figure 6-22: Prioritising requirements: RankP, RateP, and PointP (standard deviation for requirements and specific requirements in parentheses).

The elicitation method influenced the prioritisation. For example, the project objective "extensible for future features" was prioritised disproportionately high in RateP, and disproportionately low in PointP and RankP. As RateP allowed stakeholders to rate as many requirements as they wanted, "nice to have" features were rated high. In PointP, stakeholders were given limited points, hence they allocated the points for requirements they really need rather than future features. In RankP, developer related project objectives such as "compatibility with existing UCL systems" and "project deliverables[75]" were prioritised disproportionately high. This was because developers who participated in the survey listed development requirements (e.g., the maintenance team needed the requirements documentation for their work) rather than system requirements (e.g., easier to use access cards), and the other stakeholders provided relatively fewer requirements in RankP compared to RateP and PointP.

RateP had the advantage of suggesting requirements that the respondents were unaware of, which improved the accuracy of prioritisation. Upon looking at the predefined requirements in RateP, some stakeholders commented that they were reminded about requirements which did not cross their minds while they were completing RankP. For example, the requirement "centralised management of access and identification information" had high priority in the ground truth. But in RankP, only one respondent rated this requirement, resulting in a biased overall prioritisation. The accuracy of prioritisation for the list of requirements under the same project objective was $\rho = -0.1$, indicating that the list was negatively correlated with the ground truth. In contrast, this requirement, which was provided in the predefined list in RateP, received positive ratings from 68 respondents, resulting in a prioritisation that was highly correlated with the ground truth ($\rho = 0.7$).

Stakeholders found it easy to point out requirements they actively do not want from the predefined list of requirements in RateP. However, they found it more difficult to do so in RankP where no requirements were provided. Although RateP suggested requirements to stakeholders, stakeholders did not blindly follow the suggestions. For example, although the "Santander bank card" requirement was in the predefined list, the majority of stakeholders were against it. The requirement received a rating of zero from 25 respondents and a rating of –1 (actively do not want) from 20 respondents. Only 23 respondents rated it positively, suggesting that if UCL were to implement it, the card would not be well received.

Stakeholders' preference. The majority of stakeholders preferred RateP as they found it to require the least effort. Nevertheless, as they had to go through a predefined list of requirements, they found it more time consuming than RankP and PointP, where they only

---

[75] This project objective contains development related requirements such as requirements documentation, technical documentation, and change management.

entered the requirements they wanted. For example, a security guard found the RateP list too student focused, and commented that it was "tedious to go through a list of requirements that are mostly unrelated." In general, stakeholders found all three elicitation methods easy to complete, requiring little time and effort (Figure 6-23). The average responses sat between Low and Medium for all three elicitation methods in all criteria.

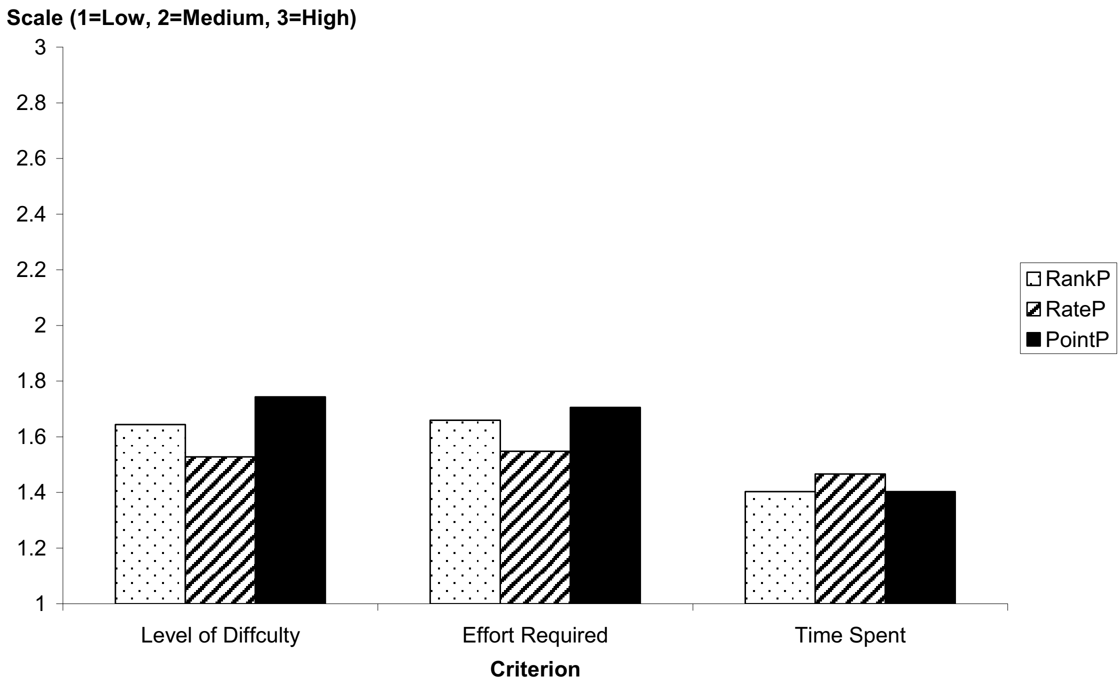


Figure 6-23: Stakeholder feedback on elicitation method.

Different types of stakeholders preferred different elicitation methods. Many decision-makers preferred PointP, as they were used to making decisions under constraints. System users such as students and gym users preferred RateP, where options were provided. RankP was challenging to some as they found it difficult to articulate their needs without prompts. Nevertheless, stakeholders with specific requirements in mind preferred RankP, where they could freely articulate their requirements. Some stakeholders found the predefined list of requirements constraining. For example, a respondent had trouble rating the requirement "enable the gathering and retrieval of the time which individuals enter and leave buildings." He explained that the requirement should be worded as two requirements because he would provide a negative rating for gathering the time individuals enter buildings (he did not want the time he arrived at work to be recorded), but a high positive rating for gathering the time individuals leave buildings for security reasons.

Finally, many stakeholders found the arithmetic exercise in PointP distracting, especially those who allocated points at a fine level of granularity. As such, PointP was rated the highest in terms of effort and difficulty. Future implementations of PointP should provide automatic point calculations.

Rating all requirements. Stakeholders were not prepared to rate the complete list of requirements. The four stakeholders involved in rating the alternative questionnaire found the task tedious and time consuming. They preferred to only rate a subset of requirements that were relevant to them. One complained that she was bored and wanted to stop halfway. This suggests that it is useful to recommend relevant requirements to stakeholders when the list of requirements is long.

RQ4: Predicting Requirements

The fourth research question asks:

- How accurately can collaborative filtering predict stakeholder requirements?
- Are the results consistent regardless of the elicitation method used?

Method

To evaluate StakeRare's prediction accuracy, 10-fold cross-validation (Witten and Frank, 2005) was used to predict the stakeholders' ratings for project objectives, requirements, and specific requirements. The Weka[76] data mining software was used for the *k*NN algorithm and the evaluation. Cross-validation was used to find the optimal value for *k*. This was done using the built-in cross validation in Weka by setting *k* to the total number of stakeholders who provided more than one rating. The resulting optimal value was corroborated through an exhaustive search using all possible values of *k* (from 1 to the total number of stakeholders who provided more than one rating) during preliminary experiments.

The mean absolute error (MAE) metric was used to evaluate the accuracy of the predictions (Herlocker et al., 2004). MAE is a measure of the deviation of recommendations from their true user-specified values widely used in the collaborative filtering literature (Sarwar et al., 2001, Jin et al., 2004, Xue et al., 2005, Wang et al., 2006). The MAE is computed by first summing these absolute errors of the *n* corresponding rating-prediction pairs and then computing the average. Formally,

$$MAE = \frac{\sum_{i=1}^{n} |r_i - p_i|}{n}, \qquad (6\text{-}9)$$

[76] Weka version 3.6 http://www.cs.waikato.ac.nz/ml/weka/

where n is the number of tested ratings, and $< r_i, p_i >$ is a rating-prediction pair. The lower the MAE, the more accurately the recommendation system predicts user ratings. Stakeholders must provide at least one rating before their preference can be predicted, hence stakeholders who provided only one rating were removed.

The results produced from using *k*NN with optimal *k* were compared to the following controls.

- **Random**. Random predictions for the ratings were produced with a uniform distribution within the rating range, which was different for RankP, RateP, and PointP (Table 6-6). The experiment was repeated 50 times and the average MAE was computed.
- **Max k**. All stakeholders were assumed to be the same by running *k*NN with k = the total number of stakeholders who provided more than one rating.

To check if the result was consistent regardless of the elicitation method, the datasets for RankP and PointP were evaluated using the same experiment.

Table 6-6: Data Characteristics

	RankP	**RateP**	**PointP**
Project Objectives			
Number of Stakeholders Providing > 1 Rating	66	75	71
Number of Items	10	10	10
Number of Ratings	249	438	270
Requirements			
Number of Stakeholders Providing > 1 Rating	71	75	71
Number of Items	51	48	45
Number of Ratings	461	1513	664
Specific Requirements			
Number of Stakeholders Providing > 1 Rating	76	75	75
Number of Items	132	104	83
Number of Ratings	1106	3112	1217
Rating Range[77]	$0 \leq x < 1$	$-1 \leq x \leq 5$	$0 < x \leq 100$

---

[77] As mentioned in the data cleaning at the beginning of this section (page 187), the ratings for RankP have been normalised between 0 and 1, where the rating for actively do not want is 0. The ratings for RateP are integers. The ratings for PointP are real numbers.

Results

StakeRare predicted the stakeholders' preference with high accuracy using the default RateP dataset (Figure 6-24). As expected, random predictions were inaccurate, with an MAE of about 2.5 for all three hierarchy levels. *k*NN with maximum *k* improved the prediction accuracy by more than half, and *k*NN with optimal *k* performed the best in all three levels. This showed that identifying similar stakeholders improved prediction accuracy. The average MAE after applying *k*NN was about 1 (Figure 6-24). This meant that if a stakeholder rated a requirement as 4, StakeRare's prediction of her rating was between 3 and 5. This result was comparable to that reported in the literature for standard collaborative filtering applications, such as movie rating (Jin et al., 2004). In Jin et al.'s (2004) experiments with two datasets (one with five ratings and one with six ratings), the MAE ranged between 0.8 and 1.3. The StakeRare RateP dataset had six ratings (i.e., actively do not want, 1, 2, 3, 4, and 5).

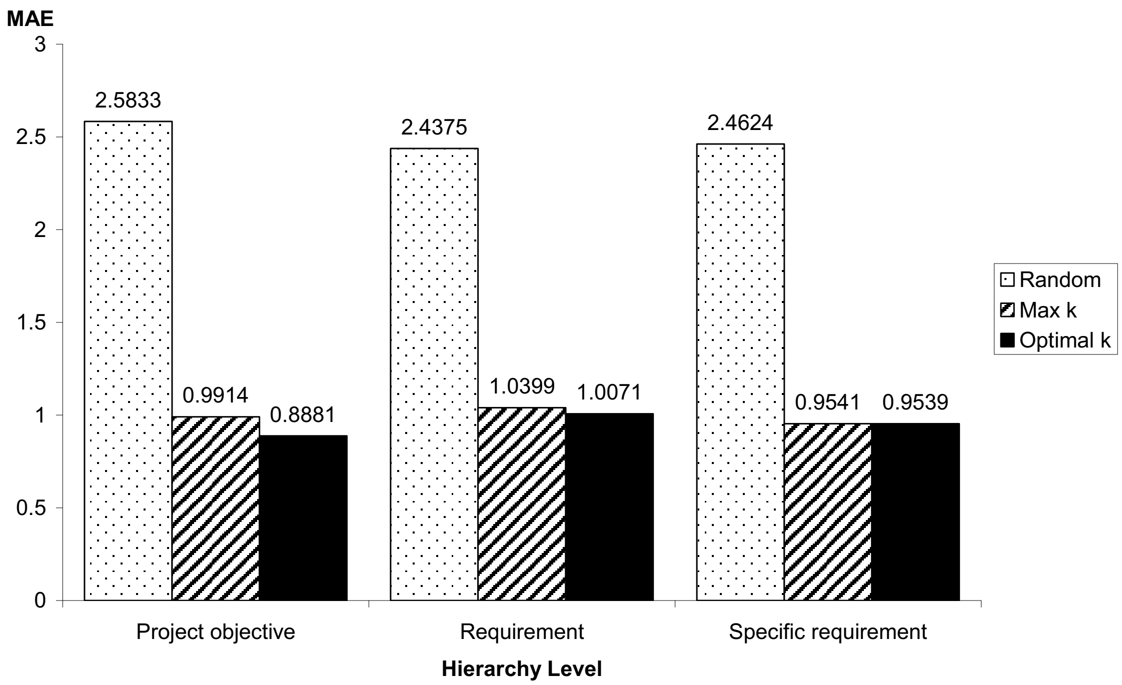
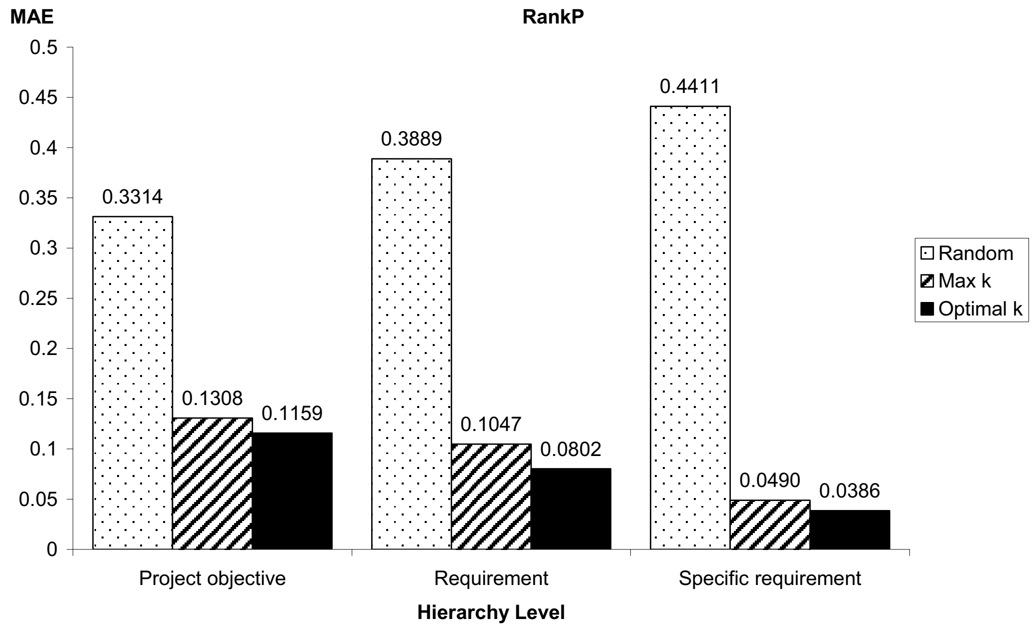


Figure 6-24: RateP: Predicting requirements (smaller MAE indicates higher prediction accuracy).

The prediction results were consistent regardless of the elicitation method (Figure 6-25). Random predictions were the least accurate, followed by *k*NN with maximum *k*, and *k*NN with optimal *k* produced the most accurate prediction. The MAE for RankP was small as the rank was normalised. The MAE for PointP was large, with random guessing having an MAE as large as 44.6, as possible ratings ranged between 0 and 100. *k*NN managed to reduce the MAE to as low as 3.9 for that dataset.

(a)


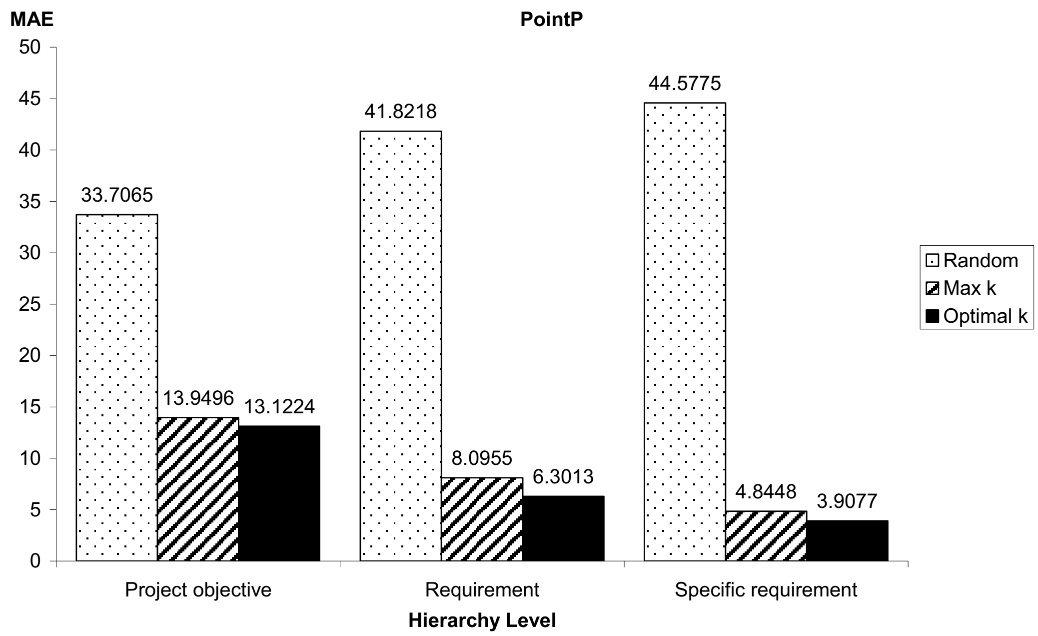
(b)


Figure 6-25: Predicting requirements: (a) RankP and (b) PointP (smaller MAE indicates higher prediction accuracy).

RQ5: Predicting Requirements: Enhanced Profiles

The fifth research question asks:

- Does enhancing stakeholder profile by adding stakeholder information improve the accuracy of predicting stakeholder interest in requirements?

- Are the results consistent regardless of the elicitation method used?

Method

For enhancing stakeholders' profiles, two attributes were added to each stakeholder's profile: the stakeholder's role (referred to as Role in the Results section) and number of ratings (referred to as #Rtgs in the Results section). The attributes were first added separately, and then together (referred to as Both in the Results section). The experiment as before was used to predict stakeholders' ratings using the enhanced profiles. 10-fold cross-validation (Witten and Frank, 2005) was used to predict the stakeholders' ratings for project objectives, requirements, and specific requirements. The mean absolute error (MAE) evaluation metric was used to evaluate the accuracy of the predictions (Herlocker et al., 2004). The control was *k*NN with optimal *k* from the previous research question (referred to as Basic in the Results section).

To check if the result was consistent regardless of the elicitation method, the datasets for RankP and PointP were evaluated using the same experiment.

Results

Enhancing the stakeholders' profiles improved the accuracy of predicting their requirements for the default RateP dataset (Figure 6-26). Adding stakeholder role improved prediction accuracy because stakeholders with the same roles tend to have similar requirements. For example, members of the UCL Development & Corporate Communications Office required the card to have UCL branding but security guards preferred otherwise for security reasons in case the cards were lost. In requirements and specific requirements, adding each attribute separately significantly improved the prediction accuracy, and adding both attributes produced the most accurate prediction. In project objectives, the improvement was less obvious, and adding each attribute separately produced better prediction than adding both attributes together.

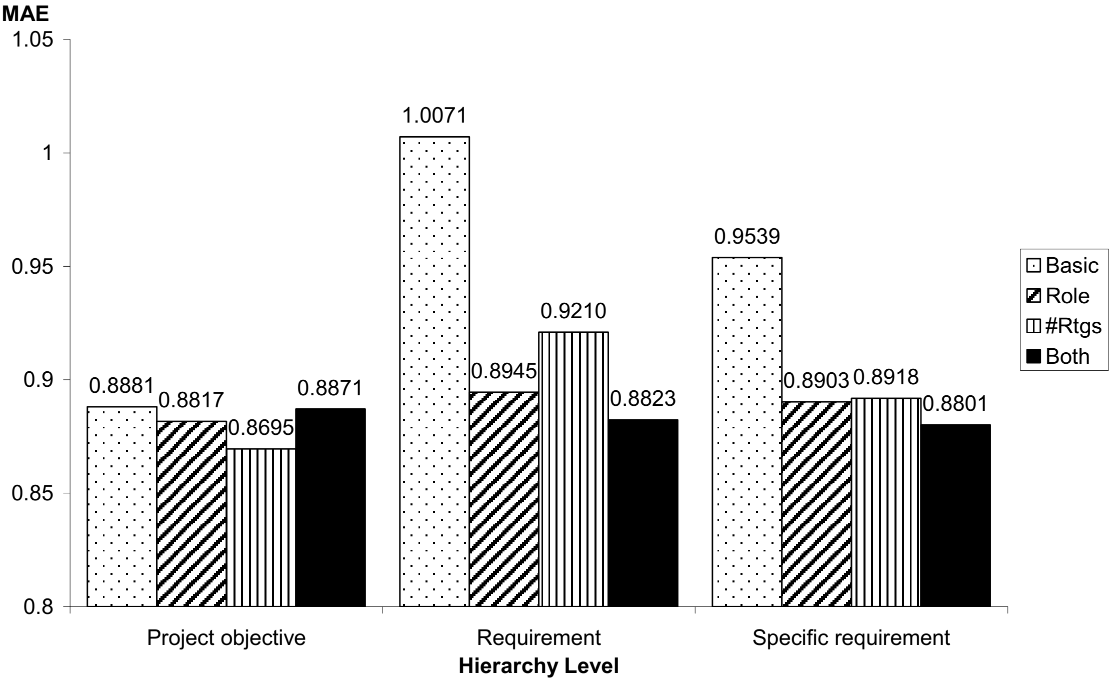
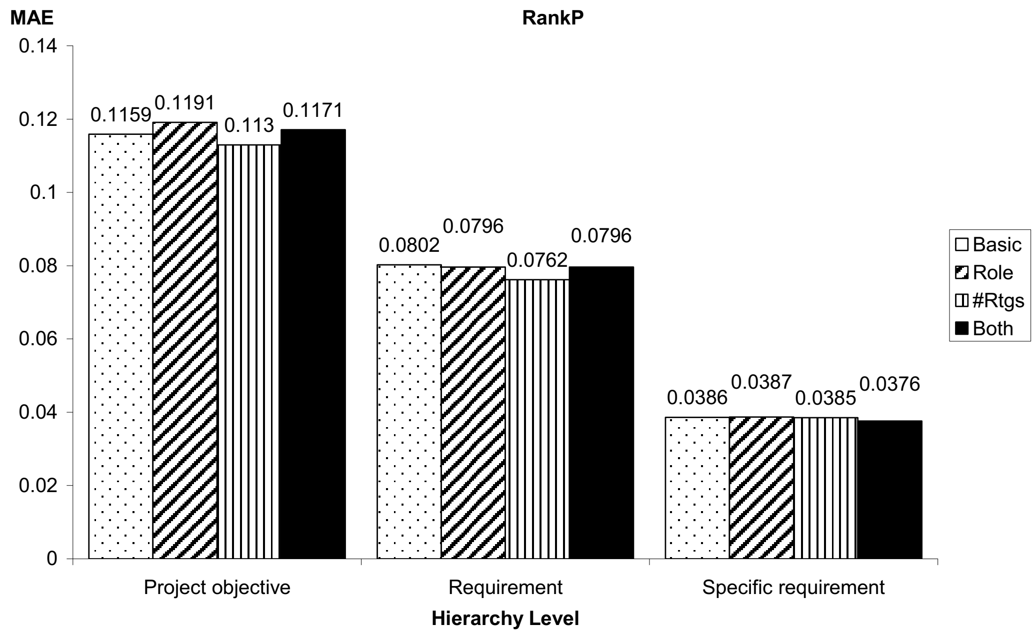


Figure 6-26: RateP: Enhanced profiles (smaller MAE indicates higher prediction accuracy).

The results were less consistent for RankP and PointP (Figure 6-27). For PointP, prediction accuracy improved after adding roles to the profiles, but prediction accuracy became worse when both attributes were added. For RankP, no significant improvements could be observed after enhancing profiles. Hence, different attributes may be needed for different datasets to improve prediction accuracy.

(a)



(b)

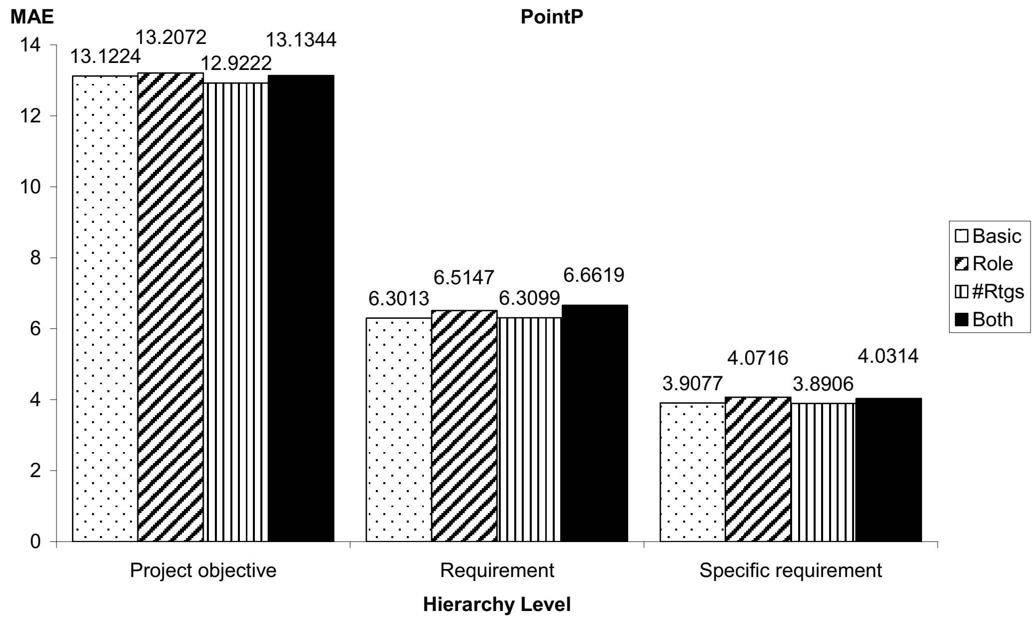


Figure 6-27: Enhanced profiles: (a) RankP and (b) PointP (smaller MAE indicates higher prediction accuracy).

RQ6: Predicting Requirements: Other Algorithms

The sixth research question asks:

- Does using other algorithms and combinations of algorithms improve the prediction accuracy?
- Are the results consistent regardless of the elicitation method used?

Method

To answer the question about using other algorithms and combinations of algorithms, linear regression was used to predict the stakeholders' preferences (Witten and Frank, 2005). Principle Component Analysis (PCA) was also used to preprocess the data before the prediction algorithms (i.e., *k*NN or linear regression) were applied (Pearson, 1901, Howley et al., 2006, Witten and Frank, 2005). PCA is widely used in exploratory data analysis and for making predictive models (Pearson, 1901). It involves a mathematical procedure that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called principal components (Pearson, 1901). The experiment in the previous research question was used to predict stakeholders' ratings using four permutations as follows:

- *k*NN with optimal *k* (*k*NN),
- PCA and *k*NN with optimal *k* (P+*k*NN),

- linear regression (LR), and
- PCA and linear regression (P+LR).

To check if the result was consistent regardless of the elicitation method, the datasets for RankP and PointP were evaluated using the same experiment.

Results

The use of other algorithms improved the accuracy of prediction in general (Figure 6-28). Applying PCA before *k*NN improved the prediction accuracy for project objectives and requirements, but not for specific requirements. As PCA finds the principle components, it potentially discards some information and focuses on the variables that make classification easiest. The lower prediction accuracy for specific requirements suggested that the specific requirements were more complex and needed more information for better classification. Using linear regression instead of *k*NN improved the prediction accuracy significantly for all three hierarchy levels. However, applying PCA before linear regression did not produce better results in general. For project objectives and specific requirements, it performed slightly worse.

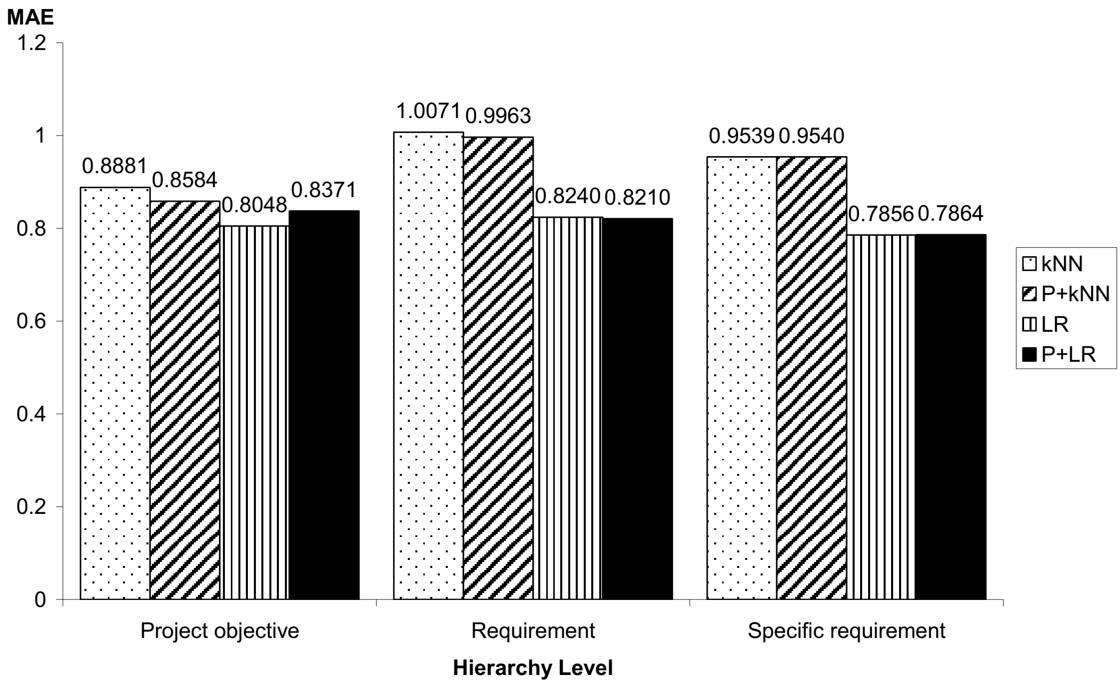
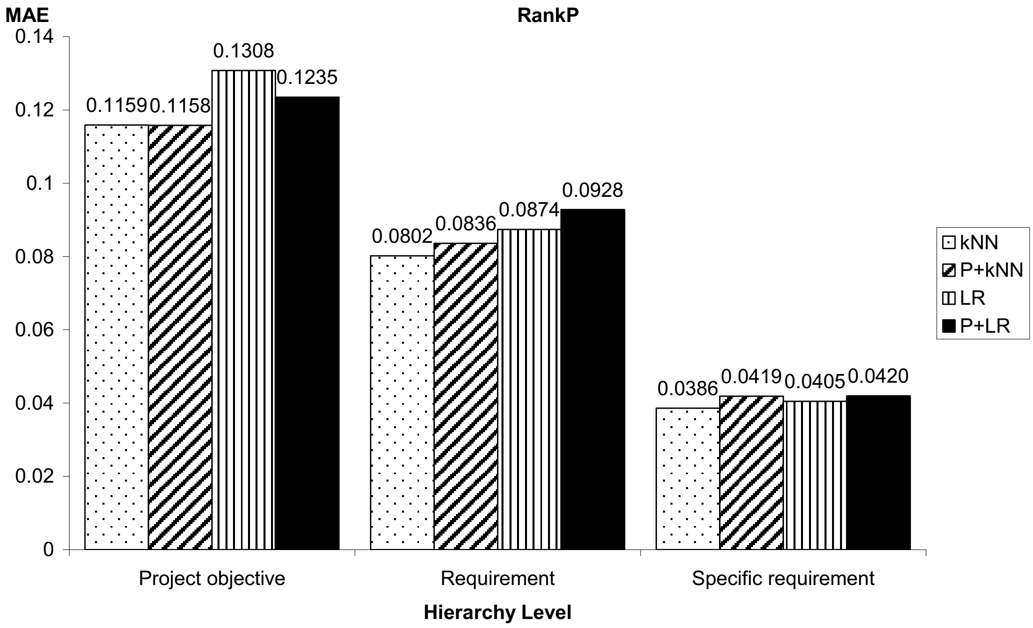


Figure 6-28: Other algorithms (smaller MAE indicates higher prediction accuracy).

The best algorithm differed across different datasets. For RankP, apart from the objective level, *k*NN was the most accurate (Figure 6-29). For PointP, apart from the objective level, linear regression was slightly more accurate than the others. Applying PCA before *k*NN or linear regression consistently produced lower accuracy for specific requirements in all three datasets. This confirmed that specific requirements were complex and required more information for better classification.

(a)



(b)

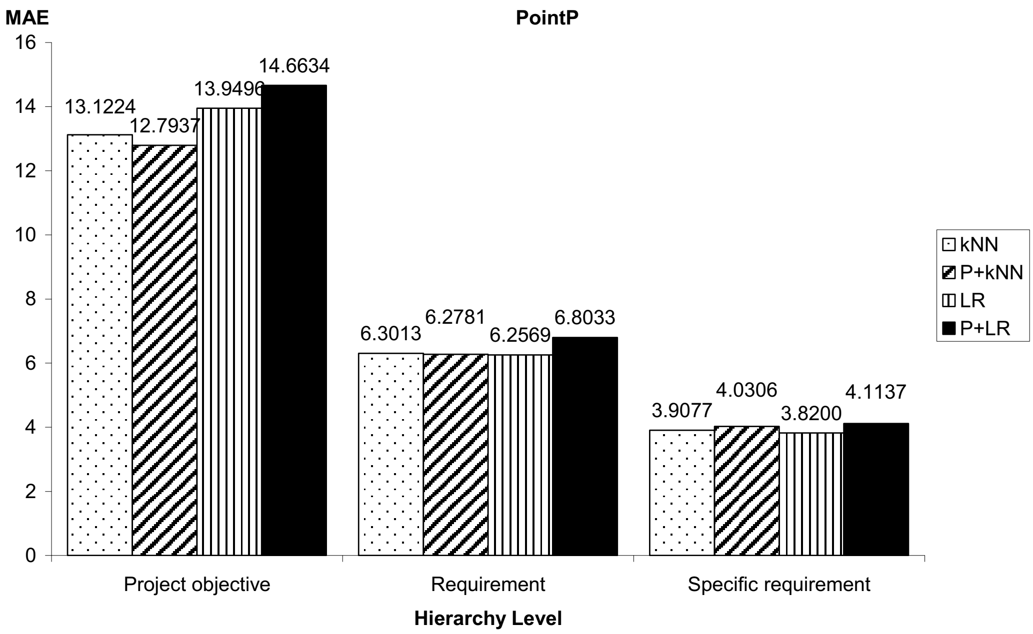


Figure 6-29: Other algorithms: (a) RankP and (b) PointP (smaller MAE indicates higher prediction accuracy).

RQ7: Survey Response and Time Spent

The final research question asks:

- Are stakeholders motivated to provide requirements for StakeRare?
- How much time did stakeholders spend in identifying and prioritising requirements as compared to the existing method in the project?

Method

To determine the stakeholders' motivation to provide ratings, the response rate of the survey was calculated as the number of stakeholders who responded, over the total number of stakeholders who were contacted, expressed as a percentage. In the calculation, "non-stakeholders" and stakeholders who have left but yet to be replaced were excluded. For stakeholders who responded, their level of interest in the project, which was collected during the survey, was also investigated.

The time spent using StakeRare was calculated using Equation 6-10.

$$time_{StakeRare} = time_{predefined\_list} + \frac{time_{questionnaire}}{3}, \qquad (6\text{-}10)$$

where $time_{predefined\_list}$ is the time spent building the predefined list of requirements. As the predefined list of requirements was taken from the first draft requirements, $time_{predefined\_list}$ is the number of hours the stakeholders spent in meetings until the draft requirements was produced on 8 August 2005, which was 61 hours (Table 6-7). $time_{questionnaire}$ is the total time spent answering the questionnaire, which is the total survey time minus the time spent introducing StakeRare and interviewing the respondents after the survey, which was approximately 10 minutes per respondent. $time_{questionnaire}$ is divided by 3, to consider only one elicitation method out of the three. Only the respondents' time spent was calculated, as this researcher's presence while the respondents were completing the questionnaires was just to observe them for research purposes. The calculation was an approximation that assumed the elicitation methods take an equal amount of time. The time spent using StakeRare was compared with the time spent using the existing method in the project, which was 127 hours, as reported in Chapter 4 (Section 4.4, page 100).

Results

Stakeholders were motivated to provide ratings. The survey response rate was 79%, about 30% higher than the weighted average response rate without regard to technique described in the previous chapter (page 156). Most of the stakeholders who responded were very interested in

RALIC, only 13% indicated that they have little interest and 3% no interest. Those with little or no interest may not have responded in tool-based implementations of the survey.

The time spent using StakeRare was 71 hours, 56 hours less than the time spent using the existing method in the project. While the existing method in the project returned an unprioritised list of requirements, StakeRare's list of requirements was accurately prioritised and highly complete, as shown in the previous research questions.

Table 6-7: Time Spent to Create the Predefined List of Requirements

Meetings before Sign-off	Number of Stakeholders[78]	Hours[79]	Total Hours
Project board meeting (2 Jun 05)	12	2	24 (excluded[80])
Project team meeting (29 Jun 05)	7	1.5	10.5
Project team meeting (7 Jul 05)	5	1.5	7.5
Project board meeting (14 Jul 05)	11	2	22
Project team meeting (21 Jul 05)	7	1.5	10.5
Project team meeting (3 Aug 05)	7	1.5	10.5
Total Man Hours			61

Finally, many stakeholders preferred using StakeRare to provide requirements rather than attend lengthy meetings. In line with the existing literature, elicitation meetings used in existing methods can be time consuming and ineffective (Gause and Weinberg, 1989). One stakeholder commented, "I was only interested in one issue, but had to sit through hours of meetings, where unrelated items were discussed. What a waste of time. With this method, I could just write it down and get on with my work!"

6.4 Summary

StakeRare is a requirements elicitation method that uses social networks and collaborative filtering to identify and prioritise the requirements for large-scale software projects. The

[78] The names of stakeholders who attended the meetings were recorded in the meeting minutes.

[79] According to the post implementation report, project board meetings were approximately 2 hours and project team meetings were approximately 1.5 hours.

[80] This meeting was used for stakeholder analysis, hence it is excluded from both the calculation for requirements elicitation using existing method and StakeRare.

evaluation results provide clear evidence that StakeRare provides effective support for requirements elicitation as follows.

- The first step of StakeRare, which uses the StakeNet method, identifies a highly complete set of stakeholders and prioritises them accurately based on their influence in the project. The evaluation is described in the previous chapter (Section 5.3).
- StakeRare identifies a highly complete set of requirements compared to the existing method used in the project. By eliciting requirements from various perspectives, StakeRare detects conflicts and has the potential of increasing stakeholder buy-in.
- StakeRare prioritises requirements accurately using the stakeholders' influence produced by the social network measures. The director of Information Systems experienced in options rankings for major decisions commended StakeRare's prioritisation as "surprisingly accurate."
- The investigation of different elicitation methods, such as RankP and PointP, shows that StakeRare's elicitation method, RateP, which provides stakeholders with a predefined list of requirements as well as allows them to add new requirements, is rated by stakeholders as low difficulty and requiring little effort. It also produces the most accurate prioritisation of requirements. Nevertheless, stakeholders prefer not to be overloaded by information, which happens when there is a long list of requirements for them to rate.
- StakeRare handles information overload by drawing stakeholders' attention to only the relevant requirements that they are unaware of. The recommendations by StakeRare that are approved by the stakeholders will then improve global prioritisation. The *k*NN collaborative filtering algorithm accurately predicts a stakeholder's requirements based on the requirements provided by similar stakeholders.
- Adding stakeholder profiles can increase prediction accuracy, and using other collaborative filtering algorithms can also improve prediction accuracy.
- Stakeholders are motivated to provide their requirements using StakeRare. StakeRare requires less time from the requirements engineers and the stakeholders as compared to the existing method used in the project.

The next chapter describes StakeSource, a web-based tool that supports requirements elicitation by automating the manual labour required from the requirements engineer, such as contacting and surveying each stakeholder, and running the social network algorithms to prioritise stakeholders.

Chapter 7

StakeSource

This chapter examines the bottlenecks in the StakeNet method, reviews the existing tool support, describes the automation of stakeholder analysis in StakeSource, and reports the evaluation of StakeSource using two real projects.

The previous chapter demonstrated that social networks and collaborative filtering provide effective support for requirements elicitation. StakeNet uses social networks to produce a prioritised list of stakeholders and their roles. StakeRare incorporates StakeNet to identify and prioritise stakeholders, asks the stakeholders for their requirements, and uses the stakeholders' influence in StakeNet to prioritise all the requirements in the project. To address information overload, StakeRare uses collaborative filtering to recommend requirements of interest to stakeholders. The evaluation of StakeNet and StakeRare using the RALIC project showed that StakeNet identifies a highly complete and accurately prioritised list of stakeholders and their roles, and StakeRare identifies a highly complete set of requirements, prioritises them accurately, and predicts the stakeholders' requirements accurately.

This chapter describes StakeSource[81], a web-based tool developed in this work to support requirements elicitation by automating stakeholder analysis. Although StakeNet and StakeRare provide effective support for requirements elicitation, the effectiveness can be

---

[81] StakeSource has been published as Soo Ling Lim, Daniele Quercia, and Anthony Finkelstein. (2010) StakeSource: harnessing the power of crowdsourcing and social networks in stakeholder analysis, in *Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering-Volume 2*. Association for Computing Machinery, New York. pp. 239-242.

significantly improved by automating a large portion of the requirements engineer’s task, such as face-to-face surveys with stakeholders, data entry and processing. StakeSource *crowdsources*[82] the stakeholders themselves for recommendations about other stakeholders and aggregates their answers using social network analysis. This chapter reviews the lessons learnt from applying StakeNet to the RALIC project, details existing tool support, describes StakeSource, and reports its evaluation with two real projects that have used StakeSource for stakeholder analysis. One project is a large-scale software project to build a university admissions software system. The other is a university-wide research project on sustainable cities.

7.1 Tool Support

StakeNet Review

Although StakeNet has been shown to be an effective method for stakeholder analysis, the evaluation of StakeNet on the RALIC project highlighted bottlenecks in the method that require a significant amount of time from the requirements engineer.

- **Questionnaire generation**. The requirements engineer has to prepare the questionnaires, which include an introduction to the project, project scope description, survey instructions, prompts, definitions, and example recommendations.
- **Emails and reminders**. The requirements engineer has to contact each stakeholder by email. The requirements engineer also has to remind stakeholders who have not responded.
- **Surveys**. The requirements engineer has to conduct face-to-face surveys with the stakeholders to collect recommendations.
- **Data entry**. The requirements engineer has to input the stakeholders’ responses into the system and ensure that information about the project, stakeholders and their recommendations is consistent and traceable.
- **Data validation**. The requirements engineer has to validate the stakeholders’ recommendations. For example, a recommendation without the level of influence is an invalid recommendation.

[82] Crowdsourcing is a concept that harnesses the knowledge contained in diverse communities of people (Surowiecki, 2004, Howe, 2009). In this case, StakeSource harnesses the knowledge of stakeholders for stakeholder analysis.

- **Data cleaning**. The requirements engineer has to convert the recommendations to the appropriate format for the social network measures. If a stakeholder recommends a role but not the actual stakeholder, the requirements engineer has to link that recommendation to all the stakeholders with the same role who are identified so far. The output from the social network measures also has to be manually converted so that stakeholders are prioritised by the influence of their roles in the project, and then by their influence in the role. In addition, the requirements engineer has to clean inconsistent data such as different names referring to the same person or role.

- **Computation**. The requirements engineer has to apply social network measures to the stakeholder network, as well as compute the priorities of the stakeholders and their roles. Additions to, removals of, and modifications in the recommendations require the rerun of all the computations.

To provide effective support in requirements elicitation for the requirements engineer, these bottlenecks should be reduced or eliminated. One way to reduce or eliminate the bottlenecks is by having a tool that supports the StakeNet method. During the StakeNet survey, stakeholders involved in project management, stakeholder analysis, and systems support expressed interest in having such a tool for their work. The tool should replace the requirements engineer in mundane tasks such as questionnaire generation, data entry, computation, and network visualisation.

The evaluation of StakeNet using the RALIC project revealed the following key requirements for an effective tool support.

- **Widely available and easy to access**. As recommendations come from stakeholders, the tool should be widely available and easy to access to encourage a sufficient number of stakeholders contribute with their recommendations.

- **Simple and intuitive to use**. The ease of recommendation is vital to encourage stakeholders' contribution.

- **Easy to make recommendations without compromising quality**. Closed-ended recommendations where stakeholders are provided with an existing list of stakeholder roles are easier to complete but return a less complete set of roles. As such, the tool should enable stakeholders to make recommendations easily, but should not provide a list of stakeholders for them to select from.

- **Interactive stakeholder network view**. The requirements engineer should be able to interact with the stakeholder network view to learn about the stakeholders, their recommendations, location in the network, and priority in the project.

- **Use of existing standard components**. Well-established tools are available for network visualisation and social network measures. To develop the tool within the timing constraints of the work while still maintaining its quality and reliability, well-established components should be used whenever possible.

Existing Tool Support

Although stakeholder analysis is important in software engineering, existing tools for stakeholder analysis provide little support in the actual identification and prioritisation of stakeholders. These tools only hold and process the stakeholders' information, relying on the requirements engineers themselves to identify and prioritise the stakeholders.

A simple but widely used tool is the stakeholder analysis matrix[83]. To use the matrix, requirements engineers make a list of stakeholders, and then plot the stakeholders against two variables on a matrix, such as power and interest (Figure 7-1), or importance and influence. The Power Interest Grid is also described in Chapter 2 (Section 2.1, page 32).

Figure 7-1: The Power Interest Grid template (MindTools [84]) (reproduced with permission).

---

[83] http://www.mindtools.com/pages/article/newPPM_07.htm

[84] Available at http://www.mindtools.com/pages/article/worksheets/PowerInterestGridDownload.htm

The checklist-based approaches described in Chapter 2 (Section 2.1, page 30), such as the Onion Model and the Volere Stakeholder Analysis Template, have their respective tool support. Checklists contain a set of generic stakeholder roles (e.g., user and regulator). To use the checklists, the requirements engineers refer to the generic roles to derive project specific stakeholder roles (e.g., students and data protection officer). The Onion Model (Alexander and Robertson, 2004, Alexander, 2005) has been implemented as an editable model with customisable slots (Figure 7-2). The model is implemented in a requirements traceability tool environment, IBM® Rational® DOORS® [85], so that the requirements captured in the requirements traceability tool can be linked to the stakeholders in the Onion Model. The Volere Stakeholder Analysis Template is provided as an excel sheet in which the requirements engineers can record the names, description, and details of the stakeholders (Figure 7-3).

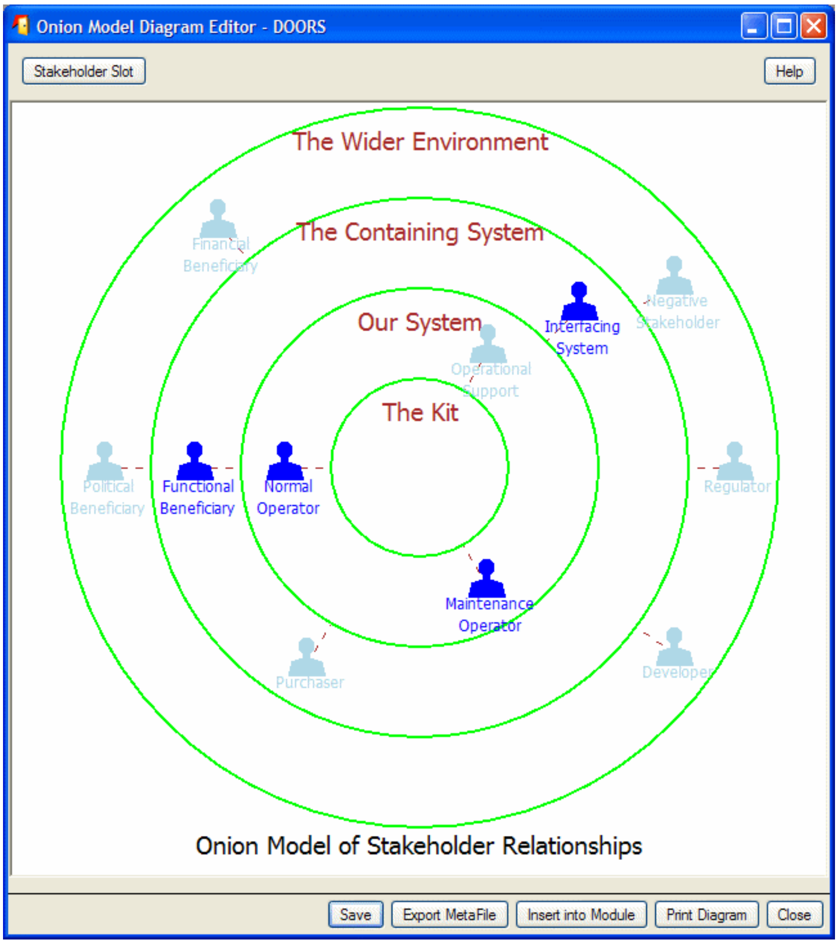


Figure 7-2: Stakeholder Onion Model editor[86].

[85] http://www-01.ibm.com/software/awdtools/doors/

[86] http://www.scenarioplus.org.uk/

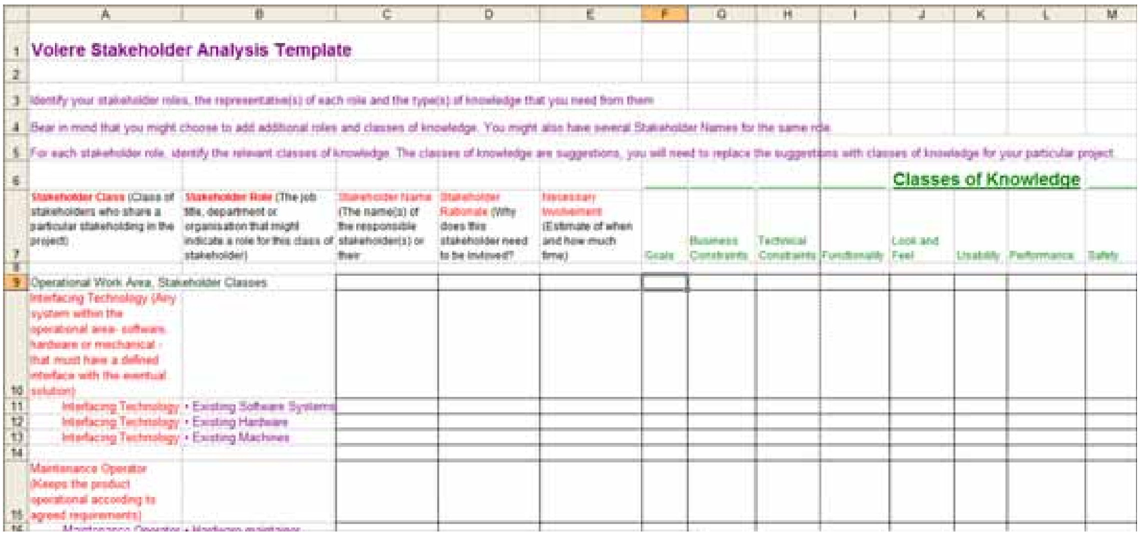


Figure 7-3: Partial Volere Stakeholder Analysis Template[87] (reproduced with permission © The Atlantic Systems Guild).

Stakeholder Circle[88] is a commercial stakeholder analysis tool. To use the tool, requirements engineers enter stakeholder information into the tool, such as their names, roles in the project, requirements, significance to the project, and stake in the project (Figure 7-4). The requirements engineers also rate the stakeholders in terms of their power, proximity, and urgency. These ratings are used by the tool to prioritise the stakeholders. Based on the information provided by the requirements engineers, the tool produces printed reports such as the list of stakeholders, their engagement profile, communications plan, and stakeholder issues list (Figure 7-5). The tool also produces a visualisation of the top 15 stakeholders in a Stakeholder Circle™ (Figure 7-6). The data collected by the tool can be exported for use in other tools. The free version of Stakeholder Circle is available for 30 days and the professional version is sold[89] for USD1,000.

---

[87] http://www.volere.co.uk/templates.htm

[88] http://www.stakeholder-management.com/

[89] http://www.stakeholder-management.com/shopdisplayproducts.asp?id=12&cat=Software

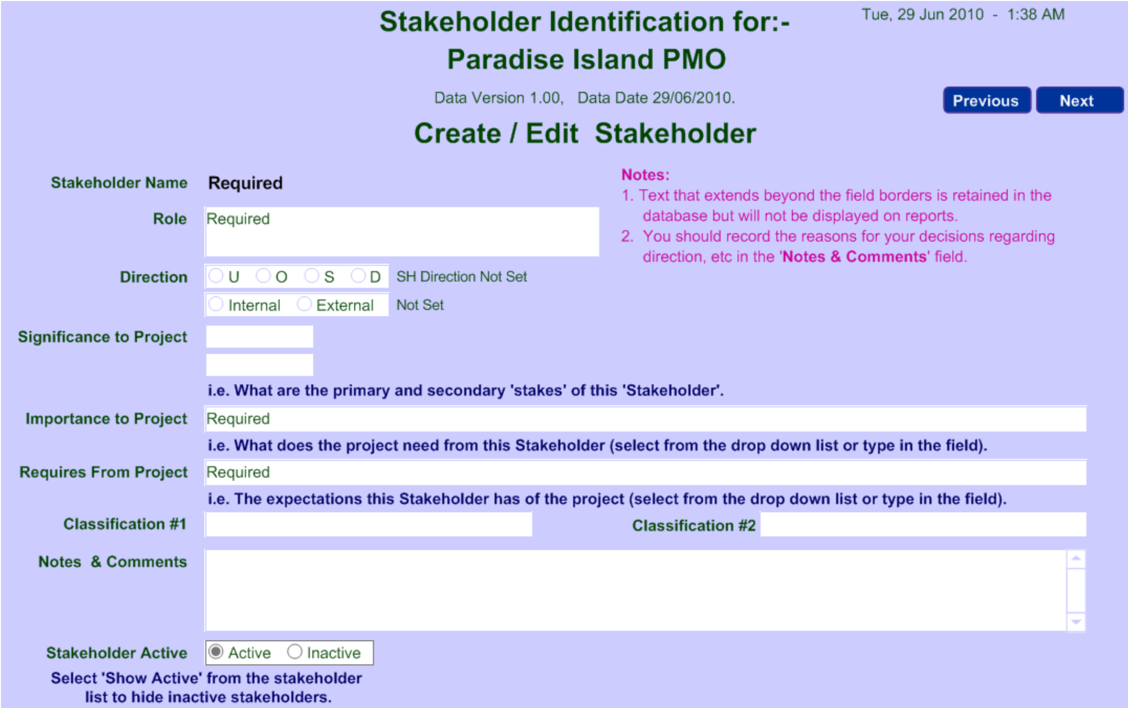


Figure 7-4: Stakeholder Circle: Requirements engineers enter stakeholder details.

Figure 7-5: Stakeholder Circle: Prioritised list of stakeholders for the Paradise Island PMO fictional project.

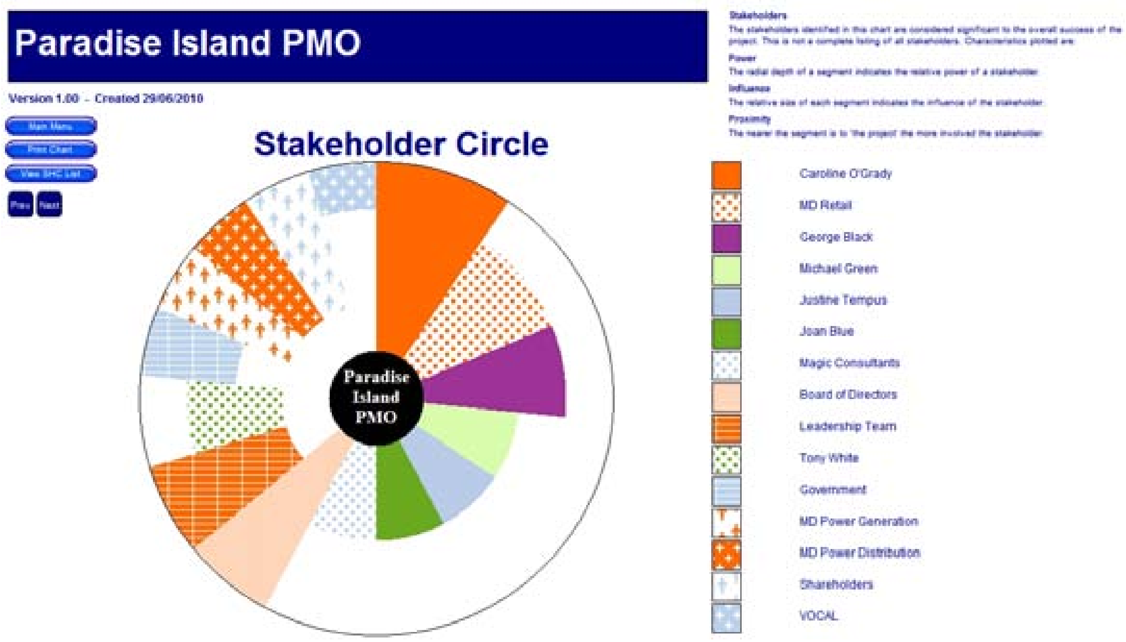


Figure 7-6: Stakeholder Circle for the Paradise Island PMO fictional project.

In summary, StakeNet's effectiveness in supporting stakeholder analysis can be improved by tool support. Nevertheless, existing tools in stakeholder analysis provide little support in the actual identification and prioritisation of stakeholders. These tools only hold the stakeholders' information, relying on the requirements engineers themselves to identify and prioritise the stakeholders.

In contrast, StakeSource aims to minimise the time spent by the requirements engineers on mundane tasks, such as questionnaire preparation, data entry, and computations.

7.2 StakeSource

StakeSource[90] reduces the bottlenecks in the StakeNet method as summarised in Table 7-1. By using StakeSource, the requirements engineers only need to provide details about the project and initial stakeholders at the start of the project. StakeSource automatically contacts the initial stakeholders for recommendations, and also contacts each newly identified stakeholder for their recommendations. It builds the social network from the recommendations, applies the social network measures, and returns a prioritised list of stakeholders and their roles. Based on the key requirements identified in the previous section, the design decisions for developing StakeSource are summarised in Table 7-2.

---

[90] A video demonstrating StakeSource is available at http://vimeo.com/18250588.

StakeSource is developed and tested using the data from the RALIC project. The use of StakeSource for stakeholder analysis involves three steps: set up project, get recommendations, and analyse stakeholders.

Table 7-1: Bottlenecks Addressed by StakeSource

Bottleneck	Effect	Description
Questionnaire generation	Reduced	With StakeSource, the requirements engineer no longer needs to prepare the questionnaires. StakeSource elicits project details from the requirements engineer and generate the questionnaires.
Emails and reminders	Reduced	StakeSource automatically sends emails to initial stakeholders and newly identified stakeholders. The requirements engineer can choose to customise StakeSource's default email template. For reminders, the requirements engineer selects which stakeholder to send reminders to, using the filter feature in StakeSource. The requirements engineer can compose a reminder email template, which is then used by StakeSource when sending reminders to stakeholders.
Surveys	Eliminated	The requirements engineers no longer need to approach each stakeholder to collect recommendations.
Data entry	Eliminated	Stakeholders enter recommendations directly into StakeSource, removing the need for the requirements engineer to enter their handwritten data into the system.
Data validation	Reduced	StakeSource performs basic data validation to ensure that the recommendations have all the required fields. For example, recommendations without influence will be highlighted and StakeSource will prompt stakeholders to fill in the missing recommendations.

Bottleneck	Effect	Description
Data cleaning	Reduced	StakeSource converts the stakeholders' recommendations into the format suitable for the social network measures. If a stakeholder recommends a role but not the actual stakeholder, StakeSource automatically links that recommendation to all the stakeholders with the same role who are identified so far. It also automatically formats the data for display. StakeSource enables the requirements engineer to merge stakeholders and roles that were recommended using different names. For example, to merge duplicate stakeholder roles, the requirements engineer scans through the list of roles, identifies the ones that refer to the same role, and combines them into one. It also provides an autocomplete feature to support stakeholders in their recommendations. For example, when a stakeholder enters the role "Estates and Facilities", autocomplete suggests "Estates and Facilities Division" so that the stakeholder can select the suggestion and be consistent with existing recommendations.
Computation	Eliminated	StakeSource runs the social network measures automatically.

Table 7-2: Design Decision for StakeSource

Key Requirements	Design Decision
Widely available and easy to access	To make StakeSource widely accessible for the requirements engineers and stakeholders, StakeSource was implemented as a web application.
Simple and intuitive to use	StakeSource uses standard user interface for the questionnaires, and standard survey interface for the recommendation forms. In addition, StakeSource uses easily understood language rather than domain-specific terminology whenever possible. Finally, it provides tool tips and pop-up to assist users.
Easy to make recommendations without compromising quality	To support stakeholders in providing stakeholder roles, StakeSource uses autocomplete rather than a drop-down list of existing stakeholder roles. This is because drop-down lists are similar to closed-ended recommendations which restrict the stakeholders' recommendations.

Key Requirements	Design Decision
Interactive stakeholder network view	The stakeholder network is connected to the prioritised list of stakeholders and their roles, the stakeholders' recommendation, and their details. Selecting the stakeholder's node on the network should reveal information such as the stakeholder's details, relations to other stakeholders, recommendations, role and priority.
Use of well-established components	The stakeholder network view uses Kap Visualizer[91], a well-established software component for network visualisation. The social network measures are provided by NetworkX[92], a Python package for analysing complex networks. The StakeSource web application uses standard web technologies such as HTML, CSS, XHTML, PHP, and JavaScript[93]. MySQL[94] was used for data storage as it is reliable, open source, and compatible with PHP[95].

Step 1: Set Up Project

StakeSource reduces the effort requirements engineers spend preparing questionnaires by eliciting project details from the requirements engineers, and using the details to generate the questionnaires. For each project that requires stakeholder analysis, StakeSource supports the requirements engineers in setting up the project, and generates the questionnaire automatically. StakeSource asks the requirements engineers for the following information: project details, description of the project scope, and contact details of initial stakeholders.

To use StakeSource, the requirements engineers are required to log in to the StakeSource web application to prevent unauthorised access to project data. To perform stakeholder analysis for a project, the requirements engineers create the project by entering project details such as name, description, start and end dates (Figure 7-7). The project name and description will be used by StakeSource to explain the projects to stakeholders when it contacts them for recommendations. As such, the requirements engineers should describe the project clearly to improve the quality of recommendations. StakeSource uses a default email template to

---

[91] http://lab.kapit.fr/display/kaplabhome/Home

[92] http://www.adobe.com/products/flex/

[93] http://www.w3schools.com/

[94] http://www.mysql.com/

[95] http://www.mysql.com/why-mysql/topreasons.html

contact stakeholders (Figure 7-8). Nevertheless, as the email is StakeSource's first point of contact with the stakeholders, StakeSource provides a customisable template so that the requirements engineers can modify the email content to evoke the stakeholders' interests and motivate them to make recommendations.

Once the project is created, all the stakeholder related information in the project will be contained within the project folder. StakeSource also asks the requirements engineers to enter a list of scope items and their descriptions. As described in the StakeNet method (Section 5.2, page 116), scope describes the boundary of the project so that the stakeholders who should be involved can be identified. Hence, the scope items in StakeSource should describe what is in the scope and out of scope for the project. StakeSource uses the project and scope item description to generate a web-based recommendation form to collect recommendations from the stakeholders. It allows the requirements engineers to view and validate the recommendation form.

To prompt the requirements engineers for initial stakeholders, StakeSource provides a wizard to ask for initial stakeholder roles such as users, developers, legislators, and decision-makers (Figure 7-9). For each role, the wizard also asks the requirements engineers for the stakeholders and their contact details. Using the wizard, the requirements engineers create a list of initial stakeholders in the format

<name, role, email address>.

An example entry is

<Soo Ling Lim, PhD student, s.lim@cs.ucl.ac.uk> (Figure 7-10).

Requirements engineers who are familiar with the types of initial stakeholders can turn off the wizard and provide initial stakeholders directly.

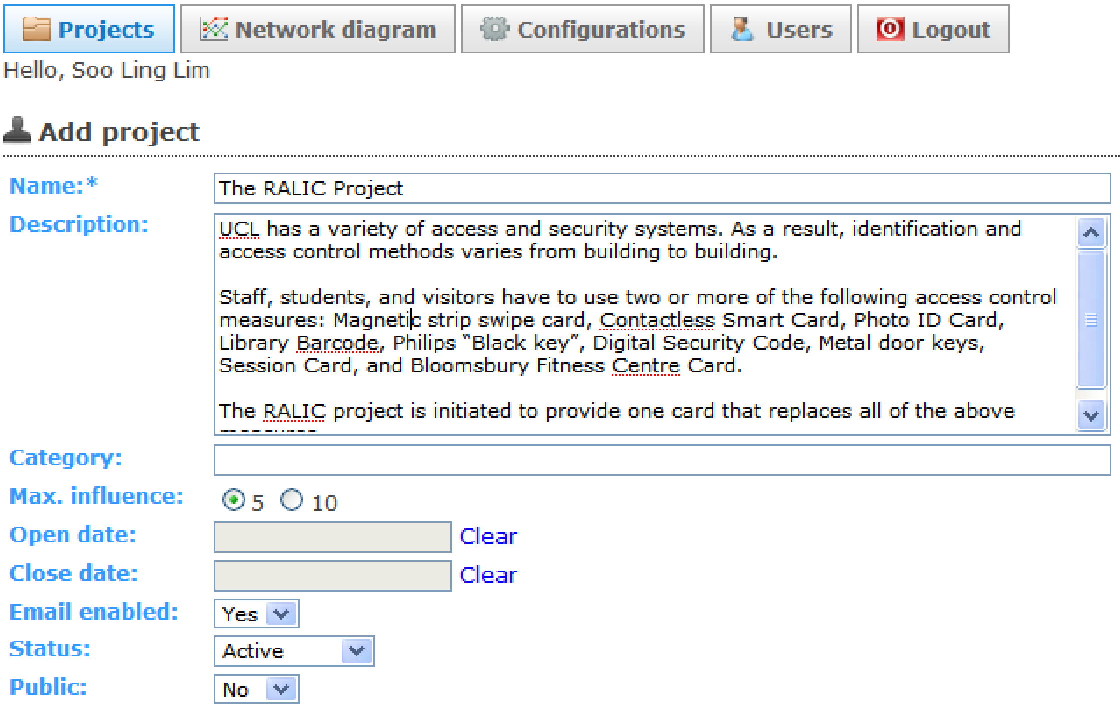


Figure 7-7: Project creation.

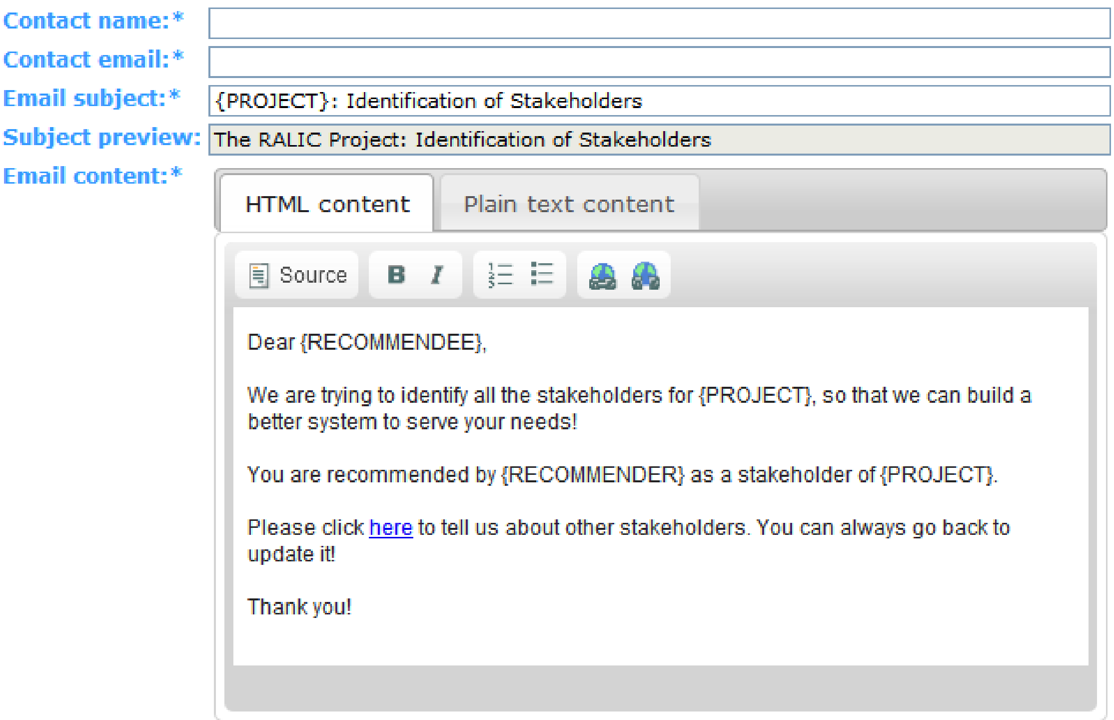


Figure 7-8: Customisable email template.

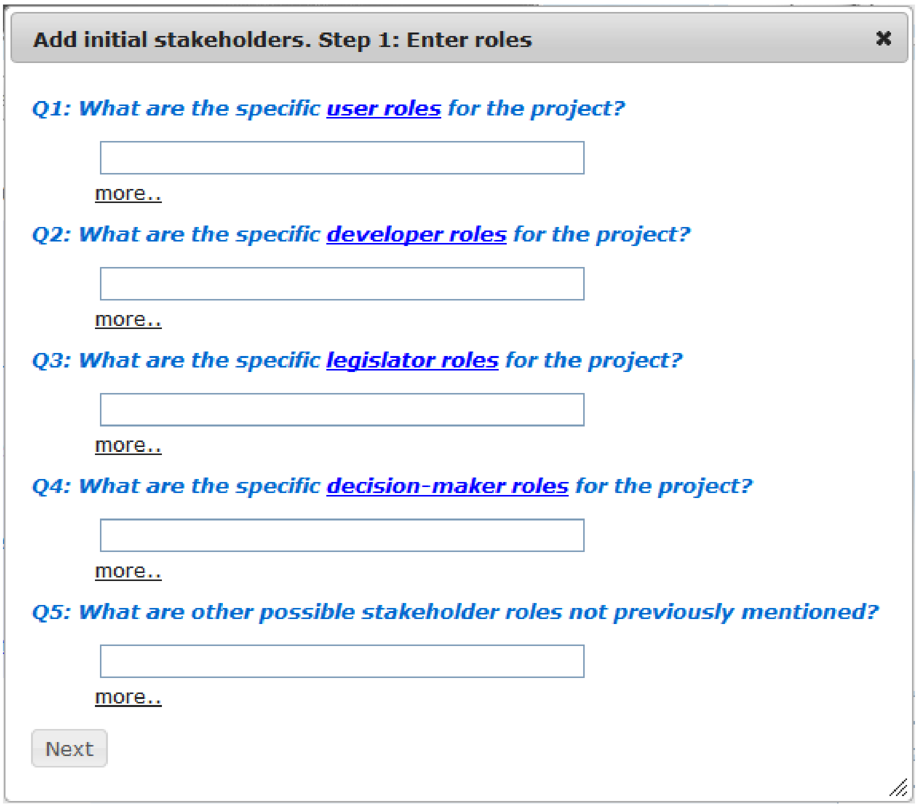


Figure 7-9: StakeSource launches a wizard to prompt for initial stakeholders.

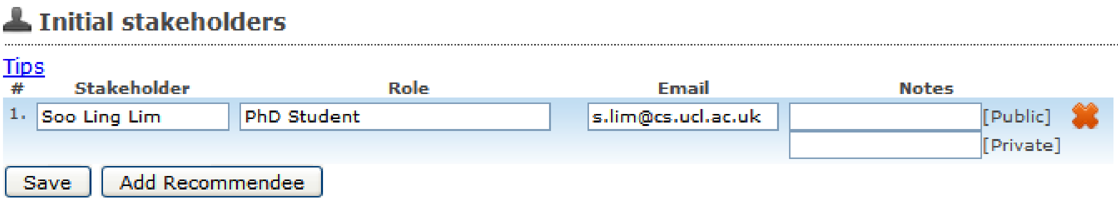


Figure 7-10: Example initial stakeholder.

Step 2: Get Recommendations

StakeSource reduces the effort requirements engineers spend on contacting the stakeholders by automatically sending emails to the stakeholders when they are identified. StakeSource eliminates the need for requirements engineers to approach each stakeholder to collect their recommendations, by providing an online recommendation form accessible from the stakeholders' emails. By enabling stakeholders to enter their recommendations electronically, StakeSource also eliminates the need for requirements engineers to enter the stakeholders' handwritten data into the system.

The email feature in StakeSource can be turned off while data is being populated, so that the information can be checked to be correct before the emails are sent out to the initial stakeholders. When the requirements engineers turn on the email feature, StakeSource emails the initial stakeholders to ask for recommendations (Figure 7-11). The email provides a link that brings the stakeholders to the web-based recommendation form. The recommendation form introduces the project to the stakeholders using the project details provided by the requirements engineers, such as project description, scope items, and their descriptions (Figure 7-12).

One of the key requirements of StakeSource is to be simple and intuitive to use. The web-based recommendation forms were implemented using a standard survey interface from the Smarty Template Engine[96] (Figure 7-12). In addition, easily understood terminologies were used whenever possible. For example, the term "level of influence" was chosen over "salience" because beta testing revealed that "level of influence" is easier for stakeholders to understand. In addition, tool tips and pop-up help were provided to assist users. For example, in Figure 7-12, clicking on the question marks next to the headings Stakeholder, Roles, and Influence produces a pop-up that explains the terms. Finally, StakeSource also provides hints and examples to help stakeholders in their recommendations (Figure 7-13).

For each scope item, the stakeholders make recommendations about other stakeholders in the format

<name, role, level of influence, email address>.

An example recommendation is

<Anthony Finkelstein, head of department, 5, a.finkelstein@cs.ucl.ac.uk>.

If a stakeholder is aware of a role but is not aware of the stakeholders with that role, he is allowed to recommend only the role. Following StakeNet, if a stakeholder recommends a role but not the actual stakeholder, StakeSource automatically links that recommendation to all the stakeholders with the same role who are identified so far.

To assist stakeholders while not constraining their recommendations, StakeSource provides autocomplete for the stakeholder role entry using jQuery[97] (Figure 7-14). This encourages stakeholders to provide stakeholder roles that are consistent with existing recommendations, hence relieving the requirements engineers from needing to merge the roles.

The StakeNet survey revealed that stakeholders may make comments while providing recommendations. Hence, StakeSource enables public and private notes to be made about the stakeholder. Public notes can be viewed by anyone who has access to the stakeholder analysis user interface; private notes are only available to the requirements engineers. For example, Soo Ling can enter a public note that Anthony is busy on Wednesdays, so that the requirements engineer will know not to arrange Wednesday meetings with Anthony.

---

[96] http://www.smarty.net/

[97] http://jquery.com/

To reduce the need for requirements engineers to manually validate the data, StakeSource performs basic validation when the stakeholders are making recommendations. Each stakeholder recommendation must contain the stakeholder's name, the stakeholder's role, level of influence, and a valid email address. Role recommendation is permitted for recommendations where the actual stakeholders are not known. Each role recommendation must contain the stakeholder's role and level of influence. StakeSource highlights the incomplete recommendations so that the stakeholders can amend them.

When the recommendation is saved, Anthony will receive an email from StakeSource asking for recommendations. Again, clicking on the link in the email launches the recommendation form. In a public project, StakeSource enables stakeholders to view the stakeholder network after they have made recommendations. Allowing stakeholders to see their position and relations in the stakeholder network provides additional motivation for them to make recommendations. Once recommendations are saved, StakeSource provides a link which launches the stakeholder analysis user interface when clicked (Figure 7-15).

As discovered during the StakeNet survey, sometimes the people who are recommended may be "non-stakeholders" or they may not have the time or interest to be involved in the project. Hence, StakeSource provides an option for these people to unsubscribe from the project (Figure 7-16). The survey also revealed that these people may refer the requirements engineers to other stakeholders, hence StakeSource gives them the opportunity to recommend other stakeholders when they unsubscribe.

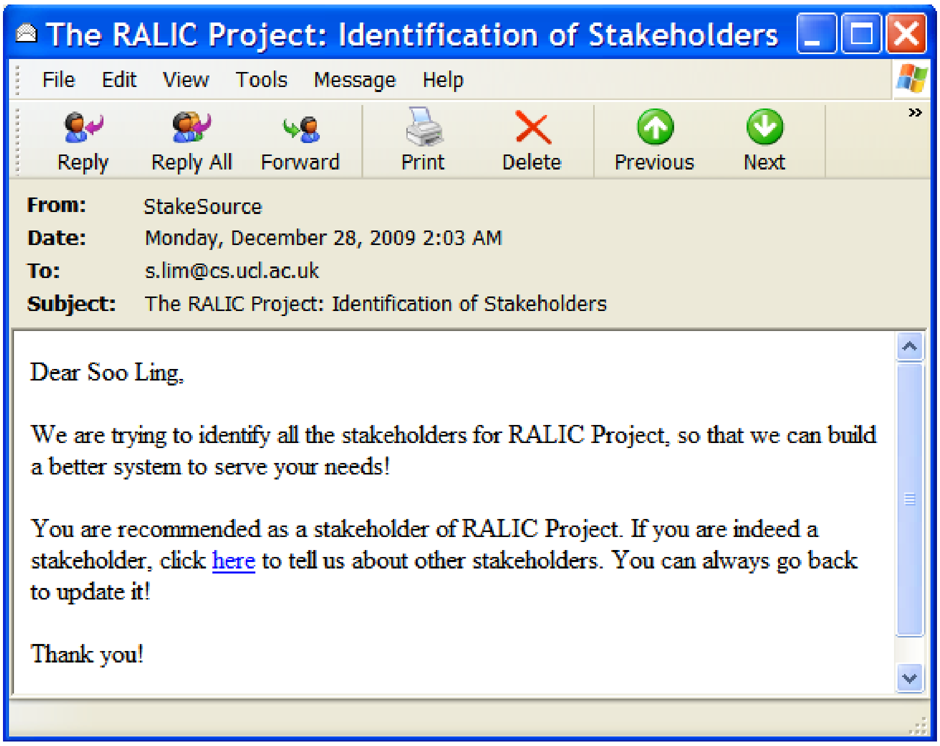


Figure 7-11: StakeSource sends an email to the stakeholder.

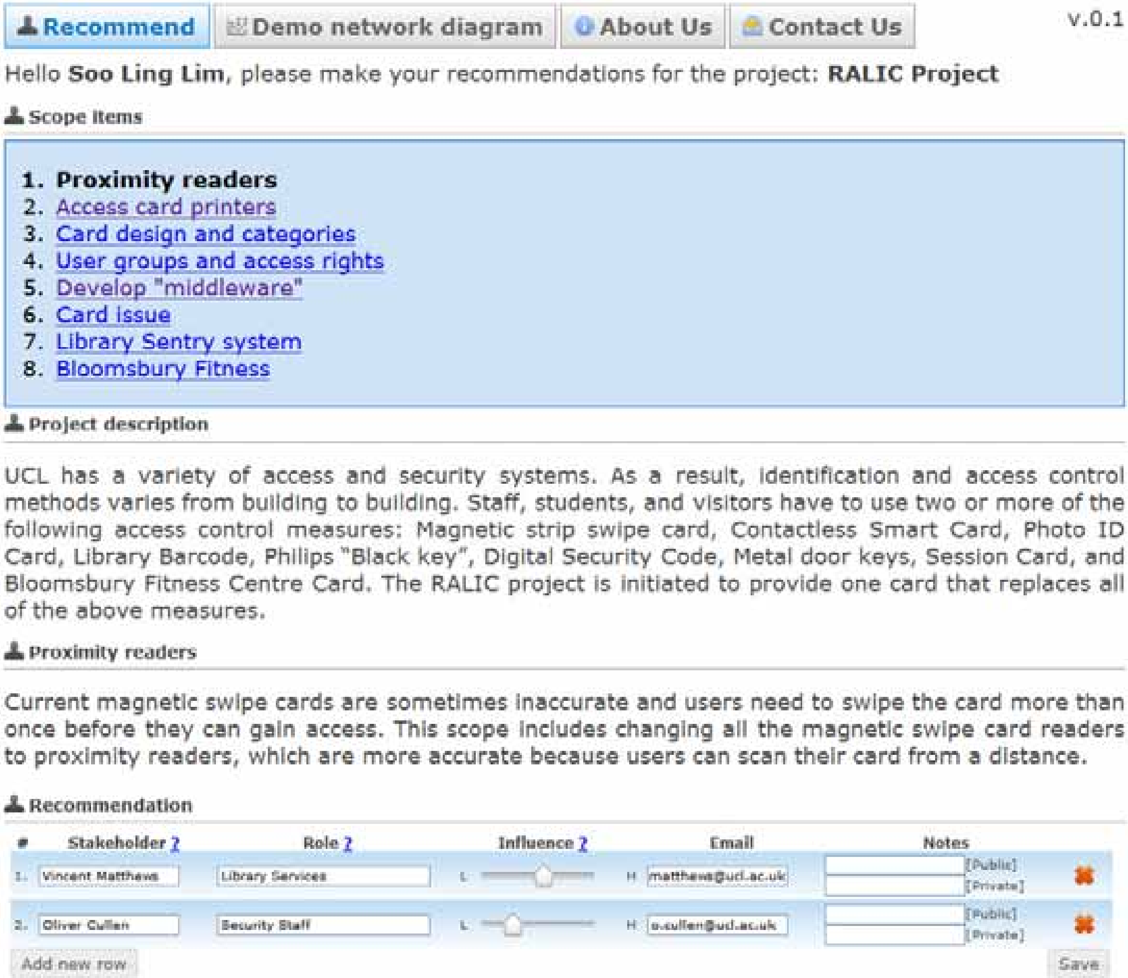


Figure 7-12: Recommendation form.

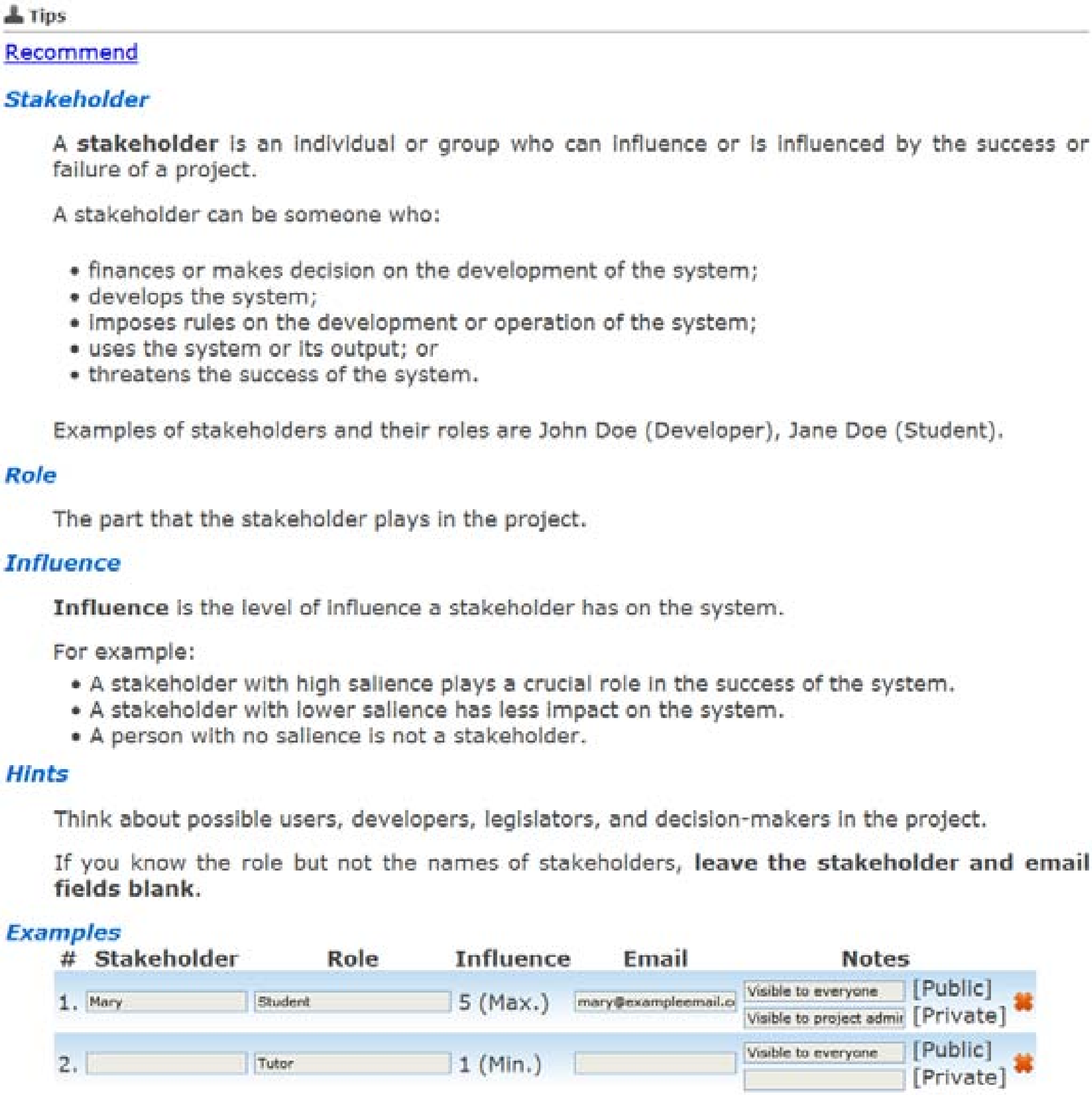


Figure 7-13: Recommendation hints for stakeholders.

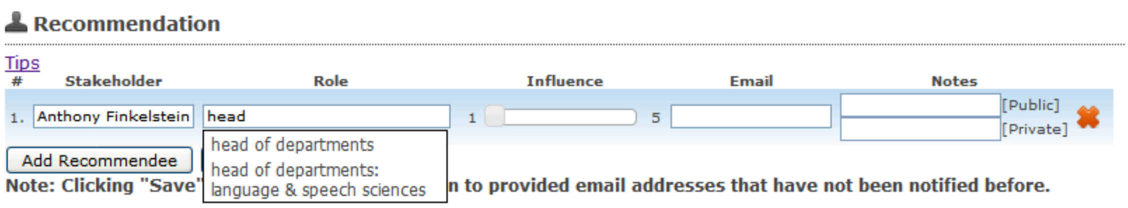


Figure 7-14: Autocomplete to aid stakeholders in their recommendations.

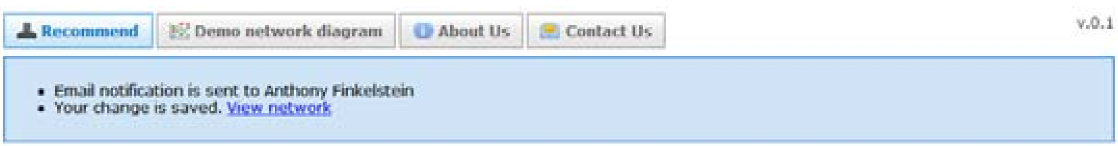


Figure 7-15: A link to the stakeholder network after the stakeholder recommended.

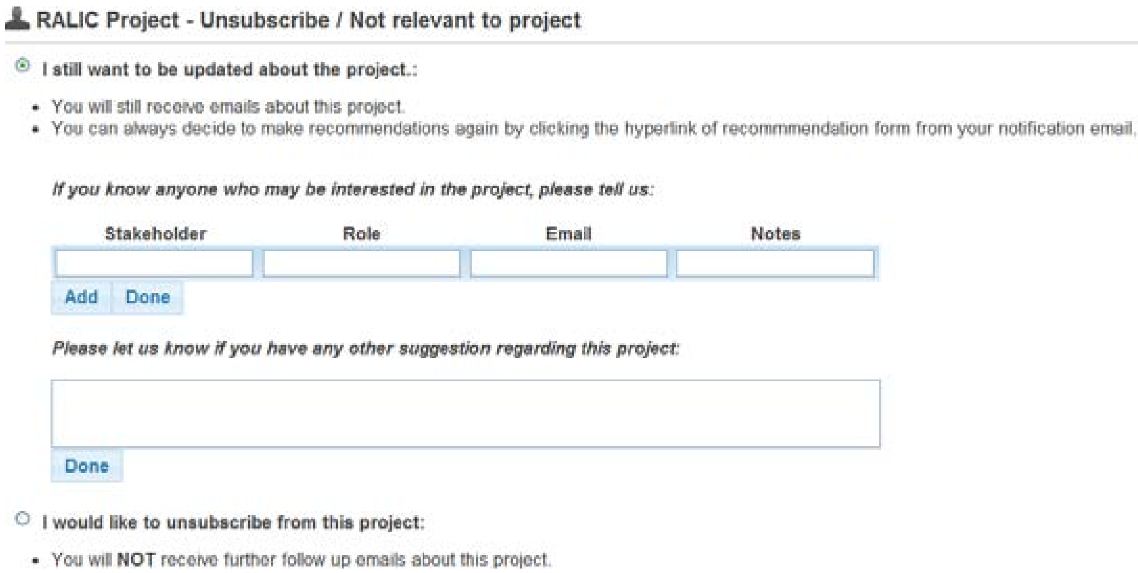


Figure 7-16: StakeSource enables "non-stakeholders" to unsubscribe.

Step 3: Analyse Stakeholders

StakeSource supports stakeholder analysis by capturing the stakeholders' recommendations, building the social network of stakeholders, using social network measures to prioritise stakeholders and their roles, identifying potential problems that stakeholders may have during the project, and capturing stakeholder details.

StakeSource provides the stakeholder analysis information to requirements engineers in an easily accessible way via a stakeholder analysis user interface. To ensure a robust and high quality visualisation within the timing constraint of this work, the existing software component Kap Visualizer[98] was used for its customisable and interactive network visualisation. The component is implemented in Flex[99], which is a software development kit for the development and deployment of cross-platform rich Internet applications based on the Adobe Flash platform. For consistency, the stakeholder analysis user interface was also implemented in Flex.

The stakeholder analysis user interface displays the prioritised list of stakeholders and their roles (Figure 7-17 Panel A), and the stakeholder network and stakeholder details (Figure 7-17 Panel C). StakeSource also provides the features to find a stakeholder in the network and highlight stakeholders in the network who may have problems in the project (Figure 7-17 Panel B). This stakeholder analysis user interface is also available to stakeholders in a public project who have already made their recommendations.

---

[98] http://lab.kapit.fr/display/kaplabhome/Home

[99] http://www.adobe.com/products/flex/

When the interface is first launched, only the Projects panel is enabled. This increases the usability of the tool as the users are guided towards selecting a project first before looking at the other panels. When the dropdown beside a folder is clicked, StakeSource reveals the list of scope items for the project (Figure 7-17). Once a project is selected, all the other panels (stakeholder network, prioritisation, and details) are populated.

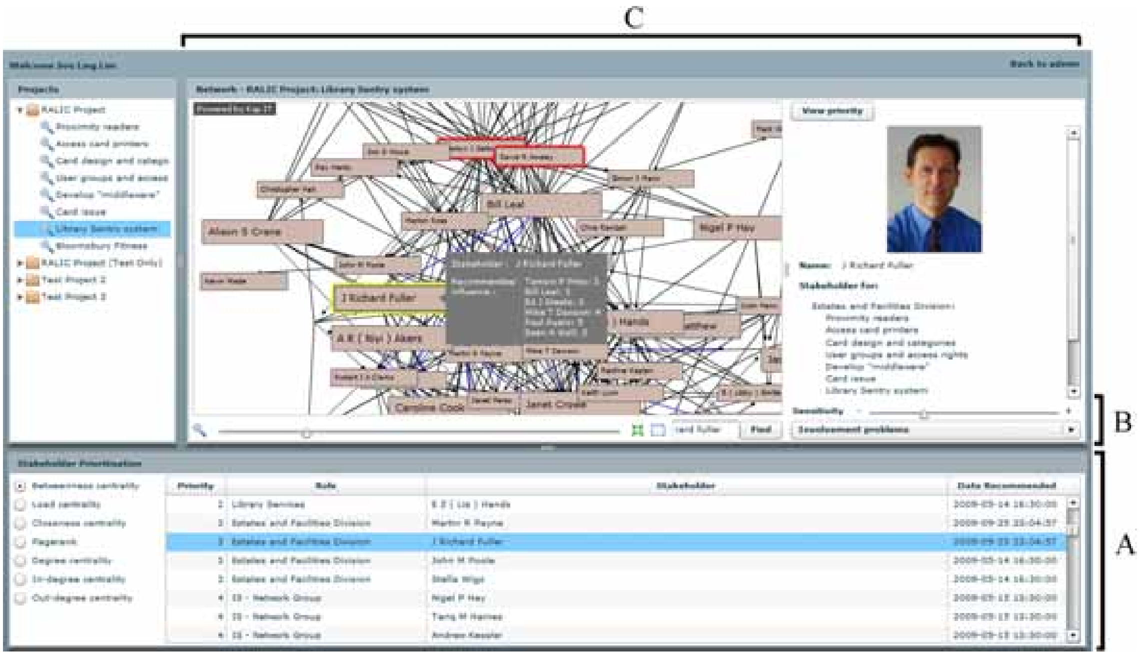


Figure 7-17: The three panels (A, B, and C) of StakeSource's user interface.

StakeSource removes the need for requirements engineers to format the stakeholders' recommendations for the social network measures. Using the recommendations, StakeSource builds a social network with the stakeholders as nodes, and their recommendations as directed edges: *S1* links to *S2* if *S1* believes *S2* to be a stakeholder. StakeSource provides two levels of social network: scope item and project. At the scope item level, the salience in each recommendation determines the weight of the link. At the project level, StakeSource combines scope-level recommendations such that if *S1* recommends *S2* in *N* number of scope items, *N* determines the weight of the link. By clicking on the project folder, StakeSource displays the stakeholder network at the project level, and by clicking on the scope items, the tool displays the stakeholders for the specific scope item (Figure 7-18).

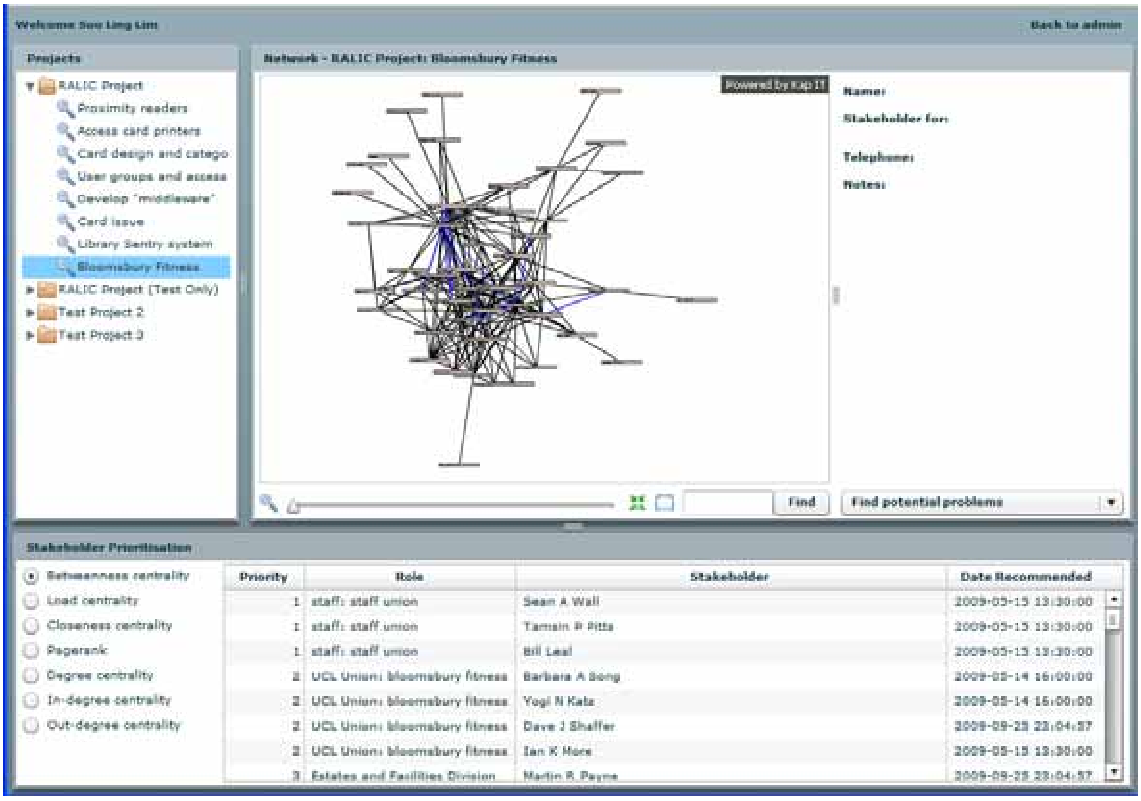


Figure 7-18: Stakeholder analysis at the scope item level.

Prioritised List of Stakeholders and Roles

StakeSource removes the need for requirements engineers to prioritise the stakeholders and their roles. When the stakeholder analysis user interface is launched, StakeSource automatically applies the social network measures described in the StakeNet method (Section 5.2, page 116) to prioritise the stakeholders in the stakeholder network. The social network measures include betweenness centrality, load centrality, closeness centrality, PageRank, degree centrality, in-degree centrality, and out-degree centrality. The NetworkX [100] package was used for its implementation of the social network measures as it is a well-established software component for social network analysis. NetworkX is implemented in Python[101].

StakeSource removes the need for requirements engineers to format the prioritised list for display. StakeSource processes the output of the social network measures to produce a prioritised list of stakeholder roles, and within each role, a prioritised list of stakeholders. This list is displayed on the stakeholder analysis user interface.

---

[100] http://networkx.lanl.gov/

[101] http://www.python.org/

In StakeSource, stakeholders are identified by their emails. Hence, a stakeholder who is recommended using different email addresses appears as different stakeholders on the stakeholder network. To improve the quality of prioritisation, StakeSource provides requirements engineers with the feature to merge different emails referring to the same person as well as different descriptions referring to the same role.

By default, the betweenness centrality algorithm is selected because the application of StakeNet on the RALIC project showed that it is the most accurate measure to prioritise stakeholders based on their influence in the project. Nevertheless, as discussed throughout Chapter 5, different measures prioritise different kinds of stakeholders. Hence, StakeSource provides the option to select other measures. The requirements engineers can click on the radio buttons for the different measures, and StakeSource automatically runs the social network measures, and displays the prioritised list of stakeholders and their roles in the stakeholder analysis user interface.

As the recommendations are continuous, running the network measures on demand ensures that the requirements engineers are always provided with the most recent stakeholder network and prioritisation. The stakeholders can also be sorted by the date and time they are recommended to reveal the most recently recommended stakeholders.

Identify Potential Problems

The evaluation of StakeNet using the RALIC project revealed that comparing a stakeholder's rank in different measures can reveal potential problems. Hence, StakeSource supports the analysis of stakeholders who may have involvement or communications problems during the project. Knowing the problems in advance enables the requirements engineers to rectify them, for example, they can increase communication with stakeholders or encourage their participation, thus benefiting the project (Damian et al., 2007). StakeSource has a "find potential problems" function, which identifies two potential problems by comparing a stakeholder's rank in different measures as follows.

- **Involvement problems**. StakeSource finds stakeholders who rank high in degree centrality but low in betweenness centrality.
- **Communication problems**. StakeSource finds stakeholders who rank high in betweenness centrality but low in closeness centrality.

When the requirements engineers select one of the problems, StakeSource highlights stakeholders in the network who may potentially have the problem in the project (Figure 7-19). StakeSource provides a slider which can be tweaked to change its sensitivity. When the slider is in a more sensitive mode, the allowable difference in the ranks between the relevant measures is less and the number of stakeholders highlighted with potential problems increases. When the slider is in a less sensitive mode, the allowable difference is more and the number of stakeholders highlighted with potential problems decreases. This helps the requirements engineers to decide the right level of problem detection for the project, which is a trade-off between the risk of the problem affecting the project and the cost to rectify the problem.

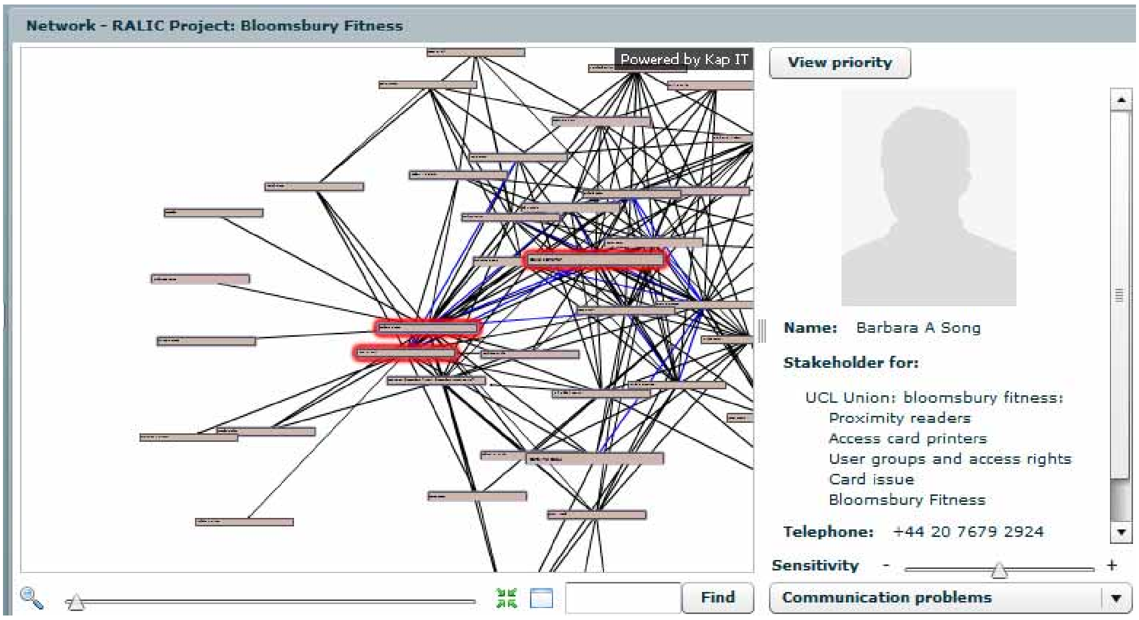


Figure 7-19: Stakeholders with potential communication problems are highlighted in red.

Network Diagram and Stakeholder Information

StakeSource enables the requirements engineers to study a stakeholder's location in the network, and the stakeholder's details and priority concurrently. By clicking on a stakeholder on the network diagram, the prioritisation panel highlights the stakeholder's role and the stakeholder details panel displays information about the stakeholder. Similarly, clicking on the stakeholder in the prioritisation panel highlights its node in the network. The recommendations can also be visualised as a stakeholder network. StakeSource provides two functions to view the stakeholder network in detail: zoom in (Figure 7-20) and full screen.

For each stakeholder, StakeSource displays the following information: name, role, photo, the scope items they are recommended for, and comments from other stakeholders. It also visualises the stakeholder's position on the network, who they recommend, and their rank as different kinds of stakeholders. For example, by clicking on Richard Fuller's node, the tool displays Richard's photo and other details such as name, role, photo, the scope items he was recommended for, and comments from other stakeholders. Figure 7-21 illustrates that Soo Ling has entered the note that Richard is unavailable on Wednesdays. Clicking on the "View priority" button shows that Richard is an important Broker and Information Passer for the project, but is less enthusiastic in his recommendations compared to some stakeholders (Figure 7-21). By searching for the stakeholder Richard, the network diagram highlights all nodes with the name Richard on them. By hovering over Richard's node with the mouse pointer, StakeSource displays Richard's recommendations.

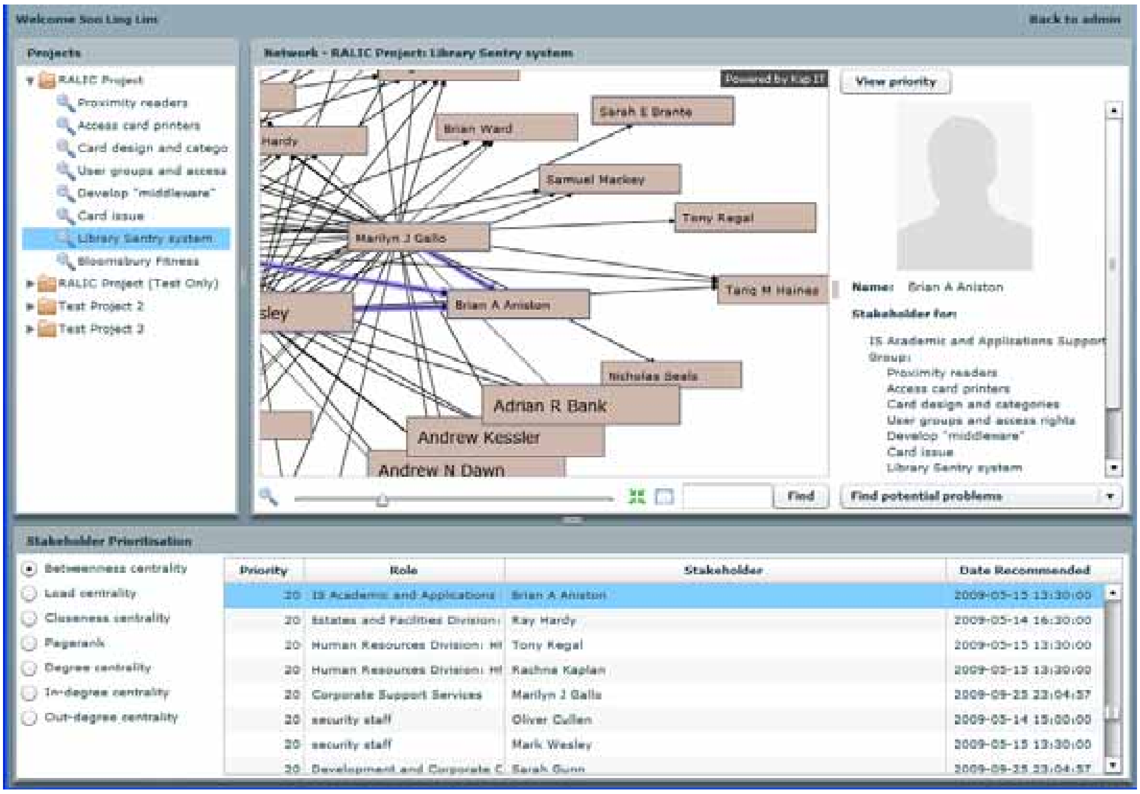


Figure 7-20: Zoom in and stakeholder selection.

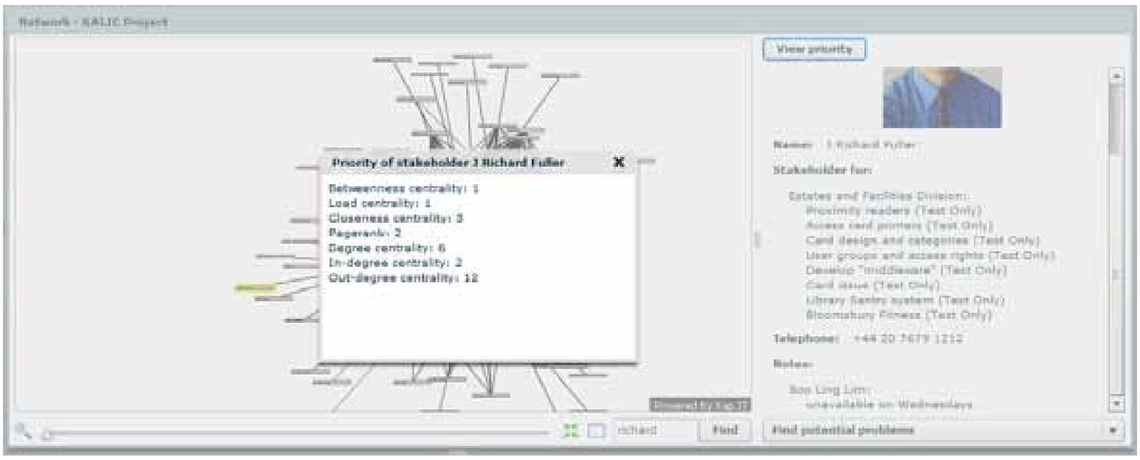


Figure 7-21: StakeSource reveals more about Richard.

7.3 Evaluation

The goal of StakeSource is to provide effective support for stakeholder analysis in large-scale software projects. Although StakeNet identifies and prioritises stakeholders and their roles at a high level of completeness and accuracy, the requirements engineers have to manually set up the project, contact stakeholders, collect and process the information provided by stakeholders. StakeSource supports requirements elicitation by significantly reducing these bottlenecks.

StakeSource is evaluated by having practitioners use the tool in their projects, as described in the research methodology in Chapter 3 (Section 3.4, page 69). The practitioners were provided with access to StakeSource for their projects. After they have finished using the tool in their project, they were interviewed for their feedback on how well StakeSource supports stakeholder analysis. The interviews were semi-structured, allowing the practitioners to expand on their responses to the questions (Lindlof and Taylor, 2002). Some of the interview questions include:

- What is your experience in using stakeholder analysis tools?
- How useful are the list of stakeholders identified by StakeSource?
- Has StakeSource discovered any unexpected stakeholders?
- Which StakeSource features are the most and least useful for stakeholder analysis?
- Will you use StakeSource for future projects?

At the time of writing, StakeSource is increasingly being used for real projects; in this chapter, the evaluation focuses on the first two projects that used StakeSource: the Admissions System project and the Healthy Cities project.

The Admissions System Project

The Admissions System project[102] is a large-scale software project in University College London involving more than 70 stakeholder roles and 30,000 stakeholders. This project aims to deliver an admissions system for University College London (UCL) that is transparent, fair, and efficient to reduce the administrative burden on UCL staff and ensure that UCL continues to attract students of the highest standard in an increasingly competitive market.

[102] http://www.ucl.ac.uk/isd/community/projects/azlist-projects

The project manager and communications manager, Gage and Jerome [103], were interested in using StakeSource to identify the stakeholders for the Admissions System project. Gage has 30 years of experience in software engineering, with 20 years as a project manager. Before joining UCL she worked in IT software houses such as IBM[104]. Jerome has also been working in software projects for 30 years, with 20 years as a communications and change manager. Before joining UCL, she worked with Cable & Wireless[105].

A meeting was held with Gage and Jerome to demonstrate the StakeSource tool. The concepts behind StakeNet were explained with the help of slides, and then the features of StakeSource were demonstrated using the RALIC project. A StakeSource client was created for the trial, and both the project manager and communications manager were given admin access to the client. A sample project with five stakeholders was included in the client as an example.

Tool Usage

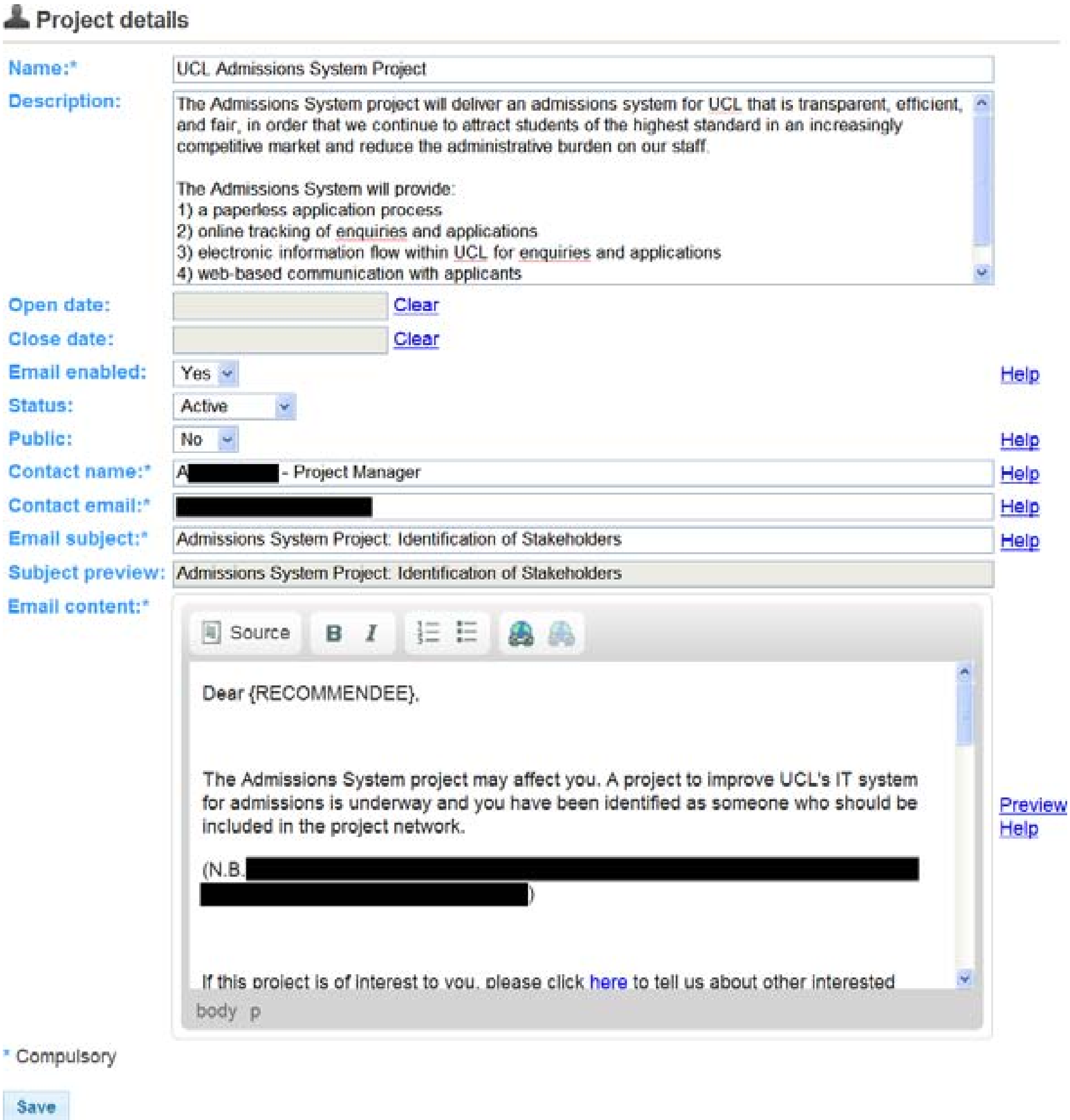
The Admissions System project was set up in StakeSource by the project manager and communications manager. Together, they created the project in StakeSource, entered project details, and customised the email template (Figure 7-22). They then created scope items (Figure 7-23), provided descriptions for each scope item, and entered a list of initial stakeholders (Figure 7-24). The email feature was turned off while data was being populated, so that the information can be validated before the emails were sent out. Care was taken to ensure that the email template had the right message to encourage stakeholders to respond and make recommendations (Figure 7-25), and that the scope items were well defined and explained. The project manager was set as main contact for queries to be directed to her.

---

[103] The names have been changed for reasons of privacy.

[104] http://www.ibm.com/uk/en/

[105] http://www.cw.com/



Project details

Name:* UCL Admissions System Project

Description: The Admissions System project will deliver an admissions system for UCL that is transparent, efficient, and fair, in order that we continue to attract students of the highest standard in an increasingly competitive market and reduce the administrative burden on our staff.

The Admissions System will provide:
1) a paperless application process
2) online tracking of enquiries and applications
3) electronic information flow within UCL for enquiries and applications
4) web-based communication with applicants

Open date: Clear

Close date: Clear

Email enabled: Yes — Help

Status: Active

Public: No — Help

Contact name:* A[redacted] - Project Manager — Help

Contact email:* [redacted] — Help

Email subject:* Admissions System Project: Identification of Stakeholders — Help

Subject preview: Admissions System Project: Identification of Stakeholders

Email content:* Source B I

Dear {RECOMMENDEE},

The Admissions System project may affect you. A project to improve UCL's IT system for admissions is underway and you have been identified as someone who should be included in the project network.

(N.B.[redacted])

If this project is of interest to you, please click here to tell us about other interested

body p

Preview
Help

* Compulsory

Save

Figure 7-22: Project details for the Admissions System project [106].

[106] Information sensitive to UCL has been redacted.

Scope items (8)

Create scope item

Name	Owner	Status	Action
Undergraduate Admissions	A[redacted]	active	Edit | Delete
Graduate Admissions	A[redacted]	active	Edit | Delete
Affiliate Admissions	A[redacted]	active	Edit | Delete
Non-standard Applicants	A[redacted]	active	Edit | Delete
Enquiries	A[redacted]	active	Edit | Delete
Interviews and Open Days	A[redacted]	active	Edit | Delete
Admissions System links to other systems	A[redacted]	active	Edit | Delete

Figure 7-23: Scope items for the Admissions System project.

Initial stakeholders

Tips

#	Stakeholder ?	Role ?	Email	Notes
1.	A[redacted]	Project Manager	[redacted]	[Public]
2.	L[redacted]	Communications Manager	[redacted]	[Public]
3.	N[redacted]	Chair of Admissions System project board	[redacted]	[Public]
4.	K[redacted]	Director, Registry Information and Data Services	[redacted]	[Public]
5.	B[redacted]	Head of Admissions	[redacted]	[Public]
6.	P[redacted]	Dean of Students (Academic)	[redacted]	[Public]
7.	B[redacted]	Management Systems	[redacted]	[Public]
8.	W[redacted]	Senior Supplier, Management Systems	[redacted]	[Public]
9.	M[redacted]	Faculty Tutor, Engineering Sciences	[redacted]	[Public]
10.	B[redacted]	Faculty Tutor, Arts & Humanities	[redacted]	[Public]
11.	D[redacted]	Faculty Tutor, Social and Historical Sciences	[redacted]	[Public]
12.	D[redacted]	Faculty Tutor, Maths and Physical Sciences	[redacted]	[Public]

Figure 7-24: Partial initial stakeholders for the Admissions System project.

Dear [redacted],

The Admissions System project may affect you. A project to improve UCL's IT system for admissions is underway and you have been identified as someone who should be included in the project network.

(N.B. [redacted])

If this project is of interest to you, please click here to tell us about other interested parties and help us build our network.

If this project is **not** of interest to you, please click here to let us know.

The Admissions System will provide:

- a paperless applications process
- online tracking of enquiries and applications
- electronic information flow within UCL for enquiries and applications
- web-based communication with applicants
- reporting tools

For more information about the project visit http[redacted]

The Admission Systems project team is keen to identify all the people with an interest in the project so that we can:

- keep them informed on the progress of the project
- involve them as appropriate to help us build an effective solution
- invite them to presentations starting January 2010

When you have submitted the details of the people that you believe we should add to our team you will be able to view the network that we have built to date and see who else shares your interest in the success of this important project. You can always go back to update the information you have provided.

Thank you.
Kind regards

A[redacted]

Senior Project Manager
UCL Management Systems

Figure 7-25: Email template for the Admissions System project[107].

[107] Information sensitive to UCL has been redacted.

Once all the data was populated, the email feature was turned on, and StakeSource sent an email to ask each initial stakeholder for recommendations. Figure 7-26 illustrates the recommendations provided by a stakeholder using StakeSource. A feature was added to import recommendations from different scope items so that the same stakeholders can be recommended for different scope items easily.

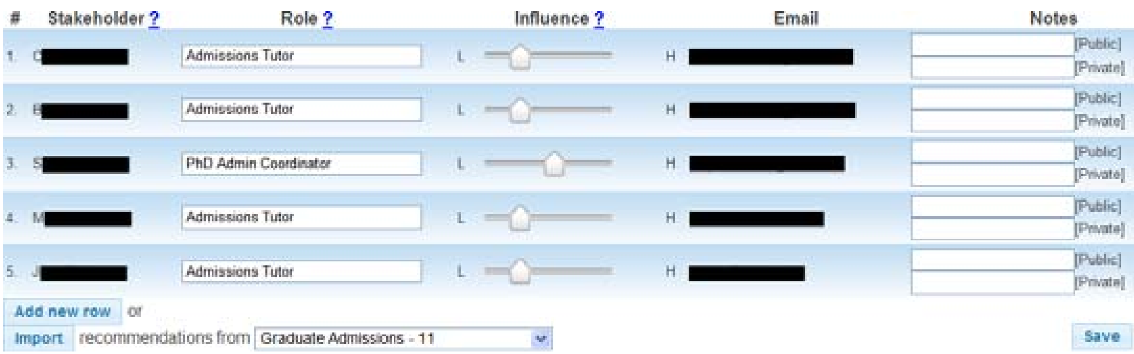


Figure 7-26: Recommendations from a stakeholder for the Admissions System project.

The initial stakeholders were contacted by StakeSource on the 17th of December 2009. The aim was to identify stakeholders to attend project presentations starting on the 15th of January 2010. The highest number of recommendations happened the first day the stakeholders were contacted (Figure 7-27).

Findings

The response rate was skewed by the time and duration StakeSource was used. According to Gage and Jerome, "it was the time of year where people were particularly busy. We were warned to do it another time, but we had no choice as the meetings started in January." The duration given for stakeholders to make recommendations was just two weeks, after excluding the Christmas break. In UCL, the first term ended on the 18th of December and the second term begins on 11th of January, hence many stakeholders were on holiday between those dates. According to Gage, "There is never a quiet time especially for large projects involving many departments or organisations because different departments have their own busy time. Project managers need to be cautious about the best time to run StakeSource to increase the number of recommendations." The snowballing was able to recover after an email was sent out by StakeSource to invite stakeholders to attend the presentations. The number of recommendations increased on the day the email was sent out and the following day. This suggests that email prompts when used appropriately can remind stakeholders to make recommendations.

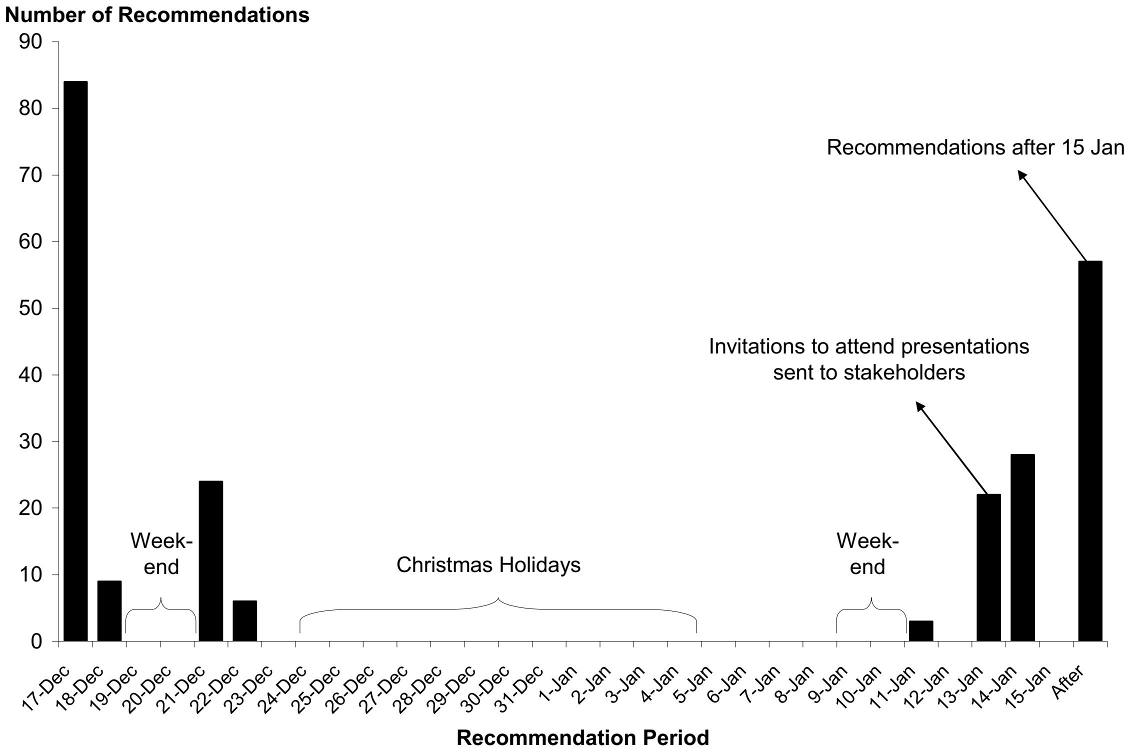


Figure 7-27: Number of recommendations over time.

The project started out with 66 initial stakeholders. The results are summarised in Table 7-3. A total of 124 stakeholder roles and 209 stakeholders were identified. Most of the stakeholders could be reached via email, only three emails bounced. Stakeholders who recommended made an average of seven recommendations each. Some people who were recommended indicated that they were not stakeholders, not interested or had no time to be involved in the project. While doing so, a few suggested other stakeholders.

Table 7-3: Results of StakeSource Applied to the Admissions System Project

Initial stakeholders	66
Recommendations	226
Stakeholders who made recommendations	32
Unsubscribed/ Not interested (but recommended)	7 (2)
Email bounced	3
No response	168
Stakeholders identified	209
Stakeholder roles identified	124

Interestingly, the stakeholder network for the project is disconnected (Figure 7-28). The disconnected network suggests that UCL was a siloed organisation in this area at the start of the project[108]. Each department was autonomous and independent. As a result, respondents identified with their own department but not UCL as a whole, and only thought about the immediate people in their own department when making recommendations, rather than all the people they knew who would be affected by the project. For example, none of the faculty administrators recommended departmental administrators although they were aware that departmental administrators were stakeholders. Also, some stakeholders were not keen to involve other stakeholders. According to the communications manager, the disconnected network diagram was used to support the communications plan for the project.

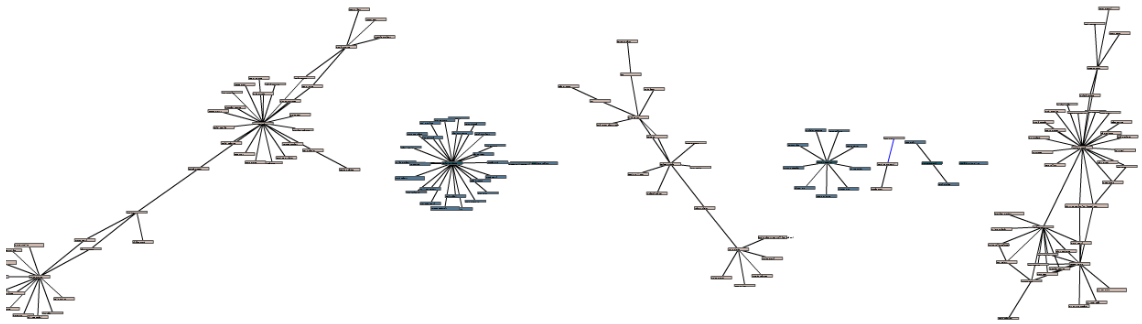


Figure 7-28: Partial stakeholder network for the Admissions System project.

In addition to investigating the relations between stakeholders, the lack of relations between stakeholders should also be investigated, as they can reveal important information about the project and the stakeholders. Although StakeSource is open and inclusive, some stakeholders may not want to share their knowledge, ties, and interests. The reasons may be political, because a way to support their power base is by restricting other people's access to their knowledge. Also, stakeholders may refrain from recommending a stakeholder they know in order to exclude the stakeholder's involvement in the project. As the network was available to all the stakeholders in this project, some stakeholders may prefer not to make any recommendations to avoid excluding someone important to them.

After the stakeholders were identified for the project presentation, StakeSource continued to be used as a repository for stakeholder information, and the network diagram was

---

[108] The source of sensitive information is not revealed in this section to protect the individuals and their relationships with the stakeholders.

consulted for the relations among stakeholders. It also served to inform stakeholders about the other stakeholders in the project.

An interview was conducted with Gage and Jerome for feedback on StakeSource. Both of them had no previous experience in using stakeholder analysis tools and did not know any existed but found it easy to set up the project. The feature to customise the initial email to stakeholders was very important and useful to them, and the time used on drafting the email was well spent. According to them, "People suffer from email fatigue. It is very important to get the wording in the email right. The first sentence of the email should be able to catch the respondents' attention."

The interview also revealed that StakeSource identified some unexpected stakeholders early in the project. The list of stakeholders and their roles was frequently used in project communication. Other useful features include the ability to filter stakeholders and create different email templates for further communication. According to Gage, "the network diagram is the most useful feature of the software. It told us so much about the culture of the organisation, shows the stakeholder's relationships with other stakeholders, and it is the easiest way to justify the use of StakeSource to my superiors. The network diagram immediately tells you so much about the stakeholders. It is useful for any project." Both Gage and Jerome were keen to use StakeSource for other projects.

A directors' meeting was held to review StakeSource's use on the Admissions System project. The meeting was attended by the Director of Management Systems, the Director of Information Services Division, project manager Gage, communications manager Jerome, and this researcher. The meeting started with a demonstration of StakeSource on the Admissions System project by the researcher, followed by positive feedback from Gage and Jerome on StakeSource. They reported that StakeSource identified some unexpected stakeholders and the stakeholder network highlighted the need for communication among clusters of stakeholders for the project to be successful. At the end of the meeting, the Director of Information Services Division asked the project manager, "Would you use StakeSource in future projects?" in which the project manager replied "Absolutely." The Director of Management Systems commented that StakeSource can be marketed as a Web 2.0 customer relationship management tool and large companies, such as EMC[109], may be interested in using StakeSource.

The successful use of StakeSource in the Admissions System project has encouraged more projects to use the tool for stakeholder analysis. The Directors of Information Services Division and Management Systems decided to make StakeSource a standard tool for all software projects in UCL. A recent email from one of the Directors proposes the use of

---

[109] http://uk.emc.com/

StakeSource in all new major projects in UCL (Figure 7-29). Jerome continues to use StakeSource in other software projects, the most recent one being the Staff Survey Action Group Project[110], which examines the organisational structures, processes, people practices, culture and values, and management of change in UCL to improve operations management in UCL.

From: "W[redacted]" <w[redacted]>
To: "S.Lim" <S.Lim@cs.ucl.ac.uk>
Cc: "C[redacted]" <n[redacted]>
Sent: Thursday, July 08, 2010 7:12 AM
Subject: RE: Update

Soo,

I think we would use it for all new major projects. I wonder whether it is too late to use with IRIS...N[redacted], would it help in finding key opinion formers in Depts?

Regards
W[redacted]

Figure 7-29: Director keen to use StakeSource in all major projects.

The Healthy Cities Project

The Healthy Cities project is the second project that uses StakeSource for stakeholder analysis. The project was part of UCL's Grand Challenge in Sustainable Cities[111] supported by the UCL Environment Institute. UCL was working with the Lancet[112], a weekly peer-reviewed general medical journal, on a Commission into Healthy Cities. The Commission was interested in all aspects of urban life that impact on people's health, in how health in urban areas may be improved and in the specific interventions and policies that should be put in place to make cities healthier places for their residents. The commission planned to draw on expertise across UCL to provide a unique analysis of the problem of health in urban environments.

The Chair of the Healthy Cities Commission, Professor Yvonne Rydin, was interested in using StakeSource to identify academics in UCL who have expertise in the areas of health in urban environments and might be interested in being involved in the Healthy Cities project. Yvonne is the Professor of Planning, Environment and Policy at the Faculty of Built Environment at UCL. Her research looks at networks and discourses of local planning. These academics are stakeholders, because being involved in the project will benefit their academic career. However, in this case the stakeholders have a reason not to recommend others, for more people being involved may lead to less potential funding for each individual.

---

[110] http://www.ucl.ac.uk/news/news-articles/1008/10081204

[111] http://www.ucl.ac.uk/sustainable-cities/

[112] http://www.thelancet.com/

A meeting was held with Yvonne to demonstrate the StakeSource tool. The concepts behind StakeNet were explained with the help of slides, and then the features of StakeSource were demonstrated using the RALIC project. A StakeSource client was created for the trial, and Yvonne was given admin access to the client. A project created by a group of Master of Science students[113] was included as an example.

Tool Usage

Yvonne set up the project by creating the Healthy Cities project in StakeSource, entering the project details, and customising the email template (Figure 7-30). Care was taken to ensure that the email template had the right message to encourage experts to respond and make recommendations (Figure 7-31). She then created scope items (Figure 7-32), provided descriptions for each scope item, and entered a list of initial experts (Figure 7-33). The list of initial experts was extracted from an existing list of commission invitees. The list of commission invitees was built by Yvonne prior to using StakeSource, by sending an open call to the academics in two email distribution lists: UCL Environmental Institute and UCL Institute for Global Health. Those who responded to the open call were included in the list of commission invitees.

---

[113] These students were doing a requirements engineering course with Dr. Emmanuel Letier at UCL and had used StakeSource to identify and prioritise stakeholders in their project.

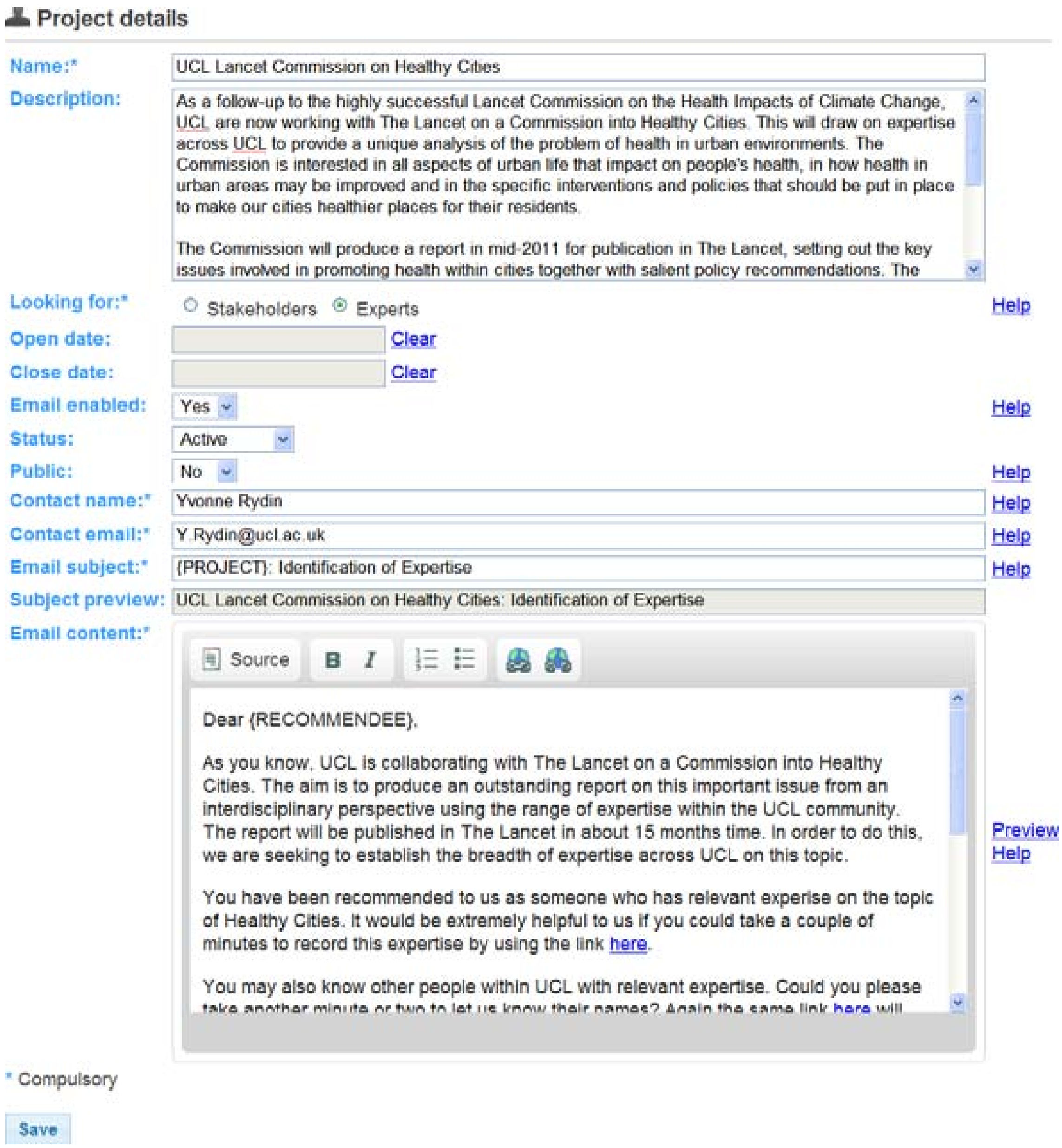


Figure 7-30: Project details for the Healthy Cities project.

Dear [redacted].

As you know, UCL is collaborating with The Lancet on a Commission into Healthy Cities. The aim is to produce an outstanding report on this important issue from an interdisciplinary perspective using the range of expertise within the UCL community. The report will be published in The Lancet in about 15 months time. In order to do this, we are seeking to establish the breadth of expertise across UCL on this topic.

You have been recommended to us as someone who has relevant experise on the topic of Healthy Cities. It would be extremely helpful to us if you could take a couple of minutes to record this expertise by using the link here.

You may also know other people within UCL with relevant expertise. Could you please take another minute or two to let us know their names? Again the same link here will allow you to do this.

With many thanks for your help

Yvonne Rydin
Professor of Planning, Environment and Public Policy &
Co-Director of the UCL Environment Institute
Bartlett School of Planning
University College London

[redacted]

NB. This exericse is being supported by an innovative software tool being developed by UCL Department of Computer Science.

Figure 7-31: Email template for the Healthy Cities project.

Scope items (3)

Create scope item

Name	Owner	Status	Action
The scope of 'Healthy'	Yvonne Rydin	active	Edit | Delete
The scope of 'Cities'	Yvonne Rydin	active	Edit | Delete
The scope of 'Healthy Cities' interventions	Yvonne Rydin	active	Edit | Delete

Figure 7-32: Scope items for the Healthy Cities project.

Initial stakeholders

Tips

#	Expert ?	Role ?	Email	Comments
1.	M[redacted]	(Secretary), Environment Institute	[redacted]	[Public] [Private]
2.	[redacted]	Grand Challenges	[redacted]	[Public] [Private]
3.	S[redacted]	CEGE	[redacted]	[Public] [Private]
4.	A[redacted]	Wellcome Trust Centre for the History of Medicine	[redacted]	[Public] [Private]
5.	M[redacted]	Geography and Urban Lab	[redacted]	[Public] [Private]

Figure 7-33: Partial initial stakeholders for the Healthy Cities project.

StakeSource was extended to support the identification of experts. In the project set up for StakeSource, an option was added to either identify stakeholders or experts (Figure 7-30). The recommendation form for identifying experts is different from that the one to identify stakeholders. The terminology and prompts support expert recommendation, and an additional field was added before the recommendation, where experts are asked to describe their expertise (Figure 7-34). The expertise descriptions are collected as tags separated by commas.

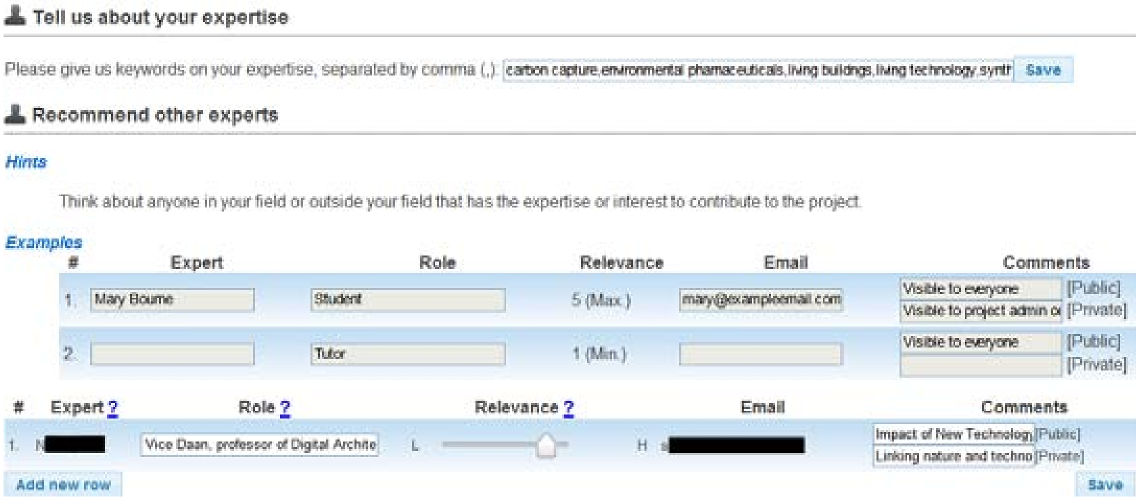


Figure 7-34: Expert recommendation form enables experts to describe their own expertise and recommend other experts.

A control project was created in StakeSource, with the same project details, scope items, and customised email template as the Healthy Cities project. Rather than an initial list of experts, the control project uses an initial list of random UCL staff members. As there were 30 experts in the initial list, the number of random staff members was also set to 30. The random list was created by randomly selecting 30 departments from the list of UCL departments and affiliated organisations[114], and then randomly selecting a staff member from the UCL staff directory[115] who worked with the selected departments. A random number generator[116] with a uniform distribution was used. The members in the random list and the expert list were mutually exclusive.

Once all data was populated, the email feature was turned on for both projects, and StakeSource emailed the experts and random UCL staff members for recommendations on the 11th of February 2010. Similar to the Admissions System project, the highest number of response occurred the first day the people were contacted (Figure 7-27). There was no end date for recommendations, but recommendations stopped after the 2nd of March 2010.

[114] http://www.ucl.ac.uk/departments/a-z/

[115] http://www.ucl.ac.uk/directory/

[116] http://www.random.org/

Findings

StakeSource uncovered a list of expertise valuable to the Healthy Cities project such as bio-politics, disease, infrastructure, public health, urban history, and sustainable architecture (Table 7-4). The Comments field in the recommendation form was mostly unpopulated in the Admissions System project. But in the Healthy Cities project, some recommendations came with justification for the recommendation (e.g., "Connected++, exercise+, holistic, excellent 'leader'") or description of the expert (e.g., "Judy[117] has been contributing to a DPU/Leonard Cheshire Disability & Inclusive Development Centre project on children, disabilities and well-being in informal settlements in India").

Table 7-4: Partial List of Expertise as Provided by Experts

Expertise
bio-politics, disease, infrastructure, public health, urban history, water
climate change, global, social determinants, urban health equity
ethnic and minority populations, people with disabilities; accessibility issues, vulnerable populations
grassroots vulnerability and resilience to climate change, urban environmental justice, use and appropriation of public green spaces, water and sanitation
cities, cultivating communities, minority cultures, sustainable architecture, sustainable planning, urban activities, urban cultures, urban farming
general systems theory, urban agriculture

Most respondents focused on providing their expertise rather than recommending other experts. About 90% of the respondents provided descriptions of their expertise but only 40% of them recommended other experts, with an average of one recommendation per respondent (Table 7-5). This suggests that in some projects, there can be a lack of incentive to make recommendations, for example, if the stakeholders were competing for funding or exclusive involvement in the project. In addition, the phrasing of the email template elicits expertise before asking for recommendations (Figure 7-31), which may skew responses towards the former.

The results revealed interesting tendencies for this unusual type of project. In the Healthy Cities project, very few recommendations were made and the majority of newly identified stakeholders did not make recommendations (Figure 7-35 (a)). The initial emails were

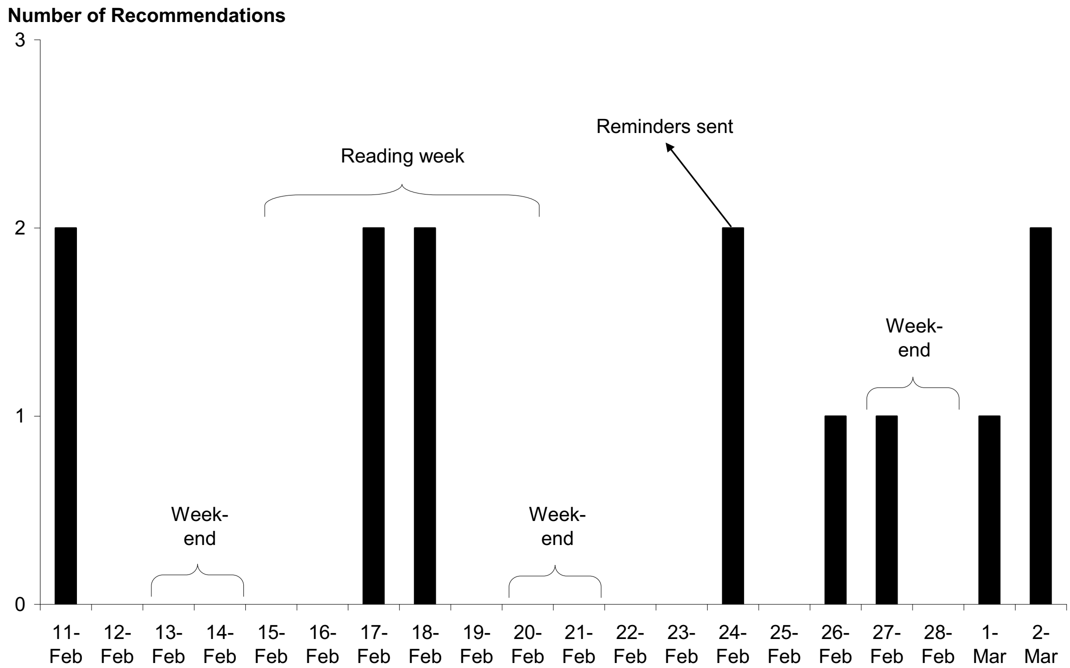
[117] The name has been changed for reasons of privacy.

sent out before the reading week, a week during the term where no teaching takes place, in which some academics may be on holiday. Hence, email reminders were sent after the reading week to those who had not responded. The email reminders triggered more recommendations. In the control project, only one recommendation was made, after the email reminders were sent out (Figure 7-35 (b)). Figure 7-36 illustrates the expert network for both projects.

Table 7-5: Results of StakeSource Applied to the Healthy Cities Project and Control Project

Item	Healthy Cities	Control
Initial set of experts/random UCL staff	30	30
Recommendations	13	1
Responded	25	5
Experts who made recommendations	10	1
Experts who described their expertise	22	4
Unsubscribed/ Not interested	0	1
Not interested but recommended	0	0
Email bounced	0	0
Experts identified	40	4
Expert roles identified	27	1

(a)



(b)

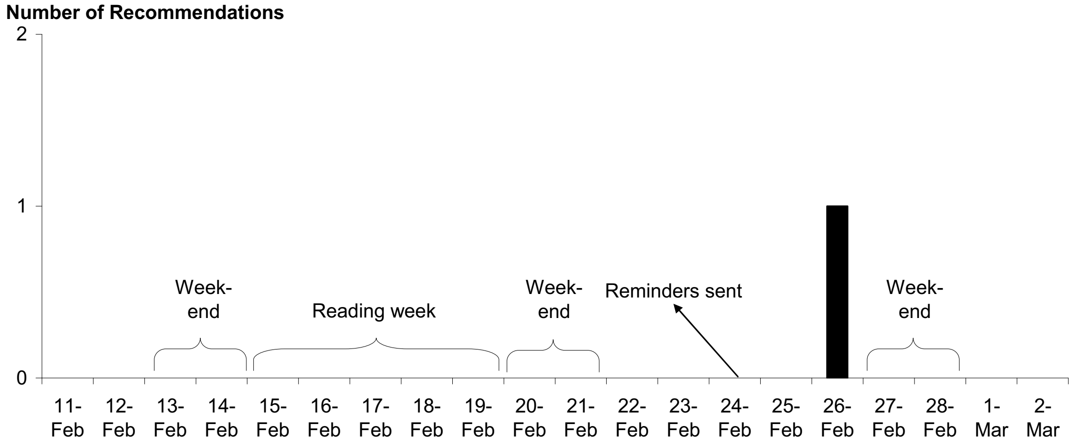


Figure 7-35: Number of recommendations over time: (a) Healthy Cities project (b) control project.

(a)

(b)

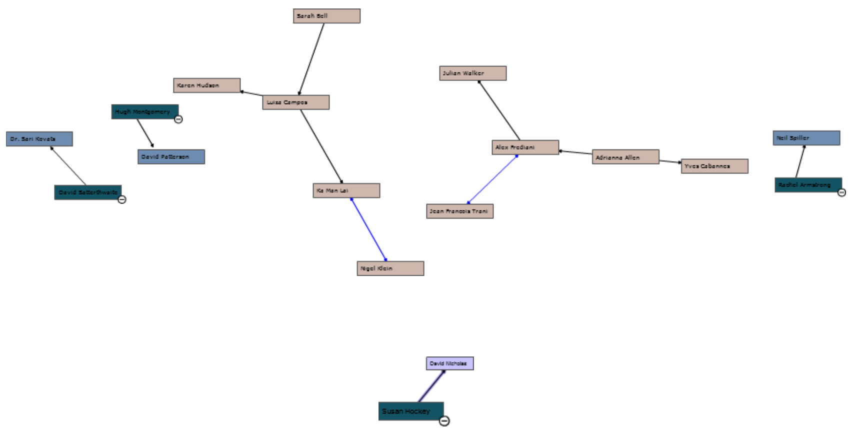


Figure 7-36: Expert network: (a) Healthy Cities project (b) control project.

In the Healthy Cities project, phone interviews with those who did not make recommendations revealed that they did not see the purpose of the recommendations, as the experts they were aware of were already attending project meetings. Nevertheless, StakeSource identified some enthusiastic experts (Figure 7-37).

From: R[redacted]
Sent: 24 February 2010 14:11
To: Yvonne Rydin
Subject: Re: UCL Lancet Commission on Healthy Cities

Dear Yvonne,

I hope I responded in the correct way. I used the form to recommend N[redacted] Professor of Architecture and Digital Theory and Director of the AVATAR group (a research group that looks at the impact of new technologies on architecture & the environment) ...

Please let me know how else I can register my interest in participating in this exciting project!!

Many thanks

R[redacted]

Figure 7-37: Enthusiastic email from expert.

The control project demonstrates that the initial list is important in determining the quality of recommendations. If there are a high number of irrelevant people in the initial list, the quality of stakeholders identified by StakeSource will be affected. Phone interviews with those who did not make recommendations revealed that many people from the random list did not have phone numbers. Among those with phone numbers, some are based outside UCL (e.g., one was in Switzerland), and some were no longer with UCL (e.g., one retired six years ago). The few who have received the email did not respond as the topic of healthy cities was not their area of interest. According to a professor from the Department of Mathematics, "UCL sends a lot of these emails, so if they are not relevant, I just delete them."

An interview was conducted with Yvonne for feedback on StakeSource. Yvonne had no experience using stakeholder analysis tools but found the project set up in StakeSource easy. According to Yvonne, "The context is very important for StakeSource to work: stakeholders must be incentivised to make recommendations. In this project, most respondents may have been more incentivised to provide their expertise than recommend other experts." Another reason for the low number of recommendations was the project was already on-going when StakeSource was used. According to Yvonne, "there was already a bit of snowballing going on during the open call. For example, some people replied my email with 'I am not interested but x and y may be.' Hence, they may not see the point of doing it again. Besides, academics are awful in answering emails. We spend time ignoring emails and survey requests." Yvonne also commented that StakeSource is more suitable for large projects with many stakeholders. According to Yvonne, "From my experience, there is less bias from false entries with a bigger number of nodes in the network. In other words, in a larger the network the prioritisations are more reliable."

Despite the low number of recommendations, StakeSource managed to identify an important stakeholder for the project. According to Yvonne, "the experts identified by StakeSource were already involved in the project or haven't been involved anyway. One exception was Lenard[118]. He came to meetings after StakeSource identified him. And since then, he has been absolutely invaluable."

Following the evaluation of StakeSource using the Admissions System project and Healthy Cities project, a commercial website for StakeSource was set up at http://www.stakesource.co.uk/ and free trials were extended to organisations outside UCL. Without any advertisements or marketing, an average of two free trials per week have been requested from project managers and requirements engineers at various organisations such as Intel, the British Library, Zuhlke Engineering, and SOS Kinderdorf Azerbaijan.

7.4 Summary

StakeSource is a stakeholder analysis tool that uses social networks to identify and prioritise stakeholders in large-scale software projects. The evaluation of StakeSource using two real projects provides clear evidence that the tool improves the ability of the StakeNet and StakeRare methods to provide effective support for requirements elicitation as follows.

- StakeSource reduces and eliminates the time consuming tasks in the StakeNet method, such as questionnaire generation, data collection and processing, computations of social network measures, and network visualisation.
    - **Questionnaire generation**. The requirements engineers find it easy to enter project details and provide initial stakeholders in StakeSource.
    - **Emails and reminders**. StakeSource contacts each stakeholder by email or remind stakeholders who have not responded. The requirements engineers only need to customise the email template.
    - **Surveys**. StakeSource collects recommendations from stakeholders via an online recommendation form.
    - **Data entry**. As StakeSource collects recommendations from stakeholders directly, the requirements engineers no longer need to input the stakeholders'

[118] The name has been changed for reasons of privacy.

responses into the system. StakeSource stores project and stakeholder details, and stakeholder recommendations in a database for consistency and traceability.

- **Data validation**. StakeSource highlights invalid recommendations (e.g., a recommendation without the level of influence) to the stakeholders so that the stakeholders can amend invalid recommendations.
- **Data cleaning**. StakeSource converts the recommendations to the appropriate format for the social network measures. If a stakeholder recommends a role but not the actual stakeholder, StakeSource links that recommendation to all the stakeholders with the same role who are identified so far. StakeSource converts the output from the social network measures so that stakeholders are prioritised by the influence of their roles in the project, and then by their influence in the role. StakeSource provides support for the requirements engineer to clean inconsistent data such as different names referring to the same person or role.
- **Computation**. StakeSource runs the social network measures as well as the prioritisations of the stakeholders and their roles automatically.

- StakeSource met the key requirements for an effective tool support.
  - **Widely available and easy to access**. StakeSource was able to reach the stakeholders in both projects, as they all have email and web access. By studying the email bounce rate, more than 99% of emails were successfully sent to stakeholders in both the Admissions System project and the Healthy Cities project.
  - **Simple and intuitive to use**. Stakeholders who have no knowledge about StakeSource and StakeNet were able to access the recommendation forms and make recommendations.
  - **Easy to make recommendations without compromising quality**. StakeSource identified important and unexpected stakeholders in both the Admissions System project and the Healthy Cities project. According to the project manager and communications manager of the Admissions System project, the list of stakeholders and their roles returned by StakeSource is one of the most useful features in StakeSource.
  - **Interactive stakeholder network**. The project managers and requirements engineers were able to interact with the stakeholder network to learn about the stakeholders, their recommendations, location in the network, and priority in the project. They found the stakeholder network to be one of the most important features in StakeSource. It revealed the relations and lack of relations among

stakeholders, and was used to support the communications plan in the Admissions System project. According to the project manager, having a stakeholder network is "useful for any project."

- StakeSource is being adopted in practice.
    - The communications manager who used StakeSource in the Admissions System project continued using StakeSource in other software projects.
    - The IT Directors in UCL saw value in StakeSource and requested to use StakeSource in all major software development projects in UCL.
    - Project managers in organisations outside UCL are requesting to trial StakeSource.

The next and final chapter of this thesis describes future work and concludes.

Chapter 8

Conclusion

This chapter summarises the thesis, discusses potential limitations, and puts forward a research agenda for the future.

8.1 Thesis Synopsis

Three problems in requirements engineering motivated the work in this thesis: information overload, inadequate stakeholder input, and biased prioritisation of requirements. Motivated by these problems, this work hypothesises that social networks and collaborative filtering provide effective support for requirements elicitation in large-scale software projects.

As described in the second chapter, existing methods in stakeholder analysis are likely to either omit stakeholder roles or return "non-stakeholders". In addition, they do not distinguish suitable stakeholders to be involved in requirements elicitation. These methods can be biased in large projects where no individual has the global perspective. Existing methods in requirements elicitation do not scale to projects with many stakeholders and requirements, and can also be biased in large projects. Most elicitation methods require face-to-face meetings with the stakeholders, which are time consuming. Based on the review of existing definitions of large-scale software projects, this work defines a large-scale software project as a software project with more than 50 stakeholder groups and 10,000 users, where users are members of the stakeholder groups.

In order to provide evidence to support the hypothesis, this work uses the case study research methodology, as described in Chapter 3. A summary of the research methodology is as follows. A large-scale software project, RALIC, was selected from the list of software projects in University College London. A method that identifies and prioritises stakeholders using social networks was developed, applied to the project, and empirically evaluated. Then, a method that identifies and prioritises requirements using social networks and collaborative filtering was developed, applied to the project, and empirically evaluated. Finally, a software tool that supports stakeholder analysis was developed, used by practitioners in real projects, and evaluated based on their feedback.

As demonstrated in Chapter 4, the RALIC project was a well-documented software project. The study of requirements change in RALIC from the start of the project until two years after the system went live provided this work with the knowledge to produce the data used to evaluate the work. The list of stakeholders and their roles produced by using the existing method in the project and ground truth of stakeholders and their roles were used to evaluate StakeNet. The list of requirements produced by using the existing method in the project and the ground truth of requirements were used to evaluate StakeRare.

StakeNet, described in Chapter 5, is a novel method that uses social networks to identify and prioritise stakeholders and their roles in large-scale software projects. The evaluation of StakeNet using the RALIC project demonstrates that StakeNet provides effective support for stakeholder analysis. StakeNet identifies a highly complete set of stakeholders and their roles compared to the existing method used in the project, requiring less time from the requirements engineers and the stakeholders. StakeNet also prioritises the stakeholders and their roles accurately. Compared to individual stakeholders, StakeNet is more accurate in prioritising stakeholder roles.

StakeRare, described in Chapter 6, is a novel method that uses social networks and collaborative filtering to identify and prioritise requirements in large-scale software projects. StakeRare elicits requirements from the stakeholders identified by StakeNet. The evaluation of StakeRare with RALIC demonstrates that StakeRare provides effective support for requirements elicitation. StakeRare identifies a highly complete set of requirements compared to the existing method used in the project, requiring less time from the requirements engineers and the stakeholders. StakeRare also prioritises the requirements accurately. StakeRare handles information overload by drawing stakeholders' attention to only the relevant requirements that they are unaware of. StakeRare's elicitation method, which provides stakeholders with a predefined list of requirements as well as allowing them to add new requirements, is rated by stakeholders as low difficulty and requiring little effort.

Although StakeNet and StakeRare provide effective support for requirements elicitation, these methods require considerable amount of effort from the requirements engineers with bottlenecks such as questionnaire generation, recommendation collection, data cleaning, and computation. StakeSource, described in Chapter 7, is a novel software tool that relieves the requirements engineers from these bottlenecks. The evaluation of StakeSource with two real projects demonstrates that StakeSource provides more effective support for stakeholder analysis by relieving the requirements engineers from the bottlenecks. UCL is now using StakeSource in all major software development projects, and organisations outside UCL are also adopting StakeSource.

To summarise, this work provides evidence that social networks and collaborative filtering can effectively support requirements elicitation in large-scale software projects. To provide the evidence, the objectives described in Chapter 1 (Section 1.4, page 21) were achieved by this work. Table 8-1 reiterates the objectives and summarises the chapters in this thesis that addressed each objective.

Table 8-1: Objectives and Thesis Chapters

Objective	Chapter(s)
To review the existing methods in stakeholder analysis and requirements elicitation, and the existing definitions of large-scale software projects.	Chapter 2 reviewed the existing literature in stakeholder analysis and requirements elicitation. It also reviewed existing definitions of large-scale software projects to arrive with a definition used in this thesis.
To select a large-scale software project to evaluate the work, study the project in detail, and build the ground truth and existing method lists of stakeholders and requirements to evaluate the methods developed in the work.	Chapter 3 described the selection of a large-scale software project, RALIC, from the list of software projects in University College London. Chapter 4 described the RALIC project, and reviews the project documentation, and the study of requirements change in the RALIC project from the start until two years after the system was deployed. The chapter also described the construction of the existing method and ground truth lists of stakeholders and requirements.
To review the existing literature in social network analysis, develop a method that uses social networks in stakeholder analysis, and evaluate the method empirically.	Chapter 5 reviewed the existing literature in social network analysis, and the existing software engineering literature which uses social network analysis. It also described StakeNet, the application of StakeNet on the RALIC project, and the results of the empirical evaluation.

Objective	Chapter(s)
To review the existing literature in collaborative filtering, develop a method that uses social networks and collaborative filtering in requirements elicitation, and evaluate the method empirically.	Chapter 6 reviewed the existing literature in collaborative filtering and the existing software engineering literature which uses collaborative filtering. It also described StakeRare, the application of StakeRare on the RALIC project, and the results of the empirical evaluation.
To analyse the bottlenecks in the proposed methods, review the existing tool support literature, develop a tool that reduces the bottlenecks, and evaluate the tool with real projects by practitioners.	Chapter 7 analysed the bottlenecks in StakeNet and reviewed the existing literature on tool support for stakeholder analysis. It also described StakeSource and its evaluation using the Admissions System project and the Healthy Cities project.
To identify the limitations in this work and propose future work to address the limitations.	The remaining sections in this final chapter will analyse the limitations in the work and put forward a research agenda for the future.

8.2 Threats to Validity

This work uses the case study research methodology to provide evidence to support the hypothesis. The threats to validity in each stage of the methodology (Figure 8-1) are investigated.

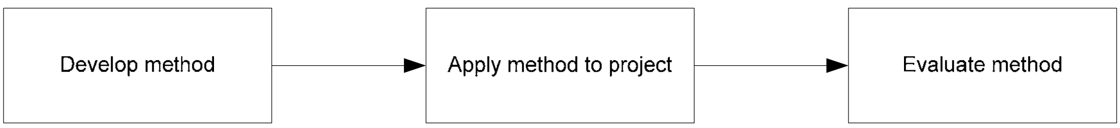


Figure 8-1: Case study research (Yin, 2008).

Develop Method

In the StakeNet and StakeRare methods and the StakeSource tool, the quality of the results depends on the following factors.

- **Initial stakeholders**. The quality of StakeNet's results depends on the initial set of stakeholders. For example, in the Healthy Cities project, the control project which used random UCL staff members as initial stakeholders performed much worse than the actual project which used targeted initial stakeholders. As such, to identify a high quality list of stakeholders and their roles in a software project, the requirements engineers should ensure that the initial stakeholders cover the key stakeholder categories of users, developers, legislators, and decision-makers.

- **Initial requirements**. The quality of the requirements identified by StakeRare may depend on the initial set of requirements, especially in projects where stakeholders are less aware of their requirements. Future work should investigate the effect of the initial requirements on the result, for example, by using a control project with a lower quality set of initial requirements. The initial requirements in StakeRare are identified using the existing elicitation methods discussed in Chapter 2. Future work can also explore ways to improve the quality of the initial requirements, for example by selecting suitable existing elicitation methods for different projects.
- **Email content**. As the methods and tool contact stakeholders by email, the content of the email plays an important role in encouraging the stakeholders' response. The application of StakeSource on real projects revealed that some requirements engineers face difficulty composing clear and attractive emails. A solution, which should be investigated in future work, may be to provide a selection of email templates that users can edit for their needs.
- **Motivation and availability to recommend**. As demonstrated in the Admissions System project and the Healthy Cities project, external factors, such as timing constraints of the project, holidays, and busy periods, can affect the stakeholders' availability to respond. This reduces the number of recommendations and may stop the snowballing process. This threat can be mitigated by considering a suitable time to apply the methods or tool. Email reminders can also prompt stakeholders to recommend and resume the snowballing process. In addition, other ways of collecting recommendations, such as telephone or face-to-face interviews, should be considered for stakeholders with low availability and stakeholders without email access.
- **Malicious stakeholders**. The methods and tool currently assumes that stakeholders recommend honestly. However, malicious stakeholders may provide responses for their personal benefit, such as recommend "non-stakeholders", exclude some stakeholders, or manipulate the requirements ratings. This, in turn, affects the quality of stakeholders and requirements returned by the methods and tool. Some social network measures, such as betweenness centrality and PageRank, mitigates the effect of biased recommendations. For example, betweenness centrality avoids stakeholder communities who highly suggest one another from gaining disproportional influence. Still, future

work should develop more sophisticated methods that account for malicious stakeholders who manipulate recommendations and ratings for personal gains.

- **Disconnected network**. StakeNet assumes that the stakeholder network is connected, and in the RALIC project, the stakeholder network is connected. However, in the Admissions System project, the stakeholder network is disconnected. Future work should explore the social network measures in terms of their suitability in analysing disconnected stakeholder networks. Future work should also investigate if the lack of relations between stakeholders can reveal potential problems in the project.
- **Privacy**. The stakeholder network in StakeSource is available to all stakeholders after they make recommendations, in order to encourage them to participate. However, this raises privacy concerns in some projects and for some stakeholders who do not want other stakeholders to know about their relations. This can be solved by providing additional privacy options in StakeSource.
- **Suitability of project**. As demonstrated in the evaluation of StakeSource, project context determines the successful application of the tool. For example, the methods and tools are suitable in software projects where stakeholders share the benefit of involving other stakeholders, but unsuitable in projects where stakeholders compete for exclusive involvement in the project, as the stakeholders are likely not to recommend other stakeholders to secure exclusivity. Also, in projects where stakeholders are unclear about their requirements, focus groups, and workshops may be more suitable to help stakeholders to articulate and discover requirements. Hence, the requirements engineer should ascertain in advance whether their project is suitable before using the tool.
- **Simplified Prioritisation of Stakeholders**. StakeNet prioritises stakeholders based on their overall influence in the project over the duration of the project. For more realistic prioritisation, StakeNet should be extended to address the following factors.
    - A stakeholder’s influence in a project may change over time. For example, the maintenance team may have little or no influence at the start of the project but high influence at the end.
    - A stakeholder’s role in a project may change over time.
    - The discovery of new stakeholders may uncover new requirements and change the project scope, which in turn changes the stakeholders of the project.
    - Stakeholders have different influence across different issues, such as funding, development, and usage.

  - Organisational change and staff turnover may alter the stakeholders, their roles, and influence in the project.
  - A stakeholder's influence is multi-dimensional. For example, according to the stakeholder salience model (Mitchell et al., 1997) discussed in Chapter 2 (Section 2.1, page 33), three attributes constitute a stakeholder's salience: the power to influence the project, and the legitimacy and urgency of their claims.
- **Simplified prioritisation of requirements**. StakeRare uses the stakeholders' priority produced by StakeNet to prioritise requirements, which means that the prioritisation is also simplified based on stakeholders' overall influence in the project. For more realistic prioritisation, StakeRare should be extended to address the following factors.
  - Requirements and their importance in the project change over time.
  - The knowledge about the implementation cost of each requirement may influence the stakeholders' rating on the requirement.
  - The dependencies among requirements may influence the prioritisation. For example, if an essential requirement depends on a trivial requirement to be realised, then the trivial requirement deserves high priority.
  - The propagation of ratings from higher-level requirements to lower-level unrated requirements may skew the prioritisation. For example, if A is a higher-level requirement and B and C are lower-level ones, but B and C are in conflict with each other and therefore represent options for satisfying A, then the propagation of ratings from A to B and C may skew their priority.
- **Tool support for StakeRare**. StakeSource successfully reduces the bottlenecks in the StakeNet method. As StakeNet is part of StakeRare, StakeSource also removes bottlenecks for StakeRare. The remaining bottlenecks specific to StakeRare, such as rating collection, data cleaning for requirements, and collaborative filtering computations, should be addressed in future work.

Apply Method to Project

Single Project

The main threat to validity in the work described in Chapters 5 and 6 is the use of one project to evaluate StakeNet and StakeRare. As such, there must be some caution in generalising the results to other projects and organisations. For example, in projects to build competitive products, creative techniques involving face-to-face elicitation, such as the requirements invention technique (Maiden et al., 2005), may be more suitable. Future work should evaluate StakeNet and StakeRare using different projects in different organisations.

This threat is reduced in the evaluation of StakeSource as the tool which automates the StakeNet method was evaluated using two other projects and continues to be used for further new projects. Future work should extend the evaluation of StakeSource to different projects and organisations.

Post-project Knowledge

The StakeNet and StakeRare surveys were conducted after the RALIC project was completed, hence post-project knowledge may influence the results. This threat is removed in the evaluation of StakeSource as the tool was evaluated at the start of the projects.

Due to the threat, the respondents in the StakeNet survey may learn about the missing stakeholders during the project and recommend based on the knowledge. The work mitigates the threat by selecting a project that was completed four years ago, so that the stakeholders were less likely to recommend from memory or daily conversations. In the StakeRare survey, respondents were asked to articulate requirements for the existing system by imagining the situation before the RALIC project. Nevertheless, it is difficult for the respondents to do so without bias, as they had already been using the system and may not be aware of the difficulties before the RALIC system was implemented. Also, the stakeholders may be motivated to demonstrate better requirements recall. More importantly, the respondents from both surveys may be aware of the stakeholders and requirements due to their involvement in the project, and their knowledge may skew the evaluation results for StakeNet and StakeRare. In addition, the comparison of StakeNet and StakeRare with the existing methods used in the project could be regarded as unfair because the existing methods are used at the start of the project, when the stakeholders have no prior knowledge about the stakeholders and requirements.

However, analysis shows that the effect of this threat on the evaluation results was low. Due to staff turnover and department restructuring, only 15% of the respondents were involved in decision-making, stakeholder analysis, and requirements elicitation during the project, hence their influence on the overall prioritisation of stakeholder roles and requirements is low. The stakeholder roles provided by these respondents have a recall of 60%, which was approximately 30% lower than the recall of the stakeholder roles returned by StakeNet. These respondents overlooked some important stakeholder roles, such as the external library users. The requirements provided by these respondents have a recall of 39%, which was approximately 50% lower than the recall of the requirements returned by StakeRare. As these respondents were mainly decision-makers, their requirements missed out process related requirements such as "faster card issue." In the StakeRare list, these requirements were identified by stakeholders who were involved in the process themselves.

Misunderstanding Questionnaire

Misunderstandings during the survey can affect recommendations and the results.

In the StakeNet survey, some respondents had a different understanding of stakeholders due to multiple existing definitions (Sharp et al., 1999), and some found the concepts of salience and role difficult to grasp. In describing their own roles, respondents who were not actively involved in the project put their job titles rather than their role in the project. Feedback from respondents revealed that the types of stakeholders provided as prompts may be incomplete and should have included the categories such as those who manages the development of the system, provides input to the system, and maintains the system.

In the StakeRare survey, there was a general confusion about the term "actively do not want." Instead of providing a feature they do not want (e.g., "to combine ID card with bank card"), stakeholders provided features they want with a negative word in the description (e.g., "card not easily copied").

As StakeNet and StakeRare's surveys were conducted face-to-face, misunderstandings were mitigated by clarifications by this researcher. While using StakeSource, stakeholders can request clarification, which will be sent to the requirements engineers. This feature was used by stakeholders in both the Admissions System project and the Healthy Cities project.

Evaluate Method

Ground Truth

One may claim that the ground truth is biased in the perspective of this researcher, thus affecting the results of the study. Nevertheless, it is argued that the ground truth is representative of the actual stakeholders and requirements in the project because the global perspective of the project was acquired from reviewing project documentation, observing the stakeholders' engagement with the project, and interviewing them.

To increase the confidence that the ground truth is objective and accurate, the ground truth was validated by management-level stakeholders and stakeholders who were involved in a major part of the project. These stakeholders were provided with the ground truth and asked for feedback. Disagreements with the ground truth needed justifications, and were corroborated with the feedback from the other stakeholders, before the ground truth was amended. In Chapter 4, Section 4.3 (page 93) has described the validation for the ground truth of stakeholders, and Section 4.4 (page 103) has described the validation for the ground truth of requirements.

Future evaluations should consider alternative techniques to construct the ground truth and clean the data in order to increase their objectiveness, such as involving more than one researcher or crowdsourcing.

Data Cleaning

The responses provided by respondents during the StakeNet and StakeRare survey were cleaned by this researcher. In StakeNet, synonymous stakeholder roles were merged (e.g., research students and PhD students), and different names referring to the same person were merged (e.g., Nicholas is sometimes recommended as Nic or Nick). In StakeRare, additional requirements provided by the stakeholders were classified into their respective project objectives, synonymous requirements were merged, and statements containing more than one requirement were split. Manual merging of stakeholders roles may be subjective. For example, one may consider research students and PhD students to be different roles. Similarly, manual merging of requirements and classification of requirements into their respective project objectives may also be subjective.

Future work should investigate methods to mitigate subjective data cleaning, for example, crowdsource the stakeholders to clean the data, enable the stakeholders to comment on the requirements engineers' data cleaning, or use natural language processing to identify similar requirements (Zachos et al., 2007).

The data cleaning on the RankP dataset has the highest risk of being subjective among all the datasets in this work. StakeRare uses the RateP dataset where an initial list of requirements is provided. RankP was a dataset used solely to evaluate StakeRare. In RankP, there were no initial requirements; stakeholders provided their own requirements, which are then cleaned by this researcher by manually classifying the requirements into their respective project objectives. To determine the objectiveness of the classification, a group of 16 Master of Science students from the UCL Department of Computer Science were requested to classify the raw text provided by the respondents into the relevant project objectives. The students' classifications are then compared to the classification by this researcher.

The students were enrolled in the Systems Requirements Engineering course[119] during the time of this study. The permission to conduct this study was requested from the lecturer in charge, Dr. Emmanuel Letier. The students were familiar with StakeNet, having read the StakeNet paper (Lim et al., 2010). Their familiarity with the RALIC project comes from the brief description of the project in the StakeNet paper (Figure 8-2), and the use of their own

[119] http://www.cs.ucl.ac.uk/teaching/syllabus/mscsse/gs01.htm

access cards. Each student was given 25 or 26 requirements[120] to classify into the project objectives, referred to as categories in the survey (Figure 8-3(a)). The requirements are raw text as provided by the stakeholders (Figure 8-3(b)).

The classification survey revealed that the classification in the work appears to be valid, but dependent on project knowledge and interaction with the stakeholders. The student's classification shows agreement with the classification in this work, with a 68% match. The discrepancy was partly due to the students' lack of project knowledge about RALIC. The students found the classification easy but felt that they required more knowledge about RALIC to be certain about some classifications. For example, the students classified "cashless vending" under "all in one card," although the requirement was under the project objective "extensible future features." Some requirements can belong to more than one category. Most of the requirements were clear and easy to understand, for example those in Figure 8-3(b). Nevertheless, some can be ambiguous. For example, a stakeholder provided the requirement "student discount," which the student could not understand or classify. The requirement was clarified with the stakeholder during the survey: the stakeholder wanted the student card to be combined with the Oyster Card[121] (top up travel card for transport in London), so that students can get discounts when travelling.

2. THE RALIC PROJECT

The RALIC project was initiated to replace the existing access control systems at UCL and consolidate the new system with library access and borrowing, hence the name RALIC: *R*eplacement *A*ccess, *L*ibrary and *ID* *C*ard. RALIC was a combination of development and customisation of an off-the-shelf system. The project duration was 2.5 years and the system is now in deployment.

We select RALIC as our case study for two reasons. First, we have access to the stakeholders and project documentation as the system is developed, deployed, and maintained at UCL. Second, RALIC has a large and complex stakeholder base with more than 60 stakeholder groups, which is substantially larger than existing empirical studies in the area. Approximately 30,000 students, staff, and visitors use the system to enter buildings, borrow library resources, use the fitness centre, and gain IT access. Besides all UCL faculties and academic departments, RALIC also involves other supporting departments such as the Estates and Facilities Division that manages UCL's physical estate, Human Resource Division that manages staff information, Information Services Division, Library Services, Security Services, and so on, which must be identified and prioritised.

Figure 8-2: RALIC description (Lim et al., 2010).

[120] This is to distribute the number of requirements evenly across 16 students.

[121] http://www.tfl.gov.uk/

(a)

Please complete the following information about yourself.

Name: [redacted] [redacted]

Instructions

The stakeholders of the RALIC project have provided a list of requirements.

Please match the requirements to their corresponding categories.

Below is the list of categories.

A. **One card**: Multiple functions in a card, e.g., ID, access control, library borrowing
B. **Card design**: A UCL branded ID card
C. **Security**: Increase security and access control to buildings
D. **Process**: Produce, issue, and monitor cards efficiently
E. **Library**: Provide and suspend library access and borrowing rights automatically
F. **Cost**: Save costs
G. **Other systems**: Integrate with other systems, e.g., student, staff/HR, visitor
H. **Data**: Improve quality, availability, and accuracy of card holder data
I. **Future**: Allow future functionality, e.g., time and attendance, cashless vending
J. **Development and support**: Constraints, standards, and technology
K. **Others** (please explain why or suggest new categories)

(b)

ID	Requirement	Category
1	To utilise recording to monitor attendance at teaching and assessment events	~~Data (H)~~, card design (B) future (1)
2	To identify the student when required.	one card (A)
3	To use for "purchasing" in terms of transcripts, payment of ceremony tickets etc.	Future (1), one card (A)
4	To deliver the cards in an easy way to avoid student queuing/delays	other system (G)
5	To produce a cheap but secure option	Cost (F)
6	To enable suitable entry to students who require partial access e.g. exam resit students.	One card (A)
7	To place card access on all buildings.	Security (C)
8	To take into account disability issues/users	One card (A)
9	RALIC data is backed up and can be restored if a disaster - recovery situation arises.	Data (H)
10	RALIC services are resilient. The RALIC servers in W[redacted] must have counterparts in F[redacted] so that RALIC continues to work during a power failure.	Data (H)
11	Only security staff and a limited number of IS staff have access to the RALIC servers, i.e., the servers that control buildings access.	Security (C)
12	RALIC data must be made available to other systems, naturally HR (Resource-Link), Registry (SITS), Library (Aleph).	Other systems (G)
13	Access and data information for users of facilities, specifically Bloomsbury Fitness	One card (A)

Figure 8-3: Student survey questionnaire[122].

Empirical Evaluation

The empirical evaluation uses standard and simple measures in the information retrieval literature, such as precision, recall, and Pearson's correlation coefficient between the ranks. Nevertheless, according to the literature (e.g., (Herlocker et al., 2004)), more sophisticated

[122] The complete questionnaire is available in Appendix H.

measures can better evaluate the effectiveness of StakeNet and StakeRare. For example, using Pearson's correlation coefficient between the ranks, disagreements in the high priority stakeholders are penalised equally as disagreements in low priority stakeholders. However, in practice, a mistake in prioritising highly influential stakeholders may turn out to be more costly than a mistake in prioritising trivial stakeholders. As such, more sophisticated measures such as normalised discounted cumulative gain (NDCG) (Järvelin and Kekäläinen, 2002), which takes into account a stakeholder's position could provide more accurate evaluation of the accuracy of StakeNet in prioritising stakeholders.

Further empirical studies on stakeholders and requirements are called for. Other measurements in the information retrieval literature should be used to further evaluate the methods, such as normalised discounted cumulative gain (NDGC) (Järvelin and Kekäläinen, 2002), precision and recall graph (Müller et al., 2001), and receiver operating characteristic (ROC) curve (Fawcett, 2006). The methods should also be evaluated based on the characteristics of a good recommender system (Schafer et al., 2007), such as their ability to diversify and provide an element of surprise.

8.3 Future Work

Short Term

In addition to the future work outlined in the previous section which would mitigate the threats to validity, this section describes extensions of the work in the future.

The application of StakeSource on real projects highlighted requirements that should be incorporated in the tool to improve its support for effective requirements elicitation. These additions to StakeSource should be addressed in the immediate future and trialled on real software projects.

- **Email templates**. Although email is important, many people may not know how to draft an attractive email. Hence, more templates and examples should be provided as a guide. Future work should also explore the use of wizards to guide template creation.
- **Advanced filtering**. It will be useful for the tool to have more advanced filtering so that additional columns can be added to the list of stakeholders to categorise them. The categorisation can then be used to filter the emails sent to stakeholders. For example, in the Admissions System project, stakeholders external to UCL should have different access rights to project and stakeholder information.

- **Preview**. In the project set up, a preview should be provided to the requirements engineers while they are entering the project description. The preview enables the requirements engineers to see how the information is accessed by the stakeholders, hence helping them provide descriptions which stakeholders can understand.
- **Data import**. StakeSource should enable mass import of recommendations from other sources such as Excel[123]. In the Admissions System project, a stakeholder had an Excel sheet of about 250 existing system users which are stakeholders of the new system, but did not make the recommendations as it would be too time consuming to enter them all individually. Without an importing feature in StakeSource, the list was sent to the project manager instead.
- **Technical terms**. The stakeholder prioritisation feature of StakeSource uses the technical terms for the social network measures, such as in-degree centrality and out-degree centrality. Future work involves translating the technical terms for the social network measures to correspond to specific end-user goals. For example, out-degree centrality can be renamed as “top recommender” as it prioritises stakeholders who make the most recommendations, and in-degree centrality as “top recommendee” as it prioritises stakeholders who receive the most recommendations.
- **Data export and reporting**. In both projects, the project managers requested an Excel export of the stakeholders. To produce reports, the Admissions System project required the list of stakeholder names, emails, roles, and scope items to be exported as an Excel sheet. The project also required a printout of the stakeholder network.
- **Flexible recommendations**. In the Admissions System project, the communications manager required information about a stakeholders’ department. Future implementation of the recommendation form should be flexible to include additional fields that are specific to the project.
- **Connect to personnel directory**. To make it easier for people to make recommendations, and to provide more information about the stakeholders, StakeSource should be connected to the personnel directory of the organisation.
- **Network visualisation**. Future work should provide advanced network visualisation so that complicated stakeholder networks with a large number of stakeholders and recommendations can be analysed.

---

[123] http://office.microsoft.com/en-us/excel/

- **Support in requirements elicitation**. StakeSource should be extended to support the StakeRare method in requirements elicitation, such as collecting requirements and ratings from stakeholders, using collaborative filtering to recommend requirements to stakeholders, prioritising requirements, producing reports, and visualising the relationships between stakeholders and their requirements.
- **Dashboard**. StakeSource should provide the requirements engineers with useful statistics such as the number of stakeholders who have responded, the number of stakeholders who have unsubscribed, the number of requirements or recommendations provided by each stakeholder, and the number of recommendations over time. These statistics should be easily accessible in a customisable dashboard. The requirements engineer should also be able to play back the network to observe the growth of the network over time.

Long Term

This work has opened up opportunities to explore the following long-term research.

- **Ultra-large-scale software projects**. The methods and tool proposed in this work support requirements elicitation for large-scale software projects with more than 50 stakeholder groups and 10,000 stakeholders. But there is an increasing number of ultra-large-scale software projects with hundreds of thousands of stakeholders (Cleland-Huang and Mobasher, 2008). Future work could further develop and evaluate the methods and tool in this work so that they can provide effective support for stakeholder analysis and requirements elicitation in ultra-large-scale software projects. For example, in such projects, prioritising stakeholders by their roles may no longer be effective, as there may be hundreds of thousands of roles in these projects. Therefore, more sophisticated prioritisation methods are required, for example by clustering the stakeholders based on their similarity.
- **Global software engineering**. An increasing number of software projects are run in geographically distributed environments (Damian and Moitra, 2006). Time difference and geographical distance make it difficult to conduct face-to-face interviews and focus groups with the stakeholders (Damian and Zowghi, 2003). As StakeSource collects recommendations and requirements online without requiring the stakeholders and the requirements engineers to be present at the same time, it can provide effective support for requirements elicitation in global software projects. In such projects, the stakeholder network may be highly disconnected, and more information about each stakeholder may be required (e.g., the stakeholder’s location and organisation). As such, the methods and

tools proposed in this work should be extended to effectively support requirements elicitation in global projects. In addition, further analysis could be performed on the stakeholder network to study the collaboration between stakeholders, for example, by integrating with existing tools and methods in requirements-driven collaboration (Damian et al., 2010).

- **Collecting recommendations and ratings using portable data entry systems**. During the StakeNet and StakeRare surveys, stakeholders expressed interest in making recommendations and providing requirements via mobile devices, so that they can provide input at their convenience, for example, while they are commuting to work. In addition, the existing research on mobile elicitation tools has shown that stakeholders can effectively document their needs in situ using mobile devices (Seyff et al., 2010). Future work should investigate the collection of recommendations and ratings from stakeholders using mobile devices, for example, by integrating StakeSource with existing mobile elicitation tools such as iRequire (Seyff et al., 2010) or iRequirements[124].
- **Improve the accuracy of prioritising stakeholders and predicting requirements**. In the StakeNet evaluation, it was demonstrated that combining the different social network measures can improve the accuracy of prioritising stakeholder roles. In the StakeRare evaluation, it was demonstrated that combining different collaborative filtering algorithms can improve the accuracy of predicting stakeholder needs. Future work should extend the initial studies by using machine learning techniques, such as genetic algorithms (Goldberg, 1989), to develop more sophisticated methods that prioritise stakeholders and requirements more accurately. In addition, anomaly detection should be explored to detect malicious stakeholders. Anomaly detection systems (such as artificial immune systems (Kim et al., 2007)) are unsupervised machine learning methods that learn patterns of normal behaviour and identify abnormal behaviour which deviates from the norm. Finally, in StakeRare, stakeholders can rate requirements they actively do not want with an X. Future work should investigate the use of these negative ratings to unearth additional conflicts early in the project.
- **Predicting requirements change**. Requirements change is one of the top causes of project failure (The Standish Group, 1994) but requirements change management is under-researched (Van Lamsweerde, 2009). This work has developed a method to separate requirements into layers that change at different rates (Chapter 4 Section 4.2). Among the layers, business policies and business rules tend to be more volatile than

[124] http://itunes.apple.com/au/app/irequirements/id371939702?mt=8#

non-functional constraints, which are more volatile than functional constraints, which are more volatile than patterns. Future work should develop a predictive model to accurately anticipate the requirements that will change, so that the system can be designed to loosely couple these requirements with the rest of the system. The data collected in this work can be used for the initial training and testing of the predictive model. This data includes the requirements and their priority, the stakeholders' rating on the requirements, the stakeholders' influence in the project, their recommendations, stakeholders with conflicting requirements, and the requirements that are in conflict.

Together, these ideas comprise a research agenda for developing a web 2.0 stakeholder relationship management system that involves all stakeholders to accurately identify and prioritise stakeholders, and understand their needs. The system supports decision-making by identifying similar and dissimilar stakeholders, highlighting conflicting needs, recommending requirements to stakeholders, and predicting requirements change. The stakeholder relationship management system can also be used in projects outside software engineering, such as environmental and construction projects.

8.4 Thesis Summary

In large software projects, requirements elicitation tends to be beset by three problems: information overload, inadequate stakeholder input, and biased prioritisation of requirements. This work is one of the first in the field of requirements engineering to address these problems.

The main contribution of the work is the development of the StakeNet and StakeRare methods and the StakeSource tool, which support requirements elicitation in large software projects. The methods and tool are one of the first applications of social networks and collaborative filtering to identify and prioritise stakeholders and their requirements.

A second important contribution of the work is the extensive empirical evaluation of the methods using a real large-scale software project. This work pioneered three significant forms of evaluation: the comparison with existing elicitation methods used in the project, the comparison with the ground truth built from post-project knowledge, and the use of standard statistical measures from the information retrieval literature. This substantial empirical study using real data is one of the first in requirements elicitation research. Approximately 200 face-to-face interviews were conducted with the project stakeholders, and more than 1000 pages of project documentation were reviewed.

Another major contribution of the work is the evaluation of the StakeSource tool using real projects. Based on the positive outcome of the evaluation, StakeSource is now used in major software development projects in University College London, and other organisations are also adopting the tool. The work illustrates that it is essential for requirements elicitation research to be evaluated by practitioners in real projects and that this form of evaluation can provide more confidence for industry, providing a clear route to exploitation of the methods and tool beyond academic research.

This thesis has demonstrated that social networks and collaborative filtering provide effective support for requirements elicitation in large-scale software projects. In a broader context, this thesis proposes a new methodology in requirements elicitation that shifts the emphasis from requirements elicitation by the requirements engineers to a collaborative approach in which all stakeholders have a say. Doing so reduces the requirements engineers' workload and the likelihood of omitting stakeholders and their requirements. This methodology for supporting requirements elicitation is one of the first scalable solutions for future large projects.

StakeNet, StakeRare, and StakeSource advance the field of requirements elicitation in large-scale software projects. Using methods such as these, it is hoped that one day projects will no longer fail from information overload, inadequate stakeholder input, and biased prioritisation of requirements.

References

AHL, V. (2005) *An Experimental Comparison of Five Prioritization Methods*, Masters thesis, School of Engineering, Blekinge Institute of Technology, Ronneby, Sweden.

AKAO, Y. (2004) *Quality Function Deployment: Integrating Customer Requirements into Product Design*. New York. Productivity Press.

ALAG, S. (2008) *Collective Intelligence in Action*. Greenwich. Manning Publications.

ALBRECHT, A. J. (1979) Measuring application development productivity, in *Proceedings of the Joint SHARE, GUIDE, and IBM Application Development Symposium*, Monterey, California, pp. 83–92.

ALBRECHT, A. J. & GAFFNEY JR, J. E. (1983) Software function, source lines of code, and development effort prediction: a software science validation. *IEEE Transactions on Software Engineering,* SE-9(6)**,** 639-648.

ALEXANDER, I. (2005) A taxonomy of stakeholders: human roles in system development. *International Journal of Technology and Human Interaction,* 1(1)**,** 23-59.

ALEXANDER, I. & ROBERTSON, S. (2004) Understanding project sociology by modeling stakeholders. *IEEE Software,* 21(1)**,** 23-27.

ANDERSON, C. (2008) *The Long Tail: Why the Future of Business is Selling Less of More*. Hyperion Books.

ANDRIOLE, S. J. (1989) *Storyboard Prototyping: A New Approach to User Requirements Analysis*. Wellesley, MA. QED Information Sciences, Inc.

ANTON, A. I. (1996) Goal-based requirements analysis, in *Proceedings of the 2nd IEEE International Conference on Requirements Engineering*, pp. 136-144.

AOYAMA, M. (2005) Persona-and-scenario based requirements engineering for software embedded in digital consumer products, in *Proceedings of the 13th IEEE International Conference on Requirements Engineering*, pp. 85-94.

ARLOW, J. & NEUSTADT, I. (2003) *Enterprise Patterns and MDA: Building Better Software with Archetype Patterns and UML*. Redwood City, CA. Addison Wesley Longman Publishing Co., Inc.

AXELSSON, B. & EASTON, G. (1992) *Industrial Networks: A New View of Reality*. London. Routledge.

AZAR, J., SMITH, R. K. & CORDES, D. (2007) Value-oriented requirements prioritization in a small development organization. *IEEE Software,* 24(1)**,** 32-37.

BABBIE, E. R. (1973) *Survey Research Methods*. CA. Wadsworth Belmont.

BARABÁSI, A. L. & ALBERT, R. (1999) Emergence of scaling in random networks. *Science,* 286(5439)**,** 509.

BECK, K. & ANDRES, C. (2004) *Extreme programming explained: embrace change*. Addison-Wesley Professional.

BELL, R. M. & KOREN, Y. (2007) Scalable collaborative filtering with jointly derived neighborhood interpolation weights, in *Proceedings of the 7th IEEE International Conference on Data Mining*, pp. 43-52.

BENTLEY, C. (2002) *PRINCE2: A Practical Handbook*. 2nd ed. Butterworth-Heinemann.

BERANDER, P. & JONSSON, P. (2006) Hierarchical cumulative voting (HCV) - prioritization of requirements in hierarchies. *International Journal of Software Engineering and Knowledge Engineering,* 16(6)**,** 819-849.

BERENBACH, B., PAULISH, D. J., KAZMEIER, J., DANIEL, P. & RUDORFER, A. (2009) *Software Systems Requirements Engineering: In Practice*. McGraw-Hill Osborne Media.

BOEHM, B. W. & DEMARCO, T. (1997) Guest editors' introduction: software risk management. *IEEE Software,* 14(3)**,** 17-19.

BOEHM, B. W. & ROSS, R. (1989) Theory-W software project management principles and examples. *IEEE Transactions on Software Engineering,* 15(7)**,** 902-916.

BRAGA-NETO, U. M. & DOUGHERTY, E. R. (2004) Is cross-validation valid for small-sample microarray classification? *Bioinformatics,* 20(3)**,** 374-380.

BRAND, S. (1995) *How Buildings Learn: What Happens After They're Built*. Penguin Books.

BRANDES, U. (2001) A faster algorithm for betweenness centrality. *Journal of Mathematical Sociology,* 25(2)**,** 163-177.

BRANDES, U. (2008) On variants of shortest-path betweenness centrality and their generic computation. *Social Networks,* 30(2)**,** 136-145.

BRIN, S. & PAGE, L. (1998) The anatomy of a large-scale hypertextual Web search engine. *Computer Networks and ISDN Systems,* 30(1-7)**,** 107-117.

BROOKS JR, F. P. (1995) *The Mythical Man-Month*. Anniversary ed. Boston, MA. Addison-Wesley Longman Publishing Co., Inc.

BRUSEBERG, A. & MCDONAGH-PHILP, D. (2001) New product development by eliciting user experience and aspirations. *International Journal of Human Computer Studies,* 55(4)**,** 435-452.

BURSTIN, M. & BEN-BASSAT, M. (1984) A user's approach to requirements analysis of a large software system, in *Proceedings of the 1984 Annual Conference of the ACM on the Fifth Generation Challenge*, pp. 133-145.

CARBONE, T. A. & TIPPETT, D. D. (2004) Project risk management using the project risk FMEA. *Engineering Management Journal,* 16(4)**,** 28-35.

CASTRO-HERRERA, C., CLELAND-HUANG, J. & MOBASHER, B. (2009a) Enhancing stakeholder profiles to improve recommendations in online requirements elicitation, in

Proceedings of the 17th IEEE International Conference on Requirements Engineering, pp. 37-46.

CASTRO-HERRERA, C., DUAN, C., CLELAND-HUANG, J. & MOBASHER, B. (2009b) A recommender system for requirements elicitation in large-scale software projects, in *Proceedings of the 2009 ACM Symposium on Applied Computing*, pp. 1419-1426.

CHARETTE, R. N. (2005) Why software fails. *IEEE Spectrum,* 42(9)**,** 36.

CHENG, B. H. C. & ATLEE, J. M. (2007) Research directions in requirements engineering, in *Proceedings of the Conference on The Future of Software Engineering*, pp. 285-303.

CHUNG, L., NIXON, B. A., YU, E. & MYLOPOULOS, J. (2000) *Non-functional Requirements in Software Engineering*. Boston. Kluwer Academic Publishers.

CLELAND-HUANG, J. & MOBASHER, B. (2008) Using data mining and recommender systems to scale up the requirements process, in *Proceedings of the 2nd International Workshop on Ultra-Large-Scale Software-Intensive Systems*, pp. 3-6.

COCKBURN, A. (2000) *Writing Effective Use Cases*. Addison-Wesley Professional.

CROSS, M. (2005) Special report: public sector IT failures. PROSPECT. pp. 48-52.

DAMIAN, D., KWAN, I. & MARCZAK, S. (2010) Requirements-driven collaboration: Leveraging the invisible relationships between requirements and people. *Collaborative Software Engineering.* Berlin Heidelberg. Springer.

DAMIAN, D., MARCZAK, S. & KWAN, I. (2007) Collaboration patterns and the impact of distance on awareness in requirements-centred social networks, in *Proceedings of the 15th IEEE International Conference on Requirements Engineering*, pp. 59-68.

DAMIAN, D. & MOITRA, D. (2006) Guest editors' introduction: global software development: how far have we come? *IEEE Software,* 23(5)**,** 17-19.

DAMIAN, D. & ZOWGHI, D. (2003) Requirements engineering challenges in multi-site software development organizations. *Requirements Engineering,* 8(3)**,** 149-160.

DARDENNE, A., LAMSWEERDE, A. V. & FICKAS, S. (1993) Goal-directed requirements acquisition. *Science of Computer Programming,* 20(1-2)**,** 3-50.

DARIMONT, R. & VAN LAMSWEERDE, A. (1996) Formal refinement patterns for goal-driven requirements elaboration. *ACM SIGSOFT Software Engineering Notes,* 21(6)**,** 179-190.

DAVIS, A., DIESTE, O., HICKEY, A., JURISTO, N. & MORENO, A. M. (2006) Effectiveness of requirements elicitation techniques: Empirical results derived from a systematic review, in *Proceedings of the 14th IEEE International Conference on Requirements Engineering*, pp. 179-188.

DAVIS, A. M. (1992) Operational prototyping: a new development approach. *IEEE Software,* 9(5)**,** 70-78.

DAVIS, A. M. (1993) *Software Requirements: Objects, Functions, and States*. Upper Saddle River, NJ. Prentice-Hall, Inc.

DAVIS, A. M. (2003) The art of requirements triage. *Computer,* 36(3)**,** 42-49.

DECKER, B., RAS, E., RECH, J., JAUBERT, P. & RIETH, M. (2007) Wiki-based stakeholder participation in requirements engineering. *IEEE Software,* 24(2)**,** 28-35.

DUAN, C., LAURENT, P., CLELAND-HUANG, J. & KWIATKOWSKI, C. (2009) Towards automated requirements prioritization and triage. *Requirements Engineering,* 14(2)**,** 73-89.

EDEN, C. & ACKERMANN, F. (1998) *Making Strategy: The Journey of Strategic Management*. Sage.

EDEN, C. & HEIJDEN, V. D. (1993) The relationship between stakeholder analysis and scenario planning, in *Strategy Seminar, London School of Economics*, Strathclyde Business School.

ERICCSON, K. A. & SIMON, H. A. (1993) Protocol analysis: Verbal reports as data (Rev. ed.). *Cambridge, MA: Bradford.*

FAGAN, M. E. (1976) Design and code inspections to reduce errors in program development. *IBM Systems Journal,* 15(3)**,** 182-211.

FAWCETT, T. (2006) An introduction to ROC analysis. *Pattern Recognition Letters,* 27(8)**,** 861-874.

FEATHER, M. S., FICKAS, S., FINKELSTEIN, A. & VAN LAMSWEERDE, A. (1997) Requirements and specification exemplars. *Automated Software Engineering,* 4(4)**,** 419-438.

FINKELSTEIN, A. & DOWELL, J. (1996) A comedy of errors: the London Ambulance Service case study, in *Proceedings of the 8th International Workshop on Software Specification and Design*, pp. 2-4.

FISCHER, M. & GALL, H. (2004) Visualizing feature evolution of large-scale software based on problem and modification report data. *Journal of Software Maintenance and Evolution Research and Practice,* 16(6)**,** 385-403.

FLYVBJERG, B. (2006) Five misunderstandings about case-study research. *Qualitative Inquiry,* 12(2)**,** 219.

FOOTE, B. & YODER, J. (2000) Big ball of mud, in *Proceedings of the 4th Conference on Pattern Languages of Program Design*.

FREEMAN, R. E. (1984) *Strategic Management: A Stakeholder Approach*. Boston, MA. Pitman Publishing.

GALIN, D. (2004) *Software Quality Assurance: From Theory to Implementation*. Addison-Wesley.

GAUSE, D. C. & WEINBERG, G. M. (1989) *Exploring Requirements: Quality Before Design*. Dorset House Publishing Company, Inc.

GLINZ, M. & WIERINGA, R. J. (2007) Guest editors' introduction: stakeholders in requirements engineering. *IEEE Software,* 24(2)**,** 18-20.

GOH, K. I., KAHNG, B. & KIM, D. (2001) Universal behavior of load distribution in scale-free networks. *Physical Review Letters,* 87(278701).

GOLDBERG, D., NICHOLS, D., OKI, B. M. & TERRY, D. (1992) Using collaborative filtering to weave an information tapestry. *Communications of the ACM,* 35(12)**,** 61-70.

GOLDBERG, D. E. (1989) *Genetic Algorithms in Search, Optimization, and Machine Learning*. Reading, MA. Addison Wesley.

GOLDSTEIN, H. (2005) Who killed the virtual case file? *IEEE Spectrum,* 42(9)**,** 24-35.

GOODMAN, L. A. (1961) Snowball sampling. *The Annals of Mathematical Statistics,* 32(1)**,** 148-170.

GREENWOOD, D., KHAJEH-HOSSEINI, A. & SOMMERVILLE, I. (2010) Lessons from the failure and subsequent success of a complex healthcare sector IT project. *arXiv preprint arXiv:1003.3880*.

HALL, R. R. (2001) Prototyping for usability of new technology. *International Journal of Human-Computer Studies,* 55(4)**,** 485-501.

HANNEMAN, R. A. & RIDDLE, M. (2005) *Introduction to Social Network Methods*. Riverside, CA. University of California, Riverside.

HARKER, S. D. P., EASON, K. D. & DOBSON, J. E. (1993) The change and evolution of requirements as a challenge to the practice of software engineering, in *Proceedings of the IEEE International Symposium on Requirements Engineering*, pp. 266-272.

HEER, J. & BOYD, D. (2005) Vizster: Visualizing online social networks, in *Proceedings of the IEEE Symposium on Information Visualization (INFOVIS 2005)*, pp. 32-39.

HERLOCKER, J. L., KONSTAN, J. A., BORCHERS, A. & RIEDL, J. (1999) An algorithmic framework for performing collaborative filtering, in *Proceedings of the 22nd Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, pp. 230-237.

HERLOCKER, J. L., KONSTAN, J. A., TERVEEN, L. G. & RIEDL, J. T. (2004) Evaluating collaborative filtering recommender systems. *ACM Transactions on Information Systems,* 22(1)**,** 5-53.

HERRMANN, A. & DANEVA, M. (2008) Requirements prioritization based on benefit and cost prediction: an agenda for future research, in *Proceedings of the 16th IEEE International Conference on Requirements Engineering*, pp. 125-134.

HOLBROOK III, H. (1990) A scenario-based methodology for conducting requirements elicitation. *ACM SIGSOFT Software Engineering Notes,* 15(1)**,** 95-104.

HOOD, C., WIEDEMANN, S., FICHTINGER, S. & PAUTZ, U. (2007) *Requirements Management: The Interface Between Requirements Development and All Other Systems Engineering Processes*. New York. Springer-Verlag.

HOOKS, I. F. & FARRY, K. A. (2001) *Customer-Centered Products: Creating Successful Products Through Smart Requirements Management*. AMACOM/American Management Association.

HOWE, J. (2009) *Crowdsourcing: Why The Power of the Crowd is Driving the Future of Business*. CA. Three Rivers Press.

HOWLEY, T., MADDEN, M. G., O'CONNELL, M. L. & RYDER, A. G. (2006) The effect of principal component analysis on machine learning accuracy with high dimensional spectral data. *Knowledge Based Systems,* 19(5)**,** 209-222.

IEEE (1998) *IEEE Recommended Practice for Software Requirements Specifications.* IEEE Standards.

ISO (2001) *ISO/IEC 9126 Software Engineering - Product Quality Standard.* International Organisation for Standardisation.

JACOBSON, I. (1991) *Object-Oriented Software Engineering*. New York. ACM Press.

JÄRVELIN, K. & KEKÄLÄINEN, J. (2002) Cumulated gain-based evaluation of IR techniques. *ACM Transactions on Information Systems,* 20(4)**,** 422-446.

JEFFERY, D. R. & LAWRENCE, M. J. (1979) An inter-organisational comparison of programming productivity, in *Proceedings of the 4th International Conference on Software Engineering*, pp. 369-377.

JIN, R., CHAI, J. Y. & SI, L. (2004) An automatic weighting scheme for collaborative filtering, in *Proceedings of the 27th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, pp. 337-344.

JIROTKA, M. & GOGUEN, J. A. (1994) *Requirements Engineering: Social and Technical Issues*. San Diego, CA. Academic Press Professional, Inc.

JONES, C. (1995) Patterns of large software systems: failure and success. *Computer,* 28(3)**,** 86-87.

JONES, C. (1998) *Estimating Software Costs*. New York. McGraw-Hill.

JONES, C. (2008) *Applied Software Measurement: Global Analysis of Productivity and Quality*. 3rd ed*.* McGraw-Hill Osborne Media.

KARLSSON, J. (1996) Software requirements prioritizing, in *Proceedings of the 2nd International Conference on Requirements Engineering*, pp. 110-116.

KARLSSON, J. & RYAN, K. (1997) A cost-value approach for prioritizing requirements. *IEEE Software,* 14(5)**,** 67-74.

KARLSSON, J., WOHLIN, C. & REGNELL, B. (1998) An evaluation of methods for prioritizing software requirements. *Information and Software Technology,* 39(14-15)**,** 939-947.

KEENEY, R. L. & RAIFFA, H. (1993) *Decisions with Multiple Objectives: Preferences and Value Tradeoffs*. Cambridge University Press.

KEMERER, C. F. (1993) Reliability of function points measurement: a field experiment. *Communications of the ACM,* 36(2)**,** 85-97.

KIM, J., BENTLEY, P. J., AICKELIN, U., GREENSMITH, J., TEDESCO, G. & TWYCROSS, J. (2007) Immune system approaches to intrusion detection - a review. *Natural Computing,* 6(4)**,** 413-466.

KOHAVI, R. (1995) A study of cross-validation and bootstrap for accuracy estimation and model selection, in *Proceedings of the International joint Conference on Artificial Intelligence*, pp. 1137-1145.

KOTONYA, G. & SOMMERVILLE, I. (1998) *Requirements Engineering: Processes and Techniques*. John Wiley & Sons, Inc.

KRUCHTEN, P. (1995) Architectural blueprints - the "4+ 1" view model of software architecture. *IEEE Software,* 12(6)**,** 42-50.

KUNIAVSKY, M. (2003) *Observing the User Experience: A Practitioner's Guide to User Research*. Morgan Kaufmann.

LAFRANCE, M. (1987) The knowledge acquisition grid: a method for training knowledge engineers. *International Journal of Man-machine Studies,* 26(2)**,** 245-255.

LATHIA, N. (2008) Computing Recommendations with Collaborative Filtering. *Collaborative and Social Information Retrieval and Access: Techniques for Improved User Modeling.* Information Science Reference.

LAUESEN, S. (2002) *Software Requirements: Styles and Techniques*. Addison-Wesley Professional.

LAURENT, P., CLELAND-HUANG, J. & DUAN, C. (2007) Towards automated requirements triage, in *Proceedings of the 15th IEEE International Conference on Requirements Engineering*, pp. 131-140.

LEFFINGWELL, D. & WIDRIG, D. (1999) *Managing Software Requirements: A Unified Approach*. Boston, MA. Addison-Wesley Longman Publishing Co., Inc.

LEFFINGWELL, D. & WIDRIG, D. (2003) *Managing Software Requirements: A Use Case Approach*. Pearson Education.

LEHTOLA, L., KAUPPINEN, M. & KUJALA, S. (2004) Requirements prioritization challenges in practice. *Product Focused Software Process Improvement.* Berlin Heidelberg. Springer. pp. 497-508.

LETIER, E. & VAN LAMSWEERDE, A. (2002) Agent-based tactics for goal-oriented requirements elaboration, in *Proceedings of the 24th International Conference on Software Engineering*, pp. 83-93.

LICHTER, H., SCHNEIDER-HUFSCHMIDT, M. & ZULLIGHOVEN, H. (1993) Prototyping in industrial software projects-bridging the gap between theory and practice, in pp. 221-229.

LIM, S. L., QUERCIA, D. & FINKELSTEIN, A. (2010) StakeNet: using social networks to analyse the stakeholders of large-scale software projects, in *Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering-Volume 1*, pp. 295-304.

LINDEN, G., SMITH, B. & YORK, J. (2003) Amazon. com recommendations: Item-to-item collaborative filtering. *IEEE Internet Computing,* 7(1)**,** 76-80.

LINDLOF, T. R. & TAYLOR, B. C. (2002) *Qualitative Communication Research Methods*. Sage.

LIU, L. & YU, E. (2004) Designing information systems in social context: a goal and scenario modelling approach. *Information Systems,* 29(2)**,** 187-203.

LOPEZ-FERNANDEZ, L., ROBLES, G. & GONZALEZ-BARAHONA, J. M. (2004) Applying social network analysis to the information in CVS repositories, in *Proceedings of the International Workshop on Mining Software Repositories*, pp. 101-105.

LOW, G. C. & JEFFERY, D. R. (1990) Function points in the estimation and evaluation of the software process. *IEEE Transactions on Software Engineering***,** 64-71.

MACAULAY, L. (1996) *Requirements Engineering*. Berlin, Heidelberg, New York. Springer-Verlag.

MACKENZIE, D. (2004) *Mechanizing Proof: Computing, Risk, and Trust*. The MIT Press.

MAGUIRE, M. & BEVAN, N. (2002) User requirements analysis, in *Proceedings of IFIP 17th World Computer Congress*, Montreal, Canada, pp. 133-148.

MAIDEN, N., GIZIKIS, A. & ROBERTSON, S. (2005) Provoking creativity: Imagine what your requirements could be like. *Software, IEEE,* 21(5)**,** 68-75.

MAIDEN, N. A. M. (1998) CREWS-SAVRE: Scenarios for acquiring and validating requirements. *Automated Software Engineering,* 5(4)**,** 419-446.

MAIDEN, N. A. M. & RUGG, G. (1996) ACRE: selecting methods for requirements acquisition. *Software Engineering Journal,* 11(3)**,** 183-192.

MARCA, D. & HARANDI, M. (1987) Problem set for the fourth International Workshop on Software Specification and Design, in *Proceedings of the 4th International Workshop on Software Specification and Design*.

MCCONNELL, S. (1996) *Rapid Development: Taming Wild Software Schedules*. Redmond, WA. Microsoft Press.

MCCONNELL, S. (2004) *Code Complete*. Redmond, WA. Microsoft Press.

MCMANUS, J. & WOOD-HARPER, T. (2007) Understanding the sources of information systems project failure. *Management Services,* 51(3)**,** 38-43.

MEAD, N. R. (2006) Requirements Prioritization Introduction. Software Engineering Institute (web publication), Carnegie Mellon University.

MENEELY, A., WILLIAMS, L., SNIPES, W. & OSBORNE, J. (2008) Predicting failures with developer networks and social network analysis, in *Proceedings of the 16th ACM SIGSOFT International Symposium on Foundations of Software Engineering*, pp. 13-23.

MENS, T. & GALAL, G. (2002) 4th workshop on object-oriented architectural evolution. *Object-Oriented Technology.* Berlin Heidelberg. Springer. pp. 150-164.

MITCHELL, R. K., AGLE, B. R. & WOOD, D. J. (1997) Toward a theory of stakeholder identification and salience: defining the principle of who and what really counts. *Academy of Management Review,* 22(4)**,** 853-886.

MOCKUS, A. & HERBSLEB, J. D. (2002) Expertise browser: a quantitative approach to identifying expertise, in *Proceedings of the 24th IEEE International Conference on Software Engineering*, pp. 503 - 512.

MOISIADIS, F. (2000) Prioritising scenario evolution, in *Proceedings of the 4th IEEE International Conference on Requirements Engineering*, pp. 85-94.

MOISIADIS, F. (2002) The fundamentals of prioritising requirements, in *Proceedings of the System Engineering, Test and Evaluation Conference*, Sydney, Australia.

MÜLLER, H., MÜLLER, W., SQUIRE, D. M. G., MARCHAND-MAILLET, S. & PUN, T. (2001) Performance evaluation in content-based image retrieval: overview and proposals. *Pattern Recognition Letters,* 22(5)**,** 593-601.

MYERS, J. L. & WELL, A. (2003) *Research Design and Statistical Analysis*. Lawrence Erlbaum.

NAS, T. F. (1996) *Cost-benefit Analysis: Theory and Application*. Sage.

NAUR, P. & RANDELL, B. (Eds.) (1969) *Software Engineering: Report on a conference sponsored by the NATO SCIENCE COMMITTEE,* Garmisch, Germany. NATO.

NEWMAN, M. E. J. (2005) A measure of betweenness centrality based on random walks. *Social Networks,* 27(1)**,** 39-54.

NORTHROP, L., FEILER, P., GABRIEL, R. P., GOODENOUGH, J., LINGER, R., LONGSTAFF, T., KAZMAN, R., KLEIN, M., SCHMIDT, D. & SULLIVAN, K. (2006) *Ultra-Large-Scale Systems: The Software Challenge of the Future*. Software Engineering Institute.

NURMULIANI, N., ZOWGHI, D. & WILLIAMS, S. P. (2004) Using card sorting technique to classify requirements change, in *Proceedings of the 12th IEEE International Conference on Requirements Engineering*, pp. 240-248.

NUSEIBEH, B. & EASTERBROOK, S. (2000) Requirements engineering: a roadmap, in *Proceedings of the Conference on The Future of Software Engineering*, Limerick, Ireland, pp. 35 - 46.

O'NEILL, R. V. (1986) *A Hierarchical Concept of Ecosystems*. Princeton University Press.

OBJECT MANAGEMENT GROUP (2006) Business Motivation Model (BMM) Specification. Needham, Massachusetts, Technical Report dtc/06–08–03, Object Management Group.

OHIRA, M., OHSUGI, N., OHOKA, T. & MATSUMOTO, K. (2005) Accelerating cross-project knowledge collaboration using collaborative filtering and social networks. *ACM SIGSOFT Software Engineering Notes,* 30(4)**,** 5.

OLLE, T. (1982) Comparative review of information systems design methodologies - stage 1: taking stock, in *Information Systems Design Methodologies: A Comparative Review (Proceedings of the IFIP WG8.1 CRIS 1)*, pp. 1-14.

PAGE, L., BRIN, S., MOTWANI, R. & WINOGRAD, T. (1998) The pagerank citation ranking: Bringing order to the web.

PAPANTONIOU, B., NATHANAEL, D. & MARMARAS, N. (2003) Moving target: designing for evolving practice, in *Universal Access in HCI: Inclusive Design in the Information Society*, pp. 474-478.

PARK, J., PORT, D. & BOEHM, B. (1999) Supporting Distributed Collaborative Prioritization for Win-Win Requirements Capture and Negotiation, in *Proceedings of the*

International Third World Multiconference on Systemics, Cybernetics and Informatics-Volume 2, Orlando, FL, pp. 578-584.

PEARSON, K. (1901) On lines and planes of closest fit to systems of points in space. *Philosophical Magazine Series 6,* 2(11)**,** 559-572.

POTTS, C. (2001) Metaphors of intent, in *Proceedings of the 5th IEEE International Symposium on Requirements Engineering*, pp. 31-38.

POULOUDI, A. & WHITLEY, E. A. (1997) Stakeholder identification in inter-organizational systems: gaining insights for drug use management systems. *European Journal of Information Systems,* 6(1)**,** 1-14.

PREECE, J., ROGERS, Y., SHARP, H., BENYON, D., HOLLAND, S. & CAREY, T. (1994) *Human Computer Interaction*. Addison Wesley.

PRELL, C., HUBACEK, K. & REED, M. (2009) Stakeholder analysis and social network analysis in natural resource management. *Society & Natural Resources,* 22(6)**,** 501-518.

QUINLAN, J. R. (1986) Induction of decision trees. *Machine Learning,* 1(1)**,** 81-106.

RAKOS, J. J. (1990) *Software Project Management*. Prentice Hall.

REGNELL, B., HÖST, M., OCH DAG, J. N., BEREMARK, P. & HJELM, T. (2001) An industrial case study on distributed prioritisation in market-driven requirements engineering for packaged software. *Requirements Engineering,* 6(1)**,** 51-62.

RIFFENBURGH, R. H. (2005) *Statistics in Medicine*. 2nd ed. Academic Press.

ROBERTSON, S. & ROBERTSON, J. (2006) *Mastering the Requirements Process*. Addison-Wesley Professional.

RODGERS, J. L. & NICEWANDER, W. A. (1988) Thirteen ways to look at the correlation coefficient. *The American Statistician,* 42(1)**,** 59-66.

ROLLAND, C., SOUVEYET, C. & ACHOUR, C. B. (1998) Guiding goal modeling using scenarios. *IEEE Transactions on Software Engineering,* 24(12)**,** 1055-1071.

ROSS, R. G. (2003) *Principles of the Business Rule Approach*. Boston, MA. Addison-Wesley Longman Publishing Co., Inc.

ROY, B. (1996) *Multicriteria Methodology for Decision Aiding*. Springer-Verlag.

SAATY, T. L. (1980) *The Analytic Hierarchy Process*. New York. McGraw Hill.

SALTHE, S. N. (1993) *Development and Evolution: Complexity and Change in Biology*. The MIT Press.

SARMA, A., MACCHERONE, L., WAGSTROM, P. & HERBSLEB, J. (2009) Tesseract: interactive visual exploration of socio-technical relationships in software development, in *Proceedings of the 31st IEEE International Conference on Software Engineering*, pp. 23-33.

SARWAR, B., KARYPIS, G., KONSTAN, J. & REIDL, J. (2001) Item-based collaborative filtering recommendation algorithms, in *Proceedings of the 10th International Conference on World Wide Web*, pp. 285-295.

SAUER, C., GEMINO, A. & REICH, B. H. (2007) The impact of size and volatility on IT project performance. *Communications of the ACM,* 50(11)**,** 79-84.

SCHAFER, J., FRANKOWSKI, D., HERLOCKER, J. & SEN, S. (2007) Collaborative filtering recommender systems. *The Adaptive Web: Methods and Strategies of Web Personalization.* pp. 291-324.

SCOTT, J. (2000) *Social Network Analysis: A Handbook*. Sage.

SEGARAN, T. (2007) *Programming Collective Intelligence*. O'Reilly Media.

SEYFF, N., GRAF, F. & MAIDEN, N. (2010) End-user requirements blogging with iRequire, in *Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering-Volume 2*, pp. 285-288.

SHARP, H., GALAL, G. H. & FINKELSTEIN, A. (1999) Stakeholder identification in the requirements engineering process, in *Proceedings of the Database & Expert System Applications Workshop*, pp. 387–391.

SHAW, M. (1990) Prospects for an engineering discipline of software. *IEEE Software,* 7(6)**,** 15-24.

SIMMONDS, I. & ING, D. (2000) A Shearing Layers Approach to Information Systems Development. *IBM Research Report RC21694.*

SOMMERVILLE, I. (2004) *Software Engineering*. 7th ed. Harlow, UK. Addison-Wesley.

SOMMERVILLE, I. & SAWYER, P. (1997) *Requirements Engineering: A Good Practice Guide*. John Wiley & Sons, Inc.

STARK, G. E., OMAN, P., SKILLICORN, A. & AMEELE, A. (1999) An examination of the effects of requirements changes on software maintenance releases. *Journal of Software Maintenance,* 11(5)**,** 293-310.

SUROWIECKI, J. (2004) *The Wisdom of Crowds: Why the Many are Smarter than the Few and How Collective Wisdom Shapes Business, Economies, Societies, and Nations*. Doubleday Books.

THE STANDISH GROUP (1994) The CHAOS Report. *The Standish Group Report.*

THE STANDISH GROUP (2009) CHAOS Summary 2009. *The Standish Group Report.*

TRIOLA, M. F. (1992) *Elementary Statistics*. Addison Wesley.

UTTS, J. M. & HECKARD, R. F. (2005) *Statistical Ideas and Methods*. Duxbury Press.

VAN LAMSWEERDE, A. (2001) Goal-oriented requirements engineering: a guided tour, in *Proceedings of the 5th IEEE International Symposium on Requirements Engineering*, pp. 249-262.

VAN LAMSWEERDE, A. (2009) *Requirements Engineering: From System Goals to UML Models to Software Specifications*. John Wiley & Sons, Inc.

VAN LAMSWEERDE, A., DARIMONT, R. & MASSONET, P. (1995) Goal-directed elaboration of requirements for a meeting scheduler: problems and lessons learnt, in

Proceedings of the 2nd IEEE International Symposium on Requirements Engineering, pp. 194-203

VAN RIJSBERGEN, K. (1979) *Information Retrieval*. London. Butterworths.

WANG, J., DE VRIES, A. P. & REINDERS, M. J. T. (2006) Unifying user-based and item-based collaborative filtering approaches by similarity fusion, in *Proceedings of the 29th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, pp. 501-508.

WASSERMAN, S. & FAUST, K. (1994) *Social Network Analysis: Methods and Applications*. Cambridge University Press.

WIEGERS, K. (1999) First things first: prioritizing requirements. *Software Development,* 7(9)**,** 48–53.

WITTEN, I. H. & FRANK, E. (2005) *Data Mining: Practical Machine Learning Tools and Techniques*. Morgan Kaufmann Publishers, Inc.

WOLF, T., SCHROTER, A., DAMIAN, D. & NGUYEN, T. (2009) Predicting build failures using social network analysis on developer communication, in *Proceedings of the 31st IEEE International Conference on Software Engineering*, pp. 1-11.

WOOD, J. & SILVER, D. (1995) *Joint Application Development*. New York. John Wiley & Sons, Inc.

WOOLRIDGE, R. W., MCMANUS, D. J. & HALE, J. E. (2007) Stakeholder risk assessment: an outcome-based approach. *IEEE Software,* 24(2)**,** 36-45.

XUE, G. R., LIN, C., YANG, Q., XI, W. S., ZENG, H. J., YU, Y. & CHEN, Z. (2005) Scalable collaborative filtering using cluster-based smoothing, in *Proceedings of the 28th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, pp. 114-121.

YIN, R. (2008) *Case Study Research: Design and Methods*. Sage.

YU, E. S. K. (1997) Towards modelling and reasoning support for early-phase requirements engineering, in *Proceedings of the 3rd IEEE International Symposium on Requirements Engineering*, pp. 226-235.

YU, J. & COOPER, H. (1983) A quantitative review of research design effects on response rates to questionnaires. *Journal of Marketing Research,* 20(1)**,** 36-44.

YU, Y., LEITE, J. & MYLOPOULOS, J. (2004) From goals to aspects: discovering aspects from requirements goal models, in *Proceedings of the 12th IEEE International Conference on Requirements Engineering*, pp. 38-47.

ZACHOS, K., MAIDEN, N., ZHU, X. & JONES, S. (2007) Discovering web services to specify more complete system requirements, in *Proceedings of the 19th International Conference on Advanced Information Systems Engineering*, pp. 142-157.

ZAVE, P. (1997) Classification of research efforts in requirements engineering. *ACM Computing Surveys,* 29(4)**,** 315-321.

ZAVE, P. & JACKSON, M. (1997) Four dark corners of requirements engineering. *ACM Transactions on Software Engineering and Methodology,* 6(1)**,** 1-30.

ZHANG, P. (1993) Model selection via multifold cross validation. *The Annals of Statistics,* 21(1)**,** 299-313.

ZIMMERMANN, T. & NAGAPPAN, N. (2008) Predicting defects using network analysis on dependency graphs, in *Proceedings of the 30th IEEE International Conference on Software Engineering*, pp. 531-540.

Appendix A Stakeholder Lists

Existing Method List of Stakeholders

Stakeholder	Stakeholder Role
Caroline Cook	Registry: Student Records
Chris Randall	Information Strategy Committee, Information Services Division
David Shaffer	UCL Union: bloomsbury fitness
Jan Crowe	Library Services
Janet Perez	Library Services
Kathleen Niche	Registry
Kathryn Lester	Management Systems
Malcolm Bain	Management Systems: business process analyst
Martin Payne	Estates and Facilities Division
Mat Reed	Library Services
Mike Dawson	Security and Access Systems
Nick Kyle	Security and Access Systems
Niyi Akers	Human Resources Division
Peter Bates	Estates and Facilities Division: project assurance
Richard Baker	Estates and Facilities Division: project assurance
Richard Fuller	Estates and Facilities Division
Robert Clarke	Information Systems
Will Miles	Management Systems
	Administrative Systems Sub-Committee
	Cardax UK
	clubs and societies
	Corporate Support Services
	heads of departments
	hospitals
	Information Strategy Committee
	Management Systems: interface developer
	Management Systems: UPI
	Security and Access Systems: card issue
	security staff
	Site / Building / floor occupier
	staff
	students: medical students
	students: student officer
	visitors and contractors

Ground Truth of Stakeholders

Role Rank	Stakeholder Role	Stakeholder Rank	Stakeholder
1	Security and Access Systems	1	Mike Dawson
		2	Jason Ortiz
		3	Nick Kyle
		4	Paul Haywood
2	Estates and Facilities Division	1	Richard Fuller
		2	Martin Payne
		3	John Poole
3	Library Services	1	Jan Crowe
		2	Mat Reed
		3	Janet Perez
		4	Keith Lyon
		5.5	Vincent Matthew
		5.5	Paul Ayers
		7.5	Monika Sunny
		7.5	Melaine Hoyte
4	Registry: Student Records	1	Caroline Cook
5	Management Systems	1	Kathryn Lester
		2	Will Miles
		3.5	David Carne
		3.5	Anthony Rick
6.5	Information Strategy Committee	1	Chris Randall
6.5	Information Services Division	1	Chris Randall
8.5	Information Systems	1	Robert Clarke
		2	Mike Turing
8.5	Human Resources Division	1	Niyi Akers
		2.5	Sarah Brante
		2.5	Pat Leena
10.5	students: student officer		#N/A
10.5	staff		#N/A
12	Management Systems: interface developer	1	Andy Hicks
14	UCL Union: bloomsbury fitness	1	David Shaffer
		2	Barbara Song
		3.5	Yogesh Katz
		3.5	Ian More
14	Management Systems: business process analyst	1	Malcolm Bain
14	Registry	1	Kathleen Niche
		2.5	Christopher Hall
		2.5	David Ainsley
17	Dean of Students	1	Ruth Simon
17	Estates and Facilities Division: project assurance	1	Peter Bates
		2	Richard Baker
17	Corporate Support Services	1	Marilyn Gallo
23.5	IS Operating Systems Group	1.5	Brian Ward
		1.5	Andrew Dawn
		3	Adrian Bank

Role Rank	Stakeholder Role	Stakeholder Rank	Stakeholder
23.5	Management Systems: UPI	1.5	Tim Pugh
		1.5	Aaron Toms
23.5	security staff		#N/A
23.5	Development and Corporate Comms Office	1	Sarah Gunn
		2	Mark Suddy
23.5	Security and Access Systems: card issue	1.5	Libby Smite
		1.5	Diana Cates
23.5	Estates and Facilities Division: Records and Data Protection	1	Colin Penn
23.5	Management Systems: Maintenance	1.5	Brahim Boyd
		1.5	Angela Willard
		3	David Sykes
23.5	students: medical students	1	Alison Crane
23.5	Administrative Systems Sub-Committee	1	Anthony Fink
23.5	visitors and contractors		#N/A
32.5	students: short course students	1	Wendy Richey
32.5	IS - Network Group	1.5	Tariq Haines
		1.5	Nigel Hay
		3	Bob Laura
32.5	IS - Operations Group	1	Simon Mann
32.5	Vidionics	1	Kevin Wade
		2	Steve Baruty
32.5	departmental administrators	1	Kerstin Michel
32.5	Estates and Facilities Division: Property Maintenance and Facilities Management	1	Jim Howe
32.5	external library users		#N/A
32.5	UCL Union: bloomsbury fitness: bloomsbury reception staff		#N/A
49.5	universal smart cards		#N/A
49.5	students: UCL Language Centre	1.5	Tina Dina
		1.5	Chris Meely
49.5	Estates and Facilities Division: Mail Services		Steve Shields
49.5	cardax uk		Steve Bunk
49.5	Management Systems: Portico		Steph Garcia
49.5	Estates and Facilities Division: Administration		Ray Hardy
49.5	public		#N/A
49.5	potential criminals		#N/A
49.5	Management Systems: New servers		Paul Chrone
49.5	Management Systems: VPN		Nic Crone
49.5	Human Resources Division: HR system	1.5	Neil Heir
		1.5	Jeremy Gulliver
49.5	Management Systems: UPI/SITS		Mick Carin
49.5	Management Systems: HR data	1.5	Martin Skinner
		1.5	Majid Khande
49.5	Provost		Malcolm Graves
49.5	Sentry		Kevin Sony
49.5	Web Services		#N/A
49.5	heads of departments		#N/A
49.5	gunnebo		#N/A

Role Rank	Stakeholder Role	Stakeholder Rank	Stakeholder
49.5	Estates and Facilities Division: Capital Programme Management and Procurement		Greg Beech
49.5	gladstone mrm		#N/A
49.5	Graduate School		David Boggs
49.5	senior tutor		Bob Alford
49.5	Estates and Facilities Division: Property Management and Room Bookings		Alec Ground
49.5	IS Academic and Applications Support Group		Brian Aniston
49.5	gym users		#N/A
49.5	Estates and Facilities Division: UCL shop		Christina Solis

Appendix B Requirements Lists

Existing Method List of Requirements

Project Objective	Requirement	Specific Requirement
better user experience	easier to use	more accurate scanning
	use the same access control for library entrance	
	all in 1 card	combine ID card and session card
		combine Library card
		combine Bloomsbury fitness card
		combine Club and societies card
		be compatible with NHS
card design	card to include user details	card to include name
		card to include photo
		card to include UPI
		card design to include card type/user status
		card to include expiry date
	card to include barcode	
	card should be secure	
	card to include UCL branding	
to improve security and access control in UCL	ensure appropriate access for each individual	
	control access to UCL buildings	control access to departments
		control access to library
		control access to Bloomsbury
		to access Kathleen Lonsdale
		control access to departmental offices
		control access to private offices
		control access to high hazard area
		control access to computer cluster
		control access to rooms
	enable visual checking	enable photo visual checks
	access control to include movement tracking/logs	movement tracking in buildings other than library
		movement tracking/logs in the library
		use card to mark attendance
	increase access control to buildings	
improve processes	faster issue of cards	fast production of cards
		many issue points
	reduce queuing time	

Project Objective	Requirement	Specific Requirement
	easy to replace lost cards	UCL shop to handle lost cards
	granting access rights	view and modify access rights, time of access, online, without card being present
		activate and inactivate card
		role-based method to grant access rights
	able to create access reports	
reduce cost	save money on cards	no longer require MRM smart cards
	save processing time	
	reduce paper trials	
compatible with existing administrative systems	compatible with Bloomsbury system (Gladstone MRM)	
	compatible with library systems	compatible with library barcode
	compatible with UPI	map user identity to UPI (including group memberships and roles)
	compatible with current network infrastructure	
	minimal impact to other systems	
better data quality	centralised management of access and identification information	card must have unique id
		data should not be duplicated
	export data to other systems	export data to student system
		export data to library (access card changes, leavers, barcode)
		export data to staff system
	import data from other systems	import data from staff and student systems
		import photo from registry
	data access: able to view, update, delete remotely and securely	able to view data from any computer
		update/delete data
		enter data
		ensure secure data storage
extensible for future features	include payment mechanism	use as bank card
		used for cashless vending
	used for computer logon	
	upgradable (software revisions)	
project delivery activities	supplier support	5 years minimum
		card readers
		card printers
technical constraints	conform to standards and legislations	
	technology	smart card technology
		not constrained by card solution
		card printers technology
	lifecycle	5 years

Project Objective	Requirement	Specific Requirement
	reliable	reliable such that people can open doors
		continue operation
		secure network
	direct printing on both sides of card	
	supplier must have a proven track record	
	photo ID pass software must be an embedded feature of the access control software	
	the system manufacturer must be a Microsoft Certified Partner	
	the system must utilise Microsoft Windows 2000 and/or XP Operating System	
	the database platform must support Microsoft SQL Server and/or Oracle Server	

Ground Truth of Requirements

Rank	Project Objective	Rank	Requirement	Rank	Specific Requirement
1.5	better user experience	1	all in 1 card	1.5	combine ID card and session card
				1.5	combine Library card
				3	combine Bloomsbury fitness card
				4	the combine card should not have too many features (don't want it to become too valuable to change for locker keys)
		2	easier to use	1	more accurate scanning
		3	use the same access control for library entrance		
1.5	to improve security and access control in UCL	1	ensure appropriate access for each individual		
		2	control access to UCL buildings	1	control access to departments
				2	control access to library
				3	control access to Bloomsbury
				4	control access to computer cluster
				5	control access to high hazard area
				7	to access Kathleen Lonsdale
				7	control access to private offices
				7	control access to rooms
		3	increase access control to buildings	1	easy to install new readers
		4	enable visual checking	1	enable photo visual checks
				2	visual checking cardholder's role
		5	access control to include movement tracking/logs	1	movement tracking/logs in the library
				2	movement tracking in buildings other than library
				3	use card to mark attendance
3	improve processes	1	reduce queuing time		
		2	faster issue of cards	1	fast production of cards
				2	many issue points

Rank	Project Objective	Rank	Requirement	Rank	Specific Requirement
		3	granting access rights	1	role-based method to grant access rights
				2	close to real time update
				3	activate and inactivate card
				4	view and modify access rights, time of access, online, without card being present
		4	easy to replace lost cards	1	UCL shop to handle lost cards
		5	able to create access reports		
4.5	card design	1	card to include user details	2	card to include name
				2	card to include photo
				2	card to include UPI
				4	card design to include card type/user status
				5	card to include expiry date
				6	card to include job title
				7	card to include department
				8	card to include student number
		2	card should be secure	1.5	card not easily copied
				1.5	card should have features that prevent sharing
		3	card to include UCL branding		
		4	card to include barcode	1	easier reading of barcode by scanner
		5	card should be sturdy/robust		
		6	easy identification/card is clear looking		
		7	card should be attractive		
4.5	better data quality	1	data should not be duplicated	1.5	card must have unique id
				1.5	centralised management of access and identification information
		2	import data from other systems	1	import data from staff and student systems
				2	import photo from registry
		3	data access: able to view, update, delete remotely and securely	1	ensure secure data storage
				2	authorised access with firewalls and time limitations

Rank	Project Objective	Rank	Requirement	Rank	Specific Requirement
				3	update/delete data
				4	enter data
				5	able to view data from any computer
		4	export data to other systems	1.5	export data to student system
				1.5	export data to library (access card changes, leavers, barcode)
		5	clear policies on use of access data		
7	reduce cost	1	save money on cards	1	no longer require MRM smart cards
		2	save processing time		
		3	reduce paper trials		
7	compatible with existing administrative systems	1	compatible with UPI	1	map user identity to UPI (including group memberships and roles)
		2	compatible with library systems	1	compatible with library barcode
		3	compatible with current network infrastructure		
		4	compatible with Bloomsbury system (Gladstone MRM)		
		5	minimal impact to other systems		
7	extensible for future features	1	include payment mechanism	1	used for cashless vending
				2	use as bank card
		2	upgradable (software revisions)		
9	technical constraints	1	fail safe	1	failure does not restrict access
		2	available	2	working without interruption for 100 days
				2	data backup
				2	switch to standby system in the event of a hardware fail
		3	network infrastructure	1.5	cabling
				1.5	landswitch
		4	reliable	2.5	antivirus
				2.5	reliable such that people can open doors
				2.5	continue operation
				2.5	secure network
		7	technology	2	smart card technology

Rank	Project Objective	Rank	Requirement	Rank	Specific Requirement
				2	not constrained by card solution
				2	card printers technology
		7	direct printing on both sides of card		
		7	the system manufacturer must be a Microsoft Certified Partner		
		7	the system must utilise Microsoft Windows 2000 and/or XP Operating System		
		7	the database platform must support Microsoft SQL Server and/or Oracle Server		
		10.5	conform to standards and legislations	2	technical architecture standards
				2	management system standards
				2	security standards
		10.5	supplier must have a proven track record		
		12	lifecycle	1	5 years
		13	photo ID pass software must be an embedded feature of the access control software		
10	project delivery activities	1	supplier support	2	5 years minimum
				2	card readers
				2	card printers

Appendix C StakeNet Questionnaire

Stakeholder Identification Survey

As part of our research at the Department of Computer Science, we have developed a method to identify the stakeholders of a software project.

The survey aims to collect project data for testing the method. It should take less than 30 minutes to complete.

Your name and answers are confidential and will be used strictly for research.

Thank you for your participation.

Regards,

Soo Ling Lim
Dr. Daniele Quercia
Professor Anthony Finkelstein

Department of Computer Science
University College London
Gower Street
London WC1E 6BT
United Kingdom

Stakeholders and their Salience

A **stakeholder** is a person or group who *can affect* or *is affected by* the *success* or *failure* of a software system.

A stakeholder can be someone who:

- *finances* or *makes decision on* the development of the system;
- *develops* the system;
- *imposes rules* on the development or operation of the system;
- *uses* the system or its output; or
- *threatens* the success of the system.

Examples of stakeholders and their roles are John Doe (Developer), Jane Doe (Student).

Salience is the *level of influence* a stakeholder has on the system.

For example:

- A stakeholder with high salience plays a crucial role in the success of the system.
- A stakeholder with lower salience has less impact on the system.
- A person with no salience is not a stakeholder.

Stakeholder Recommendation Form

RALIC Project

Q1. Please complete the following information about yourself.

Name:____

Position:____

Department:____

Q2. What is your role in the RALIC project?

____

Q3. Below is a summarised scope for the RALIC project.

1. Replace magnetic swipe card readers with proximity readers
2. Source and install access card printers
3. Decide on card design and categories
4. Define user groups and default access rights
5. Provide a more accurate card holder database, save resources on manual data input, and facilitate automated provision and suspension of access and library borrowing rights
6. Issue new cards to staff, students, visitors and contractors
7. Replace the Library access control system
8. Use new cards at the Bloomsbury Fitness Centre

For each scope, please list down the stakeholders in the space provided in the following pages.

Scope 1: Replace magnetic swipe card readers with proximity readers to improve usability and reliability of the access control system

Name of Stakeholder and Role; or only Name of Role if Stakeholder unknown	Please circle the level of salience.				
	High		Medium		Low
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1

Scope 2: Source and install access card printers that can reliably print digital photos, person information, library bar codes and encode smart card chips

Name of Stakeholder and Role; or only Name of Role if Stakeholder unknown	Please circle the level of salience.				
	High		Medium		Low
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1

Scope 3: Decide on card design and categories

Name of Stakeholder and Role; or only Name of Role if Stakeholder unknown	Please circle the level of salience.				
	High		Medium		Low
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1

Scope 4: Define user groups and default access rights

Name of Stakeholder and Role; or only Name of Role if Stakeholder unknown	Please circle the level of salience.				
	High		Medium		Low
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1

Scope 5: Provide a more accurate card holder database, save resources on manual data input, and facilitate automated provision and suspension of access and library borrowing rights by implementing middleware to interface with the Library, Human Resource, Student and Visitor systems

Name of Stakeholder and Role; or only Name of Role if Stakeholder unknown	Please circle the level of salience.				
	High		Medium		Low
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1

Scope 6: Issue new cards to staff, students, visitors and contractors

Name of Stakeholder and Role; or only Name of Role if Stakeholder unknown	Please circle the level of salience.				
	High		Medium		Low
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1

Scope 7: Replace the Library access control system that uses bar code readers with proximity readers

Name of Stakeholder and Role; or only Name of Role if Stakeholder unknown	Please circle the level of salience.				
	High		Medium		Low
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1

Scope 8: Use new cards at the Bloomsbury Fitness Centre to save costs on additional cards and increase user-friendliness (one card does all)

Name of Stakeholder and Role; or only Name of Role if Stakeholder unknown	Please circle the level of salience.				
	High		Medium		Low
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1

Stakeholder Identification

Survey Form

RALIC Project

Q1. Please complete the following information about yourself.

Name:________________________________

Position:________________________________

Department:________________________________

Q2. What is your role in the RALIC project?

____

Q3. Below is a summarised scope for the RALIC project.

1. Replace magnetic swipe card readers with smart card readers
2. Source and install access card printers
3. Decide on card design and categories
4. Define user groups and default access rights
5. Provide a more accurate card holder database, save resources on manual data input, and facilitate automated provision and suspension of access and library borrowing rights
6. Issue new cards to staff, students, visitors and contractors
7. Replace the Library access control system
8. Use new cards at the Bloomsbury Fitness Centre

Q1: Who are the stakeholders for the RALIC project?

The following is a list of names in alphabetical order.
Check all that apply and **circle** their level of salience.

Name (annonymised)		←		High salience					Low salience		→
Axxxx Toxxxx	☐	10	9	8	7	6	5	4	3	2	1
Axxxxx Hixxxxx	☐	10	9	8	7	6	5	4	3	2	1
Axxxxx Wixxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Axxxxxx Rixxxxx	☐	10	9	8	7	6	5	4	3	2	1
Bxxxxx Boxxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Cxxxxxxx Coxxxx	☐	10	9	8	7	6	5	4	3	2	1
Dxxxx Sqxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Ex Stxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Gxxxxx Joxxx	☐	10	9	8	7	6	5	4	3	2	1
Jxx Crxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Jxxxx Pexxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Jxxxx Orxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Jxxx Mixxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Jxxx Poxxxx	☐	10	9	8	7	6	5	4	3	2	1
Kxxxxxxxx Pixxx	☐	10	9	8	7	6	5	4	3	2	1
Kxxxxxx Lexxx	☐	10	9	8	7	6	5	4	3	2	1
Kxxxx Gaxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Kxxxx Waxxxx	☐	10	9	8	7	6	5	4	3	2	1
Mxxxxxx Baxxxx	☐	10	9	8	7	6	5	4	3	2	1
Mxxxxx Gaxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Mxxxxx Paxx	☐	10	9	8	7	6	5	4	3	2	1
Mxxxxxx Rexxxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Mxxx Daxx	☐	10	9	8	7	6	5	4	3	2	1
Mxxx Mcxxxx	☐	10	9	8	7	6	5	4	3	2	1
Nxxxx Goxxxx	☐	10	9	8	7	6	5	4	3	2	1
Nxxxxxxx Kyxxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Nxxx Akxxxxxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Pxxx Chxxxxxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Pxxxx Baxxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Pxxxx Chxxxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Rxxxxxx Baxxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Rxxxxxx Fuxxxx	☐	10	9	8	7	6	5	4	3	2	1
Rxx Chxxx	☐	10	9	8	7	6	5	4	3	2	1
Rxxxxx Clxxx	☐	10	9	8	7	6	5	4	3	2	1
Rxxxxx Wixxx	☐	10	9	8	7	6	5	4	3	2	1
Rxxxxx Roxxxx	☐	10	9	8	7	6	5	4	3	2	1
Rxxxxxxx Cuxxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Sxxxx Baxx	☐	10	9	8	7	6	5	4	3	2	1
Sxxxx Buxxxxx	☐	10	9	8	7	6	5	4	3	2	1
Vxxxxxx Toxxxx	☐	10	9	8	7	6	5	4	3	2	1
Wxxxx Rixxx	☐	10	9	8	7	6	5	4	3	2	1
Wxxx Mixxxx	☐	10	9	8	7	6	5	4	3	2	1
Others	☐										

If you checked others, please **write** the names and roles of the other stakeholders below and **circle** their salience.

Stakeholder	←	High salience					Low salience			→
Name: Role:	10	9	8	7	6	5	4	3	2	1
Name: Role:	10	9	8	7	6	5	4	3	2	1
Name: Role:	10	9	8	7	6	5	4	3	2	1
Name: Role:	10	9	8	7	6	5	4	3	2	1
Name: Role:	10	9	8	7	6	5	4	3	2	1
Name: Role:	10	9	8	7	6	5	4	3	2	1
Name: Role:	10	9	8	7	6	5	4	3	2	1
Name: Role:	10	9	8	7	6	5	4	3	2	1
Name: Role:	10	9	8	7	6	5	4	3	2	1
Name: Role:	10	9	8	7	6	5	4	3	2	1

Q2: For all the stakeholders that you have checked in Q1, please rank them by their order of salience (1 being the most salient).

1.	11.
2.	12.
3.	13.
4.	14.
5.	15.
6.	16.
7.	17.
8.	18.
9.	19.
10.	20.

Appendix D StakeNet Datasets

The datasets are also available at http://www.cs.ucl.ac.uk/staff/S.Lim/phd/dataset.html.

OpenR

Aaron Toms, Andy Hicks, 1
Aaron Toms, Angela Willard, 1
Aaron Toms, Anthony Fink, 2
Aaron Toms, Art Waller, 1
Aaron Toms, Barbara Song, 1
Aaron Toms, Bloomsbury reception staff, 1
Aaron Toms, Brahim Boyd, 1
Aaron Toms, Cardax UK, 1
Aaron Toms, Caroline Cook, 1
Aaron Toms, Chris Randall, 2
Aaron Toms, Christopher Hall, 2
Aaron Toms, David Ainsley, 1
Aaron Toms, Derek Pack, 3
Aaron Toms, Diana Cates, 1
Aaron Toms, Greg Beech, 3
Aaron Toms, Jan Crowe, 3
Aaron Toms, Jason Ortiz, 1
Aaron Toms, Jim Howe, 3
Aaron Toms, John Poole, 3
Aaron Toms, Kathleen Niche, 2
Aaron Toms, Kathryn Lester, 4
Aaron Toms, Libby Smite, 1
Aaron Toms, Mark Suddy, 1
Aaron Toms, Mark Wesley, 1
Aaron Toms, Martin Payne, 7
Aaron Toms, Mike Dawson, 6
Aaron Toms, Neil Roper, 1
Aaron Toms, Nick Kyle, 1
Aaron Toms, Nick Seals, 1
Aaron Toms, Niyi Akers, 3
Aaron Toms, Oliver Cullen, 1
Aaron Toms, Paul Haywood, 1
Aaron Toms, Peter Bates, 3
Aaron Toms, Rachna Kaplan, 2
Aaron Toms, Ray Hardy, 3
Aaron Toms, Richard Baker, 3
Aaron Toms, Richard Fuller, 3
Aaron Toms, Sarah Brante, 1
Aaron Toms, Sarah Gunn, 1
Aaron Toms, Stella Wigs, 3
Aaron Toms, Steph Garcia, 1
Aaron Toms, Tim Pugh, 3
Aaron Toms, Tony Regal, 2
Aaron Toms, Universal Smart Cards, 1
Aaron Toms, Yogesh Katz, 1
Alison Crane, Barbara Song, 1
Alison Crane, Christopher Hall, 1
Alison Crane, David Ainsley, 1
Alison Crane, Derek Pack, 1
Alison Crane, Diana Cates, 1
Alison Crane, Greg Beech, 1
Alison Crane, Jason Ortiz, 1
Alison Crane, Jim Howe, 1
Alison Crane, John Poole, 1
Alison Crane, Kerstin Michel, 1
Alison Crane, Libby Smite, 1
Alison Crane, Mark Wesley, 1
Alison Crane, Martin Payne, 1
Alison Crane, Mike Dawson, 1
Alison Crane, Nick Kyle, 5
Alison Crane, Oliver Cullen, 1
Alison Crane, Paul Ayers, 2
Alison Crane, Paul Haywood, 1
Alison Crane, Peter Bates, 1
Alison Crane, Ray Hardy, 1
Alison Crane, Richard Baker, 1
Alison Crane, Richard Fuller, 4
Alison Crane, Sarah Brante, 1
Alison Crane, Stella Wigs, 1
Andy Hicks, Aaron Toms, 1
Andy Hicks, Alison Crane, 1
Andy Hicks, Angela Willard, 1
Andy Hicks, Anthony Rick, 1
Andy Hicks, Barbara Song, 1
Andy Hicks, Bill Leal, 2
Andy Hicks, Brian Ward, 1
Andy Hicks, Cardax UK, 2
Andy Hicks, Caroline Cook, 2
Andy Hicks, Diana Cates, 1
Andy Hicks, Ed Steele, 2
Andy Hicks, external library users, 1
Andy Hicks, Jan Crowe, 5
Andy Hicks, Jason Ortiz, 2
Andy Hicks, John Poole, 1
Andy Hicks, Kathryn Lester, 1
Andy Hicks, Keith Lyon, 3
Andy Hicks, Kerstin Michel, 2
Andy Hicks, Kevin Wade, 1
Andy Hicks, Libby Smite, 1
Andy Hicks, Majid Khande, 1
Andy Hicks, Malcolm Graves, 1
Andy Hicks, Marilyn Gallo, 1
Andy Hicks, Mark Wesley, 1
Andy Hicks, Martin Payne, 8
Andy Hicks, Mat Reed, 2
Andy Hicks, Michael Wondor, 1
Andy Hicks, Mick Carin, 1
Andy Hicks, Mike Dawson, 7
Andy Hicks, Nic Crone, 1
Andy Hicks, Nick Kyle, 1
Andy Hicks, Noel Forrest, 1
Andy Hicks, Oliver Cullen, 1
Andy Hicks, Paul Ayers, 1
Andy Hicks, Paul Chrone, 1
Andy Hicks, Paul Haywood, 1
Andy Hicks, Peter Bates, 1
Andy Hicks, Quentin Nord, 1
Andy Hicks, Richard Baker, 1
Andy Hicks, Richard Fuller, 1
Andy Hicks, Sean Wall, 2
Andy Hicks, Steve Curry, 1
Andy Hicks, Tamsin Pitts, 2
Andy Hicks, Wendy Richey, 1
Andy Hicks, Will Miles, 1
Andy Hicks, Yogesh Katz, 1
Angela Willard, Andy Hicks, 1
Angela Willard, Caroline Cook, 3
Angela Willard, Jan Crowe, 3
Angela Willard, Jason Ortiz, 1
Angela Willard, Kathryn Lester, 1
Angela Willard, Keith Lyon, 1
Angela Willard, Martin Payne, 4
Angela Willard, Mat Reed, 1
Angela Willard, Mike Dawson, 5
Angela Willard, Niyi Akers, 3
Anthony Rick, Angela Willard, 1
Anthony Rick, Barbara Song, 1
Anthony Rick, Bloomsbury reception staff, 1
Anthony Rick, Brahim Boyd, 1
Anthony Rick, David Sykes, 1
Anthony Rick, Diana Cates, 1
Anthony Rick, Jan Crowe, 5
Anthony Rick, Jason Ortiz, 1
Anthony Rick, Jim Howe, 3
Anthony Rick, Kerstin Michel, 3
Anthony Rick, Libby Smite, 1
Anthony Rick, Mark Wesley, 1
Anthony Rick, Martin Payne, 5
Anthony Rick, Mike Dawson, 8
Anthony Rick, Niyi Akers, 1
Anthony Rick, Richard Fuller, 2
Anthony Rick, Will Miles, 1
Anthony Rick, Yogesh Katz, 1
Barbara Song, Bill Leal, 1
Barbara Song, Bloomsbury reception staff, 1
Barbara Song, David Shaffer, 1
Barbara Song, Ed Steele, 1
Barbara Song, Gladstone MRM, 1
Barbara Song, Gunnebo, 1
Barbara Song, Sean Wall, 1
Barbara Song, Tamsin Pitts, 1
Barbara Song, Yogesh Katz, 1
Bill Leal, Adrian Bank, 3
Bill Leal, Andrew Dawn, 3
Bill Leal, Andrew Kessler, 3
Bill Leal, Anthony Fink, 1
Bill Leal, Brian Aniston, 3
Bill Leal, Brian Ward, 3
Bill Leal, Caroline Cook, 2
Bill Leal, Chris Randall, 1
Bill Leal, Christopher Hall, 2
Bill Leal, David Ainsley, 2
Bill Leal, Derek Pack, 2
Bill Leal, Diana Cates, 1
Bill Leal, Ed Steele, 3
Bill Leal, Fred Bean, 1
Bill Leal, Greg Beech, 2
Bill Leal, Jan Crowe, 1
Bill Leal, Jason Ortiz, 1
Bill Leal, Jeremy Spain, 2
Bill Leal, Jim Howe, 2
Bill Leal, John Poole, 2
Bill Leal, Kathleen Niche, 2
Bill Leal, Keith Lyon, 1
Bill Leal, Kerstin Michel, 3
Bill Leal, Libby Smite, 1
Bill Leal, Lis Hands, 1
Bill Leal, Liz Hopper, 3
Bill Leal, major incident team, 2
Bill Leal, Maria Damon, 3
Bill Leal, Marion Ross, 3
Bill Leal, Mark Wesley, 4
Bill Leal, Martin Payne, 2
Bill Leal, Mat Reed, 1
Bill Leal, Mike Dawson, 1
Bill Leal, Nick Kyle, 1
Bill Leal, Nick Seals, 2
Bill Leal, Nigel Hay, 3
Bill Leal, Niyi Akers, 1
Bill Leal, Oliver Cullen, 1
Bill Leal, Paul Ayers, 1
Bill Leal, Paul Haywood, 1
Bill Leal, Peter Bates, 2
Bill Leal, Rachna Kaplan, 1
Bill Leal, Ray Hardy, 2
Bill Leal, Richard Baker, 2
Bill Leal, Richard Fuller, 2
Bill Leal, Robert Clarke, 3
Bill Leal, Samuel Mackey, 3
Bill Leal, Sarah Brante, 1
Bill Leal, Sean Wall, 3
Bill Leal, Simon Mann, 3
Bill Leal, Stella Wigs, 2
Bill Leal, Tamsin Pitts, 3
Bill Leal, Tariq Haines, 3
Bill Leal, Tony Boston, 1
Bill Leal, Tony Regal, 1
Bill Leal, Vincent Matthew, 1
Brahim Boyd, Caroline Cook, 2
Brahim Boyd, Christopher Hall, 1
Brahim Boyd, David Ainsley, 1
Brahim Boyd, Jan Crowe, 2
Brahim Boyd, Jason Ortiz, 1
Brahim Boyd, Kathleen Niche, 1
Brahim Boyd, Keith Lyon, 1
Brahim Boyd, Martin Payne, 2
Brahim Boyd, Mat Reed, 1
Brahim Boyd, Mike Dawson, 4
Brahim Boyd, Nick Seals, 1
Brahim Boyd, Niyi Akers, 2
Brahim Boyd, Rachna Kaplan, 1
Brahim Boyd, Sarah Brante, 1
Brahim Boyd, Tim Pugh, 1
Brahim Boyd, Tony Regal, 1
Brian Ward, Andrew Dawn, 1
Brian Ward, Andy Hicks, 1
Brian Ward, Martin Payne, 1
Brian Ward, Mike Dawson, 1
Brian Ward, Robert Clarke, 1
Brian Ward, Tariq Haines, 1
Caroline Cook, Aaron Toms, 1
Caroline Cook, Angela Willard, 3
Caroline Cook, Barbara Song, 1
Caroline Cook, Bob Alford, 1
Caroline Cook, Brahim Boyd, 1
Caroline Cook, David Boggs, 1
Caroline Cook, Jan Crowe, 3
Caroline Cook, Jason Ortiz, 3
Caroline Cook, Keith Lyon, 1
Caroline Cook, Martin Payne, 4
Caroline Cook, Mike Dawson, 4
Caroline Cook, Richard Fuller, 2
Caroline Cook, Ruth Simon, 1
Caroline Cook, Tim Pugh, 1
Caroline Cook, Yogesh Katz, 1
Chris Randall, Adrian Bank, 1
Chris Randall, Andrew Dawn, 2
Chris Randall, Andrew Kessler, 1
Chris Randall, Caroline Cook, 1
Chris Randall, Christopher Hall, 1
Chris Randall, David Ainsley, 1
Chris Randall, Harry Gore, 1
Chris Randall, Jan Crowe, 4
Chris Randall, Maria Damon, 4
Chris Randall, Marilyn Gallo, 1
Chris Randall, Marion Ross, 3
Chris Randall, Martin Payne, 2
Chris Randall, Nick Kyle, 3
Chris Randall, Nicolas Curry, 1
Chris Randall, Niyi Akers, 2
Chris Randall, Paul Ayers, 3
Chris Randall, Paul Lake, 2
Chris Randall, Quentin Nord, 1
Chris Randall, Richard Baker, 1
Chris Randall, Richard Fuller, 3
Chris Randall, Robert Clarke, 2
Chris Randall, Sarah Brante, 3
Chris Randall, Simon Farmer, 2
Chris Randall, Will Miles, 1
Christopher Hall, Art Waller, 1
Christopher Hall, David Shaffer, 1
Christopher Hall, Kathleen Niche, 2
Christopher Hall, Nick Kyle, 1
Christopher Hall, Nick Seals, 1
Christopher Hall, Niyi Akers, 2
Christopher Hall, Paul Ayers, 1
Christopher Hall, Ray Hardy, 2
Christopher Hall, Richard Fuller, 3
Colin Penn, Aaron Toms, 3
Colin Penn, Adrian Bank, 1
Colin Penn, Andrew Dawn, 1
Colin Penn, Andrew Kessler, 1
Colin Penn, Andy Hicks, 3
Colin Penn, Andy Kirb, 3
Colin Penn, Angela Willard, 3
Colin Penn, Anthony Rick, 3
Colin Penn, Brahim Boyd, 3
Colin Penn, Brian Aniston, 1
Colin Penn, Brian Ward, 1

Colin Penn, Caroline Cook, 2
Colin Penn, Christopher Hall, 2
Colin Penn, Conrad Moore, 3
Colin Penn, David Ainsley, 2
Colin Penn, David Carne, 3
Colin Penn, David Sykes, 3
Colin Penn, Derek Pack, 1
Colin Penn, Diana Cates, 5
Colin Penn, Greg Beech, 1
Colin Penn, Jan Crowe, 3
Colin Penn, Jason Ortiz, 5
Colin Penn, Jim Howe, 1
Colin Penn, John Poole, 1
Colin Penn, Jots Semb, 3
Colin Penn, Kathleen Niche, 2
Colin Penn, Kathryn Lester, 3
Colin Penn, Keith Lyon, 3
Colin Penn, Kerstin Michel, 1
Colin Penn, Libby Smite, 5
Colin Penn, Lis Hands, 3
Colin Penn, Liz Hopper, 1
Colin Penn, Majid Khande, 3
Colin Penn, Malcolm Bain, 3
Colin Penn, Maria Damon, 1
Colin Penn, Marion Ross, 1
Colin Penn, Mark Wesley, 5
Colin Penn, Martin Payne, 1
Colin Penn, Mat Reed, 3
Colin Penn, Mick Carin, 3
Colin Penn, Mike Dawson, 5
Colin Penn, Mike Hawan, 3
Colin Penn, Nic Crone, 3
Colin Penn, Nick Kyle, 5
Colin Penn, Nick Seals, 2
Colin Penn, Nigel Hay, 1
Colin Penn, Niyi Akers, 2
Colin Penn, Noshir Holmes, 3
Colin Penn, Oliver Cullen, 5
Colin Penn, Paul Ayers, 3
Colin Penn, Paul Chrone, 3
Colin Penn, Paul Haywood, 5
Colin Penn, Peter Bates, 1
Colin Penn, Quentin Nord, 3
Colin Penn, Rachna Kaplan, 2
Colin Penn, Ray Hardy, 1
Colin Penn, Richard Baker, 1
Colin Penn, Richard Fuller, 1
Colin Penn, Robert Clarke, 1
Colin Penn, Samuel Mackey, 1
Colin Penn, Sarah Brante, 2
Colin Penn, Simon Mann, 1
Colin Penn, Stella Wigs, 1
Colin Penn, Steph Garcia, 3
Colin Penn, Tariq Haines, 1
Colin Penn, Tim Pugh, 3
Colin Penn, Tony Regal, 2
Colin Penn, Vincent Matthew, 3
Colin Penn, Will Miles, 3
Conrad Moore, Aaron Toms, 2
Conrad Moore, Adrian Bank, 2
Conrad Moore, Art Waller, 1
Conrad Moore, Diana Cates, 5
Conrad Moore, Jan Crowe, 3
Conrad Moore, Jason Ortiz, 5
Conrad Moore, Jeremy Spain, 1
Conrad Moore, Kathleen Niche, 3
Conrad Moore, Kathryn Lester, 1
Conrad Moore, Libby Smite, 5
Conrad Moore, Malcolm Graves, 1
Conrad Moore, Mark Suddy, 1
Conrad Moore, Mark Wesley, 5
Conrad Moore, Martin Payne, 5
Conrad Moore, Mike Dawson, 5
Conrad Moore, Mike Hawan, 1
Conrad Moore, Neil Roper, 1
Conrad Moore, Nick Kyle, 5
Conrad Moore, Niyi Akers, 3
Conrad Moore, Oliver Cullen, 5
Conrad Moore, Paul Haywood, 5
Conrad Moore, Robert Clarke, 1
Conrad Moore, Sarah Gunn, 1
Conrad Moore, Steve Curry, 1
Conrad Moore, Tim Pugh, 2
David Ainsley, Adrian Bank, 6
David Ainsley, Andrew Dawn, 6
David Ainsley, Andrew Kessler, 6
David Ainsley, Art Waller, 1
David Ainsley, Brian Aniston, 6
David Ainsley, Brian Ward, 6
David Ainsley, Caroline Cook, 6
David Ainsley, David Shaffer, 1
David Ainsley, Derek Pack, 8
David Ainsley, Ed Steele, 1
David Ainsley, Greg Beech, 8
David Ainsley, Ian More, 1
David Ainsley, Jan Crowe, 5
David Ainsley, Jim Howe, 8
David Ainsley, John Poole, 8
David Ainsley, Kathleen Niche, 4
David Ainsley, Keith Lyon, 5
David Ainsley, Lis Hands, 5
David Ainsley, Liz Hopper, 6
David Ainsley, Maria Damon, 6
David Ainsley, Marion Ross, 6
David Ainsley, Mark Suddy, 1
David Ainsley, Martin Payne, 8
David Ainsley, Mat Reed, 5
David Ainsley, Neil Roper, 1
David Ainsley, Nigel Hay, 6
David Ainsley, Niyi Akers, 6
David Ainsley, Paul Ayers, 5
David Ainsley, Peter Bates, 8
David Ainsley, Rachna Kaplan, 6
David Ainsley, Ray Hardy, 8
David Ainsley, Richard Baker, 8
David Ainsley, Richard Fuller, 8
David Ainsley, Robert Clarke, 6
David Ainsley, Samuel Mackey, 6
David Ainsley, Sarah Brante, 6
David Ainsley, Sarah Gunn, 1
David Ainsley, Simon Mann, 6
David Ainsley, Stella Wigs, 8
David Ainsley, Tariq Haines, 6
David Ainsley, Tony Regal, 6
David Ainsley, Vincent Matthew, 5
David Carne, Aaron Toms, 4
David Carne, Adrian Bank, 2
David Carne, Andrew Dawn, 2
David Carne, Andrew Kessler, 2
David Carne, Andy Hicks, 4
David Carne, Andy Kirb, 4
David Carne, Angela Willard, 4
David Carne, Anthony Rick, 4
David Carne, Bill Leal, 1
David Carne, Brahim Boyd, 4
David Carne, Brian Aniston, 2
David Carne, Brian Ward, 2
David Carne, Caroline Cook, 2
David Carne, Christopher Hall, 2
David Carne, Conrad Moore, 4
David Carne, David Ainsley, 2
David Carne, David Shaffer, 5
David Carne, David Sykes, 4
David Carne, Diana Cates, 4
David Carne, Ed Steele, 5
David Carne, Ian More, 5
David Carne, Jan Crowe, 4
David Carne, Jason Ortiz, 4
David Carne, Jots Semb, 4
David Carne, Kathleen Niche, 2
David Carne, Kathryn Lester, 4
David Carne, Keith Lyon, 4
David Carne, Kerstin Michel, 1
David Carne, Libby Smite, 4
David Carne, Lis Hands, 4
David Carne, Liz Hopper, 2
David Carne, Majid Khande, 4
David Carne, Malcolm Bain, 4
David Carne, Maria Damon, 2
David Carne, Marion Ross, 2
David Carne, Mark Wesley, 4
David Carne, Mat Reed, 4
David Carne, Mick Carin, 4
David Carne, Mike Dawson, 4
David Carne, Mike Hawan, 4
David Carne, Nic Crone, 4
David Carne, Nick Kyle, 4
David Carne, Nick Seals, 2
David Carne, Nigel Hay, 2
David Carne, Niyi Akers, 5
David Carne, Noshir Holmes, 4
David Carne, Oliver Cullen, 4
David Carne, Paul Ayers, 4
David Carne, Paul Chrone, 4
David Carne, Paul Haywood, 4
David Carne, Quentin Nord, 4
David Carne, Rachna Kaplan, 5
David Carne, Robert Clarke, 2
David Carne, Samuel Mackey, 2
David Carne, Sarah Brante, 5
David Carne, Sean Wall, 1
David Carne, Simon Mann, 2
David Carne, Steph Garcia, 4
David Carne, Tamsin Pitts, 1
David Carne, Tariq Haines, 2
David Carne, Tim Pugh, 4
David Carne, Tony Regal, 5
David Carne, Vincent Matthew, 4
David Carne, Will Miles, 4
David Shaffer, Barbara Song, 3
David Shaffer, Colin Street, 1
David Shaffer, Ian More, 2
David Shaffer, Mark Wesley, 1
David Shaffer, Mike Dawson, 6
David Shaffer, Roger All, 1
David Shaffer, Yogesh Katz, 3
David Sykes, Aaron Toms, 3
David Sykes, Andy Hicks, 3
David Sykes, Angela Willard, 4
David Sykes, Anthony Fink, 1
David Sykes, Barbara Song, 1
David Sykes, Brahim Boyd, 4
David Sykes, Brian Ward, 1
David Sykes, Caroline Cook, 5
David Sykes, Chris Randall, 2
David Sykes, Christopher Hall, 1
David Sykes, David Ainsley, 1
David Sykes, David Shaffer, 1
David Sykes, Diana Cates, 2
David Sykes, Ed Steele, 3
David Sykes, Jan Crowe, 1
David Sykes, Janet Perez, 1
David Sykes, Jason Ortiz, 1
David Sykes, Kathleen Niche, 2
David Sykes, Kathryn Lester, 2
David Sykes, Kevin Wade, 1
David Sykes, Libby Smite, 1
David Sykes, Mark Wesley, 3
David Sykes, Martin Payne, 3
David Sykes, Mike Dawson, 8
David Sykes, Nic Crone, 1
David Sykes, Nick Kyle, 2
David Sykes, Nick Seals, 1
David Sykes, Niyi Akers, 2
David Sykes, Oliver Cullen, 1
David Sykes, Paul Haywood, 1
David Sykes, Peter Bates, 1
David Sykes, Rachna Kaplan, 1
David Sykes, Richard Baker, 1
David Sykes, Richard Fuller, 1
David Sykes, Robert Clarke, 1
David Sykes, Sarah Brante, 3
David Sykes, Tony Regal, 1
David Sykes, Will Miles, 1
Diana Cates, Anthony Fink, 8
Diana Cates, Bill Leal, 8
Diana Cates, Caroline Cook, 8
Diana Cates, Chris Randall, 8
Diana Cates, David Shaffer, 8
Diana Cates, Ed Steele, 8
Diana Cates, Jan Crowe, 8
Diana Cates, Jason Ortiz, 8
Diana Cates, Kathryn Lester, 8
Diana Cates, Libby Smite, 8
Diana Cates, Malcolm Bain, 8
Diana Cates, Martin Payne, 8
Diana Cates, Mat Reed, 8
Diana Cates, Mike Dawson, 8
Diana Cates, Peter Bates, 8
Diana Cates, Sean Wall, 8
Diana Cates, Tamsin Pitts, 8
Ed Steele, Barbara Song, 3
Ed Steele, Bill Leal, 6
Ed Steele, Bloomsbury reception staff, 1
Ed Steele, Jan Crowe, 5
Ed Steele, Keith Lyon, 5
Ed Steele, Kerstin Michel, 1
Ed Steele, Lis Hands, 5
Ed Steele, Mat Reed, 5
Ed Steele, Paul Ayers, 5
Ed Steele, Sean Wall, 6
Ed Steele, Tamsin Pitts, 6
Ed Steele, Vincent Matthew, 5
Ed Steele, Yogesh Katz, 2
Ian More, Barbara Song, 2
Ian More, Diana Cates, 2
Ian More, Jason Ortiz, 2
Ian More, Libby Smite, 2
Ian More, Mark Wesley, 2
Ian More, Mike Dawson, 2
Ian More, Nick Kyle, 2
Ian More, Oliver Cullen, 2
Ian More, Paul Ayers, 2
Ian More, Paul Haywood, 2
Ian More, Yogesh Katz, 2
Jan Crowe, Andy Hicks, 1
Jan Crowe, Caroline Cook, 1
Jan Crowe, Chris Randall, 1
Jan Crowe, David Shaffer, 1
Jan Crowe, Janet Perez, 1
Jan Crowe, Kathleen Niche, 1
Jan Crowe, Kathryn Lester, 3
Jan Crowe, Martin Payne, 2
Jan Crowe, Mat Reed, 1
Jan Crowe, Mike Dawson, 5
Jan Crowe, Nick Kyle, 1
Jan Crowe, Niyi Akers, 2
Jan Crowe, Paul Ayers, 1
Jan Crowe, Peter Bates, 1
Jan Crowe, Richard Baker, 1
Jan Crowe, Richard Fuller, 1
Jan Crowe, Robert Clarke, 1
Jan Crowe, Will Miles, 1
Jason Ortiz, Diana Cates, 2
Jason Ortiz, Libby Smite, 2
Jason Ortiz, Martin Payne, 4
Jason Ortiz, Mat Reed, 2
Jason Ortiz, Mike Dawson, 8
Jason Ortiz, Nick Kyle, 3
Jason Ortiz, Paul Haywood, 5
Jason Ortiz, Richard Fuller, 3
Jim Howe, Derek Pack, 1
Jim Howe, Diana Cates, 1
Jim Howe, Jason Ortiz, 3
Jim Howe, Libby Smite, 3
Jim Howe, Mark Wesley, 2
Jim Howe, Mike Dawson, 8
Jim Howe, Nick Kyle, 3
Jim Howe, Oliver Cullen, 1
Jim Howe, Richard Fuller, 1
Jim Howe, Stella Wigs, 1
John Poole, Andy Hicks, 1
John Poole, Angela Willard, 1
John Poole, Brahim Boyd, 1
John Poole, Caroline Cook, 2
John Poole, David Shaffer, 1
John Poole, Jan Crowe, 2
John Poole, Jason Ortiz, 1
John Poole, Kevin Wade, 3
John Poole, Mark Suddy, 1
John Poole, Martin Payne, 5
John Poole, Mat Reed, 2
John Poole, Mike Dawson, 7
John Poole, Nick Kyle, 1
John Poole, Niyi Akers, 1
John Poole, Peter Bates, 1
John Poole, Richard Fuller, 1
John Poole, Will Miles, 1
Kathleen Niche, Aaron Toms, 1
Kathleen Niche, Angela Willard, 2
Kathleen Niche, Anthony Fink, 1
Kathleen Niche, Art Waller, 1
Kathleen Niche, Barbara Song, 1
Kathleen Niche, Bill Leal, 1
Kathleen Niche, Bloomsbury reception staff, 1
Kathleen Niche, Brahim Boyd, 2
Kathleen Niche, Caroline Cook, 1
Kathleen Niche, Chris Randall, 1
Kathleen Niche, Christopher Hall, 1
Kathleen Niche, David Ainsley, 3
Kathleen Niche, David Sykes, 2
Kathleen Niche, Derek Pack, 3
Kathleen Niche, Diana Cates, 1
Kathleen Niche, Ed Steele, 1
Kathleen Niche, Greg Beech, 3
Kathleen Niche, Jan Crowe, 2
Kathleen Niche, Jason Ortiz, 1
Kathleen Niche, Jim Howe, 3
Kathleen Niche, John Poole, 3
Kathleen Niche, Keith Lyon, 2
Kathleen Niche, Kerstin Michel, 1
Kathleen Niche, Libby Smite, 1
Kathleen Niche, Lis Hands, 2
Kathleen Niche, Mark Suddy, 1
Kathleen Niche, Martin Payne, 3
Kathleen Niche, Mat Reed, 2
Kathleen Niche, Mike Dawson, 2
Kathleen Niche, Neil Roper, 1
Kathleen Niche, Nick Seals, 2
Kathleen Niche, Niyi Akers, 4
Kathleen Niche, Paul Ayers, 2
Kathleen Niche, Peter Bates, 3
Kathleen Niche, Rachna Kaplan, 4
Kathleen Niche, Ray Hardy, 3
Kathleen Niche, Richard Baker, 3
Kathleen Niche, Richard Fuller, 3
Kathleen Niche, Sarah Brante, 4
Kathleen Niche, Sarah Gunn, 1
Kathleen Niche, Sean Wall, 1
Kathleen Niche, Stella Wigs, 3
Kathleen Niche, Tamsin Pitts, 1
Kathleen Niche, Tony Regal, 4
Kathleen Niche, Vincent Matthew, 2
Kathleen Niche, Will Miles, 1
Kathleen Niche, Yogesh Katz, 1
Kathryn Lester, Aaron Toms, 2
Kathryn Lester, Andy Hicks, 3
Kathryn Lester, Andy Kirb, 2
Kathryn Lester, Angela Willard, 2
Kathryn Lester, Anthony Rick, 2
Kathryn Lester, Art Waller, 1
Kathryn Lester, Barbara Song, 1
Kathryn Lester, Bill Leal, 4
Kathryn Lester, Bloomsbury reception staff, 1
Kathryn Lester, Brahim Boyd, 2
Kathryn Lester, Cardax UK, 2
Kathryn Lester, Caroline Cook, 3
Kathryn Lester, Chris Randall, 1
Kathryn Lester, Christopher Hall, 2
Kathryn Lester, Colin Street, 1
Kathryn Lester, Conrad Moore, 2
Kathryn Lester, David Ainsley, 2
Kathryn Lester, David Carne, 2
Kathryn Lester, David Shaffer, 2
Kathryn Lester, David Sykes, 2
Kathryn Lester, Diana Cates, 3
Kathryn Lester, Ed Steele, 5
Kathryn Lester, external library users, 1
Kathryn Lester, Ian More, 1
Kathryn Lester, Jan Crowe, 3

Sarah Gunn, Diana Cates, 3
Sarah Gunn, Ed Steele, 1
Sarah Gunn, external library users, 1
Sarah Gunn, Jan Crowe, 3
Sarah Gunn, Jason Ortiz, 3
Sarah Gunn, Jim Howe, 1
Sarah Gunn, Keith Lyon, 3
Sarah Gunn, Kerstin Michel, 2
Sarah Gunn, Libby Smite, 3
Sarah Gunn, Lis Hands, 3
Sarah Gunn, Liz Hopper, 1
Sarah Gunn, Maria Damon, 1
Sarah Gunn, Marilyn Gallo, 1
Sarah Gunn, Marion Ross, 1
Sarah Gunn, Mark Suddy, 1
Sarah Gunn, Mark Wesley, 3
Sarah Gunn, Martin Payne, 2
Sarah Gunn, Mat Reed, 3
Sarah Gunn, Mike Dawson, 3
Sarah Gunn, Nick Kyle, 4
Sarah Gunn, Nigel Hay, 1
Sarah Gunn, Niyi Akers, 3
Sarah Gunn, Noel Forrest, 1
Sarah Gunn, Oliver Cullen, 3
Sarah Gunn, Paul Ayers, 3
Sarah Gunn, Paul Haywood, 3
Sarah Gunn, Rachna Kaplan, 3
Sarah Gunn, Richard Fuller, 1
Sarah Gunn, Robert Clarke, 1
Sarah Gunn, Roger All, 1
Sarah Gunn, Samuel Mackey, 1
Sarah Gunn, Sarah Brante, 3
Sarah Gunn, Sean Wall, 2
Sarah Gunn, Simon Mann, 1
Sarah Gunn, Tamsin Pitts, 2
Sarah Gunn, Tariq Haines, 1
Sarah Gunn, Tony Regal, 3
Sarah Gunn, Vincent Matthew, 3
Sarah Gunn, Yogesh Katz, 1
Sean Wall, Alison Crane, 2
Sean Wall, alumni and bequests, 1
Sean Wall, Art Waller, 1
Sean Wall, Barbara Song, 1
Sean Wall, Bill Leal, 6
Sean Wall, Bloomsbury reception staff, 1
Sean Wall, Caroline Cook, 5
Sean Wall, Colin Penn, 3
Sean Wall, David Shaffer, 8
Sean Wall, Diana Cates, 2
Sean Wall, Ed Steele, 7
Sean Wall, Ian More, 7
Sean Wall, Jan Crowe, 5
Sean Wall, Jason Ortiz, 2
Sean Wall, Kathryn Lester, 5
Sean Wall, Keith Lyon, 1
Sean Wall, Libby Smite, 2
Sean Wall, Lis Hands, 1
Sean Wall, Malcolm Bain, 5
Sean Wall, Mark Suddy, 1
Sean Wall, Mark Wesley, 2
Sean Wall, Martin Payne, 5
Sean Wall, Mat Reed, 5
Sean Wall, Mike Dawson, 6
Sean Wall, Neil Roper, 1
Sean Wall, Nick Kyle, 4
Sean Wall, Niyi Akers, 4
Sean Wall, Noel Forrest, 1
Sean Wall, Oliver Cullen, 2
Sean Wall, Paul Ayers, 2
Sean Wall, Paul Haywood, 2
Sean Wall, Peter Bates, 5
Sean Wall, public, 3
Sean Wall, Rachna Kaplan, 4
Sean Wall, Richard Fuller, 2
Sean Wall, Ruth Simon, 3
Sean Wall, Sarah Brante, 5
Sean Wall, Sarah Gunn, 1
Sean Wall, Tamsin Pitts, 6
Sean Wall, Tony Regal, 4
Sean Wall, Vincent Matthew, 1
Sean Wall, Yogesh Katz, 1
Simon Mann, Adrian Bank, 1
Simon Mann, Andrew Dawn, 2
Simon Mann, Andrew Kessler, 1
Simon Mann, Bill Leal, 5
Simon Mann, Brian Aniston, 1
Simon Mann, Brian Ward, 2
Simon Mann, Caroline Cook, 1
Simon Mann, Colin Street, 1
Simon Mann, David Shaffer, 1
Simon Mann, Diana Cates, 1
Simon Mann, Ed Steele, 5
Simon Mann, Ian More, 1
Simon Mann, Jan Crowe, 1
Simon Mann, Janet Perez, 2
Simon Mann, Jason Ortiz, 5
Simon Mann, Libby Smite, 1
Simon Mann, Liz Hopper, 1
Simon Mann, Maria Damon, 1
Simon Mann, Marilyn Gallo, 1
Simon Mann, Marion Ross, 1
Simon Mann, Mark Wesley, 1
Simon Mann, Martin Payne, 4
Simon Mann, Mike Dawson, 8
Simon Mann, Neil Roper, 1
Simon Mann, Nick Kyle, 3
Simon Mann, Nigel Hay, 4
Simon Mann, Niyi Akers, 1
Simon Mann, Paul Ayers, 1
Simon Mann, Rachna Kaplan, 1
Simon Mann, Robert Clarke, 1
Simon Mann, Roger All, 1
Simon Mann, Samuel Mackey, 1
Simon Mann, Sarah Gunn, 1
Simon Mann, Sean Wall, 5
Simon Mann, Tamsin Pitts, 5
Simon Mann, Tariq Haines, 1
Simon Mann, Tony Regal, 1
Simon Mann, Vincent Matthew, 1
Simon Mann, Wendy Richey, 1
Simon Mann, Will Miles, 1
Tamsin Pitts, Barry Wayne, 4
Tamsin Pitts, Bruce Cornell, 3
Tamsin Pitts, Caroline Goodman, 2
Tamsin Pitts, Chris Randall, 1
Tamsin Pitts, Colin Street, 1
Tamsin Pitts, David Shaffer, 1
Tamsin Pitts, Janet Perez, 3
Tamsin Pitts, Mike Dawson, 4
Tamsin Pitts, Richard Marsh, 3
Tamsin Pitts, Roger All, 1
Tariq Haines, David Shaffer, 1
Tariq Haines, Diana Cates, 3
Tariq Haines, Jason Ortiz, 3
Tariq Haines, Libby Smite, 3
Tariq Haines, Mark Wesley, 3
Tariq Haines, Mike Dawson, 4
Tariq Haines, Nick Kyle, 3
Tariq Haines, Oliver Cullen, 3
Tariq Haines, Paul Haywood, 3
Tim Pugh, Aaron Toms, 1
Tim Pugh, Andy Hicks, 1
Tim Pugh, Anthony Rick, 1
Tim Pugh, Brahim Boyd, 1
Tim Pugh, Conrad Moore, 1
Tim Pugh, Diana Cates, 1
Tim Pugh, Jan Crowe, 2
Tim Pugh, Kathryn Lester, 2
Tim Pugh, Martin Payne, 4
Tim Pugh, Mike Dawson, 8
Tim Pugh, Niyi Akers, 1
Tim Pugh, Will Miles, 1
Wendy Richey, Adrian Bank, 5
Wendy Richey, Andrew Dawn, 5
Wendy Richey, Andrew Kessler, 5
Wendy Richey, Barbara Song, 1
Wendy Richey, Bill Leal, 3
Wendy Richey, Bloomsbury reception staff, 1
Wendy Richey, Brian Aniston, 5
Wendy Richey, Brian Ward, 5
Wendy Richey, Caroline Cook, 3
Wendy Richey, Christopher Hall, 4
Wendy Richey, David Ainsley, 3
Wendy Richey, Derek Pack, 1
Wendy Richey, Ed Steele, 3
Wendy Richey, Greg Beech, 1
Wendy Richey, Jan Crowe, 3
Wendy Richey, Jim Howe, 1
Wendy Richey, John Poole, 1
Wendy Richey, Kathleen Niche, 3
Wendy Richey, Keith Lyon, 3
Wendy Richey, Kerstin Michel, 2
Wendy Richey, Lis Hands, 3
Wendy Richey, Liz Hopper, 5
Wendy Richey, Maria Damon, 5
Wendy Richey, Marion Ross, 5
Wendy Richey, Martin Payne, 1
Wendy Richey, Mat Reed, 3
Wendy Richey, Nick Seals, 3
Wendy Richey, Nigel Hay, 5
Wendy Richey, Niyi Akers, 1
Wendy Richey, Paul Ayers, 3
Wendy Richey, Peter Bates, 1
Wendy Richey, Rachna Kaplan, 1
Wendy Richey, Ray Hardy, 1
Wendy Richey, Richard Baker, 1
Wendy Richey, Richard Fuller, 1
Wendy Richey, Robert Clarke, 5
Wendy Richey, Samuel Mackey, 5
Wendy Richey, Sarah Brante, 1
Wendy Richey, Sean Wall, 3
Wendy Richey, Simon Mann, 5
Wendy Richey, Stella Wigs, 1
Wendy Richey, Tamsin Pitts, 3
Wendy Richey, Tariq Haines, 5
Wendy Richey, Tony Regal, 1
Wendy Richey, Vincent Matthew, 4
Wendy Richey, Yogesh Katz, 1
Will Miles, Aaron Toms, 4
Will Miles, Andy Hicks, 1
Will Miles, Angela Willard, 2
Will Miles, Anthony Fink, 1
Will Miles, Anthony Rick, 2
Will Miles, Bill Leal, 5
Will Miles, Brian Aniston, 1
Will Miles, Chris Randall, 1
Will Miles, Conrad Moore, 1
Will Miles, Ed Steele, 5
Will Miles, Jan Crowe, 4
Will Miles, Jeremy Spain, 1
Will Miles, Kathleen Niche, 3
Will Miles, Maria Damon, 3
Will Miles, Mark Wesley, 1
Will Miles, Martin Payne, 1
Will Miles, Mike Dawson, 6
Will Miles, Nick Kyle, 2
Will Miles, Niyi Akers, 4
Will Miles, Ray Hardy, 1
Will Miles, Richard Fuller, 1
Will Miles, Sean Wall, 5
Will Miles, Steve Curry, 5
Will Miles, Tamsin Pitts, 5
Will Miles, Tim Pugh, 1
Yogesh Katz, Barbara Song, 1
Yogesh Katz, David Shaffer, 1
Yogesh Katz, Ian More, 1
Yogesh Katz, Johnny Glenn, 1
Yogesh Katz, Malcolm Graves, 1

ClosedR

Aaron Toms, Andy Hicks, 10
Aaron Toms, Angela Willard, 9
Aaron Toms, Anthony Rick, 7
Aaron Toms, Brahim Boyd, 9
Aaron Toms, Caroline Cook, 4
Aaron Toms, Chris Randall, 7
Aaron Toms, Jan Crowe, 4
Aaron Toms, Kathleen Niche, 4
Aaron Toms, Kathryn Lester, 8
Aaron Toms, Malcolm Bain, 7
Aaron Toms, Martin Payne, 10
Aaron Toms, Mike Dawson, 10
Aaron Toms, Neena Goland, 1
Aaron Toms, Nick Seals, 4
Aaron Toms, Niyi Akers, 4
Aaron Toms, Robert Clarke, 5
Aaron Toms, Vincent Tooney, 1
Aaron Toms, Will Miles, 6
Alison Crane, Caroline Cook, 8
Alison Crane, Mike Dawson, 10
Alison Crane, Richard Fuller, 8
Andy Hicks, Aaron Toms, 1
Andy Hicks, Angela Willard, 6
Andy Hicks, Anthony Rick, 2
Andy Hicks, Brahim Boyd, 6
Andy Hicks, Caroline Cook, 7
Andy Hicks, Chris Randall, 9
Andy Hicks, David Shaffer, 1
Andy Hicks, Jan Crowe, 7
Andy Hicks, Jason Ortiz, 6
Andy Hicks, John Poole, 3
Andy Hicks, Kathleen Niche, 2
Andy Hicks, Kathryn Lester, 10
Andy Hicks, Kevin Wade, 4
Andy Hicks, Malcolm Bain, 6
Andy Hicks, Marilyn Gallo, 1
Andy Hicks, Martin Payne, 10
Andy Hicks, Mat Reed, 5
Andy Hicks, Mike Dawson, 10
Andy Hicks, Neena Goland, 3
Andy Hicks, Nick Seals, 3
Andy Hicks, Paul Chrone, 3
Andy Hicks, Peter Bates, 4
Andy Hicks, Richard Fuller, 10
Andy Hicks, Robert Clarke, 3
Andy Hicks, Vincent Tooney, 1
Andy Hicks, Will Miles, 2
Angela Willard, Aaron Toms, 2
Angela Willard, Alison Crane, 7
Angela Willard, Andy Hicks, 10
Angela Willard, Anthony Rick, 7
Angela Willard, Brahim Boyd, 5
Angela Willard, Caroline Cook, 9
Angela Willard, Chris Randall, 3
Angela Willard, Colin Penn, 4
Angela Willard, David Sykes, 2
Angela Willard, Jan Crowe, 9
Angela Willard, Jason Ortiz, 8
Angela Willard, John Poole, 2
Angela Willard, Kathleen Niche, 6
Angela Willard, Kathryn Lester, 10
Angela Willard, Malcolm Bain, 8
Angela Willard, Marilyn Gallo, 3
Angela Willard, Martin Payne, 10
Angela Willard, Mat Reed, 8
Angela Willard, Mike Dawson, 10
Angela Willard, Niyi Akers, 9
Angela Willard, Paul Chrone, 7
Angela Willard, Peter Bates, 4
Angela Willard, Richard Fuller, 6
Angela Willard, Robert Clarke, 3
Angela Willard, Sarah Gunn, 6
Angela Willard, Will Miles, 4
Anthony Rick, Aaron Toms, 6
Anthony Rick, Alison Crane, 4
Anthony Rick, Andy Hicks, 4
Anthony Rick, Angela Willard, 8
Anthony Rick, Brahim Boyd, 7
Anthony Rick, Caroline Cook, 4
Anthony Rick, Chris Randall, 3
Anthony Rick, Colin Penn, 4
Anthony Rick, David Shaffer, 10
Anthony Rick, Jan Crowe, 10
Anthony Rick, Janet Perez, 4
Anthony Rick, Jean Mitchon, 4
Anthony Rick, Kathleen Niche, 3
Anthony Rick, Kathryn Lester, 8
Anthony Rick, Malcolm Bain, 3
Anthony Rick, Marilyn Gallo, 6
Anthony Rick, Martin Payne, 7
Anthony Rick, Mike Dawson, 10
Anthony Rick, Neena Goland, 3
Anthony Rick, Nick Kyle, 9
Anthony Rick, Nick Seals, 2
Anthony Rick, Niyi Akers, 4
Anthony Rick, Paul Chrone, 4
Anthony Rick, Peter Bates, 2
Anthony Rick, Richard Baker, 2
Anthony Rick, Richard Fuller, 8
Anthony Rick, Robert Clarke, 3
Anthony Rick, Vincent Tooney, 4
Anthony Rick, Will Miles, 5
Barbara Song, Bill Leal, 6
Barbara Song, Bloomsbury reception staff, 5
Barbara Song, Colin Penn, 8
Barbara Song, David Shaffer, 7
Barbara Song, Ed Steele, 6
Barbara Song, Gladstone MRM, 5
Barbara Song, Gunnebo, 3
Barbara Song, Martin Payne, 9
Barbara Song, Mike Dawson, 9
Barbara Song, Nick Kyle, 9
Barbara Song, Richard Fuller, 9
Barbara Song, Sean Wall, 6
Barbara Song, Tamsin Pitts, 6
Barbara Song, Yogesh Katz, 6
Bill Leal, Chris Randall, 9
Bill Leal, Colin Penn, 8
Bill Leal, Jan Crowe, 8
Bill Leal, Janet Perez, 8
Bill Leal, Jeremy Whitten, 10
Bill Leal, Marilyn Gallo, 8
Bill Leal, Mat Reed, 6
Bill Leal, Nick Kyle, 10
Bill Leal, Richard Fuller, 10
Bill Leal, Robert Clarke, 10
Bill Leal, Sarah Brante, 10
Bill Leal, Tony Boston, 10
Brahim Boyd, Aaron Toms, 3
Brahim Boyd, Andy Hicks, 10
Brahim Boyd, Angela Willard, 10
Brahim Boyd, Anthony Rick, 5
Brahim Boyd, Caroline Cook, 7
Brahim Boyd, Chris Randall, 1
Brahim Boyd, David Sykes, 5
Brahim Boyd, Jan Crowe, 5
Brahim Boyd, Jason Ortiz, 4
Brahim Boyd, John Poole, 1
Brahim Boyd, Kathleen Niche, 9
Brahim Boyd, Kathryn Lester, 10
Brahim Boyd, Malcolm Bain, 4
Brahim Boyd, Marilyn Gallo, 1
Brahim Boyd, Martin Payne, 4
Brahim Boyd, Mike Dawson, 10
Brahim Boyd, Nick Seals, 1
Brahim Boyd, Niyi Akers, 7
Brahim Boyd, Paul Chrone, 6
Brahim Boyd, Peter Bates, 7
Brahim Boyd, Richard Fuller, 1
Brahim Boyd, Robert Clarke, 1
Brian Aniston, Aaron Toms, 9
Brian Aniston, Chris Randall, 6
Brian Aniston, Jan Crowe, 6
Brian Aniston, Kathryn Lester, 9
Brian Aniston, Niyi Akers, 8
Brian Aniston, Robert Clarke, 6
Brian Aniston, Will Miles, 8
Brian Ward, Andy Hicks, 10
Brian Ward, Angela Willard, 6
Brian Ward, Brahim Boyd, 8
Brian Ward, David Shaffer, 6
Brian Ward, Jan Crowe, 6
Brian Ward, Martin Payne, 9
Brian Ward, Mike Dawson, 10
Brian Ward, Robert Clarke, 6
Caroline Cook, Aaron Toms, 8
Caroline Cook, Alison Crane, 7
Caroline Cook, Andy Hicks, 7
Caroline Cook, Angela Willard, 9
Caroline Cook, Chris Randall, 6
Caroline Cook, Colin Penn, 6
Caroline Cook, David Shaffer, 2
Caroline Cook, Jan Crowe, 9
Caroline Cook, Jason Ortiz, 9
Caroline Cook, Kathleen Niche, 7
Caroline Cook, Kathryn Lester, 9
Caroline Cook, Malcolm Bain, 1
Caroline Cook, Marilyn Gallo, 7
Caroline Cook, Martin Payne, 10
Caroline Cook, Mat Reed, 8
Caroline Cook, Mike Dawson, 10
Caroline Cook, Neena Goland, 8
Caroline Cook, Nick Kyle, 8
Caroline Cook, Nick Seals, 4
Caroline Cook, Niyi Akers, 8
Caroline Cook, Peter Bates, 8
Caroline Cook, Richard Fuller, 10
Caroline Cook, Robert Clarke, 6
Caroline Cook, Vincent Tooney, 3
Caroline Cook, Wendy Richey, 4
Caroline Cook, Will Miles, 6
Chris Randall, Anthony Rick, 7
Chris Randall, Ed Steele, 4
Chris Randall, Jan Crowe, 8
Chris Randall, Kathryn Lester, 6
Chris Randall, Malcolm Bain, 5
Chris Randall, Martin Payne, 6
Chris Randall, Nick Kyle, 9
Chris Randall, Nick Seals, 7
Chris Randall, Niyi Akers, 8
Chris Randall, Paul Chrone, 4
Chris Randall, Peter Bates, 3
Chris Randall, Richard Baker, 5
Chris Randall, Richard Fuller, 8
Chris Randall, Robert Clarke, 8
Chris Randall, Simon Farmer, 8
Chris Randall, Will Miles, 8
Christopher Hall, Caroline Cook, 4
Christopher Hall, Chris Randall, 9
Christopher Hall, Colin Penn, 7
Christopher Hall, David Shaffer, 6
Christopher Hall, Kathleen Niche, 8
Christopher Hall, Marilyn Gallo, 10
Christopher Hall, Martin Payne, 7
Christopher Hall, Nick Kyle, 7
Christopher Hall, Nick Seals, 7
Christopher Hall, Niyi Akers, 8
Christopher Hall, Paul Ayers, 7
Christopher Hall, Ray Hardy, 7
Christopher Hall, Richard Fuller, 9
Christopher Hall, Robert Clarke, 8
Christopher Hall, Sarah Gunn, 5
Christopher Hall, Will Miles, 8
Colin Penn, Jan Crowe, 8
Colin Penn, John Poole, 6
Colin Penn, Kathleen Niche, 5
Colin Penn, Marilyn Gallo, 10
Colin Penn, Marion Ross, 8
Colin Penn, Martin Payne, 7
Colin Penn, Mike Dawson, 8
Colin Penn, Nick Kyle, 8
Colin Penn, Niyi Akers, 4
Colin Penn, Richard Fuller, 9
Colin Penn, Will Miles, 8
David Ainsley, Anthony Rick, 9
David Ainsley, Caroline Cook, 9
David Ainsley, Chris Randall, 9
David Ainsley, Colin Penn, 3
David Ainsley, David Shaffer, 3
David Ainsley, Ed Steele, 3
David Ainsley, Jan Crowe, 8
David Ainsley, Kathleen Niche, 9
David Ainsley, Malcolm Bain, 5
David Ainsley, Marilyn Gallo, 10
David Ainsley, Nick Kyle, 9
David Ainsley, Nick Seals, 9
David Ainsley, Niyi Akers, 9
David Ainsley, Richard Fuller, 10
David Ainsley, Robert Clarke, 9
David Ainsley, Sarah Gunn, 7
David Ainsley, Will Miles, 9
David Carne, Aaron Toms, 6
David Carne, Alison Crane, 6
David Carne, Andy Hicks, 8
David Carne, Angela Willard, 8
David Carne, Anthony Rick, 8
David Carne, Brahim Boyd, 1
David Carne, Caroline Cook, 6
David Carne, Chris Randall, 8
David Carne, Colin Penn, 8
David Carne, Jan Crowe, 8
David Carne, Janet Perez, 8
David Carne, John Poole, 6
David Carne, Katherine Pirl, 7
David Carne, Kathleen Niche, 7
David Carne, Kathryn Lester, 7
David Carne, Malcolm Bain, 5
David Carne, Marilyn Gallo, 9
David Carne, Martin Payne, 8
David Carne, Mike Dawson, 6
David Carne, Neena Goland, 1
David Carne, Nick Seals, 8
David Carne, Paul Chrone, 5
David Carne, Richard Fuller, 7
David Carne, Robert Clarke, 7
David Carne, Vincent Tooney, 1
David Carne, Will Miles, 5
David Shaffer, Barbara Song, 4
David Shaffer, Chris Randall, 7
David Shaffer, Ed Steele, 7
David Shaffer, Marilyn Gallo, 10
David Shaffer, Mike Dawson, 9
David Shaffer, Nick Kyle, 9
David Shaffer, Richard Fuller, 9
David Shaffer, Robert Clarke, 8
David Sykes, Aaron Toms, 8
David Sykes, Andy Hicks, 10
David Sykes, Angela Willard, 8
David Sykes, Anthony Rick, 6
David Sykes, Brahim Boyd, 6
David Sykes, Brian Ward, 8
David Sykes, Caroline Cook, 6
David Sykes, Chris Randall, 8
David Sykes, David Shaffer, 6
David Sykes, Jan Crowe, 8
David Sykes, Kathleen Niche, 8
David Sykes, Kathryn Lester, 7
David Sykes, Malcolm Bain, 6
David Sykes, Marilyn Gallo, 8
David Sykes, Martin Payne, 8
David Sykes, Mike Dawson, 10
David Sykes, Nick Kyle, 8
David Sykes, Nick Seals, 8
David Sykes, Niyi Akers, 8
David Sykes, Paul Chrone, 6
David Sykes, Richard Fuller, 8
David Sykes, Robert Clarke, 8
David Sykes, Will Miles, 8
Ed Steele, Barbara Song, 8
Ed Steele, David Shaffer, 6
Ed Steele, Janet Perez, 9
Ed Steele, Marilyn Gallo, 10
Ed Steele, Mat Reed, 10
Ed Steele, Nick Kyle, 10
Ed Steele, Richard Fuller, 10
Ian More, Caroline Cook, 9
Ian More, David Shaffer, 7
Ian More, Ed Steele, 5
Ian More, Janet Perez, 8
Ian More, Kathryn Lester, 8
Ian More, Malcolm Bain, 6
Ian More, Marilyn Gallo, 8
Ian More, Mike Dawson, 9
Ian More, Nick Kyle, 8
Ian More, Richard Fuller, 6
Ian More, Robert Clarke, 7
Jan Crowe, Alison Crane, 4
Jan Crowe, Andy Hicks, 8
Jan Crowe, Caroline Cook, 7
Jan Crowe, Chris Randall, 9
Jan Crowe, Colin Penn, 8
Jan Crowe, Janet Perez, 4
Jan Crowe, Kathleen Niche, 9
Jan Crowe, Kathryn Lester, 7
Jan Crowe, Malcolm Bain, 8
Jan Crowe, Marilyn Gallo, 10
Jan Crowe, Martin Payne, 10
Jan Crowe, Mat Reed, 6
Jan Crowe, Mike Dawson, 8
Jan Crowe, Nick Kyle, 7
Jan Crowe, Niyi Akers, 8
Jan Crowe, Peter Bates, 6
Jan Crowe, Richard Fuller, 10
Jan Crowe, Robert Clarke, 8
Jan Crowe, Will Miles, 8
Jason Ortiz, Brahim Boyd, 9
Jason Ortiz, Caroline Cook, 4
Jason Ortiz, Chris Randall, 7
Jason Ortiz, Janet Perez, 2
Jason Ortiz, John Poole, 3
Jason Ortiz, Kathleen Niche, 2
Jason Ortiz, Kathryn Lester, 9
Jason Ortiz, Kevin Gabbel, 2
Jason Ortiz, Kevin Wade, 7
Jason Ortiz, Marilyn Gallo, 1
Jason Ortiz, Martin Payne, 10
Jason Ortiz, Mat Reed, 3
Jason Ortiz, Mike Dawson, 10
Jason Ortiz, Nick Kyle, 4
Jason Ortiz, Peter Bates, 6
Jason Ortiz, Richard Baker, 6
Jason Ortiz, Richard Fuller, 10
Jason Ortiz, Robert Clarke, 7
Jim Howe, Jason Ortiz, 7
Jim Howe, John Poole, 5
Jim Howe, Marilyn Gallo, 4
Jim Howe, Martin Payne, 6
Jim Howe, Mike Dawson, 10
Jim Howe, Nick Kyle, 8
Jim Howe, Peter Bates, 6
Jim Howe, Richard Baker, 3
Jim Howe, Richard Fuller, 8
John Poole, Andy Hicks, 7
John Poole, Angela Willard, 5
John Poole, Brahim Boyd, 5
John Poole, Caroline Cook, 6
John Poole, Jan Crowe, 8
John Poole, Jason Ortiz, 6
John Poole, Katherine Pirl, 4
John Poole, Kevin Wade, 8
John Poole, Martin Payne, 10
John Poole, Mat Reed, 8
John Poole, Mike Dawson, 10
John Poole, Nick Kyle, 6
John Poole, Niyi Akers, 7
John Poole, Peter Bates, 4
John Poole, Richard Fuller, 8

John Poole, Sarah Gunn, 6
John Poole, Will Miles, 6
Kathleen Niche, Aaron Toms, 10
Kathleen Niche, Andy Hicks, 10
Kathleen Niche, Anthony Rick, 10
Kathleen Niche, Caroline Cook, 10
Kathleen Niche, Christopher Hall, 10
Kathleen Niche, David Ainsley, 10
Kathleen Niche, Malcolm Bain, 10
Kathleen Niche, Marilyn Gallo, 10
Kathleen Niche, Nick Seals, 10
Kathleen Niche, Niyi Akers, 10
Kathleen Niche, Richard Fuller, 10
Kathleen Niche, Will Miles, 10
Kathryn Lester, Aaron Toms, 4
Kathryn Lester, Alison Crane, 4
Kathryn Lester, Andy Hicks, 6
Kathryn Lester, Angela Willard, 2
Kathryn Lester, Anthony Rick, 1
Kathryn Lester, Bill Leal, 1
Kathryn Lester, Brahim Boyd, 6
Kathryn Lester, Caroline Cook, 10
Kathryn Lester, Chris Randall, 3
Kathryn Lester, David Shaffer, 8
Kathryn Lester, Ed Steele, 1
Kathryn Lester, Jan Crowe, 6
Kathryn Lester, Jason Ortiz, 8
Kathryn Lester, Kathleen Niche, 4
Kathryn Lester, Kerstin Michel, 5
Kathryn Lester, Malcolm Bain, 6
Kathryn Lester, Martin Payne, 8
Kathryn Lester, Mat Reed, 8
Kathryn Lester, Mike Dawson, 10
Kathryn Lester, Niyi Akers, 10
Kathryn Lester, Peter Bates, 1
Kathryn Lester, Richard Fuller, 8
Kathryn Lester, Robert Clarke, 3
Kathryn Lester, Sarah Gunn, 8
Kathryn Lester, Sean Wall, 1
Kathryn Lester, Tamsin Pitts, 1
Kathryn Lester, Vincent Tooney, 3
Kathryn Lester, Will Miles, 7
Kerstin Michel, Anthony Rick, 7
Kerstin Michel, Brahim Boyd, 8
Kerstin Michel, Caroline Cook, 8
Kerstin Michel, Chris Randall, 10
Kerstin Michel, Colin Penn, 7
Kerstin Michel, Jan Crowe, 8
Kerstin Michel, Janet Perez, 8
Kerstin Michel, Jason Ortiz, 8
Kerstin Michel, Kathleen Niche, 8
Kerstin Michel, Kathryn Lester, 9
Kerstin Michel, Malcolm Bain, 7
Kerstin Michel, Marilyn Gallo, 10
Kerstin Michel, Mat Reed, 8
Kerstin Michel, Mike Dawson, 9
Kerstin Michel, Nick Kyle, 7
Kerstin Michel, Nick Seals, 7
Kerstin Michel, Niyi Akers, 9
Kerstin Michel, Richard Fuller, 10
Kerstin Michel, Robert Clarke, 10
Kerstin Michel, Wendy Richey, 5
Kerstin Michel, Will Miles, 9
Malcolm Bain, Andy Hicks, 10
Malcolm Bain, Caroline Cook, 8
Malcolm Bain, Chris Randall, 8
Malcolm Bain, Jan Crowe, 9
Malcolm Bain, Janet Perez, 7
Malcolm Bain, John Poole, 5
Malcolm Bain, Kathleen Niche, 6
Malcolm Bain, Kathryn Lester, 8
Malcolm Bain, Martin Payne, 10
Malcolm Bain, Mat Reed, 7
Malcolm Bain, Mike Dawson, 10
Malcolm Bain, Peter Bates, 7
Malcolm Bain, Richard Fuller, 9
Malcolm Bain, Robert Clarke, 6
Malcolm Bain, Vincent Tooney, 8
Maria Damon, Anthony Rick, 10
Maria Damon, Chris Randall, 10
Maria Damon, Ed Steele, 10
Maria Damon, Jan Crowe, 10
Maria Damon, Kathryn Lester, 10
Maria Damon, Marilyn Gallo, 10
Maria Damon, Mike Dawson, 10
Maria Damon, Nick Kyle, 10
Maria Damon, Richard Fuller, 10
Maria Damon, Robert Clarke, 8
Maria Damon, Will Miles, 10
Marilyn Gallo, Alison Crane, 6
Marilyn Gallo, Anthony Rick, 10
Marilyn Gallo, Chris Randall, 10
Marilyn Gallo, Colin Penn, 6
Marilyn Gallo, David Shaffer, 10
Marilyn Gallo, Ed Steele, 10
Marilyn Gallo, Jan Crowe, 10
Marilyn Gallo, Janet Perez, 10
Marilyn Gallo, Jason Ortiz, 10
Marilyn Gallo, Kathleen Niche, 10
Marilyn Gallo, Kathryn Lester, 10
Marilyn Gallo, Malcolm Bain, 10
Marilyn Gallo, Martin Payne, 10
Marilyn Gallo, Mike Dawson, 10
Marilyn Gallo, Nick Kyle, 10
Marilyn Gallo, Nick Seals, 10
Marilyn Gallo, Niyi Akers, 10
Marilyn Gallo, Richard Fuller, 10
Marilyn Gallo, Robert Clarke, 10
Marilyn Gallo, Will Miles, 10
Marion Ross, Colin Penn, 10
Marion Ross, Ed Steele, 3
Marion Ross, Jan Crowe, 8
Marion Ross, Janet Perez, 8
Marion Ross, Kathryn Lester, 7
Marion Ross, Marilyn Gallo, 10
Marion Ross, Martin Payne, 9
Marion Ross, Mike Dawson, 10
Marion Ross, Nick Kyle, 10
Marion Ross, Niyi Akers, 10
Marion Ross, Richard Fuller, 10
Marion Ross, Robert Clarke, 7
Martin Payne, Aaron Toms, 1
Martin Payne, Alison Crane, 3
Martin Payne, Andy Hicks, 10
Martin Payne, Angela Willard, 6
Martin Payne, Anthony Rick, 1
Martin Payne, Brahim Boyd, 6
Martin Payne, Caroline Cook, 8
Martin Payne, Chris Randall, 8
Martin Payne, Colin Penn, 1
Martin Payne, David Shaffer, 4
Martin Payne, Jan Crowe, 10
Martin Payne, Janet Perez, 8
Martin Payne, Jason Ortiz, 8
Martin Payne, John Poole, 9
Martin Payne, Kathleen Niche, 8
Martin Payne, Kathryn Lester, 9
Martin Payne, Kevin Wade, 6
Martin Payne, Malcolm Bain, 7
Martin Payne, Marilyn Gallo, 3
Martin Payne, Mat Reed, 10
Martin Payne, Mike Dawson, 10
Martin Payne, Nick Kyle, 7
Martin Payne, Niyi Akers, 6
Martin Payne, Peter Bates, 8
Martin Payne, Richard Baker, 8
Martin Payne, Richard Fuller, 10
Martin Payne, Robert Clarke, 4
Martin Payne, Sarah Gunn, 4
Martin Payne, Vincent Tooney, 8
Martin Payne, Will Miles, 7
Mat Reed, Aaron Toms, 7
Mat Reed, Andy Hicks, 10
Mat Reed, Angela Willard, 9
Mat Reed, Brahim Boyd, 9
Mat Reed, Caroline Cook, 9
Mat Reed, Chris Randall, 5
Mat Reed, Colin Penn, 6
Mat Reed, Jan Crowe, 8
Mat Reed, Janet Perez, 6
Mat Reed, Jason Ortiz, 8
Mat Reed, Kathleen Niche, 7
Mat Reed, Kathryn Lester, 10
Mat Reed, Malcolm Bain, 7
Mat Reed, Martin Payne, 10
Mat Reed, Mike Dawson, 10
Mat Reed, Nick Kyle, 7
Mat Reed, Niyi Akers, 9
Mat Reed, Peter Bates, 7
Mat Reed, Richard Fuller, 7
Mat Reed, Robert Clarke, 7
Mike Dawson, Alison Crane, 1
Mike Dawson, Andy Hicks, 10
Mike Dawson, Angela Willard, 5
Mike Dawson, Brahim Boyd, 7
Mike Dawson, Caroline Cook, 6
Mike Dawson, Chris Randall, 3
Mike Dawson, David Shaffer, 1
Mike Dawson, Jan Crowe, 6
Mike Dawson, Jason Ortiz, 8
Mike Dawson, John Poole, 2
Mike Dawson, Kathleen Niche, 6
Mike Dawson, Kathryn Lester, 9
Mike Dawson, Kevin Wade, 5
Mike Dawson, Malcolm Bain, 5
Mike Dawson, Martin Payne, 10
Mike Dawson, Mat Reed, 6
Mike Dawson, Niyi Akers, 6
Mike Dawson, Peter Bates, 1
Mike Dawson, Richard Baker, 2
Mike Dawson, Richard Fuller, 10
Mike Dawson, Robert Clarke, 6
Mike Dawson, Steve Baruty, 2
Mike Dawson, Will Miles, 6
Niyi Akers, Aaron Toms, 5
Niyi Akers, Andy Hicks, 9
Niyi Akers, Angela Willard, 6
Niyi Akers, Anthony Rick, 6
Niyi Akers, Brahim Boyd, 9
Niyi Akers, Caroline Cook, 8
Niyi Akers, Chris Randall, 10
Niyi Akers, Colin Penn, 6
Niyi Akers, David Shaffer, 8
Niyi Akers, Jan Crowe, 9
Niyi Akers, Janet Perez, 6
Niyi Akers, Katherine Pirl, 2
Niyi Akers, Kathleen Niche, 7
Niyi Akers, Kathryn Lester, 7
Niyi Akers, Malcolm Bain, 5
Niyi Akers, Marilyn Gallo, 10
Niyi Akers, Martin Payne, 10
Niyi Akers, Mike Dawson, 10
Niyi Akers, Nick Kyle, 10
Niyi Akers, Nick Seals, 8
Niyi Akers, Peter Bates, 5
Niyi Akers, Richard Baker, 6
Niyi Akers, Richard Fuller, 10
Niyi Akers, Robert Clarke, 7
Niyi Akers, Sarah Gunn, 6
Niyi Akers, Will Miles, 7
Noshir Holmes, Aaron Toms, 7
Noshir Holmes, Angela Willard, 10
Noshir Holmes, Brahim Boyd, 10
Noshir Holmes, David Carne, 7
Noshir Holmes, Jan Crowe, 7
Noshir Holmes, Kathleen Niche, 6
Noshir Holmes, Kathryn Lester, 8
Noshir Holmes, Marilyn Gallo, 4
Noshir Holmes, Martin Payne, 10
Noshir Holmes, Mike Dawson, 10
Noshir Holmes, Najeeb Gulte, 7
Noshir Holmes, Niyi Akers, 6
Noshir Holmes, Quentin Nord, 7
Noshir Holmes, Robert Gooseby, 7
Paul Ayers, Jan Crowe, 10
Paul Ayers, Janet Perez, 10
Paul Ayers, Vincent Matthew, 10
Peter Bates, Andy Hicks, 3
Peter Bates, Angela Willard, 1
Peter Bates, David Shaffer, 4
Peter Bates, Jan Crowe, 6
Peter Bates, Janet Perez, 6
Peter Bates, Jason Ortiz, 6
Peter Bates, Kathleen Niche, 7
Peter Bates, Malcolm Bain, 6
Peter Bates, Martin Payne, 9
Peter Bates, Mat Reed, 6
Peter Bates, Mike Dawson, 7
Peter Bates, Nick Kyle, 6
Peter Bates, Niyi Akers, 4
Peter Bates, Richard Baker, 7
Peter Bates, Richard Fuller, 9
Peter Bates, Robert Clarke, 4
Quentin Nord, Angela Willard, 9
Quentin Nord, Martin Payne, 10
Quentin Nord, Will Miles, 6
Ray Hardy, Christopher Hall, 7
Ray Hardy, David Shaffer, 6
Ray Hardy, Derek Pack, 8
Ray Hardy, Greg Beech, 6
Ray Hardy, Jim Howe, 7
Ray Hardy, Martin Payne, 10
Ray Hardy, Mike Dawson, 7
Ray Hardy, Nick Kyle, 8
Ray Hardy, Paul Ayers, 9
Ray Hardy, Richard Fuller, 9
Ray Hardy, Sarah Brante, 7
Richard Baker, Chris Randall, 4
Richard Baker, John Poole, 5
Richard Baker, Katherine Pirl, 7
Richard Baker, Kathryn Lester, 7
Richard Baker, Malcolm Bain, 7
Richard Baker, Marilyn Gallo, 8
Richard Baker, Martin Payne, 10
Richard Baker, Mike Dawson, 9
Richard Baker, Nick Kyle, 8
Richard Baker, Nick Seals, 8
Richard Baker, Peter Bates, 8
Richard Baker, Richard Fuller, 10
Richard Baker, Robert Clarke, 4
Richard Baker, Vincent Tooney, 8
Richard Baker, Will Miles, 4
Richard Fuller, Anthony Rick, 2
Richard Fuller, Chris Randall, 4
Richard Fuller, Colin Penn, 4
Richard Fuller, David Shaffer, 6
Richard Fuller, Jan Crowe, 9
Richard Fuller, Janet Perez, 9
Richard Fuller, Jason Ortiz, 9
Richard Fuller, Jean Mitchon, 1
Richard Fuller, John Poole, 3
Richard Fuller, Katherine Pirl, 3
Richard Fuller, Kathleen Niche, 8
Richard Fuller, Kathryn Lester, 8
Richard Fuller, Kevin Gabbel, 4
Richard Fuller, Malcolm Bain, 5
Richard Fuller, Marilyn Gallo, 7
Richard Fuller, Martin Payne, 8
Richard Fuller, Mike Dawson, 8
Richard Fuller, Nick Kyle, 8
Richard Fuller, Nick Seals, 4
Richard Fuller, Niyi Akers, 7
Richard Fuller, Paul Chrone, 3
Richard Fuller, Peter Bates, 5
Richard Fuller, Richard Baker, 6
Richard Fuller, Robert Clarke, 7
Richard Fuller, Sarah Gunn, 6
Richard Fuller, Wendy Richey, 2
Richard Fuller, Will Miles, 7
Robert Clarke, Aaron Toms, 7
Robert Clarke, Alison Crane, 7
Robert Clarke, Andy Hicks, 10
Robert Clarke, Angela Willard, 8
Robert Clarke, Anthony Rick, 5
Robert Clarke, Brahim Boyd, 7
Robert Clarke, Caroline Cook, 7
Robert Clarke, Chris Randall, 5
Robert Clarke, Colin Penn, 6
Robert Clarke, David Shaffer, 1
Robert Clarke, Ed Steele, 1
Robert Clarke, Jan Crowe, 7
Robert Clarke, Janet Perez, 8
Robert Clarke, Jason Ortiz, 7
Robert Clarke, Jean Mitchon, 1
Robert Clarke, John Poole, 1
Robert Clarke, Katherine Pirl, 1
Robert Clarke, Kathleen Niche, 8
Robert Clarke, Kathryn Lester, 10
Robert Clarke, Malcolm Bain, 7
Robert Clarke, Marilyn Gallo, 8
Robert Clarke, Martin Payne, 10
Robert Clarke, Mike Dawson, 10
Robert Clarke, Neena Goland, 7
Robert Clarke, Nick Kyle, 10
Robert Clarke, Niyi Akers, 10
Robert Clarke, Paul Chrone, 6
Robert Clarke, Peter Bates, 7
Robert Clarke, Richard Baker, 7
Robert Clarke, Richard Fuller, 10
Robert Clarke, Sarah Gunn, 5
Robert Clarke, Wendy Richey, 1
Robert Clarke, Will Miles, 8
Sarah Gunn, Anthony Rick, 7
Sarah Gunn, Chris Randall, 9
Sarah Gunn, Colin Penn, 7
Sarah Gunn, David Shaffer, 8
Sarah Gunn, John Poole, 8
Sarah Gunn, Katherine Pirl, 1
Sarah Gunn, Kathryn Lester, 7
Sarah Gunn, Marilyn Gallo, 9
Sarah Gunn, Martin Payne, 9
Sarah Gunn, Neena Goland, 5
Sarah Gunn, Nick Kyle, 9
Sarah Gunn, Niyi Akers, 7
Sarah Gunn, Richard Fuller, 9
Sarah Gunn, Robert Clarke, 8
Sarah Gunn, Will Miles, 7
Sean Wall, Anthony Rick, 6
Sean Wall, Bill Leal, 7
Sean Wall, Chris Randall, 8
Sean Wall, Colin Penn, 9
Sean Wall, David Shaffer, 6
Sean Wall, Janet Perez, 7
Sean Wall, John Poole, 6
Sean Wall, Kathryn Lester, 6
Sean Wall, Marilyn Gallo, 7
Sean Wall, Nick Kyle, 8
Sean Wall, Niyi Akers, 7
Sean Wall, Richard Fuller, 7
Sean Wall, Robert Clarke, 7
Sean Wall, Tamsin Pitts, 7
Sean Wall, Will Miles, 8
Tamsin Pitts, Bill Leal, 6
Tamsin Pitts, Chris Randall, 10
Tamsin Pitts, David Shaffer, 8
Tamsin Pitts, Ed Steele, 6
Tamsin Pitts, Janet Perez, 8
Tamsin Pitts, Jason Ortiz, 7
Tamsin Pitts, Malcolm Graves, 8
Tamsin Pitts, Marilyn Gallo, 7
Tamsin Pitts, Martin Payne, 6
Tamsin Pitts, Mike Dawson, 10
Tamsin Pitts, Nick Kyle, 10
Tamsin Pitts, Niyi Akers, 7
Tamsin Pitts, Richard Fuller, 10
Tamsin Pitts, Robert Clarke, 9
Tamsin Pitts, Ruth Simon, 8
Tamsin Pitts, Sarah Brante, 7
Tamsin Pitts, Sean Wall, 6
Tim Pugh, Aaron Toms, 8
Tim Pugh, Andy Hicks, 8
Tim Pugh, Angela Willard, 6
Tim Pugh, Anthony Rick, 8
Tim Pugh, Brahim Boyd, 7
Tim Pugh, Caroline Cook, 6
Tim Pugh, Jan Crowe, 8
Tim Pugh, Jason Ortiz, 7
Tim Pugh, John Poole, 5
Tim Pugh, Kathryn Lester, 7
Tim Pugh, Marilyn Gallo, 5
Tim Pugh, Martin Payne, 9
Tim Pugh, Mat Reed, 7
Tim Pugh, Mike Dawson, 10
Tim Pugh, Niyi Akers, 6

Tim Pugh, Richard Fuller, 6
Tim Pugh, Robert Clarke, 6
Tim Pugh, Will Miles, 7
Wendy Richey, Anthony Rick, 7
Wendy Richey, Caroline Cook, 8
Wendy Richey, Chris Randall, 10
Wendy Richey, Christopher Hall, 10
Wendy Richey, Ed Steele, 10
Wendy Richey, Kathryn Lester, 10
Wendy Richey, Kerstin Michel, 10
Wendy Richey, Malcolm Bain, 10
Wendy Richey, Marilyn Gallo, 10
Wendy Richey, Niyi Akers, 8
Wendy Richey, Richard Fuller, 10
Wendy Richey, Robert Clarke, 10
Wendy Richey, Vincent Matthew, 10
Wendy Richey, Will Miles, 10
Will Miles, Aaron Toms, 10
Will Miles, Andy Hicks, 10
Will Miles, Angela Willard, 7
Will Miles, Anthony Rick, 9
Will Miles, Brahim Boyd, 4
Will Miles, Brian Aniston, 9
Will Miles, Chris Randall, 4
Will Miles, Colin Penn, 1
Will Miles, Jan Crowe, 9
Will Miles, Janet Perez, 6
Will Miles, Kathleen Niche, 7
Will Miles, Kathryn Lester, 5
Will Miles, Malcolm Bain, 3
Will Miles, Maria Damon, 6
Will Miles, Marilyn Gallo, 2
Will Miles, Martin Payne, 8
Will Miles, Mike Dawson, 10
Will Miles, Niyi Akers, 9
Will Miles, Noshir Holmes, 8
Will Miles, Paul Chrone, 2
Will Miles, Ray Hardy, 6
Will Miles, Richard Fuller, 6
Will Miles, Robert Clarke, 2
Will Miles, Tim Pugh, 8
Yogesh Katz, Barbara Song, 5
Yogesh Katz, David Shaffer, 8
Yogesh Katz, Ian More, 8
Yogesh Katz, Johnny Glenn, 5
Yogesh Katz, Malcolm Graves, 10
Yogesh Katz, Nick Kyle, 10
Yogesh Katz, Robert Clarke, 10

Stakeholders and Their Roles

Stakeholder	Stakeholder Role
Aaron Toms	Management Systems: UPI
Adrian Bank	IS Operating Systems Group
Alison Crane	students: medical students
Andrew Dawn	IS Operating Systems Group
Andrew Kessler	IS - Network Group
Andy Faulk	heads of departments: language & speech sciences
Andy Hicks	Management Systems: interface developer
Andy Kirb	Management Systems
Angela Willard	Management Systems: Maintenance
Anthony Fink	Administrative Systems Sub-Committee
Anthony Rick	Management Systems
Art Waller	Development and Corporate Comms Office
Barbara Song	UCL Union: bloomsbury fitness
Barry Wayne	staff: division of biosciences
Bill Leal	staff: staff union
Bob Alford	senior tutor
Brahim Boyd	Management Systems: Maintenance
Brian Aniston	IS Academic and Applications Support Group
Brian Ward	IS Operating Systems Group
Bruce Cornell	staff: division of biosciences
Caroline Cook	Registry: Student Records
Caroline Goodman	staff: division of biosciences
Chris Randall	Information Strategy Committee, Information Services Division
Christina Solis	Estates and Facilities Division: UCL shop
Christopher Hall	Registry
Colin Penn	Estates and Facilities Division: Records and Data Protection
Colin Street	gym users
Conrad Moore	Management Systems: UPI
David Ainsley	Registry
David Boggs	Graduate School
David Carne	Management Systems
David Shaffer	UCL Union: bloomsbury fitness
David Sykes	Management Systems: Maintenance
Derek Pack	Estates and Facilities Division: Property Maintenance and Facilities Management
Diana Cates	Security and Access Systems: card issue
Ed Steele	students: student officer
Fred Bean	visitors and contractors: volunteers
Greg Beech	Estates and Facilities Division: Capital Programme Management and Procurement
Harry Gore	Information Services Division
Ian More	UCL Union: bloomsbury fitness
Jan Crowe	Library Services
Janet Perez	Library Services
Jason Ortiz	Security and Access Systems
Jeremy Spain	Web Services
Jim Howe	Estates and Facilities Division: Property Maintenance and Facilities Management

Stakeholder	Stakeholder Role
John Poole	Estates and Facilities Division
Johnny Glenn	clubs and societies
Jots Semb	Management Systems
Kathleen Niche	Registry
Kathryn Lester	Management Systems
Keith Lyon	Library Services
Kerstin Michel	departmental administrators
Kevin Wade	Vidionics
Libby Smite	Security and Access Systems: card issue
Lis Hands	Library Services
Liz Hopper	IS - Operations Group
Majid Khande	Management Systems: HR data
Malcolm Bain	Management Systems: business process analyst
Malcolm Graves	Provost
Maria Damon	Information Systems
Maria Wilkes	Information Systems
Marilyn Gallo	Corporate Support Services
Marion Lam	Disability Centre
Marion Ross	IS - Computer Security Team
Mark Suddy	Development and Corporate Comms Office
Mark Wesley	security staff
Martin Payne	Estates and Facilities Division
Mat Reed	Library Services
Michael Wondor	Provost
Mick Carin	Management Systems: UPI/SITS
Mike Dawson	Security and Access Systems
Mike Hawan	Management Systems: FIS
Neil Roper	Development and Corporate Comms Office
Nic Crone	Management Systems: VPN
Nick Kyle	Security and Access Systems
Nick Seals	Registry
Nicolas Curry	potential criminals
Nigel Hay	IS - Network Group
Niyi Akers	Human Resources Division
Noel Forrest	security staff: library
Noshir Holmes	Management Systems
Oliver Cullen	security staff
Paul Ayers	Library Services
Paul Chrone	Management Systems: New servers
Paul Haywood	Security and Access Systems
Paul Lake	Security and Access Systems
Peter Bates	Estates and Facilities Division: project assurance
Quentin Nord	Management Systems
Rachna Kaplan	Human Resources Division: HR system
Ray Hardy	Estates and Facilities Division: Administration
Richard Baker	Estates and Facilities Division: Project assurance
Richard Fuller	Estates and Facilities Division
Richard Marsh	staff: division of biosciences
Robert Clarke	Information Systems
Roger All	gym users
Ruth Simon	Dean of Students

Stakeholder	Stakeholder Role
Samuel Mackey	IS Academic and Applications Support Group
Sarah Brante	Human Resources Division
Sarah Gunn	Development and Corporate Comms Office
Sean Wall	staff: staff union
Simon Farmer	Information Services Division
Simon Mann	IS - Operations Group
Stella Wigs	Estates and Facilities Division
Steph Garcia	Management Systems: Portico
Steve Curry	heads of departments
Tamsin Pitts	staff: staff union
Tariq Haines	IS - Network Group
Tim Pugh	Management Systems: UPI
Tony Boston	security staff
Tony Regal	Human Resources Division: HR system
Vincent Matthew	Library Services
Wendy Richey	students: short course students
Will Miles	Management Systems
Yogesh Katz	UCL Union: bloomsbury fitness
	alumni and bequests
	Bloomsbury reception staff
	Cardax UK
	external library users
	Gladstone MRM
	Gunnebo
	major incident team
	other higher education institutes
	potential criminals
	public
	Security and Access Systems: photographers
	UCL affiliated NHS trusts
	Universal Smart Cards

Appendix E StakeRare Questionnaire

Requirements Elicitation Survey

As part of our research at the Department of Computer Science, we have developed a method to gather the requirements for a software project.

The survey aims to collect project data for testing the method. It should take 30 minutes to complete.

Your name and answers are confidential and will be used strictly for research.

Thank you for your participation.

Regards,

Soo Ling Lim
Professor Anthony Finkelstein

Department of Computer Science
University College London
Gower Street
London WC1E 6BT
United Kingdom

The RALIC Project

In 2005, UCL had a variety of access and security systems. As a result, identification and access control methods varied from building to building.

Staff, students, and visitors had to use two or more of the following access control measures:

- Magnetic strip swipe card
- Contactless Smart Card
- Photo ID Card
- Library Barcode
- Philips “Black key”
- Digital Security Code
- Metal door keys
- Session Card
- Bloomsbury Fitness Centre Card

The RALIC project was initiated to provide one card that replaces all of the above measures.

Below is the summarised scope of the RALIC project.

1. Replace magnetic swipe card readers with smart card readers
2. Source and install access card printers
3. Decide on card design and categories
4. Define user groups and default access rights
5. Provide a more accurate card holder database, save resources on manual data input, and facilitate automated provision and suspension of access and library borrowing rights
6. Issue new cards to staff, students, visitors and contractors
7. Replace the Library access control system
8. Use new cards at the Bloomsbury Fitness Centre

Requirements

A requirement is a statement that identifies a necessary attribute, capability, characteristic, or quality of a system in order for it to have value and utility to a stakeholder.

Examples	Template
• To reduce the time a student spends queuing for access cards (provided by student registry). • To borrow library books (provided by students).	To <a goal you want to achieve by using the system>.
• To control access to university buildings.	To <a goal the enterprise should achieve from the system in operation>.
• Per annum, save 9000 pounds on purchase of access cards (provided by director of Estates).	By / Within / Per annum <a measurable criteria to know if the enterprise's goal is achieved>.
• Security guards should be able to view cardholder photos (provided by security guard).	<subject> should [not] be able to <action> (by using the system).
• An individual without an access card must not enter the Computer Science building (provided by Computer Science department admin). • The identification card must display the UCL logo.	<subject> must / should [not] <action> [if/while <condition>].
• The system must be compatible with other UCL systems. • The system should have an expected Life Cycle and Product Support of more than 10 years.	The system must / should [not] <performance criteria>. Examples of performance criteria: • Compliance • Time behaviour • Fault tolerance

Types of Requirements

A requirement can be:

- A **Business Goal**: a state or target that the enterprise intends to achieve or maintain with the system.
- An **Objective**: a quantitatively measurable and specific state or target that the enterprise intends to achieve or maintain with the system.
- A **System Goal**: a state or target that you intend to achieve or maintain by using the system.
- A **Capability Constraint**: a restriction on how the system achieves your goal.
- A **Quality of Service Constraint**: a quality restriction on the behaviour of the system.
- A **Business Policy**: a directive from the enterprise that defines what can be done and what must not be done, and may indicate or set limits on how it should be done.
- A **Business Rule**: a directive from the enterprise that provides specific and discrete governance or guidance to implement Business Policies.

The RALIC Project

Questionnaire for

Requirements Elicitation

Please complete the following information about yourself.

Name:________________________________

Position:________________________________

Department:________________________________

What stakeholder do you represent in the RALIC project?

Question 1

Please **write your requirements for RALIC** in the space below following the template we provided.

Then, **rank the requirements** based on their importance to you in the right-hand column (1 being the most important).

Finally, **write requirements that you actively do not want**, and **put an X** in the right-hand column.

Requirement	Rank/X

Requirement	Rank/X

How did you find Question 1?

Please **circle** the appropriate answer.

Level of difficulty	**Low**	**Medium**	**High**
Effort required	**Low**	**Medium**	**High**
Time spent	**Low**	**Medium**	**High**

-- End of Question 1 ---

Question 2

Below is a list of requirements for RALIC.

Rate them from 0 (not important to you) to 5 (very important to you).

Circle -1 for requirements that you **actively do not want** in the system.

Requirements	**Increasing importance →**						
1. Better user experience	-1	0	1	2	3	4	5
1.1 Access cards that are easier to use with more accurate scanning	-1	0	1	2	3	4	5
1.2 For library entrance, remove the need to put card in exact location for barcode scanning	-1	0	1	2	3	4	5
1.3 All in one card	-1	0	1	2	3	4	5
1.3.1 ID card and session card	-1	0	1	2	3	4	5
1.3.2 Library card	-1	0	1	2	3	4	5
1.3.3 Bloomsbury fitness	-1	0	1	2	3	4	5
1.3.4 Club and societies	-1	0	1	2	3	4	5
1.3.5 Cashless vending	-1	0	1	2	3	4	5
1.3.6 Time and attendance	-1	0	1	2	3	4	5
1.3.7 Computer Logon	-1	0	1	2	3	4	5
1.3.8 Santander Bank Card	-1	0	1	2	3	4	5
2. Improve processes (reduce manual data entry and improve efficiency for access control and library processes)	-1	0	1	2	3	4	5
2.1 Library barcode generated together with card (less 1 library queue)	-1	0	1	2	3	4	5
2.2 Import photos from registry for advance card production (save queuing time for students)	-1	0	1	2	3	4	5
2.3 Centralised management of access and identification information	-1	0	1	2	3	4	5
2.4 Card issue available anywhere within the UCL campus	-1	0	1	2	3	4	5
2.5 Digitally storing, printing and exporting photographs to other systems	-1	0	1	2	3	4	5
2.5.1 Staff photograph	-1	0	1	2	3	4	5
2.5.2 Student photograph	-1	0	1	2	3	4	5
3. Improved security	-1	0	1	2	3	4	5
3.1 Enable security/reception staff to check that the appearance of the card user matches the digitally stored photo	-1	0	1	2	3	4	5
3.2 More locations to be controlled by smart card access readers	-1	0	1	2	3	4	5
3.3 Enable the reliable removal/suspension of access rights and library borrowing privileges	-1	0	1	2	3	4	5
3.4 Enable the gathering and retrieval of the time which individuals enter and leave buildings	-1	0	1	2	3	4	5
3.4.1 Library	-1	0	1	2	3	4	5
3.4.2 Other buildings	-1	0	1	2	3	4	5

Write other requirements you have or actively do not want following the template we provided. Please also **rate** the requirements.

Requirements	Increasing importance →						
	-1	0	1	2	3	4	5
	-1	0	1	2	3	4	5
	-1	0	1	2	3	4	5
	-1	0	1	2	3	4	5

Requirements	Increasing importance →						
	-1	0	1	2	3	4	5
	-1	0	1	2	3	4	5
	-1	0	1	2	3	4	5
	-1	0	1	2	3	4	5

How did you find Question 2?

Please **circle** the appropriate answer.

Level of difficulty	**Low**	**Medium**	**High**
Effort required	**Low**	**Medium**	**High**
Time spent	**Low**	**Medium**	**High**

-- End of Question 2 ---

Question 3

You are given 100 points.

Please **distribute the points** among the requirements you want in **Question 2**.
Allocate *more* points to requirements that are more important to you.

Requirement	Points

Requirement	Points

How did you find Question 3?

Please **circle** the appropriate answer.

Level of difficulty	**Low**	**Medium**	**High**
Effort required	**Low**	**Medium**	**High**
Time spent	**Low**	**Medium**	**High**

-- End of Question 3 ---

Question 4

How much do you care about RALIC?

Please **circle** the appropriate answer.

Not at all	**A little**	**So so**	**A lot**

Please write any other comments below.

Appendix F StakeRare Datasets

The datasets are also available at http://www.cs.ucl.ac.uk/staff/S.Lim/phd/dataset.html.

Requirements List

ID	Short Description of Requirement
a	better user experience
a.1	easier to use
a.1.1	more accurate scanning
a.1.2	easy to see
a.1.3	easy to reach
a.1.4	card convenient and likely to be carried
a.2	use the same access control for library entrance
a.3	all in 1 card
a.3.1	combine ID card and session card
a.3.2	combine Library card
a.3.3	combine Bloomsbury fitness card
a.3.4	combine Club and societies card
a.3.5	be compatible with NHS
a.3.6	the combine card should not have too many features (don't want it to become too valuable to change for locker keys)
b	card design
b.1	card to include user details
b.1.1	card to include name
b.1.2	card to include photo
b.1.3	card to include UPI
b.1.4	card design to include card type/user status
b.1.5	card to include payroll number
b.1.6	card to include job title
b.1.7	card to include expiry date
b.1.8	card to include department
b.1.9	card to include student number
b.2	card to include barcode
b.2.1	easier reading of barcode by scanner
b.3	card should be secure
b.3.1	card not easily copied
b.3.2	card should have features that prevent sharing
b.3.3	card to include pin
b.3.4	card should have multiple security feature
b.4	card to include UCL branding
b.5	easy identification/card is clear looking
b.6	card should be sturdy/robust
b.6.1	card should lasts for 5 or more years

ID	Short Description of Requirement
b.7	card should be attractive
c	to improve security and access control in UCL
c.1	ensure appropriate access for each individual
c.1.1	must stop at the end of the last day of service
c.1.2	must work until the last day of service
c.2	control access to UCL buildings
c.2.1	control access to departments
c.2.2	control access to library
c.2.3	control access to Bloomsbury
c.2.4	to access Kathleen Lonsdale
c.2.5	control access to departmental offices
c.2.6	control access to private offices
c.2.7	control access to high hazard area
c.2.8	control access to computer cluster
c.2.9	control access to rooms
c.2.10	control access to exam venues
c.3	enable visual checking
c.3.1	enable photo visual checks
c.3.2	visual checking cardholder's role
c.4	access control to include movement tracking/logs
c.4.1	movement tracking in buildings other than library
c.4.2	movement tracking/logs in the library
c.4.3	enable alumni tracking
c.4.4	use card to mark attendance
c.4.5	clocking in and out
c.4.6	clear policies on movement tracking/logs
c.5	increase access control to buildings
c.5.1	easy to install new readers
d	improve processes
d.1	faster issue of cards
d.1.1	fast production of cards
d.1.2	many issue points
d.2	reduce queuing time
d.2.1	staff do not go to HR for cards
d.2.2	distance arrangements for preparation of cards
d.2.3	appointment system to reduce queuing time
d.3	ID card status: Ability to check if a user has collected an ID card
d.4	easy to replace lost cards
d.4.1	UCL shop to handle lost cards
d.5	granting access rights
d.5.1	view and modify access rights, time of access, online, without card being present
d.5.2	activate and inactivate card
d.5.3	role-based method to grant access rights
d.5.4	close to real time update
d.5.5	reminders of access end dates
d.6	able to create access reports
d.7	procedures for dealing with fraud
e	reduce cost
e.1	save money on cards
e.1.1	no longer require MRM smart cards
e.1.2	cheap x 10p item

ID	Short Description of Requirement
e.1.3	card is reusable/recyclable
e.2	save processing time
e.3	reduce paper trials
f	compatible with existing administrative systems
f.1	compatible with Bloomsbury system (Gladstone MRM)
f.2	compatible with library systems
f.2.1	compatible with library barcode
f.2.2	compatible with library management system
f.3	compatible with HR system
f.4	compatible with UPI
f.4.1	map user identity to UPI (including group memberships and roles)
f.5	compatible with current network infrastructure
f.6	minimal impact to other systems
f.6.1	UPI
f.6.2	portico
f.6.3	does not interface with HR directly
g	better data quality
g.1	centralised management of access and identification information
g.1.1	card must have unique id
g.1.2	data should not be duplicated
g.2	export data to other systems
g.2.1	export data to student system
g.2.2	export data to library (access card changes, leavers, barcode)
g.2.3	export data to staff system
g.3	import data from other systems
g.3.1	import data from staff and student systems
g.3.2	import photo from registry
g.4	data access: able to view, update, delete remotely and securely
g.4.1	able to view data from any computer
g.4.2	update/delete data
g.4.3	enter data
g.4.4	authorised access with firewalls and time limitations
g.4.5	ensure secure data storage
g.5	clear policies on use of access data
h	extensible for future features
h.1	include digital certificate
h.2	include payment mechanism
h.2.1	use as bank card
h.2.2	combine with photocopy card
h.2.3	used for cashless vending
h.2.4	oyster card
h.3	used for computer logon
h.4	upgradable (software revisions)
h.5	increase security
h.5.1	thumb reader
i	project delivery activities
i.1	supplier support
i.1.1	5 years minimum
i.1.2	Support virtual machine environment
i.1.3	card readers
i.1.4	card printers

ID	Short Description of Requirement
i.2	technical documents
i.2.1	all software
i.2.2	business rules document
i.2.3	requirements document
i.2.4	design document
i.2.5	documented processes of dependent systems
i.2.6	technical document for upi
i.3	project management activities
i.3.1	requirements management
i.3.2	change management
i.3.3	quality management
i.3.4	budget management
i.3.5	development
i.3.6	maintenance
j	technical constraints
j.1	fail safe
j.1.1	failure does not restrict access
j.1.2	safe in case of power failure
j.2	conform to standards and legislations
j.2.1	technical architecture standards
j.2.2	management system standards
j.2.3	security standards
j.2.4	health and safety legislations
j.3	technology
j.3.1	no change to existing technology approach
j.3.2	smart card technology
j.3.3	not constrained by card solution
j.3.4	card printers technology
j.4	lifecycle
j.4.1	5 years
j.5	reliable
j.5.1	antivirus
j.5.2	reliable such that people can open doors
j.5.3	software interface
j.5.4	continue operation
j.5.5	secure network
j.6	available
j.6.1	server software run in a virtual machine environme
j.6.2	working without interruption for 100 days
j.6.3	data backup
j.6.4	switch to standby system in the event of a hardware fail
j.7	network infrastructure
j.7.1	cabling
j.7.2	landswitch
j.8	direct printing on both sides of card
j.9	supplier must have a proven track record
j.10	photo ID pass software must be an embedded feature of the access control software
j.11	the system manufacturer must be a Microsoft Certified Partner
j.12	the system must utilise Microsoft Windows 2000 and/or XP Operating System
j.13	the database platform must support Microsoft SQL Server and/or Oracle Server

RankP

Project Objectives

Aaron Toms, f, 0.666666667
Aaron Toms, i, 0.333333333
Adrian Bank, h, 1
Alison Crane, a, 1
Andrew Dawn, f, 0.4
Andrew Dawn, h, 0.1
Andrew Dawn, i, 0.3
Andrew Dawn, j, 0.2
Andy Faulk, a, 0.4
Andy Faulk, b, 0.2
Andy Faulk, c, 0.1
Andy Faulk, d, 0.3
Andy Hicks, c, 0.266666667
Andy Hicks, d, 0.333333333
Andy Hicks, g, 0.066666667
Andy Hicks, i, 0.2
Andy Hicks, j, 0.133333333
Angela Willard, f, 0.333333333
Angela Willard, i, 0.333333333
Angela Willard, j, 0.333333333
Anthony Rick, a, 0.047619048
Anthony Rick, b, 0.19047619
Anthony Rick, c, 0.285714286
Anthony Rick, d, 0.142857143
Anthony Rick, g, 0.095238095
Anthony Rick, j, 0.238095238
Astrid Haynes, a, 0.166666667
Astrid Haynes, b, 0.5
Astrid Haynes, c, 0.333333333
Barbara Song, a, 0.3
Barbara Song, b, 0.3
Barbara Song, c, 0.3
Barbara Song, e, 0.1
Bill Leal, a, 0.666666667
Bill Leal, c, 0.333333333
Bob Alford, a, 0.416666667
Bob Alford, b, 0.416666667
Bob Alford, c, 0
Bob Alford, d, 0.166666667
Brahim Boyd, i, 1
Brian Aniston, a, 0.4
Brian Aniston, b, 0.3
Brian Aniston, c, 0.2
Brian Aniston, g, 0.1
Brian Ward, g, 0.333333333
Brian Ward, j, 0.666666667
Caroline Cook, a, 0.5
Caroline Cook, b, 0.5
Caroline Goodman, a, 0.333333333
Caroline Goodman, c, 0.666666667
Chris Randall, a, 0.232142857
Chris Randall, b, 0.178571429
Chris Randall, c, 0.232142857
Chris Randall, d, 0.125
Chris Randall, e, 0.035714286
Chris Randall, g, 0.125
Chris Randall, h, 0.071428571
Christina Solis, d, 1
Christopher Hall, a, 0.5
Christopher Hall, b, 0.5
Colin Penn, g, 1
Colin Street, a, 0.5
Colin Street, b, 0.166666667
Colin Street, d, 0.333333333
Colin Street, h, 0
David Ainsley, a, 0.333333333
David Ainsley, c, 0.266666667
David Ainsley, d, 0.2
David Ainsley, e, 0.133333333
David Ainsley, h, 0.066666667
David Carne, g, 0.333333333
David Carne, j, 0.666666667
Diana Cates, b, 0.222222222
Diana Cates, d, 0.555555556
Diana Cates, j, 0.222222222
Ed Steele, a, 1
Farid Sonya, b, 0.333333333
Farid Sonya, c, 0.5
Farid Sonya, h, 0.166666667
Fickle Andrews, b, 0.666666667
Fickle Andrews, c, 0.333333333
Harry Gore, a, 0.666666667
Harry Gore, b, 0.333333333
Harry Gore, c, 0
Ian More, a, 0.333333333
Ian More, c, 0.266666667
Ian More, e, 0
Ian More, f, 0.133333333
Ian More, i, 0.2
Ian More, j, 0.066666667
Jan Crowe, a, 0.266666667
Jan Crowe, b, 0.266666667
Jan Crowe, d, 0.066666667
Jan Crowe, g, 0.266666667
Jan Crowe, h, 0.133333333
Jason Ortiz, a, 0.222222222
Jason Ortiz, b, 0.222222222
Jason Ortiz, c, 0.138888889
Jason Ortiz, d, 0.305555556
Jason Ortiz, f, 0.055555556
Jason Ortiz, i, 0.055555556
Jeremy Spain, a, 0.5
Jeremy Spain, c, 0.166666667
Jeremy Spain, d, 0.333333333
Jim Howe, c, 0.4
Jim Howe, d, 0.2
Jim Howe, e, 0.1
Jim Howe, f, 0.3
Johnny Glenn, a, 1
Jots Semb, f, 0.5
Jots Semb, i, 0.5
Kathleen Niche, a, 0.333333333
Kathleen Niche, b, 0.166666667
Kathleen Niche, d, 0.5
Kathryn Lester, c, 0.3
Kathryn Lester, d, 0.4
Kathryn Lester, i, 0.2
Kathryn Lester, j, 0.1
Kerstin Michel, a, 0.5
Kerstin Michel, c, 0.333333333
Kerstin Michel, d, 0.166666667
Liz Hopper, a, 0.2
Liz Hopper, c, 0.3
Liz Hopper, d, 0.133333333
Liz Hopper, g, 0.3
Liz Hopper, h, 0.066666667
Magali Persi, a, 0.266666667
Magali Persi, b, 0.2
Magali Persi, c, 0.333333333
Magali Persi, d, 0.066666667
Magali Persi, h, 0.133333333
Malcolm Bain, i, 1
Maria Damon, c, 0.1
Maria Damon, d, 0.2
Maria Damon, f, 0.4
Maria Damon, h, 0.3
Marilyn Gallo, a, 0.238095238
Marilyn Gallo, c, 0.285714286
Marilyn Gallo, d, 0.142857143
Marilyn Gallo, e, 0.19047619
Marilyn Gallo, g, 0.095238095
Marilyn Gallo, j, 0.047619048
Marion Lam, a, 0.333333333
Marion Lam, c, 0.5
Marion Lam, d, 0.166666667
Marion Ross, a, 1
Mark Wesley, a, 0.3
Mark Wesley, b, 0
Mark Wesley, c, 0.4
Mark Wesley, g, 0.1
Mark Wesley, i, 0.2
Martin Payne, a, 1
Mat Reed, a, 0.4
Mat Reed, b, 0.2
Mat Reed, f, 0.3
Mat Reed, g, 0.1
Mick Carin, a, 0.333333333
Mick Carin, f, 0.666666667
Mike Dawson, a, 0.333333333
Mike Dawson, b, 0.133333333
Mike Dawson, d, 0.2
Mike Dawson, g, 0.266666667
Mike Dawson, h, 0.066666667
Neil Roper, a, 0.3
Neil Roper, b, 0.4
Neil Roper, c, 0.2
Neil Roper, h, 0.1
Nicolas Curry, a, 0.5
Nicolas Curry, c, 0.166666667
Nicolas Curry, h, 0.333333333
Niyi Akers, a, 0.222222222
Niyi Akers, b, 0.222222222
Niyi Akers, c, 0.555555556
Niyi Akers, d, 0
Noshir Holmes, b, 0.166666667
Noshir Holmes, d, 0.333333333
Noshir Holmes, f, 0.5
Oliver Cullen, a, 0.3
Oliver Cullen, b, 0.2
Oliver Cullen, c, 0.4
Oliver Cullen, e, 0.1
Paul Ayers, a, 0.5
Paul Ayers, c, 0.333333333
Paul Ayers, d, 0
Paul Ayers, e, 0
Paul Ayers, f, 0.166666667
Pepi Sands, a, 0.416666667
Pepi Sands, b, 0.166666667
Pepi Sands, c, 0.416666667
Rachna Kaplan, a, 0.214285714
Rachna Kaplan, b, 0.047619048
Rachna Kaplan, c, 0.214285714
Rachna Kaplan, d, 0.047619048
Rachna Kaplan, e, 0.047619048
Rachna Kaplan, f, 0.214285714
Rachna Kaplan, j, 0.214285714
Ray Hardy, a, 0.35
Ray Hardy, c, 0.35
Ray Hardy, d, 0.1
Ray Hardy, f, 0.2
Richard Fuller, a, 0.285714286
Richard Fuller, b, 0.095238095
Richard Fuller, c, 0.047619048
Richard Fuller, d, 0.142857143
Richard Fuller, g, 0.238095238
Richard Fuller, h, 0.19047619
Richard Marsh, c, 0.416666667
Richard Marsh, i, 0.416666667
Richard Marsh, j, 0.166666667
Robert Clarke, f, 0.166666667
Robert Clarke, i, 0.333333333
Robert Clarke, j, 0.5
Roger All, a, 0.666666667
Roger All, d, 0.333333333
Ruth Simon, a, 0.666666667
Ruth Simon, c, 0.333333333
Samuel Mackey, a, 1
Sarah Brante, a, 0.047619048
Sarah Brante, b, 0.119047619
Sarah Brante, c, 0.19047619
Sarah Brante, d, 0.238095238
Sarah Brante, e, 0.119047619
Sarah Brante, f, 0.285714286
Sean Wall, c, 0.214285714
Sean Wall, d, 0.285714286
Sean Wall, e, 0.095238095
Sean Wall, g, 0.214285714
Sean Wall, h, 0.047619048
Sean Wall, j, 0.142857143
Shawn Wills, a, 0.5
Shawn Wills, c, 0.5
Simon Farmer, c, 0.214285714
Simon Farmer, d, 0.214285714
Simon Farmer, e, 0.119047619
Simon Farmer, f, 0.285714286
Simon Farmer, h, 0.047619048
Simon Farmer, j, 0.119047619
Simon Mann, c, 1
Steve Curry, c, 1
Tamsin Pitts, b, 0.333333333
Tamsin Pitts, c, 0.333333333
Tamsin Pitts, d, 0.333333333
Tariq Haines, g, 0.333333333
Tariq Haines, i, 0.333333333
Tariq Haines, j, 0.333333333
Tim Pugh, d, 1
Tim Pugh, f, 0
Tony Boston, b, 0.2
Tony Boston, c, 0.266666667
Tony Boston, g, 0.133333333
Tony Boston, h, 0.066666667
Tony Boston, j, 0.333333333
Wendy Richey, b, 0.5
Wendy Richey, d, 0.5
Will Miles, e, 0.333333333
Will Miles, f, 0.066666667
Will Miles, g, 0.266666667
Will Miles, i, 0.2
Will Miles, j, 0.133333333
Yogesh Katz, a, 0.166666667
Yogesh Katz, f, 0.333333333
Yogesh Katz, j, 0.5

Requirements

Aaron Toms, f.4, 0.5
Aaron Toms, f.6, 0.333333333
Aaron Toms, i.3, 0.166666667
Adrian Bank, h.1, 1
Alison Crane, a.3, 1
Andrew Dawn, f.1, 0.110576923
Andrew Dawn, f.2, 0.110576923
Andrew Dawn, f.3, 0.110576923
Andrew Dawn, f.4, 0.110576923
Andrew Dawn, f.5, 0.110576923
Andrew Dawn, f.6, 0.110576923
Andrew Dawn, h.1, 0.009615385
Andrew Dawn, h.2, 0.009615385
Andrew Dawn, h.3, 0.009615385
Andrew Dawn, h.4, 0.009615385
Andrew Dawn, h.5, 0.009615385
Andrew Dawn, i.1, 0.072115385
Andrew Dawn, i.3, 0.072115385
Andrew Dawn, j.2, 0.048076923
Andrew Dawn, j.5, 0.057692308
Andrew Dawn, j.6, 0.038461538
Andy Faulk, a.1, 0.133333333
Andy Faulk, a.3, 0.333333333
Andy Faulk, b.1, 0.2
Andy Faulk, c.5, 0.066666667
Andy Faulk, d.5, 0.266666667
Andy Hicks, c.1, 0.266666667
Andy Hicks, d.5, 0.333333333
Andy Hicks, g.2, 0.066666667
Andy Hicks, i.3, 0.2
Andy Hicks, j.5, 0.133333333
Angela Willard, f.1, 0.125
Angela Willard, f.2, 0.125
Angela Willard, f.3, 0.125
Angela Willard, f.4, 0.125
Angela Willard, f.5, 0.125
Angela Willard, f.6, 0.125
Angela Willard, i.3, 0.125
Angela Willard, j.2, 0.125
Anthony Rick, a.3, 0.044444444
Anthony Rick, b.1, 0.133333333
Anthony Rick, c.1, 0.1
Anthony Rick, c.2, 0.188888889
Anthony Rick, c.3, 0.188888889
Anthony Rick, c.4, 0.022222222
Anthony Rick, d.5, 0.1
Anthony Rick, g.4, 0.066666667
Anthony Rick, j.1, 0.155555556
Astrid Haynes, a.3, 0.2
Astrid Haynes, b.1, 0.4
Astrid Haynes, b.4, 0.1
Astrid Haynes, c.2, 0.3
Barbara Song, a.1, 0.133333333
Barbara Song, a.3, 0.133333333
Barbara Song, b.1, 0.133333333
Barbara Song, b.3, 0.133333333
Barbara Song, b.6, 0.133333333
Barbara Song, c.2, 0.133333333
Barbara Song, c.4, 0.133333333
Barbara Song, e.1, 0.022222222
Barbara Song, e.2, 0.044444444
Bill Leal, a.3, 0.5
Bill Leal, c.2, 0.333333333
Bill Leal, c.4, 0.166666667
Bob Alford, a.3, 0.416666667
Bob Alford, b.1, 0.416666667
Bob Alford, c.4, 0
Bob Alford, d.5, 0.166666667
Brahim Boyd, i.2, 1
Brian Aniston, a.3, 0.333333333
Brian Aniston, b.1, 0.266666667
Brian Aniston, c.2, 0.2
Brian Aniston, c.3, 0.133333333
Brian Aniston, g.4, 0.066666667
Brian Ward, g.4, 0.333333333
Brian Ward, j.6, 0.666666667
Caroline Cook, a.3, 0.5
Caroline Cook, b.1, 0.5
Caroline Goodman, a.3, 0.333333333
Caroline Goodman, c.2, 0.666666667
Chris Randall, a.1, 0.06043956
Chris Randall, a.2, 0.06043956
Chris Randall, a.3, 0.115384615
Chris Randall, b.3, 0.076923077
Chris Randall, c.1, 0.115384615
Chris Randall, c.2, 0.115384615
Chris Randall, c.3, 0.115384615
Chris Randall, c.4, 0.115384615
Chris Randall, c.5, 0.115384615
Chris Randall, d.5, 0.038461538
Chris Randall, e.1, 0.010989011
Chris Randall, g.4, 0.038461538
Chris Randall, h.4, 0.021978022
Christina Solis, d.4, 1
Christopher Hall, a.3, 0.35
Christopher Hall, b.1, 0.35
Christopher Hall, b.6, 0.2
Christopher Hall, b.7, 0.1
Colin Penn, g.4, 1
Colin Street, a.3, 0.5
Colin Street, b.4, 0.166666667
Colin Street, d.2, 0.333333333
Colin Street, h.2, 0
David Ainsley, a.1, 0.142857143
David Ainsley, a.3, 0.25
David Ainsley, c.1, 0.214285714
David Ainsley, c.2, 0
David Ainsley, c.4, 0.178571429
David Ainsley, d.2, 0.107142857

David Ainsley, e.1, 0.071428571
David Ainsley, h.2, 0.035714286
David Carne, g.2, 0.166666667
David Carne, g.4, 0.333333333
David Carne, j.6, 0.5
Diana Cates, b.2, 0.133333333
Diana Cates, b.5, 0.133333333
Diana Cates, d.5, 0.133333333
Diana Cates, d.6, 0.466666667
Diana Cates, j.5, 0.133333333
Ed Steele, a.1, 0.333333333
Ed Steele, a.3, 0.666666667
Farid Sonya, b.1, 0.333333333
Farid Sonya, c.2, 0.5
Farid Sonya, h.5, 0.166666667
Fickle Andrews, b.2, 0.333333333
Fickle Andrews, b.5, 0.5
Fickle Andrews, c.2, 0.166666667
Harry Gore, a.1, 0.25
Harry Gore, a.2, 0.25
Harry Gore, a.3, 0.4
Harry Gore, b.6, 0.1
Harry Gore, c.4, 0
Ian More, a.3, 0.285714286
Ian More, c.3, 0.214285714
Ian More, c.4, 0.214285714
Ian More, e.1, 0
Ian More, f.1, 0.095238095
Ian More, i.3, 0.142857143
Ian More, j.4, 0.047619048
Jan Crowe, a.2, 0.133333333
Jan Crowe, a.3, 0.133333333
Jan Crowe, b.1, 0.133333333
Jan Crowe, b.2, 0.133333333
Jan Crowe, b.3, 0.133333333
Jan Crowe, d.1, 0.022222222
Jan Crowe, g.1.2, 0.133333333
Jan Crowe, g.2, 0.133333333
Jan Crowe, h.2, 0.044444444
Jason Ortiz, a.1, 0.081699346
Jason Ortiz, a.2, 0.006535948
Jason Ortiz, a.3, 0.081699346
Jason Ortiz, b.2, 0.081699346
Jason Ortiz, b.3, 0.062091503
Jason Ortiz, b.5, 0.081699346
Jason Ortiz, c.1, 0.062091503
Jason Ortiz, d.1, 0.111111111
Jason Ortiz, d.5, 0.10130719
Jason Ortiz, d.6, 0.10130719
Jason Ortiz, f.1, 0.032679739
Jason Ortiz, f.2, 0.032679739
Jason Ortiz, f.3, 0.032679739
Jason Ortiz, f.4, 0.032679739
Jason Ortiz, f.5, 0.032679739
Jason Ortiz, f.6, 0.032679739
Jason Ortiz, i.3, 0.032679739
Jeremy Spain, a.1, 0.4
Jeremy Spain, c.2, 0.1
Jeremy Spain, c.4, 0.2
Jeremy Spain, d.5, 0.3
Jim Howe, c.2, 0.181818182
Jim Howe, c.3, 0.163636364
Jim Howe, d.2, 0.036363636
Jim Howe, e.1, 0.018181818
Jim Howe, f.1, 0.1
Jim Howe, f.2, 0.1
Jim Howe, f.3, 0.1
Jim Howe, f.4, 0.1
Jim Howe, f.5, 0.1
Jim Howe, f.6, 0.1
Johnny Glenn, a.1, 0.333333333
Johnny Glenn, a.3, 0.666666667
Jots Semb, f.1, 0.125
Jots Semb, f.2, 0.125
Jots Semb, f.3, 0.125
Jots Semb, f.4, 0.125
Jots Semb, f.5, 0.125
Jots Semb, f.6, 0.125
Jots Semb, i.1, 0.125
Jots Semb, i.2, 0.125
Kathleen Niche, a.3, 0.3
Kathleen Niche, b.5, 0.2
Kathleen Niche, b.6, 0.1
Kathleen Niche, d.5, 0.4
Kathryn Lester, c.1, 0.060606061
Kathryn Lester, d.1, 0.121212121
Kathryn Lester, d.2, 0.121212121
Kathryn Lester, d.3, 0.121212121
Kathryn Lester, d.4, 0.121212121
Kathryn Lester, d.5, 0.121212121
Kathryn Lester, d.6, 0.121212121
Kathryn Lester, d.7, 0.121212121
Kathryn Lester, i.2, 0.045454545
Kathryn Lester, i.3, 0.03030303
Kathryn Lester, j.3, 0.015151515
Kerstin Michel, a.1, 0.4
Kerstin Michel, a.3, 0.3
Kerstin Michel, c.2, 0.2
Kerstin Michel, d.5, 0.1
Liz Hopper, a.1, 0.19047619
Liz Hopper, c.2, 0.261904762
Liz Hopper, c.4, 0.095238095
Liz Hopper, d.4, 0.142857143
Liz Hopper, g.4, 0.261904762
Liz Hopper, h.2, 0.047619048
Magali Persi, a.3, 0.238095238
Magali Persi, b.1, 0.19047619
Magali Persi, b.4, 0.095238095
Magali Persi, c.2, 0.285714286
Magali Persi, d.5, 0.047619048
Magali Persi, h.2, 0.142857143
Malcolm Bain, i.2, 0.666666667
Malcolm Bain, i.3, 0.333333333
Maria Damon, c.2, 0.00952381
Maria Damon, d.1, 0.019047619
Maria Damon, d.5, 0.028571429
Maria Damon, f.1, 0.10952381
Maria Damon, f.2, 0.10952381
Maria Damon, f.3, 0.10952381
Maria Damon, f.4, 0.10952381
Maria Damon, f.5, 0.10952381
Maria Damon, f.6, 0.10952381
Maria Damon, h.1, 0.057142857
Maria Damon, h.2, 0.057142857
Maria Damon, h.3, 0.057142857
Maria Damon, h.4, 0.057142857
Maria Damon, h.5, 0.057142857
Marilyn Gallo, a.1, 0.08974359
Marilyn Gallo, c.1, 0.128205128
Marilyn Gallo, c.2, 0.128205128
Marilyn Gallo, c.3, 0.128205128
Marilyn Gallo, c.4, 0.128205128
Marilyn Gallo, c.5, 0.128205128
Marilyn Gallo, d.2, 0.038461538
Marilyn Gallo, e.1, 0.064102564
Marilyn Gallo, e.2, 0.064102564
Marilyn Gallo, e.3, 0.064102564
Marilyn Gallo, g.3, 0.025641026
Marilyn Gallo, j.5, 0.012820513
Marion Lam, a.1, 0.333333333
Marion Lam, c.2, 0.5
Marion Lam, d.5, 0.166666667
Marion Ross, a.3, 1
Mark Wesley, a.3, 0.3
Mark Wesley, b.4, 0
Mark Wesley, c.2, 0.4
Mark Wesley, g.4, 0.1
Mark Wesley, i.3, 0.2
Martin Payne, a.3, 1
Mat Reed, a.2, 0.095238095
Mat Reed, a.3, 0.261904762
Mat Reed, b.1, 0.142857143
Mat Reed, b.2, 0.261904762
Mat Reed, f.2, 0.19047619
Mat Reed, g.3, 0.047619048
Mick Carin, a.1, 0.333333333
Mick Carin, f.6, 0.666666667
Mike Dawson, a.3, 0.204545455
Mike Dawson, b.3, 0.125
Mike Dawson, b.7, 0.125
Mike Dawson, d.1, 0.159090909
Mike Dawson, d.5, 0.090909091
Mike Dawson, g.3, 0.181818182
Mike Dawson, h.1, 0.022727273
Mike Dawson, h.2, 0.022727273
Mike Dawson, h.3, 0.022727273
Mike Dawson, h.4, 0.022727273
Mike Dawson, h.5, 0.022727273
Neil Roper, a.3, 0.238095238
Neil Roper, b.1, 0.142857143
Neil Roper, b.3, 0
Neil Roper, b.4, 0.285714286
Neil Roper, b.5, 0.095238095
Neil Roper, c.2, 0
Neil Roper, c.4, 0.19047619
Neil Roper, h.2, 0.047619048
Nicolas Curry, a.1, 0.5
Nicolas Curry, c.3, 0.166666667
Nicolas Curry, h.5, 0.333333333
Niyi Akers, a.3, 0.125
Niyi Akers, b.1, 0.125
Niyi Akers, c.1, 0.3125
Niyi Akers, c.2, 0.4375
Niyi Akers, d.2, 0
Noshir Holmes, b.4, 0.166666667
Noshir Holmes, d.3, 0.333333333
Noshir Holmes, f.4, 0.5
Oliver Cullen, a.3, 0.178571429
Oliver Cullen, b.1, 0.107142857
Oliver Cullen, b.4, 0
Oliver Cullen, c.1, 0.071428571
Oliver Cullen, c.2, 0.25
Oliver Cullen, c.3, 0.142857143
Oliver Cullen, c.4, 0.214285714
Oliver Cullen, e.1, 0.035714286
Paul Ayers, a.3, 0.288888889
Paul Ayers, c.2, 0.244444444
Paul Ayers, c.3, 0
Paul Ayers, c.4, 0.2
Paul Ayers, d.2, 0
Paul Ayers, e.1, 0
Paul Ayers, e.2, 0
Paul Ayers, e.3, 0
Paul Ayers, f.1, 0.044444444
Paul Ayers, f.2, 0.044444444
Paul Ayers, f.3, 0.044444444
Paul Ayers, f.4, 0.044444444
Paul Ayers, f.5, 0.044444444
Paul Ayers, f.6, 0.044444444
Pepi Sands, a.3, 0.416666667
Pepi Sands, b.2, 0.166666667
Pepi Sands, c.2, 0.416666667
Rachna Kaplan, a.3, 0.095238095
Rachna Kaplan, b.1, 0.033333333
Rachna Kaplan, c.2, 0.095238095
Rachna Kaplan, d.2, 0.033333333
Rachna Kaplan, d.5, 0.00952381
Rachna Kaplan, e.2, 0.033333333
Rachna Kaplan, e.3, 0.033333333
Rachna Kaplan, f.1, 0.095238095
Rachna Kaplan, f.2, 0.095238095
Rachna Kaplan, f.3, 0.095238095
Rachna Kaplan, f.4, 0.095238095
Rachna Kaplan, f.5, 0.095238095
Rachna Kaplan, f.6, 0.095238095
Rachna Kaplan, j.6, 0.095238095
Ray Hardy, a.3, 0.172727273
Ray Hardy, c.2, 0.172727273
Ray Hardy, c.3, 0.090909091
Ray Hardy, d.2, 0.018181818
Ray Hardy, f.1, 0.090909091
Ray Hardy, f.2, 0.090909091
Ray Hardy, f.3, 0.090909091
Ray Hardy, f.4, 0.090909091
Ray Hardy, f.5, 0.090909091
Ray Hardy, f.6, 0.090909091
Richard Fuller, a.3, 0.144444444
Richard Fuller, b.3, 0.05
Richard Fuller, b.7, 0.05
Richard Fuller, c.1, 0.011111111
Richard Fuller, c.2, 0.011111111
Richard Fuller, c.3, 0.011111111
Richard Fuller, c.4, 0.011111111
Richard Fuller, c.5, 0.011111111
Richard Fuller, d.5, 0.066666667
Richard Fuller, g.3, 0.133333333
Richard Fuller, h.1, 0.1
Richard Fuller, h.2, 0.1
Richard Fuller, h.3, 0.1
Richard Fuller, h.4, 0.1
Richard Fuller, h.5, 0.1
Richard Marsh, c.2, 0.416666667
Richard Marsh, i.3, 0.416666667
Richard Marsh, j.2, 0.166666667
Robert Clarke, f.5, 0.047619048
Robert Clarke, i.1, 0.095238095
Robert Clarke, i.3, 0.19047619
Robert Clarke, j.2, 0.238095238
Robert Clarke, j.3, 0.142857143
Robert Clarke, j.5, 0.285714286
Roger All, a.3, 0.666666667
Roger All, d.5, 0.333333333
Ruth Simon, a.1, 0.666666667
Ruth Simon, c.2, 0.333333333
Samuel Mackey, a.3, 1
Sarah Brante, a.1, 0.041322314
Sarah Brante, b.1, 0.016528926
Sarah Brante, b.3, 0.016528926
Sarah Brante, b.6, 0.082644628
Sarah Brante, c.4, 0.123966942
Sarah Brante, d.1, 0.148760331
Sarah Brante, d.4, 0.148760331
Sarah Brante, e.1, 0.082644628
Sarah Brante, e.2, 0.082644628
Sarah Brante, e.3, 0.082644628
Sarah Brante, f.3, 0.173553719
Sarah Brante, f.6, 0
Sean Wall, c.4, 0.146153846
Sean Wall, d.7, 0.169230769
Sean Wall, e.1, 0.076923077
Sean Wall, e.2, 0.076923077
Sean Wall, e.3, 0.076923077
Sean Wall, g.5, 0.146153846
Sean Wall, h.1, 0.015384615
Sean Wall, h.2, 0.015384615
Sean Wall, h.3, 0.015384615
Sean Wall, h.4, 0.015384615
Sean Wall, h.5, 0.015384615
Sean Wall, j.1, 0.115384615
Sean Wall, j.5, 0.115384615
Shawn Wills, a.1, 0.142857143
Shawn Wills, a.3, 0.142857143
Shawn Wills, c.1, 0.142857143
Shawn Wills, c.2, 0.142857143
Shawn Wills, c.3, 0.142857143
Shawn Wills, c.4, 0.142857143
Shawn Wills, c.5, 0.142857143
Simon Farmer, c.1, 0.150793651
Simon Farmer, c.4, 0.015873016
Simon Farmer, d.5, 0.150793651
Simon Farmer, e.1, 0.103174603
Simon Farmer, e.2, 0.103174603
Simon Farmer, e.3, 0.103174603
Simon Farmer, f.4, 0.174603175
Simon Farmer, h.1, 0.015873016
Simon Farmer, h.2, 0.015873016
Simon Farmer, h.3, 0.015873016
Simon Farmer, h.4, 0.015873016
Simon Farmer, h.5, 0.015873016
Simon Farmer, j.2, 0.103174603
Simon Farmer, j.6, 0.015873016
Simon Mann, c.1, 0.416666667
Simon Mann, c.2, 0.416666667
Simon Mann, c.4, 0.166666667
Steve Curry, c.2, 1
Steve Curry, c.3, 0
Tamsin Pitts, b.3, 0.3
Tamsin Pitts, c.2, 0.3
Tamsin Pitts, d.1, 0.1
Tamsin Pitts, d.5, 0.3
Tariq Haines, g.4, 0.2
Tariq Haines, i.3, 0.2
Tariq Haines, j.5, 0.2
Tariq Haines, j.6, 0.2
Tariq Haines, j.7, 0.2
Tim Pugh, d.6, 1
Tim Pugh, f.6, 0
Tony Boston, b.3, 0.115384615
Tony Boston, c.2, 0.128205128
Tony Boston, c.4, 0.025641026
Tony Boston, g.4, 0.102564103
Tony Boston, h.1, 0.064102564
Tony Boston, h.2, 0.064102564
Tony Boston, h.3, 0.064102564
Tony Boston, h.4, 0.064102564
Tony Boston, h.5, 0.064102564
Tony Boston, j.1, 0.153846154
Tony Boston, j.3, 0.012820513
Tony Boston, j.6, 0.141025641
Wendy Richey, b.1, 0.5
Wendy Richey, d.2, 0.5
Will Miles, e.1, 0.116666667
Will Miles, e.2, 0.116666667
Will Miles, e.3, 0.116666667
Will Miles, f.1, 0.0375
Will Miles, f.2, 0.0375
Will Miles, f.3, 0.0375
Will Miles, f.4, 0.0375
Will Miles, f.5, 0.0375
Will Miles, f.6, 0.0375
Will Miles, g.1.2, 0.1
Will Miles, i.1, 0.070833333
Will Miles, i.3, 0.091666667
Will Miles, j.1, 0.083333333
Will Miles, j.2, 0.070833333
Will Miles, j.6, 0.008333333
Yogesh Katz, a.1, 0.166666667
Yogesh Katz, a.3, 0
Yogesh Katz, f.1, 0.333333333
Yogesh Katz, j.3, 0.5

Specific Requirements

Aaron Toms, f.4.1, 0.5
Aaron Toms, f.6.1, 0.333333333
Aaron Toms, i.3.6, 0.166666667
Adrian Bank, h.1, 1
Alison Crane, a.3.5, 1
Andrew Dawn, f.1, 0.080213904
Andrew Dawn, f.2.1, 0.080213904
Andrew Dawn, f.2.2, 0.080213904
Andrew Dawn, f.3, 0.080213904
Andrew Dawn, f.4.1, 0.080213904
Andrew Dawn, f.5, 0.080213904
Andrew Dawn, f.6.1, 0.080213904
Andrew Dawn, f.6.2, 0.080213904
Andrew Dawn, f.6.3, 0.080213904
Andrew Dawn, h.1, 0.005347594
Andrew Dawn, h.2.1, 0.005347594
Andrew Dawn, h.2.2, 0.005347594
Andrew Dawn, h.2.3, 0.005347594
Andrew Dawn, h.3, 0.005347594
Andrew Dawn, h.4, 0.005347594
Andrew Dawn, h.5.1, 0.005347594
Andrew Dawn, i.1.1, 0.050802139
Andrew Dawn, i.3.6, 0.050802139
Andrew Dawn, j.2.1, 0.037433155
Andrew Dawn, j.5.4, 0.042780749
Andrew Dawn, j.6.1, 0.026737968
Andrew Dawn, j.6.3, 0.032085561
Andy Faulk, a.1.1, 0.045454545
Andy Faulk, a.3.1, 0.128787879
Andy Faulk, a.3.2, 0.128787879
Andy Faulk, a.3.3, 0.128787879
Andy Faulk, a.3.4, 0.128787879
Andy Faulk, a.3.5, 0.128787879

Andy Faulk, a.3.6, 0.128787879
Andy Faulk, b.1.2, 0.060606061
Andy Faulk, b.1.4, 0.015151515
Andy Faulk, c.5.1, 0.03030303
Andy Faulk, d.5.1, 0.075757576
Andy Hicks, c.1.1, 0.196428571
Andy Hicks, c.1.2, 0.196428571
Andy Hicks, d.5.4, 0.25
Andy Hicks, g.2.1, 0.035714286
Andy Hicks, g.2.2, 0.071428571
Andy Hicks, i.3.6, 0.142857143
Andy Hicks, j.5.3, 0.107142857
Angela Willard, f.1, 0.083333333
Angela Willard, f.2.1, 0.083333333
Angela Willard, f.2.2, 0.083333333
Angela Willard, f.3, 0.083333333
Angela Willard, f.4.1, 0.083333333
Angela Willard, f.5, 0.083333333
Angela Willard, f.6.1, 0.083333333
Angela Willard, f.6.2, 0.083333333
Angela Willard, f.6.3, 0.083333333
Angela Willard, i.3.6, 0.083333333
Angela Willard, j.2.2, 0.083333333
Angela Willard, j.2.3, 0.083333333
Anthony Rick, a.3.1, 0.020833333
Anthony Rick, a.3.2, 0.020833333
Anthony Rick, a.3.3, 0.020833333
Anthony Rick, a.3.4, 0.020833333
Anthony Rick, a.3.5, 0.020833333
Anthony Rick, a.3.6, 0.020833333
Anthony Rick, b.1.4, 0.043154762
Anthony Rick, c.1.1, 0.037202381
Anthony Rick, c.1.2, 0.037202381
Anthony Rick, c.2.1, 0.0625
Anthony Rick, c.2.2, 0.0625
Anthony Rick, c.2.3, 0.0625
Anthony Rick, c.2.4, 0.0625
Anthony Rick, c.2.5, 0.0625
Anthony Rick, c.2.6, 0.0625
Anthony Rick, c.2.7, 0.0625
Anthony Rick, c.2.8, 0.0625
Anthony Rick, c.2.9, 0.0625
Anthony Rick, c.3.1, 0.0625
Anthony Rick, c.4.1, 0.00297619
Anthony Rick, c.4.2, 0.00297619
Anthony Rick, c.4.3, 0.00297619
Anthony Rick, c.4.4, 0.00297619
Anthony Rick, c.4.5, 0.00297619
Anthony Rick, c.4.6, 0.00297619
Anthony Rick, d.5.1, 0.037202381
Anthony Rick, g.4.5, 0.03125
Anthony Rick, j.1.1, 0.046130952
Astrid Haynes, a.3.1, 0.028138528
Astrid Haynes, a.3.2, 0.028138528
Astrid Haynes, a.3.3, 0.028138528
Astrid Haynes, a.3.4, 0.028138528
Astrid Haynes, a.3.5, 0.028138528
Astrid Haynes, a.3.6, 0.028138528
Astrid Haynes, b.1.1, 0.090909091
Astrid Haynes, b.1.2, 0.086580087
Astrid Haynes, b.1.4, 0.043290043
Astrid Haynes, b.1.7, 0.012987013
Astrid Haynes, b.1.8, 0.004329004
Astrid Haynes, b.4, 0.008658009
Astrid Haynes, c.2.1, 0.064935065
Astrid Haynes, c.2.2, 0.064935065
Astrid Haynes, c.2.3, 0.064935065
Astrid Haynes, c.2.4, 0.064935065
Astrid Haynes, c.2.5, 0.064935065
Astrid Haynes, c.2.6, 0.064935065
Astrid Haynes, c.2.7, 0.064935065
Astrid Haynes, c.2.8, 0.064935065
Astrid Haynes, c.2.9, 0.064935065
Barbara Song, a.1.1, 0.064285714
Barbara Song, a.1.2, 0.064285714
Barbara Song, a.1.3, 0.064285714
Barbara Song, a.1.4, 0.064285714
Barbara Song, a.3.1, 0.064285714
Barbara Song, a.3.3, 0.064285714
Barbara Song, a.3.6, 0
Barbara Song, b.1.1, 0.064285714
Barbara Song, b.1.2, 0.064285714
Barbara Song, b.1.3, 0.019047619
Barbara Song, b.1.4, 0.064285714
Barbara Song, b.1.6, 0.019047619
Barbara Song, b.1.7, 0.064285714
Barbara Song, b.1.8, 0.019047619
Barbara Song, b.1.9, 0.019047619
Barbara Song, b.3.2, 0.064285714
Barbara Song, b.6.1, 0.064285714
Barbara Song, c.2.3, 0.064285714
Barbara Song, c.4.4, 0.064285714
Barbara Song, e.1.1, 0.004761905
Barbara Song, e.2, 0.019047619
Bill Leal, a.3.1, 0.099264706
Bill Leal, a.3.2, 0.099264706
Bill Leal, a.3.3, 0.099264706
Bill Leal, a.3.4, 0.099264706
Bill Leal, a.3.5, 0.099264706
Bill Leal, a.3.6, 0.099264706
Bill Leal, c.2.1, 0.044117647
Bill Leal, c.2.2, 0.044117647
Bill Leal, c.2.3, 0.044117647
Bill Leal, c.2.4, 0.044117647
Bill Leal, c.2.5, 0.044117647
Bill Leal, c.2.6, 0.044117647
Bill Leal, c.2.7, 0.044117647
Bill Leal, c.2.8, 0.044117647
Bill Leal, c.2.9, 0.044117647
Bill Leal, c.4.5, 0.007352941
Bob Alford, a.3.1, 0.138888889
Bob Alford, a.3.2, 0.138888889
Bob Alford, a.3.3, 0.138888889
Bob Alford, a.3.4, 0.138888889
Bob Alford, a.3.5, 0.138888889
Bob Alford, a.3.6, 0.138888889
Bob Alford, b.1.2, 0.138888889
Bob Alford, c.4.4, 0
Bob Alford, d.5.2, 0.027777778
Brahim Boyd, i.2.1, 0.25
Brahim Boyd, i.2.2, 0.25
Brahim Boyd, i.2.3, 0.25
Brahim Boyd, i.2.4, 0.25
Brian Aniston, a.3.1, 0.285714286
Brian Aniston, b.1.2, 0.214285714
Brian Aniston, b.1.3, 0.214285714
Brian Aniston, c.2.4, 0.142857143
Brian Aniston, c.3.2, 0.095238095
Brian Aniston, g.4.1, 0.047619048
Brian Ward, g.4.4, 0.333333333
Brian Ward, j.6.3, 0.166666667
Brian Ward, j.6.4, 0.5
Caroline Cook, a.3.1, 0.138888889
Caroline Cook, a.3.2, 0.138888889
Caroline Cook, a.3.3, 0.138888889
Caroline Cook, a.3.4, 0.138888889
Caroline Cook, a.3.5, 0.138888889
Caroline Cook, a.3.6, 0.138888889
Caroline Cook, b.1.4, 0.138888889
Caroline Cook, b.1.9, 0.027777778
Caroline Goodman, a.3.2, 0.018181818
Caroline Goodman, c.2.1, 0.1
Caroline Goodman, c.2.2, 0.1
Caroline Goodman, c.2.3, 0.1
Caroline Goodman, c.2.4, 0.1
Caroline Goodman, c.2.5, 0.181818182
Caroline Goodman, c.2.6, 0.1
Caroline Goodman, c.2.7, 0.1
Caroline Goodman, c.2.8, 0.1
Caroline Goodman, c.2.9, 0.1
Chris Randall, a.1.1, 0.010510511
Chris Randall, a.1.2, 0.010510511
Chris Randall, a.1.3, 0.010510511
Chris Randall, a.1.4, 0.010510511
Chris Randall, a.2, 0.010510511
Chris Randall, a.3.1, 0.035285285
Chris Randall, a.3.2, 0.035285285
Chris Randall, a.3.3, 0.035285285
Chris Randall, a.3.4, 0.035285285
Chris Randall, a.3.5, 0.035285285
Chris Randall, a.3.6, 0.035285285
Chris Randall, b.3.1, 0.015015015
Chris Randall, c.1.1, 0.035285285
Chris Randall, c.1.2, 0.035285285
Chris Randall, c.2.1, 0.035285285
Chris Randall, c.2.2, 0.035285285
Chris Randall, c.2.3, 0.035285285
Chris Randall, c.2.4, 0.035285285
Chris Randall, c.2.5, 0.035285285
Chris Randall, c.2.6, 0.035285285
Chris Randall, c.2.7, 0.035285285
Chris Randall, c.2.8, 0.035285285
Chris Randall, c.2.9, 0.035285285
Chris Randall, c.3.1, 0.035285285
Chris Randall, c.3.2, 0.035285285
Chris Randall, c.4.1, 0.035285285
Chris Randall, c.4.2, 0.035285285
Chris Randall, c.4.3, 0.035285285
Chris Randall, c.4.4, 0.035285285
Chris Randall, c.4.5, 0.035285285
Chris Randall, c.4.6, 0.035285285
Chris Randall, c.5.1, 0.035285285
Chris Randall, d.5.3, 0.005255255
Chris Randall, e.1.2, 0.001501502
Chris Randall, g.4.2, 0.005255255
Chris Randall, h.4, 0.003003003
Christina Solis, d.4.1, 1
Christopher Hall, a.3.1, 0.069852941
Christopher Hall, a.3.2, 0.069852941
Christopher Hall, a.3.3, 0.069852941
Christopher Hall, a.3.4, 0.069852941
Christopher Hall, a.3.5, 0.069852941
Christopher Hall, a.3.6, 0.069852941
Christopher Hall, b.1.1, 0.069852941
Christopher Hall, b.1.2, 0.069852941
Christopher Hall, b.1.3, 0.069852941
Christopher Hall, b.1.4, 0.069852941
Christopher Hall, b.1.6, 0.069852941
Christopher Hall, b.1.7, 0.069852941
Christopher Hall, b.1.8, 0.069852941
Christopher Hall, b.1.9, 0.069852941
Christopher Hall, b.6.1, 0.014705882
Christopher Hall, b.7, 0.007352941
Colin Penn, g.4.4, 0.5
Colin Penn, g.4.5, 0.5
Colin Street, a.3.1, 0.136363636
Colin Street, a.3.2, 0.136363636
Colin Street, a.3.3, 0.136363636
Colin Street, a.3.4, 0.136363636
Colin Street, a.3.5, 0.136363636
Colin Street, a.3.6, 0.136363636
Colin Street, b.4, 0.018181818
Colin Street, d.2.1, 0.054545455
Colin Street, d.2.2, 0.054545455
Colin Street, d.2.3, 0.054545455
Colin Street, h.2.1, 0
David Ainsley, a.1.1, 0.079166667
David Ainsley, a.1.2, 0.079166667
David Ainsley, a.1.3, 0.079166667
David Ainsley, a.1.4, 0.079166667
David Ainsley, a.3.1, 0.125
David Ainsley, c.1.1, 0.1125
David Ainsley, c.1.2, 0.1125
David Ainsley, c.2.1, 0
David Ainsley, c.2.2, 0
David Ainsley, c.2.3, 0
David Ainsley, c.2.4, 0
David Ainsley, c.2.5, 0
David Ainsley, c.2.6, 0
David Ainsley, c.2.7, 0
David Ainsley, c.2.8, 0
David Ainsley, c.2.9, 0
David Ainsley, c.4.4, 0.1
David Ainsley, d.2.1, 0.05
David Ainsley, d.2.2, 0.05
David Ainsley, d.2.3, 0.05
David Ainsley, e.1.1, 0.025
David Ainsley, e.1.2, 0.025
David Ainsley, e.1.3, 0.025
David Ainsley, h.2.3, 0.008333333
David Carne, g.2.1, 0.125
David Carne, g.2.2, 0.125
David Carne, g.4.4, 0.3125
David Carne, j.6.3, 0.4375
Diana Cates, b.2.1, 0.133333333
Diana Cates, b.5, 0.133333333
Diana Cates, d.5.1, 0.133333333
Diana Cates, d.6, 0.466666667
Diana Cates, j.5.2, 0.133333333
Ed Steele, a.1.1, 0.057142857
Ed Steele, a.1.2, 0.057142857
Ed Steele, a.1.3, 0.057142857
Ed Steele, a.1.4, 0.057142857
Ed Steele, a.3.1, 0.257142857
Ed Steele, a.3.2, 0.314285714
Ed Steele, a.3.3, 0.2
Farid Sonya, b.1.4, 0.03030303
Farid Sonya, c.2.1, 0.106060606
Farid Sonya, c.2.2, 0.106060606
Farid Sonya, c.2.3, 0.106060606
Farid Sonya, c.2.4, 0.106060606
Farid Sonya, c.2.5, 0.106060606
Farid Sonya, c.2.6, 0.106060606
Farid Sonya, c.2.7, 0.106060606
Farid Sonya, c.2.8, 0.106060606
Farid Sonya, c.2.9, 0.106060606
Farid Sonya, h.5.1, 0.015151515
Fickle Andrews, b.2.1, 0.272727273
Fickle Andrews, b.5, 0.318181818
Fickle Andrews, c.2.1, 0.045454545
Fickle Andrews, c.2.2, 0.045454545
Fickle Andrews, c.2.3, 0.045454545
Fickle Andrews, c.2.4, 0.045454545
Fickle Andrews, c.2.5, 0.045454545
Fickle Andrews, c.2.6, 0.045454545
Fickle Andrews, c.2.7, 0.045454545
Fickle Andrews, c.2.8, 0.045454545
Fickle Andrews, c.2.9, 0.045454545
Harry Gore, a.1.1, 0.051282051
Harry Gore, a.1.2, 0.051282051
Harry Gore, a.1.3, 0.051282051
Harry Gore, a.1.4, 0.051282051
Harry Gore, a.2, 0.051282051
Harry Gore, a.3.1, 0.121794872
Harry Gore, a.3.2, 0.121794872
Harry Gore, a.3.3, 0.121794872
Harry Gore, a.3.4, 0.121794872
Harry Gore, a.3.5, 0.121794872
Harry Gore, a.3.6, 0.121794872
Harry Gore, b.6.1, 0.012820513
Harry Gore, c.4.1, 0
Harry Gore, c.4.2, 0
Harry Gore, c.4.3, 0
Harry Gore, c.4.4, 0
Harry Gore, c.4.5, 0
Harry Gore, c.4.6, 0
Ian More, a.3.3, 0.285714286
Ian More, c.3.1, 0.214285714
Ian More, c.4.1, 0.214285714
Ian More, e.1.1, 0
Ian More, e.1.2, 0
Ian More, e.1.3, 0
Ian More, f.1, 0.095238095
Ian More, i.3.5, 0.142857143
Ian More, j.4.1, 0.047619048
Jan Crowe, a.2, 0.121212121
Jan Crowe, a.3.2, 0.121212121
Jan Crowe, b.1.2, 0.121212121
Jan Crowe, b.2.1, 0.121212121
Jan Crowe, b.3.3, 0.121212121
Jan Crowe, d.1.2, 0.015151515
Jan Crowe, g.1.1, 0.121212121
Jan Crowe, g.2.2, 0.121212121
Jan Crowe, h.2.1, 0.045454545
Jan Crowe, h.2.2, 0.045454545
Jan Crowe, h.2.3, 0.045454545
Jason Ortiz, a.1.1, 0.052564103
Jason Ortiz, a.1.2, 0.052564103
Jason Ortiz, a.1.3, 0.052564103
Jason Ortiz, a.1.4, 0.052564103
Jason Ortiz, a.2, 0.002564103
Jason Ortiz, a.3.1, 0.002564103
Jason Ortiz, a.3.2, 0.052564103
Jason Ortiz, a.3.3, 0.002564103
Jason Ortiz, a.3.4, 0.002564103
Jason Ortiz, a.3.5, 0.002564103
Jason Ortiz, a.3.6, 0.002564103
Jason Ortiz, b.2.1, 0.052564103
Jason Ortiz, b.3.2, 0.03974359
Jason Ortiz, b.5, 0.052564103
Jason Ortiz, c.1.1, 0.03974359
Jason Ortiz, c.1.2, 0.03974359
Jason Ortiz, d.1.1, 0.069230769
Jason Ortiz, d.1.2, 0.069230769
Jason Ortiz, d.5.1, 0.064102564
Jason Ortiz, d.6, 0.064102564
Jason Ortiz, f.1, 0.023076923
Jason Ortiz, f.2.1, 0.023076923
Jason Ortiz, f.2.2, 0.023076923
Jason Ortiz, f.3, 0.023076923
Jason Ortiz, f.4.1, 0.023076923
Jason Ortiz, f.5, 0.023076923
Jason Ortiz, f.6.1, 0.023076923
Jason Ortiz, f.6.2, 0.023076923
Jason Ortiz, f.6.3, 0.023076923
Jason Ortiz, i.3.6, 0.023076923
Jeremy Spain, a.1.1, 0.134615385
Jeremy Spain, a.1.2, 0.134615385
Jeremy Spain, a.1.3, 0.134615385
Jeremy Spain, a.1.4, 0.134615385
Jeremy Spain, c.2.9, 0.012820513
Jeremy Spain, c.4.1, 0.057692308
Jeremy Spain, c.4.2, 0.057692308
Jeremy Spain, c.4.3, 0.057692308
Jeremy Spain, c.4.4, 0.057692308
Jeremy Spain, c.4.5, 0.057692308
Jeremy Spain, c.4.6, 0.057692308
Jeremy Spain, d.5.2, 0.102564103
Jim Howe, c.2.1, 0.066666667
Jim Howe, c.2.2, 0.066666667
Jim Howe, c.2.3, 0.066666667
Jim Howe, c.2.4, 0.066666667
Jim Howe, c.2.5, 0.066666667
Jim Howe, c.2.6, 0.066666667
Jim Howe, c.2.7, 0.066666667
Jim Howe, c.2.8, 0.066666667
Jim Howe, c.2.9, 0.066666667
Jim Howe, c.3.1, 0.05
Jim Howe, d.2.1, 0.013333333
Jim Howe, d.2.2, 0.013333333
Jim Howe, d.2.3, 0.013333333
Jim Howe, e.1.1, 0.003333333
Jim Howe, e.1.2, 0.003333333
Jim Howe, e.1.3, 0.003333333
Jim Howe, f.1, 0.033333333
Jim Howe, f.2.1, 0.033333333
Jim Howe, f.2.2, 0.033333333
Jim Howe, f.3, 0.033333333
Jim Howe, f.4.1, 0.033333333
Jim Howe, f.5, 0.033333333
Jim Howe, f.6.1, 0.033333333
Jim Howe, f.6.2, 0.033333333
Jim Howe, f.6.3, 0.033333333
Johnny Glenn, a.1.1, 0.083333333
Johnny Glenn, a.1.2, 0.083333333
Johnny Glenn, a.1.3, 0.083333333
Johnny Glenn, a.1.4, 0.083333333
Johnny Glenn, a.3.3, 0.333333333
Johnny Glenn, a.3.4, 0.333333333
Jots Semb, f.1, 0.071428571
Jots Semb, f.2.1, 0.071428571
Jots Semb, f.2.2, 0.071428571
Jots Semb, f.3, 0.071428571
Jots Semb, f.4.1, 0.071428571
Jots Semb, f.5, 0.071428571
Jots Semb, f.6.1, 0.071428571
Jots Semb, f.6.2, 0.071428571
Jots Semb, f.6.3, 0.071428571
Jots Semb, i.1.1, 0.071428571
Jots Semb, i.1.2, 0.071428571
Jots Semb, i.1.3, 0.071428571
Jots Semb, i.1.4, 0.071428571

Jots Semb, i.2.3, 0.071428571
Kathleen Niche, a.3.1, 0.122222222
Kathleen Niche, a.3.2, 0.122222222
Kathleen Niche, a.3.3, 0.122222222
Kathleen Niche, a.3.4, 0.122222222
Kathleen Niche, a.3.5, 0.122222222
Kathleen Niche, a.3.6, 0.122222222
Kathleen Niche, b.5, 0.044444444
Kathleen Niche, b.6.1, 0.022222222
Kathleen Niche, d.5.2, 0.2
Kathryn Lester, c.1.1, 0.028985507
Kathryn Lester, c.1.2, 0.028985507
Kathryn Lester, d.1.1, 0.062111801
Kathryn Lester, d.1.2, 0.062111801
Kathryn Lester, d.2.1, 0.062111801
Kathryn Lester, d.2.2, 0.062111801
Kathryn Lester, d.2.3, 0.062111801
Kathryn Lester, d.3, 0.062111801
Kathryn Lester, d.4.1, 0.062111801
Kathryn Lester, d.5.1, 0.062111801
Kathryn Lester, d.5.2, 0.062111801
Kathryn Lester, d.5.3, 0.062111801
Kathryn Lester, d.5.4, 0.062111801
Kathryn Lester, d.5.5, 0.062111801
Kathryn Lester, d.6, 0.062111801
Kathryn Lester, d.7, 0.062111801
Kathryn Lester, i.2.5, 0.022774327
Kathryn Lester, i.2.6, 0.01863354
Kathryn Lester, i.3.1, 0
Kathryn Lester, i.3.5, 0.014492754
Kathryn Lester, j.3.1, 0.004140787
Kathryn Lester, j.3.2, 0.004140787
Kathryn Lester, j.3.3, 0.004140787
Kathryn Lester, j.3.4, 0.004140787
Kerstin Michel, a.1.1, 0.088095238
Kerstin Michel, a.1.2, 0.088095238
Kerstin Michel, a.1.3, 0.088095238
Kerstin Michel, a.1.4, 0.088095238
Kerstin Michel, a.3.1, 0.064285714
Kerstin Michel, a.3.2, 0.064285714
Kerstin Michel, a.3.3, 0.064285714
Kerstin Michel, a.3.4, 0.064285714
Kerstin Michel, a.3.5, 0.064285714
Kerstin Michel, a.3.6, 0.064285714
Kerstin Michel, c.2.1, 0.028571429
Kerstin Michel, c.2.2, 0.028571429
Kerstin Michel, c.2.3, 0.028571429
Kerstin Michel, c.2.4, 0.028571429
Kerstin Michel, c.2.5, 0.028571429
Kerstin Michel, c.2.6, 0.028571429
Kerstin Michel, c.2.7, 0.028571429
Kerstin Michel, c.2.8, 0.028571429
Kerstin Michel, c.2.9, 0.028571429
Kerstin Michel, d.5.2, 0
Kerstin Michel, d.5.5, 0.004761905
Liz Hopper, a.1.1, 0.122222222
Liz Hopper, a.1.2, 0.122222222
Liz Hopper, a.1.3, 0.122222222
Liz Hopper, a.1.4, 0.122222222
Liz Hopper, c.2.2, 0.188888889
Liz Hopper, c.4.1, 0.044444444
Liz Hopper, d.4.1, 0.066666667
Liz Hopper, g.4.5, 0.188888889
Liz Hopper, h.2.2, 0.022222222
Magali Persi, a.3.2, 0.052287582
Magali Persi, b.1.1, 0.04248366
Magali Persi, b.1.2, 0.04248366
Magali Persi, b.1.4, 0.029411765
Magali Persi, b.1.7, 0.029411765
Magali Persi, b.4, 0.013071895
Magali Persi, c.2.1, 0.08496732
Magali Persi, c.2.2, 0.08496732
Magali Persi, c.2.3, 0.08496732
Magali Persi, c.2.4, 0.08496732
Magali Persi, c.2.5, 0.08496732
Magali Persi, c.2.6, 0.08496732
Magali Persi, c.2.7, 0.08496732
Magali Persi, c.2.8, 0.08496732
Magali Persi, c.2.9, 0.08496732
Magali Persi, d.5.2, 0.006535948
Magali Persi, h.2.2, 0.019607843
Malcolm Bain, i.2.3, 0.1
Malcolm Bain, i.2.5, 0.4
Malcolm Bain, i.3.1, 0.3
Malcolm Bain, i.3.3, 0.2
Maria Damon, c.2.8, 0.004329004
Maria Damon, d.1.1, 0.010822511
Maria Damon, d.1.2, 0.010822511
Maria Damon, d.5.2, 0.019480519
Maria Damon, d.5.4, 0.019480519
Maria Damon, f.1, 0.073593074
Maria Damon, f.2.1, 0.073593074
Maria Damon, f.2.2, 0.073593074
Maria Damon, f.3, 0.073593074
Maria Damon, f.4.1, 0.073593074
Maria Damon, f.5, 0.073593074
Maria Damon, f.6.1, 0.073593074
Maria Damon, f.6.2, 0.073593074
Maria Damon, f.6.3, 0.073593074
Maria Damon, h.1, 0.038961039
Maria Damon, h.2.1, 0.038961039
Maria Damon, h.2.2, 0.038961039
Maria Damon, h.2.3, 0.038961039
Maria Damon, h.3, 0.038961039
Maria Damon, h.4, 0.038961039
Maria Damon, h.5.1, 0.038961039
Marilyn Gallo, a.1.1, 0.021804511
Marilyn Gallo, a.1.2, 0.021804511
Marilyn Gallo, a.1.3, 0.021804511
Marilyn Gallo, a.1.4, 0.021804511
Marilyn Gallo, c.1.1, 0.039849624
Marilyn Gallo, c.1.2, 0.039849624
Marilyn Gallo, c.2.1, 0.039849624
Marilyn Gallo, c.2.2, 0.039849624
Marilyn Gallo, c.2.3, 0.039849624
Marilyn Gallo, c.2.4, 0.039849624
Marilyn Gallo, c.2.5, 0.039849624
Marilyn Gallo, c.2.6, 0.039849624
Marilyn Gallo, c.2.7, 0.039849624
Marilyn Gallo, c.2.8, 0.039849624
Marilyn Gallo, c.2.9, 0.039849624
Marilyn Gallo, c.3.1, 0.039849624
Marilyn Gallo, c.3.2, 0.039849624
Marilyn Gallo, c.4.1, 0.039849624
Marilyn Gallo, c.4.2, 0.039849624
Marilyn Gallo, c.4.3, 0.039849624
Marilyn Gallo, c.4.4, 0.039849624
Marilyn Gallo, c.4.5, 0.039849624
Marilyn Gallo, c.4.6, 0.039849624
Marilyn Gallo, c.5.1, 0.039849624
Marilyn Gallo, d.2.1, 0.009022556
Marilyn Gallo, d.2.2, 0.009022556
Marilyn Gallo, d.2.3, 0.009022556
Marilyn Gallo, e.1.1, 0.015037594
Marilyn Gallo, e.1.2, 0.015037594
Marilyn Gallo, e.1.3, 0.015037594
Marilyn Gallo, e.2, 0.015037594
Marilyn Gallo, e.3, 0.015037594
Marilyn Gallo, g.3.1, 0.006015038
Marilyn Gallo, j.5.1, 0.001503759
Marilyn Gallo, j.5.2, 0.001503759
Marilyn Gallo, j.5.3, 0.001503759
Marilyn Gallo, j.5.4, 0.001503759
Marilyn Gallo, j.5.5, 0.001503759
Marion Lam, a.1.2, 0.2
Marion Lam, a.1.3, 0.25
Marion Lam, c.2.8, 0.3
Marion Lam, d.5.1, 0.05
Marion Lam, d.5.2, 0.05
Marion Lam, d.5.3, 0.05
Marion Lam, d.5.4, 0.05
Marion Lam, d.5.5, 0.05
Marion Ross, a.3.1, 0.166666667
Marion Ross, a.3.2, 0.166666667
Marion Ross, a.3.3, 0.166666667
Marion Ross, a.3.4, 0.166666667
Marion Ross, a.3.5, 0.166666667
Marion Ross, a.3.6, 0.166666667
Mark Wesley, a.3.1, 0.035947712
Mark Wesley, a.3.2, 0.035947712
Mark Wesley, a.3.3, 0.035947712
Mark Wesley, a.3.4, 0.035947712
Mark Wesley, a.3.5, 0.035947712
Mark Wesley, a.3.6, 0.035947712
Mark Wesley, b.4, 0
Mark Wesley, c.2.1, 0.08496732
Mark Wesley, c.2.2, 0.08496732
Mark Wesley, c.2.3, 0.08496732
Mark Wesley, c.2.4, 0.08496732
Mark Wesley, c.2.5, 0.08496732
Mark Wesley, c.2.6, 0.08496732
Mark Wesley, c.2.7, 0.08496732
Mark Wesley, c.2.8, 0.08496732
Mark Wesley, c.2.9, 0.08496732
Mark Wesley, g.4.3, 0.006535948
Mark Wesley, i.3.3, 0.013071895
Martin Payne, a.3.1, 0.166666667
Martin Payne, a.3.2, 0.166666667
Martin Payne, a.3.3, 0.166666667
Martin Payne, a.3.4, 0.166666667
Martin Payne, a.3.5, 0.166666667
Martin Payne, a.3.6, 0.166666667
Mat Reed, a.2, 0.071428571
Mat Reed, a.3.2, 0.232142857
Mat Reed, b.1.4, 0.107142857
Mat Reed, b.1.7, 0
Mat Reed, b.2.1, 0.232142857
Mat Reed, f.2.1, 0.160714286
Mat Reed, f.2.2, 0.160714286
Mat Reed, g.3.1, 0.035714286
Mick Carin, a.1.1, 0.133333333
Mick Carin, a.1.2, 0.133333333
Mick Carin, a.1.3, 0.133333333
Mick Carin, a.1.4, 0.133333333
Mick Carin, f.6.2, 0.466666667
Mike Dawson, a.3.1, 0.106837607
Mike Dawson, a.3.2, 0.106837607
Mike Dawson, a.3.3, 0.106837607
Mike Dawson, a.3.4, 0.106837607
Mike Dawson, a.3.5, 0.106837607
Mike Dawson, a.3.6, 0.106837607
Mike Dawson, b.3.1, 0.055555556
Mike Dawson, b.7, 0.055555556
Mike Dawson, d.1.1, 0.068376068
Mike Dawson, d.5.3, 0.042735043
Mike Dawson, g.3.1, 0.076923077
Mike Dawson, h.1, 0.008547009
Mike Dawson, h.2.1, 0.008547009
Mike Dawson, h.2.2, 0.008547009
Mike Dawson, h.2.3, 0.008547009
Mike Dawson, h.3, 0.008547009
Mike Dawson, h.4, 0.008547009
Mike Dawson, h.5.1, 0.008547009
Neil Roper, a.3.1, 0.057142857
Neil Roper, a.3.2, 0.123809524
Neil Roper, a.3.3, 0.033333333
Neil Roper, a.3.4, 0.033333333
Neil Roper, a.3.5, 0.033333333
Neil Roper, a.3.6, 0.033333333
Neil Roper, b.1.1, 0.076190476
Neil Roper, b.1.4, 0.095238095
Neil Roper, b.1.6, 0.076190476
Neil Roper, b.3.1, 0
Neil Roper, b.4, 0.133333333
Neil Roper, b.5, 0.076190476
Neil Roper, c.2.1, 0
Neil Roper, c.2.2, 0
Neil Roper, c.2.3, 0
Neil Roper, c.2.4, 0
Neil Roper, c.2.5, 0
Neil Roper, c.2.6, 0
Neil Roper, c.2.7, 0
Neil Roper, c.2.8, 0
Neil Roper, c.2.9, 0
Neil Roper, c.4.3, 0.104761905
Neil Roper, c.4.4, 0.114285714
Neil Roper, h.2.3, 0.00952381
Nicolas Curry, a.1.1, 0.214285714
Nicolas Curry, a.1.2, 0.214285714
Nicolas Curry, a.1.3, 0.214285714
Nicolas Curry, a.1.4, 0.214285714
Nicolas Curry, c.3.1, 0.047619048
Nicolas Curry, h.5.1, 0.095238095
Niyi Akers, a.3.1, 0.00877193
Niyi Akers, b.1.1, 0.00877193
Niyi Akers, b.1.2, 0.00877193
Niyi Akers, b.1.3, 0.00877193
Niyi Akers, b.1.4, 0.00877193
Niyi Akers, b.1.6, 0.00877193
Niyi Akers, b.1.7, 0.00877193
Niyi Akers, b.1.8, 0.00877193
Niyi Akers, b.1.9, 0.00877193
Niyi Akers, c.1.1, 0.052631579
Niyi Akers, c.1.2, 0
Niyi Akers, c.2.1, 0.096491228
Niyi Akers, c.2.2, 0.096491228
Niyi Akers, c.2.3, 0.096491228
Niyi Akers, c.2.4, 0.096491228
Niyi Akers, c.2.5, 0.096491228
Niyi Akers, c.2.6, 0.096491228
Niyi Akers, c.2.7, 0.096491228
Niyi Akers, c.2.8, 0.096491228
Niyi Akers, c.2.9, 0.096491228
Niyi Akers, d.2.1, 0
Noshir Holmes, b.4, 0.166666667
Noshir Holmes, d.3, 0.333333333
Noshir Holmes, f.4.1, 0.5
Oliver Cullen, a.3.1, 0.031746032
Oliver Cullen, a.3.2, 0.010582011
Oliver Cullen, a.3.3, 0.010582011
Oliver Cullen, a.3.4, 0.010582011
Oliver Cullen, a.3.5, 0.010582011
Oliver Cullen, a.3.6, 0.010582011
Oliver Cullen, b.1.1, 0.025132275
Oliver Cullen, b.1.2, 0.025132275
Oliver Cullen, b.4, 0
Oliver Cullen, c.1.1, 0.01984127
Oliver Cullen, c.1.2, 0.01984127
Oliver Cullen, c.2.1, 0.060846561
Oliver Cullen, c.2.2, 0.060846561
Oliver Cullen, c.2.3, 0.060846561
Oliver Cullen, c.2.4, 0.060846561
Oliver Cullen, c.2.5, 0.060846561
Oliver Cullen, c.2.6, 0.060846561
Oliver Cullen, c.2.7, 0.060846561
Oliver Cullen, c.2.8, 0.060846561
Oliver Cullen, c.2.9, 0.060846561
Oliver Cullen, c.3.1, 0.029100529
Oliver Cullen, c.4.1, 0.041005291
Oliver Cullen, c.4.2, 0.041005291
Oliver Cullen, c.4.3, 0.041005291
Oliver Cullen, c.4.4, 0.041005291
Oliver Cullen, c.4.5, 0.041005291
Oliver Cullen, c.4.6, 0.041005291
Oliver Cullen, e.1.3, 0.002645503
Paul Ayers, a.3.2, 0.266666667
Paul Ayers, c.2.2, 0.233333333
Paul Ayers, c.3.1, 0
Paul Ayers, c.4.2, 0.2
Paul Ayers, d.2.1, 0
Paul Ayers, d.2.2, 0
Paul Ayers, d.2.3, 0
Paul Ayers, e.1.1, 0
Paul Ayers, e.1.2, 0
Paul Ayers, e.1.3, 0
Paul Ayers, e.2, 0
Paul Ayers, e.3, 0
Paul Ayers, f.1, 0.033333333
Paul Ayers, f.2.1, 0.033333333
Paul Ayers, f.2.2, 0.033333333
Paul Ayers, f.3, 0.033333333
Paul Ayers, f.4.1, 0.033333333
Paul Ayers, f.5, 0.033333333
Paul Ayers, f.6.1, 0.033333333
Paul Ayers, f.6.2, 0.033333333
Paul Ayers, f.6.3, 0.033333333
Pepi Sands, a.3.2, 0.098484848
Pepi Sands, b.2.1, 0.015151515
Pepi Sands, c.2.1, 0.098484848
Pepi Sands, c.2.2, 0.098484848
Pepi Sands, c.2.3, 0.098484848
Pepi Sands, c.2.4, 0.098484848
Pepi Sands, c.2.5, 0.098484848
Pepi Sands, c.2.6, 0.098484848
Pepi Sands, c.2.7, 0.098484848
Pepi Sands, c.2.8, 0.098484848
Pepi Sands, c.2.9, 0.098484848
Rachna Kaplan, a.3.1, 0.03287311
Rachna Kaplan, a.3.2, 0.03287311
Rachna Kaplan, a.3.3, 0.03287311
Rachna Kaplan, a.3.4, 0.03287311
Rachna Kaplan, a.3.5, 0.03287311
Rachna Kaplan, a.3.6, 0.03287311
Rachna Kaplan, b.1.1, 0.008547009
Rachna Kaplan, b.1.2, 0.008547009
Rachna Kaplan, b.1.3, 0.008547009
Rachna Kaplan, b.1.8, 0.008547009
Rachna Kaplan, c.2.1, 0.03287311
Rachna Kaplan, c.2.2, 0.03287311
Rachna Kaplan, c.2.3, 0.03287311
Rachna Kaplan, c.2.4, 0.03287311
Rachna Kaplan, c.2.5, 0.03287311
Rachna Kaplan, c.2.6, 0.03287311
Rachna Kaplan, c.2.7, 0.03287311
Rachna Kaplan, c.2.8, 0.03287311
Rachna Kaplan, c.2.9, 0.03287311
Rachna Kaplan, d.2.1, 0.008547009
Rachna Kaplan, d.2.2, 0.008547009
Rachna Kaplan, d.2.3, 0.008547009
Rachna Kaplan, d.5.2, 0.001314924
Rachna Kaplan, d.5.4, 0.001314924
Rachna Kaplan, e.2, 0.008547009
Rachna Kaplan, e.3, 0.008547009
Rachna Kaplan, f.1, 0.03287311
Rachna Kaplan, f.2.1, 0.03287311
Rachna Kaplan, f.2.2, 0.03287311
Rachna Kaplan, f.3, 0.03287311
Rachna Kaplan, f.4.1, 0.03287311
Rachna Kaplan, f.5, 0.03287311
Rachna Kaplan, f.6.1, 0.03287311
Rachna Kaplan, f.6.2, 0.03287311
Rachna Kaplan, f.6.3, 0.03287311
Rachna Kaplan, j.6.1, 0.03287311
Rachna Kaplan, j.6.2, 0.03287311
Rachna Kaplan, j.6.3, 0.03287311
Rachna Kaplan, j.6.4, 0.03287311
Ray Hardy, a.3.1, 0.052910053
Ray Hardy, a.3.2, 0.052910053
Ray Hardy, a.3.3, 0.052910053
Ray Hardy, a.3.4, 0.052910053
Ray Hardy, a.3.5, 0.052910053
Ray Hardy, a.3.6, 0.052910053
Ray Hardy, c.2.1, 0.052910053
Ray Hardy, c.2.2, 0.052910053
Ray Hardy, c.2.3, 0.052910053
Ray Hardy, c.2.4, 0.052910053
Ray Hardy, c.2.5, 0.052910053
Ray Hardy, c.2.6, 0.052910053
Ray Hardy, c.2.7, 0.052910053
Ray Hardy, c.2.8, 0.052910053
Ray Hardy, c.2.9, 0.052910053
Ray Hardy, c.3.1, 0.01984127
Ray Hardy, d.2.1, 0.002645503
Ray Hardy, d.2.2, 0.002645503
Ray Hardy, d.2.3, 0.002645503
Ray Hardy, f.1, 0.01984127
Ray Hardy, f.2.1, 0.01984127
Ray Hardy, f.2.2, 0.01984127
Ray Hardy, f.3, 0.01984127
Ray Hardy, f.4.1, 0.01984127
Ray Hardy, f.5, 0.01984127
Ray Hardy, f.6.1, 0.01984127
Ray Hardy, f.6.2, 0.01984127
Ray Hardy, f.6.3, 0.01984127
Richard Fuller, a.3.1, 0.071123755
Richard Fuller, a.3.2, 0.071123755
Richard Fuller, a.3.3, 0.071123755
Richard Fuller, a.3.4, 0.071123755
Richard Fuller, a.3.5, 0.071123755
Richard Fuller, a.3.6, 0.071123755
Richard Fuller, b.3.1, 0.034139403
Richard Fuller, b.7, 0.034139403
Richard Fuller, c.1.1, 0.00284495
Richard Fuller, c.1.2, 0.00284495

Richard Fuller, c.2.1, 0.00284495
Richard Fuller, c.2.2, 0.00284495
Richard Fuller, c.2.3, 0.00284495
Richard Fuller, c.2.4, 0.00284495
Richard Fuller, c.2.5, 0.00284495
Richard Fuller, c.2.6, 0.00284495
Richard Fuller, c.2.7, 0.00284495
Richard Fuller, c.2.8, 0.00284495
Richard Fuller, c.2.9, 0.00284495
Richard Fuller, c.3.1, 0.00284495
Richard Fuller, c.3.2, 0.00284495
Richard Fuller, c.4.1, 0.00284495
Richard Fuller, c.4.2, 0.00284495
Richard Fuller, c.4.3, 0.00284495
Richard Fuller, c.4.4, 0.00284495
Richard Fuller, c.4.5, 0.00284495
Richard Fuller, c.4.6, 0.00284495
Richard Fuller, c.5.1, 0.00284495
Richard Fuller, d.5.3, 0.038406828
Richard Fuller, g.3.1, 0.06116643
Richard Fuller, h.1, 0.049786629
Richard Fuller, h.2.1, 0.049786629
Richard Fuller, h.2.2, 0.049786629
Richard Fuller, h.2.3, 0.049786629
Richard Fuller, h.3, 0.049786629
Richard Fuller, h.4, 0.049786629
Richard Fuller, h.5.1, 0.049786629
Richard Marsh, c.2.1, 0.098484848
Richard Marsh, c.2.2, 0.098484848
Richard Marsh, c.2.3, 0.098484848
Richard Marsh, c.2.4, 0.098484848
Richard Marsh, c.2.5, 0.098484848
Richard Marsh, c.2.6, 0.098484848
Richard Marsh, c.2.7, 0.098484848
Richard Marsh, c.2.8, 0.098484848
Richard Marsh, c.2.9, 0.098484848
Richard Marsh, i.3.1, 0
Richard Marsh, i.3.3, 0.098484848
Richard Marsh, j.2.4, 0.015151515
Robert Clarke, f.5, 0.022222222
Robert Clarke, i.1.3, 0.044444444
Robert Clarke, i.1.4, 0.066666667
Robert Clarke, i.3.3, 0.111111111
Robert Clarke, i.3.4, 0.133333333
Robert Clarke, i.3.5, 0.155555556
Robert Clarke, j.2.1, 0.177777778
Robert Clarke, j.3.4, 0.088888889
Robert Clarke, j.5.5, 0.2
Roger All, a.3.1, 0.160714286
Roger All, a.3.2, 0.160714286
Roger All, a.3.3, 0.160714286
Roger All, a.3.4, 0.160714286
Roger All, a.3.5, 0.160714286
Roger All, a.3.6, 0.160714286
Roger All, d.5.1, 0.035714286
Ruth Simon, a.1.1, 0.233333333
Ruth Simon, a.1.2, 0.233333333
Ruth Simon, a.1.3, 0.233333333
Ruth Simon, a.1.4, 0.233333333
Ruth Simon, c.2.6, 0.066666667
Samuel Mackey, a.3.1, 0.166666667
Samuel Mackey, a.3.2, 0.166666667
Samuel Mackey, a.3.3, 0.166666667
Samuel Mackey, a.3.4, 0.166666667
Samuel Mackey, a.3.5, 0.166666667
Samuel Mackey, a.3.6, 0.166666667
Sarah Brante, a.1.1, 0.008333333
Sarah Brante, a.1.2, 0.008333333
Sarah Brante, a.1.3, 0.008333333
Sarah Brante, a.1.4, 0.041666667
Sarah Brante, b.1.2, 0.029166667
Sarah Brante, b.3.2, 0.029166667
Sarah Brante, b.6.1, 0.070833333
Sarah Brante, c.4.5, 0.1
Sarah Brante, d.1.1, 0.1125
Sarah Brante, d.4.1, 0.1125
Sarah Brante, e.1.1, 0.070833333
Sarah Brante, e.1.2, 0.070833333
Sarah Brante, e.1.3, 0.070833333
Sarah Brante, e.2, 0.070833333
Sarah Brante, e.3, 0.070833333
Sarah Brante, f.3, 0.125
Sarah Brante, f.6.3, 0
Sean Wall, c.4.6, 0.098214286
Sean Wall, d.7, 0.107142857
Sean Wall, e.1.1, 0.041666667
Sean Wall, e.1.2, 0.041666667
Sean Wall, e.1.3, 0.041666667
Sean Wall, e.2, 0.041666667
Sean Wall, e.3, 0.041666667
Sean Wall, g.5, 0.098214286
Sean Wall, h.1, 0.005952381
Sean Wall, h.2.1, 0.005952381
Sean Wall, h.2.2, 0.005952381
Sean Wall, h.2.3, 0.005952381
Sean Wall, h.3, 0.005952381
Sean Wall, h.4, 0.005952381
Sean Wall, h.5.1, 0.005952381
Sean Wall, j.1.2, 0.074404762
Sean Wall, j.5.1, 0.074404762
Sean Wall, j.5.2, 0.074404762
Sean Wall, j.5.3, 0.074404762
Sean Wall, j.5.4, 0.074404762
Sean Wall, j.5.5, 0.074404762
Shawn Wills, a.1.1, 0.033333333
Shawn Wills, a.1.2, 0.033333333
Shawn Wills, a.1.3, 0.033333333
Shawn Wills, a.1.4, 0.033333333
Shawn Wills, a.3.1, 0.033333333
Shawn Wills, a.3.2, 0.033333333
Shawn Wills, a.3.3, 0.033333333
Shawn Wills, a.3.4, 0.033333333
Shawn Wills, a.3.5, 0.033333333
Shawn Wills, a.3.6, 0.033333333
Shawn Wills, c.1.1, 0.033333333
Shawn Wills, c.1.2, 0.033333333
Shawn Wills, c.2.1, 0.033333333
Shawn Wills, c.2.2, 0.033333333
Shawn Wills, c.2.3, 0.033333333
Shawn Wills, c.2.4, 0.033333333
Shawn Wills, c.2.5, 0.033333333
Shawn Wills, c.2.6, 0.033333333
Shawn Wills, c.2.7, 0.033333333
Shawn Wills, c.2.8, 0.033333333
Shawn Wills, c.2.9, 0.033333333
Shawn Wills, c.3.1, 0.033333333
Shawn Wills, c.3.2, 0.033333333
Shawn Wills, c.4.1, 0.033333333
Shawn Wills, c.4.2, 0.033333333
Shawn Wills, c.4.3, 0.033333333
Shawn Wills, c.4.4, 0.033333333
Shawn Wills, c.4.5, 0.033333333
Shawn Wills, c.4.6, 0.033333333
Shawn Wills, c.5.1, 0.033333333
Simon Farmer, c.1.1, 0.091358025
Simon Farmer, c.1.2, 0.091358025
Simon Farmer, c.4.1, 0.004938272
Simon Farmer, c.4.2, 0.004938272
Simon Farmer, c.4.3, 0.004938272
Simon Farmer, c.4.4, 0.004938272
Simon Farmer, c.4.5, 0.004938272
Simon Farmer, c.4.6, 0.004938272
Simon Farmer, d.5.1, 0.091358025
Simon Farmer, e.1.1, 0.061728395
Simon Farmer, e.1.2, 0.061728395
Simon Farmer, e.1.3, 0.061728395
Simon Farmer, e.2, 0.061728395
Simon Farmer, e.3, 0.061728395
Simon Farmer, f.4.1, 0.101234568
Simon Farmer, h.1, 0.004938272
Simon Farmer, h.2.1, 0.004938272
Simon Farmer, h.2.2, 0.004938272
Simon Farmer, h.2.3, 0.004938272
Simon Farmer, h.3, 0.004938272
Simon Farmer, h.4, 0.004938272
Simon Farmer, h.5.1, 0.004938272
Simon Farmer, j.2.1, 0.061728395
Simon Farmer, j.2.2, 0.061728395
Simon Farmer, j.2.3, 0.061728395
Simon Farmer, j.2.4, 0.061728395
Simon Farmer, j.6.2, 0.004938272
Simon Mann, c.1.1, 0.085972851
Simon Mann, c.1.2, 0.085972851
Simon Mann, c.2.1, 0.085972851
Simon Mann, c.2.2, 0.085972851
Simon Mann, c.2.3, 0.085972851
Simon Mann, c.2.4, 0.085972851
Simon Mann, c.2.5, 0.085972851
Simon Mann, c.2.6, 0.085972851
Simon Mann, c.2.7, 0.085972851
Simon Mann, c.2.8, 0.085972851
Simon Mann, c.2.9, 0.085972851
Simon Mann, c.4.1, 0.009049774
Simon Mann, c.4.2, 0.009049774
Simon Mann, c.4.3, 0.009049774
Simon Mann, c.4.4, 0.009049774
Simon Mann, c.4.5, 0.009049774
Simon Mann, c.4.6, 0.009049774
Steve Curry, c.2.1, 1
Steve Curry, c.3.1, 0
Tamsin Pitts, b.3.2, 0.065743945
Tamsin Pitts, c.2.1, 0.065743945
Tamsin Pitts, c.2.2, 0.065743945
Tamsin Pitts, c.2.3, 0.065743945
Tamsin Pitts, c.2.4, 0.065743945
Tamsin Pitts, c.2.5, 0.065743945
Tamsin Pitts, c.2.6, 0.065743945
Tamsin Pitts, c.2.7, 0.065743945
Tamsin Pitts, c.2.8, 0.065743945
Tamsin Pitts, c.2.9, 0.065743945
Tamsin Pitts, d.1.1, 0.006920415
Tamsin Pitts, d.1.2, 0.006920415
Tamsin Pitts, d.5.1, 0.065743945
Tamsin Pitts, d.5.2, 0.065743945
Tamsin Pitts, d.5.3, 0.065743945
Tamsin Pitts, d.5.4, 0.065743945
Tamsin Pitts, d.5.5, 0.065743945
Tariq Haines, g.4.4, 0.166666667
Tariq Haines, i.3.6, 0.166666667
Tariq Haines, j.5.1, 0.166666667
Tariq Haines, j.6.3, 0.166666667
Tariq Haines, j.7.1, 0.166666667
Tariq Haines, j.7.2, 0.166666667
Tim Pugh, d.6, 1
Tim Pugh, f.6.1, 0
Tony Boston, b.3.4, 0.076190476
Tony Boston, c.2.7, 0.080952381
Tony Boston, c.4.1, 0.021428571
Tony Boston, c.4.2, 0.021428571
Tony Boston, c.4.3, 0.021428571
Tony Boston, c.4.4, 0.021428571
Tony Boston, c.4.5, 0.021428571
Tony Boston, c.4.6, 0.021428571
Tony Boston, g.4.4, 0.071428571
Tony Boston, h.1, 0.052380952
Tony Boston, h.2.1, 0.052380952
Tony Boston, h.2.2, 0.052380952
Tony Boston, h.2.3, 0.052380952
Tony Boston, h.3, 0.052380952
Tony Boston, h.4, 0.052380952
Tony Boston, h.5.1, 0.052380952
Tony Boston, j.1.1, 0.095238095
Tony Boston, j.1.2, 0.088095238
Tony Boston, j.3.3, 0.004761905
Tony Boston, j.6.3, 0.088095238
Wendy Richey, b.1.4, 0.333333333
Wendy Richey, d.2.2, 0.333333333
Wendy Richey, d.2.3, 0.333333333
Will Miles, e.1.1, 0.066137566
Will Miles, e.1.2, 0.066137566
Will Miles, e.1.3, 0.066137566
Will Miles, e.2, 0.066137566
Will Miles, e.3, 0.066137566
Will Miles, f.1, 0.018518519
Will Miles, f.2.1, 0.018518519
Will Miles, f.2.2, 0.018518519
Will Miles, f.3, 0.018518519
Will Miles, f.4.1, 0.018518519
Will Miles, f.5, 0.018518519
Will Miles, f.6.1, 0.018518519
Will Miles, f.6.2, 0.018518519
Will Miles, f.6.3, 0.018518519
Will Miles, g.1, 0.058201058
Will Miles, i.1.1, 0.041005291
Will Miles, i.1.2, 0.041005291
Will Miles, i.1.3, 0.041005291
Will Miles, i.1.4, 0.041005291
Will Miles, i.3.2, 0.005291005
Will Miles, i.3.3, 0.055555556
Will Miles, j.1.1, 0.052910053
Will Miles, j.2.1, 0.041005291
Will Miles, j.2.2, 0.041005291
Will Miles, j.2.3, 0.041005291
Will Miles, j.2.4, 0.041005291
Will Miles, j.6.3, 0.002645503
Yogesh Katz, a.1.1, 0.125
Yogesh Katz, a.1.2, 0.125
Yogesh Katz, a.1.3, 0.125
Yogesh Katz, a.1.4, 0.125
Yogesh Katz, a.3.1, 0
Yogesh Katz, a.3.2, 0
Yogesh Katz, a.3.3, 0
Yogesh Katz, a.3.4, 0
Yogesh Katz, a.3.5, 0
Yogesh Katz, a.3.6, 0
Yogesh Katz, f.1, 0.194444444
Yogesh Katz, j.3.1, 0.027777778
Yogesh Katz, j.3.2, 0.222222222
Yogesh Katz, j.3.3, 0.027777778
Yogesh Katz, j.3.4, 0.027777778

RateP

Project Objectives

Aaron Toms, a, 5
Aaron Toms, c, 5
Aaron Toms, d, 5
Aaron Toms, f, 5
Aaron Toms, g, 5
Aaron Toms, h, 4
Aaron Toms, i, 3
Adrian Bank, a, 4
Adrian Bank, c, 4
Adrian Bank, d, 4
Adrian Bank, g, 5
Adrian Bank, h, 5
Alison Crane, a, 4
Alison Crane, c, 0
Alison Crane, d, 0
Alison Crane, g, 4
Alison Crane, h, 0
Andrew Dawn, c, 5
Andrew Dawn, d, 5
Andrew Dawn, g, 5
Andrew Dawn, h, 5
Andrew Dawn, i, 5
Andrew Dawn, j, 4
Andy Faulk, a, 5
Andy Faulk, b, 4
Andy Faulk, c, 5
Andy Faulk, d, 5
Andy Faulk, g, 5
Andy Faulk, h, 0
Andy Hicks, a, 5
Andy Hicks, b, 5
Andy Hicks, c, 5
Andy Hicks, d, 5
Andy Hicks, f, 5
Andy Hicks, g, 5
Andy Hicks, h, 1
Andy Hicks, i, 5
Andy Hicks, j, 5
Andy Kirb, a, 5
Andy Kirb, c, 3
Andy Kirb, d, 0
Andy Kirb, g, 0
Andy Kirb, h, 0
Angela Willard, a, 1
Angela Willard, c, 1
Angela Willard, d, 4
Angela Willard, f, 5
Angela Willard, g, 4
Angela Willard, h, 1
Angela Willard, i, 5
Angela Willard, j, 5
Anthony Rick, a, 5
Anthony Rick, b, 5
Anthony Rick, c, 5
Anthony Rick, d, 4
Anthony Rick, g, 5
Anthony Rick, h, 5
Anthony Rick, j, 5
Astrid Haynes, a, 5
Astrid Haynes, c, 5
Astrid Haynes, d, 5
Astrid Haynes, g, 4
Astrid Haynes, h, 5
Barbara Song, a, 5
Barbara Song, b, 5
Barbara Song, c, 5
Barbara Song, d, 5
Barbara Song, e, 5
Barbara Song, g, 5
Barbara Song, h, 5
Bill Leal, a, 5
Bill Leal, c, 5
Bill Leal, d, 5
Bill Leal, g, 5
Bill Leal, h, 2
Bob Alford, a, 5
Bob Alford, c, 4
Bob Alford, d, 5
Bob Alford, g, 5
Bob Alford, h, -1
Brahim Boyd, a, 5
Brahim Boyd, c, 5
Brahim Boyd, d, 5
Brahim Boyd, g, 5
Brahim Boyd, h, 5
Brian Aniston, a, 5
Brian Aniston, b, 5
Brian Aniston, c, 4
Brian Aniston, d, 4
Brian Aniston, g, 4
Brian Aniston, h, 3
Brian Ward, g, 4
Brian Ward, j, 5
Caroline Cook, a, 5
Caroline Cook, c, 5
Caroline Cook, d, 5
Caroline Cook, g, 5
Caroline Goodman, a, 4
Caroline Goodman, c, 4
Caroline Goodman, d, 4
Caroline Goodman, g, 4
Caroline Goodman, h, 4
Chris Randall, a, 5
Chris Randall, b, 5
Chris Randall, c, 5
Chris Randall, d, 5
Chris Randall, e, 3
Chris Randall, g, 4
Chris Randall, h, 5
Chris Randall, j, 4
Christina Solis, d, 1
Christopher Hall, a, 5
Christopher Hall, b, 5
Christopher Hall, c, 5
Christopher Hall, d, 5
Christopher Hall, g, 5
Christopher Hall, h, 5
Colin Penn, a, 3
Colin Penn, c, 4
Colin Penn, d, 4
Colin Penn, g, 5
Colin Penn, h, 2
Colin Street, a, 5
Colin Street, c, 5
Colin Street, d, 5
Colin Street, g, 4
Colin Street, h, 2
Conrad Moore, a, 0
Conrad Moore, c, 5
Conrad Moore, d, 5
Conrad Moore, g, 5
Conrad Moore, h, 0
David Ainsley, a, 5
David Ainsley, c, 4
David Ainsley, d, 4
David Ainsley, g, 4
David Ainsley, h, 5
David Carne, a, 1
David Carne, c, 3
David Carne, d, 2
David Carne, g, 3
David Carne, h, 1
David Carne, i, 4
David Carne, j, 5
Diana Cates, a, 5
Diana Cates, c, 5
Diana Cates, d, 5
Diana Cates, g, 5
Diana Cates, h, 5
Ed Steele, a, 5
Ed Steele, c, 4
Ed Steele, d, 5
Ed Steele, g, 5
Ed Steele, h, 5
Farid Sonya, a, 5
Farid Sonya, c, 5
Farid Sonya, d, 5
Farid Sonya, g, 5
Farid Sonya, h, 5
Fickle Andrews, a, 4
Fickle Andrews, c, 3
Fickle Andrews, d, 5
Fickle Andrews, g, 5
Ian More, a, 5
Ian More, c, 4
Ian More, d, 5
Ian More, e, -1
Ian More, f, 3
Ian More, g, 4
Ian More, h, 1
Ian More, i, 3
Ian More, j, 2
Jan Crowe, a, 5
Jan Crowe, b, 5
Jan Crowe, c, 4
Jan Crowe, d, 5
Jan Crowe, g, 5
Jan Crowe, h, 4
Jason Ortiz, a, 5
Jason Ortiz, c, 4
Jason Ortiz, d, 5
Jason Ortiz, g, 5
Jason Ortiz, h, 2
Jason Ortiz, i, 4
Jeremy Spain, a, 5
Jeremy Spain, c, 5
Jeremy Spain, d, 5
Jeremy Spain, g, 5
Jeremy Spain, h, 2
Jim Howe, a, 4
Jim Howe, b, 3
Jim Howe, c, 5
Jim Howe, d, 4
Jim Howe, g, 4
Jim Howe, h, 2
Johnny Glenn, a, 5
Johnny Glenn, c, 4
Johnny Glenn, d, 4
Johnny Glenn, g, 4
Johnny Glenn, h, 4
Jots Semb, a, 5
Jots Semb, b, 4
Jots Semb, c, 5
Jots Semb, d, 4
Jots Semb, f, 2
Jots Semb, g, 5
Jots Semb, h, 2
Jots Semb, i, 3
Jots Semb, j, 5
Kathleen Niche, a, 5
Kathleen Niche, b, 3
Kathleen Niche, c, 5
Kathleen Niche, d, 5
Kathleen Niche, g, 5
Kathleen Niche, h, 4
Kathryn Lester, a, 5
Kathryn Lester, b, 5
Kathryn Lester, c, 4
Kathryn Lester, d, 4
Kathryn Lester, f, 4
Kathryn Lester, g, 5
Kathryn Lester, h, 3
Kathryn Lester, i, 4
Kathryn Lester, j, 5
Kerstin Michel, a, 5
Kerstin Michel, c, 5
Kerstin Michel, d, 5
Kerstin Michel, g, 5
Kerstin Michel, h, 5
Liz Hopper, a, 5
Liz Hopper, c, 5
Liz Hopper, d, 4
Liz Hopper, g, 5
Liz Hopper, h, 4
Magali Persi, a, 5
Magali Persi, c, 5
Magali Persi, d, 5
Magali Persi, g, 3
Magali Persi, h, -1
Majid Khande, a, 5
Majid Khande, c, 5
Majid Khande, d, 5
Majid Khande, g, 5
Majid Khande, h, -1
Malcolm Bain, a, 5
Malcolm Bain, c, 4
Malcolm Bain, d, 5
Malcolm Bain, i, 5
Maria Damon, a, 5
Maria Damon, c, 5
Maria Damon, d, 5
Maria Damon, f, 5
Maria Damon, g, 5
Maria Damon, h, 5
Marilyn Gallo, a, 5
Marilyn Gallo, c, 4
Marilyn Gallo, d, 5
Marilyn Gallo, e, 4
Marilyn Gallo, f, 3
Marilyn Gallo, g, 5
Marilyn Gallo, h, 5
Marilyn Gallo, j, 4
Marion Lam, a, 5
Marion Lam, c, 5
Marion Lam, d, 5
Marion Lam, g, 4
Marion Lam, h, 4
Marion Ross, a, 5
Marion Ross, b, 5
Marion Ross, c, 5
Marion Ross, d, 5
Marion Ross, g, 5
Marion Ross, h, 4
Mark Wesley, a, 4
Mark Wesley, b, 5
Mark Wesley, c, 4
Mark Wesley, d, 4
Mark Wesley, g, 4
Mark Wesley, i, 4
Martin Payne, a, 5
Martin Payne, c, 5
Martin Payne, d, 5
Martin Payne, g, 5
Martin Payne, h, -1
Mat Reed, a, 5
Mat Reed, b, 4
Mat Reed, c, 5
Mat Reed, d, 5
Mat Reed, f, 5
Mat Reed, g, 4
Mat Reed, h, 2
Mike Dawson, a, 5
Mike Dawson, b, 4
Mike Dawson, c, 5
Mike Dawson, d, 5
Mike Dawson, g, 5
Mike Dawson, h, 1
Nicolas Curry, a, 5
Nicolas Curry, c, 5
Nicolas Curry, d, 5
Nicolas Curry, g, 5
Nicolas Curry, h, 5
Niyi Akers, a, 5
Niyi Akers, b, 3
Niyi Akers, c, 5
Niyi Akers, d, 4
Niyi Akers, g, 4
Niyi Akers, h, 3
Noshir Holmes, a, 5
Noshir Holmes, b, 2
Noshir Holmes, c, 4
Noshir Holmes, d, 4
Noshir Holmes, f, 4
Noshir Holmes, g, 4
Noshir Holmes, h, 2
Oliver Cullen, a, 4
Oliver Cullen, c, 5
Oliver Cullen, d, 5
Oliver Cullen, g, 4
Oliver Cullen, h, 3
Pepi Sands, a, 5
Pepi Sands, c, 0
Pepi Sands, d, 5
Pepi Sands, g, 3
Pepi Sands, h, -1
Rachna Kaplan, a, 5
Rachna Kaplan, c, 5
Rachna Kaplan, d, 5
Rachna Kaplan, g, 5
Rachna Kaplan, h, 3
Ray Hardy, a, 5
Ray Hardy, c, 4
Ray Hardy, d, 4
Ray Hardy, g, 4
Ray Hardy, h, 3
Richard Fuller, a, 5
Richard Fuller, c, 5
Richard Fuller, d, 4
Richard Fuller, e, 3
Richard Fuller, g, 4
Richard Fuller, h, 2
Richard Marsh, a, 5
Richard Marsh, c, 5
Richard Marsh, d, 5
Richard Marsh, g, 5
Robert Clarke, a, 5
Robert Clarke, c, 5
Robert Clarke, d, 5
Robert Clarke, f, 3
Robert Clarke, g, 4
Robert Clarke, h, 4
Robert Clarke, i, 4
Robert Clarke, j, 5
Roger All, a, 5
Roger All, c, 5
Roger All, d, 5
Roger All, g, 5
Roger All, h, 1
Ruth Simon, a, 5
Ruth Simon, c, 5
Ruth Simon, d, 5
Ruth Simon, g, 5
Ruth Simon, h, 5
Samuel Mackey, a, 4
Samuel Mackey, c, 2
Samuel Mackey, d, 1
Samuel Mackey, g, 1
Samuel Mackey, h, 0
Sarah Brante, a, 4
Sarah Brante, c, 4
Sarah Brante, d, 5
Sarah Brante, g, 4
Sarah Brante, h, 3
Sean Wall, a, 2
Sean Wall, c, 2
Sean Wall, d, 2
Sean Wall, e, 3
Sean Wall, g, 5
Sean Wall, h, 2
Sean Wall, j, 5
Shawn Wills, a, 5
Shawn Wills, c, 5
Shawn Wills, d, 5
Shawn Wills, g, 5
Shawn Wills, h, 5
Simon Farmer, a, 5
Simon Farmer, b, 4
Simon Farmer, c, 4
Simon Farmer, d, 5
Simon Farmer, e, 4
Simon Farmer, f, 5
Simon Farmer, g, 5
Simon Farmer, h, 3
Simon Farmer, i, 4
Simon Farmer, j, 5
Simon Mann, a, 5
Simon Mann, c, 5
Simon Mann, d, 5
Simon Mann, g, 5
Simon Mann, h, 3
Steve Curry, a, 4
Steve Curry, c, 4
Steve Curry, d, 4
Steve Curry, g, 4
Steve Curry, h, 4
Tariq Haines, a, 5
Tariq Haines, c, 5
Tariq Haines, d, 5
Tariq Haines, g, 5
Tariq Haines, h, 5
Tariq Haines, i, 5
Tariq Haines, j, 5
Tim Pugh, a, 0
Tim Pugh, c, 1
Tim Pugh, d, 4
Tim Pugh, f, -1
Tim Pugh, g, 3
Tim Pugh, h, 0
Tony Boston, a, 4
Tony Boston, b, 5
Tony Boston, c, 5
Tony Boston, d, 5
Tony Boston, g, 4
Tony Boston, h, 4
Tony Boston, j, 5
Will Miles, a, 5
Will Miles, c, 5
Will Miles, d, 5
Will Miles, e, 5
Will Miles, f, 4
Will Miles, g, 5
Will Miles, h, 3
Will Miles, i, 5
Will Miles, j, 5
Yogesh Katz, a, 5
Yogesh Katz, c, 5
Yogesh Katz, d, 5
Yogesh Katz, g, 5
Yogesh Katz, h, 5

Requirements

Aaron Toms, a.1, 4
Aaron Toms, a.2, 4
Aaron Toms, a.3, 5
Aaron Toms, c.1, 5
Aaron Toms, c.2, 5
Aaron Toms, c.3, 5
Aaron Toms, c.4, 5
Aaron Toms, c.5, 5
Aaron Toms, d.1, 5
Aaron Toms, d.2, 5
Aaron Toms, d.3, 5
Aaron Toms, d.4, 5
Aaron Toms, d.5, 5
Aaron Toms, d.6, 5
Aaron Toms, f.4, 5
Aaron Toms, f.6, 5
Aaron Toms, g.1.2, 5
Aaron Toms, g.2, 5
Aaron Toms, g.3, 5
Aaron Toms, h.2, 2
Aaron Toms, h.3, 4
Aaron Toms, i.3, 3

Adrian Bank, a.1, 4
Adrian Bank, a.2, 4
Adrian Bank, a.3, 4
Adrian Bank, c.1, 4
Adrian Bank, c.2, 4
Adrian Bank, c.3, 4
Adrian Bank, c.4, 4
Adrian Bank, c.5, 4
Adrian Bank, d.1, 4
Adrian Bank, d.2, 4
Adrian Bank, d.3, 4
Adrian Bank, d.4, 4
Adrian Bank, d.5, 4
Adrian Bank, d.6, 4
Adrian Bank, g.1.2, 5
Adrian Bank, g.2, 2
Adrian Bank, g.3, 2
Adrian Bank, h.1, 5
Adrian Bank, h.2, 1
Adrian Bank, h.3, 4
Alison Crane, a.1, 3
Alison Crane, a.2, 3
Alison Crane, a.3, 4
Alison Crane, c.1, 0
Alison Crane, c.2, 0
Alison Crane, c.3, 0
Alison Crane, c.4, 0
Alison Crane, c.5, 0
Alison Crane, d.1, 0
Alison Crane, d.2, 0
Alison Crane, d.3, 0
Alison Crane, d.4, 0
Alison Crane, d.5, 0
Alison Crane, d.6, 0
Alison Crane, g.1.2, 0
Alison Crane, g.2, 4
Alison Crane, g.3, 0
Alison Crane, h.2, 0
Alison Crane, h.3, 0
Andrew Dawn, c.4, 5
Andrew Dawn, d.1, 3
Andrew Dawn, d.5, 5
Andrew Dawn, g.1.2, 5
Andrew Dawn, g.2, 5
Andrew Dawn, g.3, 4
Andrew Dawn, h.3, 5
Andrew Dawn, i.1, 5
Andrew Dawn, i.3, 5
Andrew Dawn, j.2, 4
Andrew Dawn, j.5, 4
Andrew Dawn, j.6, 3
Andy Faulk, a.1, 5
Andy Faulk, a.2, 4
Andy Faulk, a.3, 5
Andy Faulk, b.1, 4
Andy Faulk, c.1, 3
Andy Faulk, c.2, 3
Andy Faulk, c.3, 4
Andy Faulk, c.4, 3
Andy Faulk, c.5, 5
Andy Faulk, d.1, 5
Andy Faulk, d.2, 3
Andy Faulk, d.3, 3
Andy Faulk, d.4, 3
Andy Faulk, d.5, 5
Andy Faulk, d.6, 3
Andy Faulk, g.1.2, 5
Andy Faulk, g.2, 4
Andy Faulk, g.3, 5
Andy Faulk, h.2, 0
Andy Faulk, h.3, 0
Andy Hicks, a.1, 2
Andy Hicks, a.2, 1
Andy Hicks, a.3, 5
Andy Hicks, b.1, 3
Andy Hicks, b.3, 5
Andy Hicks, b.4, 5
Andy Hicks, b.5, 3
Andy Hicks, c.2, 0
Andy Hicks, c.3, 5
Andy Hicks, c.4, 2
Andy Hicks, c.5, 3
Andy Hicks, d.2, 5
Andy Hicks, d.3, 4
Andy Hicks, d.4, 0
Andy Hicks, d.5, 5
Andy Hicks, d.6, 0
Andy Hicks, f.1, 5
Andy Hicks, f.2, 5
Andy Hicks, f.4, 5
Andy Hicks, f.5, 5
Andy Hicks, f.6, 5
Andy Hicks, g.1.2, 5
Andy Hicks, g.2, 5
Andy Hicks, g.3, 0
Andy Hicks, g.4, 5
Andy Hicks, h.2, 1
Andy Hicks, h.3, 1
Andy Hicks, i.2, 0
Andy Hicks, i.3, 5
Andy Hicks, j.2, 5
Andy Hicks, j.6, 5
Andy Kirb, a.1, 5
Andy Kirb, a.2, 0
Andy Kirb, a.3, 3
Andy Kirb, c.1, 0
Andy Kirb, c.2, 0
Andy Kirb, c.3, 3
Andy Kirb, c.4, 0
Andy Kirb, c.5, 0
Andy Kirb, d.1, 0
Andy Kirb, d.2, 0
Andy Kirb, d.3, 0
Andy Kirb, d.4, 0
Andy Kirb, d.5, 0
Andy Kirb, d.6, 0
Andy Kirb, g.1.2, 0
Andy Kirb, g.2, 0
Andy Kirb, g.3, 0
Andy Kirb, h.2, 0
Andy Kirb, h.3, 0
Angela Willard, a.1, 1
Angela Willard, a.2, 1
Angela Willard, a.3, 1
Angela Willard, c.1, 1
Angela Willard, c.2, 1
Angela Willard, c.3, 1
Angela Willard, c.4, 1
Angela Willard, c.5, 1
Angela Willard, d.1, 4
Angela Willard, d.2, 3
Angela Willard, d.3, 3
Angela Willard, d.4, 3
Angela Willard, d.5, 3
Angela Willard, d.6, 3
Angela Willard, f.1, 5
Angela Willard, f.2, 5
Angela Willard, f.4, 5
Angela Willard, f.5, 5
Angela Willard, f.6, 5
Angela Willard, g.1.2, 4
Angela Willard, g.2, 4
Angela Willard, g.3, 3
Angela Willard, h.2, 1
Angela Willard, h.3, 1
Angela Willard, i.3, 5
Angela Willard, j.2, 5
Anthony Rick, a.1, 5
Anthony Rick, a.2, 5
Anthony Rick, a.3, 5
Anthony Rick, b.1, 5
Anthony Rick, c.1, 5
Anthony Rick, c.2, 5
Anthony Rick, c.3, 5
Anthony Rick, c.4, 5
Anthony Rick, c.5, 5
Anthony Rick, d.1, 4
Anthony Rick, d.2, 4
Anthony Rick, d.3, 4
Anthony Rick, d.4, 4
Anthony Rick, d.5, 4
Anthony Rick, d.6, 4
Anthony Rick, g.1.2, 4
Anthony Rick, g.2, 2
Anthony Rick, g.3, 5
Anthony Rick, g.4, 5
Anthony Rick, h.2, 4
Anthony Rick, h.3, 5
Anthony Rick, j.1, 5
Astrid Haynes, a.1, 5
Astrid Haynes, a.2, 5
Astrid Haynes, a.3, 5
Astrid Haynes, c.1, 5
Astrid Haynes, c.2, 5
Astrid Haynes, c.3, 5
Astrid Haynes, c.4, 5
Astrid Haynes, c.5, 5
Astrid Haynes, d.1, 5
Astrid Haynes, d.2, 5
Astrid Haynes, d.3, 5
Astrid Haynes, d.4, 5
Astrid Haynes, d.5, 5
Astrid Haynes, d.6, 5
Astrid Haynes, g.1.2, 4
Astrid Haynes, g.2, 2
Astrid Haynes, g.3, 2
Astrid Haynes, h.2, 0
Astrid Haynes, h.3, 5
Barbara Song, a.1, 5
Barbara Song, a.2, 5
Barbara Song, a.3, 5
Barbara Song, b.1, 5
Barbara Song, b.3, 5
Barbara Song, b.6, 5
Barbara Song, c.1, 4
Barbara Song, c.2, 5
Barbara Song, c.3, 5
Barbara Song, c.4, 5
Barbara Song, c.5, 4
Barbara Song, d.1, 5
Barbara Song, d.2, 5
Barbara Song, d.3, 5
Barbara Song, d.4, 5
Barbara Song, d.5, 5
Barbara Song, d.6, 5
Barbara Song, e.1, 5
Barbara Song, e.2, 4
Barbara Song, g.1.2, 5
Barbara Song, g.2, 5
Barbara Song, g.3, 5
Barbara Song, h.2, 5
Barbara Song, h.3, 3
Bill Leal, a.1, 5
Bill Leal, a.2, 5
Bill Leal, a.3, 5
Bill Leal, c.1, 5
Bill Leal, c.2, 5
Bill Leal, c.3, 5
Bill Leal, c.4, 5
Bill Leal, c.5, 5
Bill Leal, d.1, 5
Bill Leal, d.2, 5
Bill Leal, d.3, 5
Bill Leal, d.4, 5
Bill Leal, d.5, 5
Bill Leal, d.6, 5
Bill Leal, g.1.2, 4
Bill Leal, g.2, 5
Bill Leal, g.3, 2
Bill Leal, h.2, 2
Bill Leal, h.3, 0
Bob Alford, a.1, 5
Bob Alford, a.2, 5
Bob Alford, a.3, 5
Bob Alford, c.1, 4
Bob Alford, c.2, 4
Bob Alford, c.3, 4
Bob Alford, c.4, 4
Bob Alford, c.5, 4
Bob Alford, d.1, 4
Bob Alford, d.2, 4
Bob Alford, d.3, 4
Bob Alford, d.4, 4
Bob Alford, d.5, 5
Bob Alford, d.6, 4
Bob Alford, g.1.2, 3
Bob Alford, g.2, 5
Bob Alford, g.3, 3
Bob Alford, h.2, -1
Bob Alford, h.3, -1
Brahim Boyd, a.1, 5
Brahim Boyd, a.2, 5
Brahim Boyd, a.3, 4
Brahim Boyd, c.3, 5
Brahim Boyd, c.4, 5
Brahim Boyd, c.5, 5
Brahim Boyd, d.1, 5
Brahim Boyd, d.5, 3
Brahim Boyd, g.1.2, 4
Brahim Boyd, g.2, 5
Brahim Boyd, g.3, 3
Brahim Boyd, h.2, 2
Brahim Boyd, h.3, 5
Brian Aniston, a.1, 4
Brian Aniston, a.2, 4
Brian Aniston, a.3, 5
Brian Aniston, b.1, 5
Brian Aniston, c.1, 4
Brian Aniston, c.2, 4
Brian Aniston, c.3, 4
Brian Aniston, c.4, 4
Brian Aniston, c.5, 4
Brian Aniston, d.1, 4
Brian Aniston, d.2, 4
Brian Aniston, d.3, 4
Brian Aniston, d.4, 4
Brian Aniston, d.5, 4
Brian Aniston, d.6, 4
Brian Aniston, g.1.2, 4
Brian Aniston, g.2, 4
Brian Aniston, g.3, 3
Brian Aniston, g.4, 3
Brian Aniston, h.2, 3
Brian Aniston, h.3, -1
Brian Ward, g.4, 4
Brian Ward, j.6, 5
Caroline Cook, a.1, 5
Caroline Cook, a.2, 5
Caroline Cook, a.3, 5
Caroline Cook, c.1, 5
Caroline Cook, c.2, 5
Caroline Cook, c.3, 5
Caroline Cook, c.4, 5
Caroline Cook, c.5, 5
Caroline Cook, d.1, 5
Caroline Cook, d.2, 5
Caroline Cook, d.3, 5
Caroline Cook, d.4, 5
Caroline Cook, d.5, 5
Caroline Cook, d.6, 5
Caroline Cook, g.1.2, 5
Caroline Goodman, a.1, 3
Caroline Goodman, a.2, 3
Caroline Goodman, a.3, 4
Caroline Goodman, c.1, 4
Caroline Goodman, c.2, 4
Caroline Goodman, c.3, 4
Caroline Goodman, c.4, 4
Caroline Goodman, c.5, 4
Caroline Goodman, d.1, 4
Caroline Goodman, d.2, 4
Caroline Goodman, d.3, 4
Caroline Goodman, d.4, 4
Caroline Goodman, d.5, 4
Caroline Goodman, d.6, 4
Caroline Goodman, g.1.2, 4
Caroline Goodman, g.2, 4
Caroline Goodman, g.3, 4
Caroline Goodman, h.2, 4
Caroline Goodman, h.3, 4
Chris Randall, a.1, 5
Chris Randall, a.2, 5
Chris Randall, a.3, 5
Chris Randall, b.3, 5
Chris Randall, c.1, 5
Chris Randall, c.2, 5
Chris Randall, c.3, 5
Chris Randall, c.4, 5
Chris Randall, c.5, 5
Chris Randall, d.1, 5
Chris Randall, d.2, 5
Chris Randall, d.3, 5
Chris Randall, d.4, 5
Chris Randall, d.5, 5
Chris Randall, d.6, 5
Chris Randall, e.1, 3
Chris Randall, g.1.2, 4
Chris Randall, g.2, 3
Chris Randall, g.3, 4
Chris Randall, g.4, 4
Chris Randall, h.2, 5
Chris Randall, h.3, 3
Chris Randall, h.4, 4
Chris Randall, j.2, 4
Christina Solis, d.4, 1
Christopher Hall, a.1, 5
Christopher Hall, a.2, 5
Christopher Hall, a.3, 5
Christopher Hall, b.6, 5
Christopher Hall, b.7, 3
Christopher Hall, c.1, 4
Christopher Hall, c.2, 4
Christopher Hall, c.3, 5
Christopher Hall, c.4, 4
Christopher Hall, c.5, 4
Christopher Hall, d.1, 5
Christopher Hall, d.2, 5
Christopher Hall, d.3, 5
Christopher Hall, d.4, 5
Christopher Hall, d.5, 5
Christopher Hall, d.6, 5
Christopher Hall, g.1.2, 5
Christopher Hall, g.2, 5
Christopher Hall, g.3, 5
Christopher Hall, h.2, 3
Christopher Hall, h.3, 5
Colin Penn, a.1, 3
Colin Penn, a.2, 3
Colin Penn, a.3, 3
Colin Penn, c.3, 4
Colin Penn, c.4, 4
Colin Penn, c.5, 4
Colin Penn, d.1, 3
Colin Penn, d.2, 3
Colin Penn, d.3, 3
Colin Penn, d.4, 3
Colin Penn, d.5, 4
Colin Penn, d.6, 3
Colin Penn, g.1.2, 3
Colin Penn, g.2, 3
Colin Penn, g.3, 3
Colin Penn, g.4, 5
Colin Penn, h.2, 2
Colin Penn, h.3, 2
Colin Street, a.1, 4
Colin Street, a.2, 4
Colin Street, a.3, 5
Colin Street, c.1, 5
Colin Street, c.2, 5
Colin Street, c.3, 5
Colin Street, c.4, 5
Colin Street, c.5, 5
Colin Street, d.1, 5
Colin Street, d.2, 4
Colin Street, d.3, 4
Colin Street, d.4, 4
Colin Street, d.5, 4
Colin Street, d.6, 4
Colin Street, g.1.2, 4
Colin Street, g.2, 3
Colin Street, g.3, 4
Colin Street, h.2, -1
Colin Street, h.3, 2
Conrad Moore, a.1, 0
Conrad Moore, a.2, 0
Conrad Moore, a.3, 0
Conrad Moore, c.1, 5
Conrad Moore, c.2, 5
Conrad Moore, c.3, 5
Conrad Moore, c.4, 5
Conrad Moore, c.5, 5
Conrad Moore, d.1, 5
Conrad Moore, d.2, 5
Conrad Moore, d.3, 5
Conrad Moore, d.4, 5
Conrad Moore, d.5, 5
Conrad Moore, d.6, 5
Conrad Moore, g.1.2, 5
Conrad Moore, g.2, 3
Conrad Moore, g.3, 3
Conrad Moore, h.2, 0
Conrad Moore, h.3, 0
David Ainsley, a.1, 4
David Ainsley, a.2, 4
David Ainsley, a.3, 5
David Ainsley, c.2, 4
David Ainsley, c.3, 4
David Ainsley, c.4, 4
David Ainsley, c.5, 3
David Ainsley, d.1, 4
David Ainsley, d.2, 3
David Ainsley, d.3, 3
David Ainsley, d.4, 3
David Ainsley, d.5, 4
David Ainsley, d.6, 3
David Ainsley, g.1.2, 4
David Ainsley, g.2, 4
David Ainsley, g.3, 4
David Ainsley, h.2, 3
David Ainsley, h.3, 5
David Carne, a.1, 1
David Carne, a.2, 1
David Carne, a.3, 1
David Carne, c.1, 3
David Carne, c.2, 3
David Carne, c.3, 3
David Carne, c.4, 3
David Carne, c.5, 3
David Carne, d.1, 2
David Carne, d.2, 2
David Carne, d.3, 2
David Carne, d.4, 2
David Carne, d.5, 2
David Carne, d.6, 2
David Carne, g.1.2, 3
David Carne, g.2, 3
David Carne, g.3, 2
David Carne, g.4, 2
David Carne, h.2, 1
David Carne, h.3, 1
David Carne, i.2, 4
David Carne, j.6, 5
Diana Cates, a.1, 5
Diana Cates, a.2, 3
Diana Cates, a.3, 5
Diana Cates, c.3, 5
Diana Cates, c.4, 5
Diana Cates, c.5, 5
Diana Cates, d.1, 5
Diana Cates, d.5, 5
Diana Cates, g.1.2, 5
Diana Cates, g.2, 5
Diana Cates, g.3, 5
Diana Cates, h.2, 5
Diana Cates, h.3, 5
Ed Steele, a.1, 5
Ed Steele, a.2, 5
Ed Steele, a.3, 5
Ed Steele, c.1, 4
Ed Steele, c.2, 4
Ed Steele, c.3, 4
Ed Steele, c.4, 4
Ed Steele, c.5, 4
Ed Steele, d.1, 5
Ed Steele, d.2, 5
Ed Steele, d.3, 5
Ed Steele, d.4, 5
Ed Steele, d.5, 5
Ed Steele, d.6, 5
Ed Steele, g.1.2, 5
Ed Steele, g.2, 2
Ed Steele, g.3, 2
Ed Steele, h.2, 5
Ed Steele, h.3, 2
Farid Sonya, a.1, 5
Farid Sonya, a.2, 5
Farid Sonya, a.3, 5
Farid Sonya, c.1, 5
Farid Sonya, c.2, 5
Farid Sonya, c.3, 5
Farid Sonya, c.4, 5
Farid Sonya, c.5, 5
Farid Sonya, d.1, 5
Farid Sonya, d.2, 5
Farid Sonya, d.3, 5

Farid Sonya, d.4, 5
Farid Sonya, d.5, 5
Farid Sonya, d.6, 5
Farid Sonya, g.1.2, 5
Farid Sonya, g.2, 5
Farid Sonya, g.3, 5
Farid Sonya, h.2, -1
Farid Sonya, h.3, 5
Fickle Andrews, a.1, 4
Fickle Andrews, a.2, 4
Fickle Andrews, a.3, 4
Fickle Andrews, c.3, 3
Fickle Andrews, c.4, 3
Fickle Andrews, c.5, 3
Fickle Andrews, d.1, 5
Fickle Andrews, d.5, 3
Fickle Andrews, g.1.2, 4
Fickle Andrews, g.2, 4
Fickle Andrews, g.3, 5
Ian More, a.1, 3
Ian More, a.2, 3
Ian More, a.3, 5
Ian More, c.1, 4
Ian More, c.2, 4
Ian More, c.3, 4
Ian More, c.4, 4
Ian More, c.5, 4
Ian More, d.1, 5
Ian More, d.2, 5
Ian More, d.3, 5
Ian More, d.4, 5
Ian More, d.5, 5
Ian More, d.6, 5
Ian More, e.1, -1
Ian More, f.1, 3
Ian More, g.1.2, 3
Ian More, g.2, 4
Ian More, g.3, 3
Ian More, h.2, 1
Ian More, h.3, 1
Ian More, i.3, 3
Ian More, j.4, 2
Jan Crowe, a.1, 4
Jan Crowe, a.2, 5
Jan Crowe, a.3, 5
Jan Crowe, b.1, 5
Jan Crowe, b.2, 5
Jan Crowe, b.3, 5
Jan Crowe, c.1, 4
Jan Crowe, c.2, 4
Jan Crowe, c.3, 4
Jan Crowe, c.4, 4
Jan Crowe, c.5, 4
Jan Crowe, d.1, 5
Jan Crowe, d.2, 5
Jan Crowe, d.3, 5
Jan Crowe, d.4, 5
Jan Crowe, d.5, 5
Jan Crowe, d.6, 5
Jan Crowe, g.1.2, 5
Jan Crowe, g.2, 5
Jan Crowe, g.3, 4
Jan Crowe, h.2, 4
Jan Crowe, h.3, 2
Jason Ortiz, a.1, 5
Jason Ortiz, a.2, 3
Jason Ortiz, a.3, 5
Jason Ortiz, c.1, 3
Jason Ortiz, c.2, 3
Jason Ortiz, c.3, 4
Jason Ortiz, c.4, 3
Jason Ortiz, c.5, 3
Jason Ortiz, d.1, 5
Jason Ortiz, d.2, 3
Jason Ortiz, d.3, 3
Jason Ortiz, d.4, 3
Jason Ortiz, d.5, 5
Jason Ortiz, d.6, 4
Jason Ortiz, g.1.2, 3
Jason Ortiz, g.2, 1
Jason Ortiz, g.3, 5
Jason Ortiz, h.2, 1
Jason Ortiz, h.3, 2
Jason Ortiz, i.3, 4
Jeremy Spain, a.1, 5
Jeremy Spain, a.2, 4
Jeremy Spain, a.3, 4
Jeremy Spain, c.1, 5
Jeremy Spain, c.2, 5
Jeremy Spain, c.3, 5
Jeremy Spain, c.4, 5
Jeremy Spain, c.5, 5
Jeremy Spain, d.1, 4
Jeremy Spain, d.2, 4
Jeremy Spain, d.3, 4
Jeremy Spain, d.4, 4
Jeremy Spain, d.5, 5
Jeremy Spain, d.6, 4
Jeremy Spain, g.1.2, 5
Jeremy Spain, g.2, 5
Jeremy Spain, g.3, 4
Jeremy Spain, h.2, 2
Jeremy Spain, h.3, 1
Jim Howe, a.1, 4
Jim Howe, a.2, 4
Jim Howe, a.3, 4
Jim Howe, b.1, 3
Jim Howe, c.1, 5
Jim Howe, c.2, 5
Jim Howe, c.3, 5
Jim Howe, c.4, 5
Jim Howe, c.5, 5
Jim Howe, d.1, 4
Jim Howe, d.2, 4
Jim Howe, d.3, 4
Jim Howe, d.4, 4
Jim Howe, d.5, 4
Jim Howe, d.6, 4
Jim Howe, g.1.2, 4
Jim Howe, g.2, 4
Jim Howe, g.3, 4
Jim Howe, h.2, 2
Jim Howe, h.3, 2
Johnny Glenn, a.1, 5
Johnny Glenn, a.2, 5
Johnny Glenn, a.3, 5
Johnny Glenn, c.1, 4
Johnny Glenn, c.2, 4
Johnny Glenn, c.3, 4
Johnny Glenn, c.4, 4
Johnny Glenn, c.5, 4
Johnny Glenn, d.1, 4
Johnny Glenn, d.2, 4
Johnny Glenn, d.3, 4
Johnny Glenn, d.4, 4
Johnny Glenn, d.5, 4
Johnny Glenn, d.6, 4
Johnny Glenn, g.1.2, 4
Johnny Glenn, g.2, 3
Johnny Glenn, g.3, 4
Johnny Glenn, h.2, 3
Johnny Glenn, h.3, 4
Jots Semb, a.1, 5
Jots Semb, a.2, 5
Jots Semb, a.3, 5
Jots Semb, b.3, 4
Jots Semb, b.4, 4
Jots Semb, b.5, -1
Jots Semb, c.1, 5
Jots Semb, c.2, 5
Jots Semb, c.3, 5
Jots Semb, c.4, 5
Jots Semb, c.5, 5
Jots Semb, d.1, 4
Jots Semb, d.2, 3
Jots Semb, d.3, 3
Jots Semb, d.4, 3
Jots Semb, d.5, 4
Jots Semb, d.6, 3
Jots Semb, f.1, 2
Jots Semb, f.2, 2
Jots Semb, f.4, 2
Jots Semb, f.5, 2
Jots Semb, f.6, 2
Jots Semb, g.1.2, -1
Jots Semb, g.2, 4
Jots Semb, g.3, 1
Jots Semb, g.4, 5
Jots Semb, h.2, 2
Jots Semb, h.3, 2
Jots Semb, i.2, -1
Jots Semb, i.3, 3
Jots Semb, j.2, 5
Jots Semb, j.6, 3
Kathleen Niche, a.1, 5
Kathleen Niche, a.2, 5
Kathleen Niche, a.3, 5
Kathleen Niche, b.6, 3
Kathleen Niche, c.1, 5
Kathleen Niche, c.2, 5
Kathleen Niche, c.3, 5
Kathleen Niche, c.4, 5
Kathleen Niche, c.5, 5
Kathleen Niche, d.1, 5
Kathleen Niche, d.2, 5
Kathleen Niche, d.3, 5
Kathleen Niche, d.4, 5
Kathleen Niche, d.5, 5
Kathleen Niche, d.6, 5
Kathleen Niche, g.1.2, 5
Kathleen Niche, g.2, 4
Kathleen Niche, g.3, 5
Kathleen Niche, h.2, 4
Kathleen Niche, h.3, -1
Kathryn Lester, a.1, 3
Kathryn Lester, a.2, 4
Kathryn Lester, a.3, 5
Kathryn Lester, b.3, 5
Kathryn Lester, b.4, 5
Kathryn Lester, b.5, 2
Kathryn Lester, c.2, 3
Kathryn Lester, c.3, 2
Kathryn Lester, c.4, 4
Kathryn Lester, c.5, 3
Kathryn Lester, d.1, 4
Kathryn Lester, d.2, 3
Kathryn Lester, d.3, 3
Kathryn Lester, d.4, 3
Kathryn Lester, d.5, 3
Kathryn Lester, d.6, 3
Kathryn Lester, f.1, 4
Kathryn Lester, f.2, 4
Kathryn Lester, f.4, 4
Kathryn Lester, f.5, 4
Kathryn Lester, f.6, 4
Kathryn Lester, g.1.2, 5
Kathryn Lester, g.2, 4
Kathryn Lester, g.3, 4
Kathryn Lester, g.4, 4
Kathryn Lester, h.2, 3
Kathryn Lester, h.3, 3
Kathryn Lester, i.2, 3
Kathryn Lester, i.3, 4
Kathryn Lester, j.2, 3
Kathryn Lester, j.6, 5
Kerstin Michel, a.1, 5
Kerstin Michel, a.2, 5
Kerstin Michel, a.3, 5
Kerstin Michel, c.1, 4
Kerstin Michel, c.2, 4
Kerstin Michel, c.3, 4
Kerstin Michel, c.4, 5
Kerstin Michel, c.5, 4
Kerstin Michel, d.1, 5
Kerstin Michel, d.2, 5
Kerstin Michel, d.3, 5
Kerstin Michel, d.4, 5
Kerstin Michel, d.5, 5
Kerstin Michel, d.6, 5
Kerstin Michel, g.1.2, 5
Kerstin Michel, g.2, 5
Kerstin Michel, g.3, 5
Kerstin Michel, h.2, 5
Kerstin Michel, h.3, 5
Liz Hopper, a.1, 5
Liz Hopper, a.2, 5
Liz Hopper, a.3, 5
Liz Hopper, c.1, 4
Liz Hopper, c.2, 5
Liz Hopper, c.3, 4
Liz Hopper, c.4, 5
Liz Hopper, c.5, 4
Liz Hopper, d.1, 4
Liz Hopper, d.2, 4
Liz Hopper, d.3, 4
Liz Hopper, d.4, 4
Liz Hopper, d.5, 4
Liz Hopper, d.6, 4
Liz Hopper, g.1.2, 4
Liz Hopper, g.2, 3
Liz Hopper, g.3, 4
Liz Hopper, g.4, 5
Liz Hopper, h.2, 4
Liz Hopper, h.3, -1
Magali Persi, a.1, 5
Magali Persi, a.2, 5
Magali Persi, a.3, 5
Magali Persi, c.3, 2
Magali Persi, c.4, 5
Magali Persi, c.5, 5
Magali Persi, d.1, 5
Magali Persi, d.2, 3
Magali Persi, d.3, 3
Magali Persi, d.4, 3
Magali Persi, d.5, 5
Magali Persi, d.6, 3
Magali Persi, g.1.2, 2
Magali Persi, g.2, 1
Magali Persi, g.3, 3
Magali Persi, h.2, -1
Magali Persi, h.3, -1
Majid Khande, a.1, 5
Majid Khande, a.2, 4
Majid Khande, a.3, 5
Majid Khande, c.3, 3
Majid Khande, c.4, 5
Majid Khande, c.5, 0
Majid Khande, d.1, 5
Majid Khande, d.5, 5
Majid Khande, g.1.2, 5
Majid Khande, g.2, 5
Majid Khande, g.3, 5
Majid Khande, h.2, -1
Majid Khande, h.3, -1
Malcolm Bain, a.1, 5
Malcolm Bain, a.2, 5
Malcolm Bain, a.3, 5
Malcolm Bain, c.1, 4
Malcolm Bain, c.2, 4
Malcolm Bain, c.3, 4
Malcolm Bain, c.4, 4
Malcolm Bain, c.5, 4
Malcolm Bain, d.1, 5
Malcolm Bain, d.2, 5
Malcolm Bain, d.3, 5
Malcolm Bain, d.4, 5
Malcolm Bain, d.5, 5
Malcolm Bain, d.6, 5
Malcolm Bain, i.2, 5
Malcolm Bain, i.3, 5
Maria Damon, a.1, 4
Maria Damon, a.2, 4
Maria Damon, a.3, 4
Maria Damon, c.1, 5
Maria Damon, c.2, 5
Maria Damon, c.3, 5
Maria Damon, c.4, 5
Maria Damon, c.5, 5
Maria Damon, d.1, 5
Maria Damon, d.2, 5
Maria Damon, d.3, 5
Maria Damon, d.4, 5
Maria Damon, d.5, 5
Maria Damon, d.6, 5
Maria Damon, f.1, 5
Maria Damon, f.2, 5
Maria Damon, f.4, 5
Maria Damon, f.5, 5
Maria Damon, f.6, 5
Maria Damon, g.1.2, 5
Maria Damon, g.2, 5
Maria Damon, g.3, 5
Maria Damon, h.1, 5
Maria Damon, h.2, 5
Maria Damon, h.3, 5
Maria Damon, h.4, 5
Maria Damon, h.5, 5
Marilyn Gallo, a.1, 5
Marilyn Gallo, a.2, 5
Marilyn Gallo, a.3, 5
Marilyn Gallo, c.1, 4
Marilyn Gallo, c.2, 4
Marilyn Gallo, c.3, 4
Marilyn Gallo, c.4, 4
Marilyn Gallo, c.5, 4
Marilyn Gallo, d.1, 5
Marilyn Gallo, d.2, 4
Marilyn Gallo, d.3, 4
Marilyn Gallo, d.4, 4
Marilyn Gallo, d.5, 4
Marilyn Gallo, d.6, 4
Marilyn Gallo, e.1, 4
Marilyn Gallo, e.2, 4
Marilyn Gallo, f.1, 3
Marilyn Gallo, f.2, 3
Marilyn Gallo, f.4, 3
Marilyn Gallo, f.5, 3
Marilyn Gallo, f.6, 3
Marilyn Gallo, g.1.2, 5
Marilyn Gallo, g.2, 4
Marilyn Gallo, g.3, 5
Marilyn Gallo, h.2, 3
Marilyn Gallo, h.3, 5
Marilyn Gallo, j.5, 4
Marion Lam, a.1, 5
Marion Lam, a.2, 5
Marion Lam, a.3, 5
Marion Lam, c.1, 3
Marion Lam, c.2, 5
Marion Lam, c.3, 3
Marion Lam, c.4, 3
Marion Lam, c.5, 3
Marion Lam, d.1, 5
Marion Lam, d.2, 5
Marion Lam, d.3, 5
Marion Lam, d.4, 5
Marion Lam, d.5, 5
Marion Lam, d.6, 5
Marion Lam, g.1.2, 4
Marion Lam, g.2, 4
Marion Lam, g.3, 4
Marion Lam, h.2, 4
Marion Lam, h.3, 2
Marion Ross, a.1, 4
Marion Ross, a.2, 4
Marion Ross, a.3, 5
Marion Ross, b.3, 5
Marion Ross, c.1, 5
Marion Ross, c.2, 5
Marion Ross, c.3, 5
Marion Ross, c.4, 5
Marion Ross, c.5, 5
Marion Ross, d.1, 5
Marion Ross, d.2, 5
Marion Ross, d.3, 5
Marion Ross, d.4, 5
Marion Ross, d.5, 5
Marion Ross, d.6, 5
Marion Ross, g.1.2, 5
Marion Ross, g.2, 3
Marion Ross, g.3, 4
Marion Ross, h.2, 2
Marion Ross, h.3, 4
Mark Wesley, a.1, 2
Mark Wesley, a.2, 2
Mark Wesley, a.3, 4
Mark Wesley, b.4, 5
Mark Wesley, c.1, 4
Mark Wesley, c.2, 4
Mark Wesley, c.3, 4
Mark Wesley, c.4, 4
Mark Wesley, c.5, 4
Mark Wesley, d.1, 3
Mark Wesley, d.2, 3
Mark Wesley, d.3, 3
Mark Wesley, d.4, 3
Mark Wesley, d.5, 4
Mark Wesley, d.6, 3
Mark Wesley, g.1.2, 4
Mark Wesley, g.2, 4
Mark Wesley, g.4, 3
Mark Wesley, i.3, 4
Martin Payne, a.1, 5
Martin Payne, a.2, 5
Martin Payne, a.3, 5
Martin Payne, c.1, 5
Martin Payne, c.2, 5
Martin Payne, c.3, 5
Martin Payne, c.4, 5
Martin Payne, c.5, 5
Martin Payne, d.1, 5
Martin Payne, d.2, 5
Martin Payne, d.3, 5
Martin Payne, d.4, 5
Martin Payne, d.5, 5
Martin Payne, d.6, 5
Martin Payne, g.1.2, 5
Martin Payne, g.2, 5
Martin Payne, g.3, 0
Martin Payne, h.2, -1
Martin Payne, h.3, -1
Mat Reed, a.1, 5
Mat Reed, a.2, 5
Mat Reed, a.3, 5
Mat Reed, b.1, 4
Mat Reed, c.1, 5
Mat Reed, c.2, 5
Mat Reed, c.3, 5
Mat Reed, c.4, 5
Mat Reed, c.5, 5
Mat Reed, d.1, 5
Mat Reed, d.2, 5
Mat Reed, d.3, 5
Mat Reed, d.4, 5
Mat Reed, d.5, 5
Mat Reed, d.6, 5
Mat Reed, f.2, 5
Mat Reed, g.1.2, 4
Mat Reed, g.2, 4
Mat Reed, g.3, 3
Mat Reed, h.2, 1
Mat Reed, h.3, 2
Mike Dawson, a.1, 5
Mike Dawson, a.2, 4
Mike Dawson, a.3, 5
Mike Dawson, b.3, 4
Mike Dawson, c.1, 5
Mike Dawson, c.2, 5
Mike Dawson, c.3, 5
Mike Dawson, c.4, 5
Mike Dawson, c.5, 5
Mike Dawson, d.1, 5
Mike Dawson, d.2, 5
Mike Dawson, d.3, 5
Mike Dawson, d.4, 5
Mike Dawson, d.5, 5
Mike Dawson, d.6, 5
Mike Dawson, g.1.2, 4
Mike Dawson, g.2, 5
Mike Dawson, g.3, 5
Mike Dawson, h.2, 1
Mike Dawson, h.3, 1
Nicolas Curry, a.1, 5
Nicolas Curry, a.2, 5
Nicolas Curry, a.3, 5
Nicolas Curry, c.1, 5
Nicolas Curry, c.2, 5
Nicolas Curry, c.3, 5
Nicolas Curry, c.4, 5
Nicolas Curry, c.5, 5
Nicolas Curry, d.1, 5
Nicolas Curry, d.2, 5
Nicolas Curry, d.3, 5
Nicolas Curry, d.4, 5
Nicolas Curry, d.5, 5
Nicolas Curry, d.6, 5
Nicolas Curry, g.1.2, 5
Nicolas Curry, g.2, 5
Nicolas Curry, g.3, -1
Nicolas Curry, h.2, 5
Nicolas Curry, h.3, 5
Nicolas Curry, h.5, 4
Niyi Akers, a.1, 5
Niyi Akers, a.2, 5
Niyi Akers, a.3, 5

Niyi Akers, b.1, 3
Niyi Akers, c.1, 5
Niyi Akers, c.2, 5
Niyi Akers, c.3, 5
Niyi Akers, c.4, 5
Niyi Akers, c.5, 5
Niyi Akers, d.1, 4
Niyi Akers, d.2, 4
Niyi Akers, d.3, 4
Niyi Akers, d.4, 4
Niyi Akers, d.5, 4
Niyi Akers, d.6, 4
Niyi Akers, g.1.2, 4
Niyi Akers, g.2, 3
Niyi Akers, g.3, 3
Niyi Akers, h.2, 3
Niyi Akers, h.3, 3
Noshir Holmes, a.1, 5
Noshir Holmes, a.2, 5
Noshir Holmes, a.3, 5
Noshir Holmes, b.4, 2
Noshir Holmes, c.1, 4
Noshir Holmes, c.2, 4
Noshir Holmes, c.3, 4
Noshir Holmes, c.4, 4
Noshir Holmes, c.5, 4
Noshir Holmes, d.1, 4
Noshir Holmes, d.2, 4
Noshir Holmes, d.3, 4
Noshir Holmes, d.4, 4
Noshir Holmes, d.5, 4
Noshir Holmes, d.6, 4
Noshir Holmes, f.4, 4
Noshir Holmes, g.1.2, 4
Noshir Holmes, g.2, 4
Noshir Holmes, g.3, 4
Noshir Holmes, h.2, 2
Noshir Holmes, h.3, 2
Oliver Cullen, a.1, 3
Oliver Cullen, a.2, 3
Oliver Cullen, a.3, 4
Oliver Cullen, c.1, 5
Oliver Cullen, c.2, 5
Oliver Cullen, c.3, 5
Oliver Cullen, c.4, 5
Oliver Cullen, c.5, 5
Oliver Cullen, d.1, 2
Oliver Cullen, d.2, 2
Oliver Cullen, d.3, 2
Oliver Cullen, d.4, 2
Oliver Cullen, d.5, 5
Oliver Cullen, d.6, 2
Oliver Cullen, g.1.2, 4
Oliver Cullen, g.2, -1
Oliver Cullen, g.3, 1
Oliver Cullen, h.2, 3
Oliver Cullen, h.3, 2
Pepi Sands, a.1, 5
Pepi Sands, a.2, 5
Pepi Sands, a.3, 4
Pepi Sands, c.3, 0
Pepi Sands, c.4, -1
Pepi Sands, c.5, 0
Pepi Sands, d.1, 5
Pepi Sands, g.1.2, 3
Pepi Sands, g.2, -1
Pepi Sands, g.3, 2
Pepi Sands, h.2, -1
Pepi Sands, h.3, -1
Rachna Kaplan, a.1, 5
Rachna Kaplan, a.2, 5
Rachna Kaplan, a.3, 5
Rachna Kaplan, c.1, 5
Rachna Kaplan, c.2, 5
Rachna Kaplan, c.3, 5
Rachna Kaplan, c.4, 5
Rachna Kaplan, c.5, 5
Rachna Kaplan, d.1, 5
Rachna Kaplan, d.2, 5
Rachna Kaplan, d.3, 5
Rachna Kaplan, d.4, 5
Rachna Kaplan, d.5, 5
Rachna Kaplan, d.6, 5
Rachna Kaplan, g.1.2, 5
Rachna Kaplan, g.2, 5
Rachna Kaplan, g.3, 1
Rachna Kaplan, h.2, 1
Rachna Kaplan, h.3, 3
Ray Hardy, a.1, 4
Ray Hardy, a.2, 4
Ray Hardy, a.3, 5
Ray Hardy, c.1, 4
Ray Hardy, c.2, 4
Ray Hardy, c.3, 4
Ray Hardy, c.4, 4
Ray Hardy, c.5, 4
Ray Hardy, d.1, 4
Ray Hardy, d.2, 4
Ray Hardy, d.3, 4
Ray Hardy, d.4, 4
Ray Hardy, d.5, 4
Ray Hardy, d.6, 4
Ray Hardy, g.1.2, 3
Ray Hardy, g.2, -1
Ray Hardy, g.3, 4
Ray Hardy, h.2, -1
Ray Hardy, h.3, 3
Richard Fuller, a.1, 4
Richard Fuller, a.2, 4
Richard Fuller, a.3, 5
Richard Fuller, c.1, 5
Richard Fuller, c.2, 5
Richard Fuller, c.3, 5
Richard Fuller, c.4, 5
Richard Fuller, c.5, 5
Richard Fuller, d.1, 4
Richard Fuller, d.2, 4
Richard Fuller, d.3, 4
Richard Fuller, d.4, 4
Richard Fuller, d.5, 4
Richard Fuller, d.6, 4
Richard Fuller, e.2, 3
Richard Fuller, g.1.2, 4
Richard Fuller, g.2, 4
Richard Fuller, g.3, 2
Richard Fuller, h.2, 2
Richard Fuller, h.3, 2
Richard Marsh, a.1, 5
Richard Marsh, a.2, 5
Richard Marsh, a.3, 5
Richard Marsh, c.1, 5
Richard Marsh, c.2, 5
Richard Marsh, c.3, 5
Richard Marsh, c.4, 5
Richard Marsh, c.5, 5
Richard Marsh, d.1, 5
Richard Marsh, d.2, 5
Richard Marsh, d.3, 5
Richard Marsh, d.4, 5
Richard Marsh, d.5, 5
Richard Marsh, d.6, 5
Richard Marsh, g.1.2, 3
Richard Marsh, g.2, 5
Richard Marsh, g.3, 2
Robert Clarke, a.1, 4
Robert Clarke, a.2, 4
Robert Clarke, a.3, 5
Robert Clarke, c.1, 5
Robert Clarke, c.2, 5
Robert Clarke, c.3, 5
Robert Clarke, c.4, 5
Robert Clarke, c.5, 5
Robert Clarke, d.1, 5
Robert Clarke, d.2, 5
Robert Clarke, d.3, 5
Robert Clarke, d.4, 5
Robert Clarke, d.5, 5
Robert Clarke, d.6, 5
Robert Clarke, f.5, 3
Robert Clarke, g.1.2, 4
Robert Clarke, g.2, 2
Robert Clarke, g.3, 4
Robert Clarke, h.2, 4
Robert Clarke, h.3, 4
Robert Clarke, i.1, 3
Robert Clarke, i.3, 4
Robert Clarke, j.2, 4
Robert Clarke, j.3, 5
Robert Clarke, j.5, 5
Roger All, a.1, 5
Roger All, a.2, 4
Roger All, a.3, 5
Roger All, c.1, 2
Roger All, c.2, 2
Roger All, c.3, 2
Roger All, c.4, 5
Roger All, c.5, 5
Roger All, d.1, 4
Roger All, d.2, 2
Roger All, d.3, 2
Roger All, d.4, 2
Roger All, d.5, 5
Roger All, d.6, 2
Roger All, g.1.2, 5
Roger All, g.2, 2
Roger All, g.3, 2
Roger All, h.2, -1
Roger All, h.3, 1
Ruth Simon, a.1, 5
Ruth Simon, a.2, 5
Ruth Simon, a.3, 5
Ruth Simon, c.1, 5
Ruth Simon, c.2, 5
Ruth Simon, c.3, 5
Ruth Simon, c.4, 5
Ruth Simon, c.5, 5
Ruth Simon, d.1, 5
Ruth Simon, d.2, 3
Ruth Simon, d.3, 3
Ruth Simon, d.4, 3
Ruth Simon, d.5, 5
Ruth Simon, d.6, 3
Ruth Simon, g.1.2, 5
Ruth Simon, g.2, -1
Ruth Simon, g.3, 5
Ruth Simon, h.2, 2
Ruth Simon, h.3, 5
Samuel Mackey, a.1, 2
Samuel Mackey, a.2, 2
Samuel Mackey, a.3, 4
Samuel Mackey, c.1, 1
Samuel Mackey, c.2, 1
Samuel Mackey, c.3, 1
Samuel Mackey, c.4, 2
Samuel Mackey, c.5, 1
Samuel Mackey, d.1, 0
Samuel Mackey, d.2, 0
Samuel Mackey, d.3, 0
Samuel Mackey, d.4, 0
Samuel Mackey, d.5, 1
Samuel Mackey, d.6, 0
Samuel Mackey, g.1.2, 0
Samuel Mackey, g.2, 1
Samuel Mackey, g.3, 0
Samuel Mackey, h.2, 0
Samuel Mackey, h.3, 0
Sarah Brante, a.1, 4
Sarah Brante, a.2, 4
Sarah Brante, a.3, 4
Sarah Brante, c.1, 4
Sarah Brante, c.2, 4
Sarah Brante, c.3, 4
Sarah Brante, c.4, 4
Sarah Brante, c.5, 4
Sarah Brante, d.1, 4
Sarah Brante, d.2, 4
Sarah Brante, d.3, 4
Sarah Brante, d.4, 4
Sarah Brante, d.5, 5
Sarah Brante, d.6, 4
Sarah Brante, g.1.2, 4
Sarah Brante, g.2, 4
Sarah Brante, g.3, 4
Sarah Brante, h.2, 3
Sean Wall, a.1, 2
Sean Wall, a.2, 2
Sean Wall, a.3, 2
Sean Wall, c.1, 2
Sean Wall, c.2, 2
Sean Wall, c.3, 2
Sean Wall, c.4, 2
Sean Wall, c.5, 2
Sean Wall, d.1, 2
Sean Wall, d.2, 2
Sean Wall, d.3, 2
Sean Wall, d.4, 2
Sean Wall, d.5, 2
Sean Wall, d.6, 2
Sean Wall, e.1, 3
Sean Wall, e.2, 3
Sean Wall, g.1.2, -1
Sean Wall, g.2, 1
Sean Wall, g.3, 2
Sean Wall, g.4, 5
Sean Wall, g.5, 5
Sean Wall, h.1, 2
Sean Wall, h.2, 2
Sean Wall, h.3, 2
Sean Wall, h.4, 2
Sean Wall, h.5, 2
Sean Wall, j.1, 5
Sean Wall, j.5, 5
Shawn Wills, a.1, 5
Shawn Wills, a.2, 5
Shawn Wills, a.3, 5
Shawn Wills, c.3, 5
Shawn Wills, c.4, 5
Shawn Wills, c.5, 1
Shawn Wills, d.1, 5
Shawn Wills, d.5, 5
Shawn Wills, g.1.2, 5
Shawn Wills, g.2, 5
Shawn Wills, g.3, 5
Shawn Wills, h.2, -1
Shawn Wills, h.3, 5
Simon Farmer, a.1, 4
Simon Farmer, a.2, 1
Simon Farmer, a.3, 5
Simon Farmer, b.1, 3
Simon Farmer, b.3, 4
Simon Farmer, b.4, 4
Simon Farmer, b.5, 1
Simon Farmer, c.1, 4
Simon Farmer, c.2, 2
Simon Farmer, c.3, 3
Simon Farmer, c.4, 3
Simon Farmer, c.5, 2
Simon Farmer, d.1, 5
Simon Farmer, d.2, 3
Simon Farmer, d.3, 4
Simon Farmer, d.4, 1
Simon Farmer, d.5, 4
Simon Farmer, d.6, 3
Simon Farmer, e.1, 4
Simon Farmer, e.2, 4
Simon Farmer, f.1, 5
Simon Farmer, f.2, 5
Simon Farmer, f.4, 5
Simon Farmer, f.5, 5
Simon Farmer, f.6, 5
Simon Farmer, g.1.2, 5
Simon Farmer, g.2, 4
Simon Farmer, g.3, 5
Simon Farmer, g.4, 5
Simon Farmer, h.1, 2
Simon Farmer, h.2, 3
Simon Farmer, h.3, 2
Simon Farmer, h.4, 2
Simon Farmer, h.5, 2
Simon Farmer, i.2, 2
Simon Farmer, i.3, 4
Simon Farmer, j.2, 5
Simon Farmer, j.6, 5
Simon Mann, a.1, 5
Simon Mann, a.2, 3
Simon Mann, a.3, 5
Simon Mann, c.1, 5
Simon Mann, c.2, 5
Simon Mann, c.3, 5
Simon Mann, c.4, 5
Simon Mann, c.5, 5
Simon Mann, d.1, 3
Simon Mann, d.2, 3
Simon Mann, d.3, 3
Simon Mann, d.4, 3
Simon Mann, d.5, 5
Simon Mann, d.6, 3
Simon Mann, g.1.2, 5
Simon Mann, g.2, 5
Simon Mann, g.3, 2
Simon Mann, h.2, 0
Simon Mann, h.3, 3
Steve Curry, a.1, 4
Steve Curry, a.2, 4
Steve Curry, a.3, 4
Steve Curry, c.1, 4
Steve Curry, c.2, 4
Steve Curry, c.3, 4
Steve Curry, c.4, 4
Steve Curry, c.5, 4
Steve Curry, d.1, 4
Steve Curry, d.2, 4
Steve Curry, d.3, 4
Steve Curry, d.4, 4
Steve Curry, d.5, 4
Steve Curry, d.6, 4
Steve Curry, g.1.2, 4
Steve Curry, g.2, 4
Steve Curry, g.3, 4
Steve Curry, h.2, 0
Steve Curry, h.3, 4
Tariq Haines, a.1, 5
Tariq Haines, a.2, 5
Tariq Haines, a.3, 5
Tariq Haines, c.1, 5
Tariq Haines, c.2, 5
Tariq Haines, c.3, 5
Tariq Haines, c.4, 5
Tariq Haines, c.5, 5
Tariq Haines, d.1, 5
Tariq Haines, d.2, 3
Tariq Haines, d.3, 3
Tariq Haines, d.4, 3
Tariq Haines, d.5, 5
Tariq Haines, d.6, 3
Tariq Haines, g.1.2, 5
Tariq Haines, g.2, 5
Tariq Haines, g.3, 5
Tariq Haines, g.4, 5
Tariq Haines, h.2, 2
Tariq Haines, h.3, 5
Tariq Haines, i.3, 5
Tariq Haines, j.5, 5
Tariq Haines, j.6, 5
Tariq Haines, j.7, 5
Tim Pugh, a.1, 0
Tim Pugh, a.2, 0
Tim Pugh, a.3, 0
Tim Pugh, c.1, 1
Tim Pugh, c.2, 1
Tim Pugh, c.3, 1
Tim Pugh, c.4, 1
Tim Pugh, c.5, 1
Tim Pugh, d.1, 2
Tim Pugh, d.2, 2
Tim Pugh, d.3, 2
Tim Pugh, d.4, 2
Tim Pugh, d.5, 3
Tim Pugh, d.6, 4
Tim Pugh, f.6, -1
Tim Pugh, g.1.2, 3
Tim Pugh, g.2, 1
Tim Pugh, g.3, 0
Tim Pugh, h.2, 0
Tim Pugh, h.3, 0
Tony Boston, a.1, 4
Tony Boston, a.2, 4
Tony Boston, a.3, 4
Tony Boston, b.3, 5
Tony Boston, c.1, 5
Tony Boston, c.2, 5
Tony Boston, c.3, 5
Tony Boston, c.4, 5
Tony Boston, c.5, 5
Tony Boston, d.1, 3
Tony Boston, d.2, 1
Tony Boston, d.3, 1
Tony Boston, d.4, 1
Tony Boston, d.5, 5
Tony Boston, d.6, 1
Tony Boston, g.1.2, 3
Tony Boston, g.2, -1
Tony Boston, g.3, 3
Tony Boston, g.4, 4
Tony Boston, h.1, 2
Tony Boston, h.2, 4
Tony Boston, h.3, 4
Tony Boston, h.4, 2
Tony Boston, h.5, 2
Tony Boston, j.1, 5
Tony Boston, j.3, 2
Tony Boston, j.6, 5
Will Miles, a.1, 5
Will Miles, a.2, 4
Will Miles, a.3, 5
Will Miles, c.1, 5
Will Miles, c.2, 5
Will Miles, c.3, 5
Will Miles, c.4, 5
Will Miles, c.5, 5
Will Miles, d.1, 5
Will Miles, d.2, 5
Will Miles, d.3, 5
Will Miles, d.4, 5
Will Miles, d.5, 5
Will Miles, d.6, 5
Will Miles, e.1, 5
Will Miles, e.2, 5
Will Miles, f.1, 4
Will Miles, f.2, 4
Will Miles, f.4, 4
Will Miles, f.5, 4
Will Miles, f.6, 4
Will Miles, g.1.2, 5
Will Miles, g.2, 4
Will Miles, g.3, 5
Will Miles, h.2, 3
Will Miles, h.3, 0
Will Miles, i.1, 5
Will Miles, i.3, 5
Will Miles, j.1, 5
Will Miles, j.2, 5
Will Miles, j.6, 5
Yogesh Katz, a.1, 4
Yogesh Katz, a.2, 4
Yogesh Katz, a.3, 5
Yogesh Katz, c.1, 5
Yogesh Katz, c.2, 5
Yogesh Katz, c.3, 5
Yogesh Katz, c.4, 5
Yogesh Katz, c.5, 5
Yogesh Katz, d.1, 5
Yogesh Katz, d.2, 5
Yogesh Katz, d.3, 5
Yogesh Katz, d.4, 5
Yogesh Katz, d.5, 5
Yogesh Katz, d.6, 5
Yogesh Katz, g.1.2, 5
Yogesh Katz, g.2, 5
Yogesh Katz, g.3, 5
Yogesh Katz, h.2, 5
Yogesh Katz, h.3, 5

Specific Requirements

Aaron Toms, a.1.2, 4
Aaron Toms, a.1.3, 4
Aaron Toms, a.2, 4
Aaron Toms, a.3.1, 5
Aaron Toms, a.3.2, 5
Aaron Toms, a.3.3, 5
Aaron Toms, a.3.4, 5
Aaron Toms, a.3.6, 5
Aaron Toms, c.1, 5
Aaron Toms, c.2.10, 5
Aaron Toms, c.2.2, 5
Aaron Toms, c.2.3, 5
Aaron Toms, c.2.4, 5
Aaron Toms, c.2.7, 5
Aaron Toms, c.2.8, 5
Aaron Toms, c.2.9, 5
Aaron Toms, c.3.1, 5
Aaron Toms, c.3.2, 5
Aaron Toms, c.4.1, 5
Aaron Toms, c.4.2, 5
Aaron Toms, c.4.3, 5
Aaron Toms, c.4.4, 5
Aaron Toms, c.5.1, 5
Aaron Toms, d.1.1, 5
Aaron Toms, d.1.2, 5
Aaron Toms, d.2, 5
Aaron Toms, d.3, 5
Aaron Toms, d.4.1, 5
Aaron Toms, d.5.1, 5
Aaron Toms, d.5.2, 5
Aaron Toms, d.5.3, 5
Aaron Toms, d.5.4, 5
Aaron Toms, d.6, 5
Aaron Toms, f.4.1, 5
Aaron Toms, f.6.1, 5
Aaron Toms, g.1, 5
Aaron Toms, g.2.1, 5
Aaron Toms, g.2.2, 2
Aaron Toms, g.2.3, 5
Aaron Toms, g.3.2, 5
Aaron Toms, h.2.1, 1
Aaron Toms, h.2.3, 2
Aaron Toms, h.3, 4
Aaron Toms, i.3.6, 3
Adrian Bank, a.1.2, 4
Adrian Bank, a.1.3, 4
Adrian Bank, a.2, 4
Adrian Bank, a.3.1, 4
Adrian Bank, a.3.2, 4
Adrian Bank, a.3.3, 4
Adrian Bank, a.3.4, 4
Adrian Bank, a.3.6, 4
Adrian Bank, c.1, 4
Adrian Bank, c.2.10, 4
Adrian Bank, c.2.2, 4
Adrian Bank, c.2.3, 4
Adrian Bank, c.2.4, 4
Adrian Bank, c.2.7, 4
Adrian Bank, c.2.8, 4
Adrian Bank, c.2.9, 4
Adrian Bank, c.3.1, 4
Adrian Bank, c.3.2, 4
Adrian Bank, c.4.1, 4
Adrian Bank, c.4.2, 4
Adrian Bank, c.4.3, 4
Adrian Bank, c.4.4, 4
Adrian Bank, c.5.1, 4
Adrian Bank, d.1.1, 4
Adrian Bank, d.1.2, 4
Adrian Bank, d.2, 4
Adrian Bank, d.3, 4
Adrian Bank, d.4.1, 4
Adrian Bank, d.5.1, 4
Adrian Bank, d.5.2, 4
Adrian Bank, d.5.3, 4
Adrian Bank, d.5.4, 4
Adrian Bank, d.6, 4
Adrian Bank, g.1, 5
Adrian Bank, g.2.1, 2
Adrian Bank, g.2.2, 2
Adrian Bank, g.2.3, 2
Adrian Bank, g.3.2, 2
Adrian Bank, h.1, 5
Adrian Bank, h.2.1, 0
Adrian Bank, h.2.3, 1
Adrian Bank, h.3, 4
Alison Crane, a.1.2, 3
Alison Crane, a.1.3, 3
Alison Crane, a.2, 3
Alison Crane, a.3.1, 4
Alison Crane, a.3.2, 4
Alison Crane, a.3.3, 4
Alison Crane, a.3.4, 4
Alison Crane, a.3.6, 4
Alison Crane, c.1, 0
Alison Crane, c.2.10, 0
Alison Crane, c.2.2, 0
Alison Crane, c.2.3, 0
Alison Crane, c.2.4, 0
Alison Crane, c.2.7, 0
Alison Crane, c.2.8, 0
Alison Crane, c.2.9, 0
Alison Crane, c.3.1, 0
Alison Crane, c.3.2, 0
Alison Crane, c.4.1, 0
Alison Crane, c.4.2, 0
Alison Crane, c.4.3, 0
Alison Crane, c.4.4, 0
Alison Crane, c.5.1, 0
Alison Crane, d.1.1, 0
Alison Crane, d.1.2, 0
Alison Crane, d.2, 0
Alison Crane, d.3, 0
Alison Crane, d.4.1, 0
Alison Crane, d.5.1, 0
Alison Crane, d.5.2, 0
Alison Crane, d.5.3, 0
Alison Crane, d.5.4, 0
Alison Crane, d.6, 0
Alison Crane, g.1, 0
Alison Crane, g.2.1, 4
Alison Crane, g.2.2, 4
Alison Crane, g.2.3, 4
Alison Crane, g.3.2, 0
Alison Crane, h.2.1, 0
Alison Crane, h.2.3, 0
Alison Crane, h.3, 0
Andrew Dawn, c.4.1, 5
Andrew Dawn, c.4.2, 5
Andrew Dawn, c.4.3, 5
Andrew Dawn, c.4.4, 5
Andrew Dawn, d.1.1, 3
Andrew Dawn, d.5.1, 5
Andrew Dawn, d.5.2, 5
Andrew Dawn, d.5.3, 5
Andrew Dawn, d.5.4, 5
Andrew Dawn, g.1, 5
Andrew Dawn, g.2.1, 5
Andrew Dawn, g.2.2, 5
Andrew Dawn, g.2.3, 5
Andrew Dawn, g.3.2, 4
Andrew Dawn, h.3, 5
Andrew Dawn, i.1.1, 5
Andrew Dawn, i.3.6, 5
Andrew Dawn, j.2.1, 4
Andrew Dawn, j.5.4, 4
Andrew Dawn, j.6.1, 3
Andrew Dawn, j.6.3, 3
Andy Faulk, a.1.2, 5
Andy Faulk, a.1.3, 5
Andy Faulk, a.2, 4
Andy Faulk, a.3.1, 5
Andy Faulk, a.3.2, 5
Andy Faulk, a.3.3, 5
Andy Faulk, a.3.4, 5
Andy Faulk, a.3.6, 5
Andy Faulk, b.1.4, 4
Andy Faulk, c.1, 3
Andy Faulk, c.2.10, 3
Andy Faulk, c.2.2, 3
Andy Faulk, c.2.3, 3
Andy Faulk, c.2.4, 3
Andy Faulk, c.2.7, 3
Andy Faulk, c.2.8, 3
Andy Faulk, c.2.9, 3
Andy Faulk, c.3.1, 4
Andy Faulk, c.3.2, 3
Andy Faulk, c.4.1, 3
Andy Faulk, c.4.2, 3
Andy Faulk, c.4.3, 3
Andy Faulk, c.4.4, 3
Andy Faulk, c.5.1, 5
Andy Faulk, d.1.1, 5
Andy Faulk, d.1.2, 3
Andy Faulk, d.2, 3
Andy Faulk, d.3, 3
Andy Faulk, d.4.1, 3
Andy Faulk, d.5.1, 5
Andy Faulk, d.5.2, 5
Andy Faulk, d.5.3, 5
Andy Faulk, d.5.4, 5
Andy Faulk, d.6, 3
Andy Faulk, g.1, 5
Andy Faulk, g.2.1, 3
Andy Faulk, g.2.2, 3
Andy Faulk, g.2.3, 4
Andy Faulk, g.3.2, 5
Andy Faulk, h.2.1, 0
Andy Faulk, h.2.3, 0
Andy Faulk, h.3, 0
Andy Hicks, a.1.2, 2
Andy Hicks, a.1.3, 2
Andy Hicks, a.2, 1
Andy Hicks, a.3.1, 5
Andy Hicks, a.3.2, 5
Andy Hicks, a.3.3, 5
Andy Hicks, a.3.4, 5
Andy Hicks, a.3.6, 5
Andy Hicks, b.1.4, 3
Andy Hicks, b.3.1, 5
Andy Hicks, b.4, 5
Andy Hicks, b.5, 3
Andy Hicks, c.2.10, 0
Andy Hicks, c.2.2, 0
Andy Hicks, c.2.3, 0
Andy Hicks, c.2.4, 0
Andy Hicks, c.2.7, 0
Andy Hicks, c.2.8, 0
Andy Hicks, c.2.9, 0
Andy Hicks, c.3.1, 5
Andy Hicks, c.4.1, 1
Andy Hicks, c.4.2, 1
Andy Hicks, c.4.3, 2
Andy Hicks, c.4.4, 1
Andy Hicks, c.5.1, 3
Andy Hicks, d.1.1, 5
Andy Hicks, d.1.2, 0
Andy Hicks, d.2, 5
Andy Hicks, d.3, 4
Andy Hicks, d.4.1, 0
Andy Hicks, d.5.1, 5
Andy Hicks, d.5.2, 5
Andy Hicks, d.5.3, 5
Andy Hicks, d.5.4, 5
Andy Hicks, d.6, 0
Andy Hicks, f.1, 5
Andy Hicks, f.2.1, 5
Andy Hicks, f.4.1, 5
Andy Hicks, f.5, 5
Andy Hicks, f.6.1, 5
Andy Hicks, f.6.2, 5
Andy Hicks, g.1, 5
Andy Hicks, g.2.1, 5
Andy Hicks, g.2.2, 5
Andy Hicks, g.2.3, 5
Andy Hicks, g.3.2, 0
Andy Hicks, g.4.4, 5
Andy Hicks, h.2.1, -1
Andy Hicks, h.2.3, 1
Andy Hicks, h.3, 1
Andy Hicks, i.2.3, 0
Andy Hicks, i.3.6, 5
Andy Hicks, j.2.2, 5
Andy Hicks, j.2.3, 5
Andy Hicks, j.6.3, 5
Andy Hicks, j.6.4, 3
Andy Kirb, a.1.2, 5
Andy Kirb, a.1.3, 5
Andy Kirb, a.2, 0
Andy Kirb, a.3.1, 3
Andy Kirb, a.3.2, 3
Andy Kirb, a.3.3, 3
Andy Kirb, a.3.4, 3
Andy Kirb, a.3.6, 3
Andy Kirb, c.1, 0
Andy Kirb, c.2.10, 0
Andy Kirb, c.2.2, 0
Andy Kirb, c.2.3, 0
Andy Kirb, c.2.4, 0
Andy Kirb, c.2.7, 0
Andy Kirb, c.2.8, 0
Andy Kirb, c.2.9, 0
Andy Kirb, c.3.1, 3
Andy Kirb, c.3.2, 0
Andy Kirb, c.4.1, 0
Andy Kirb, c.4.2, 0
Andy Kirb, c.4.3, 0
Andy Kirb, c.4.4, 0
Andy Kirb, c.5.1, 0
Andy Kirb, d.1.1, 0
Andy Kirb, d.1.2, 0
Andy Kirb, d.2, 0
Andy Kirb, d.3, 0
Andy Kirb, d.4.1, 0
Andy Kirb, d.5.1, 0
Andy Kirb, d.5.2, 0
Andy Kirb, d.5.3, 0
Andy Kirb, d.5.4, 0
Andy Kirb, d.6, 0
Andy Kirb, g.1, 0
Andy Kirb, g.2.1, 0
Andy Kirb, g.2.2, 0
Andy Kirb, g.2.3, 0
Andy Kirb, g.3.2, 0
Andy Kirb, h.2.1, 0
Andy Kirb, h.2.3, 0
Andy Kirb, h.3, 0
Angela Willard, a.1.2, 1
Angela Willard, a.1.3, 1
Angela Willard, a.2, 1
Angela Willard, a.3.1, 1
Angela Willard, a.3.2, 1
Angela Willard, a.3.3, 1
Angela Willard, a.3.4, 1
Angela Willard, a.3.6, 1
Angela Willard, c.1, 1
Angela Willard, c.2.10, 1
Angela Willard, c.2.2, 1
Angela Willard, c.2.3, 1
Angela Willard, c.2.4, 1
Angela Willard, c.2.7, 1
Angela Willard, c.2.8, 1
Angela Willard, c.2.9, 1
Angela Willard, c.3.1, 1
Angela Willard, c.3.2, 1
Angela Willard, c.4.1, 1
Angela Willard, c.4.2, 1
Angela Willard, c.4.3, 1
Angela Willard, c.4.4, 1
Angela Willard, c.5.1, 1
Angela Willard, d.1.1, 4
Angela Willard, d.1.2, 3
Angela Willard, d.2, 3
Angela Willard, d.3, 3
Angela Willard, d.4.1, 3
Angela Willard, d.5.1, 3
Angela Willard, d.5.2, 3
Angela Willard, d.5.3, 3
Angela Willard, d.5.4, 3
Angela Willard, d.6, 3
Angela Willard, f.1, 5
Angela Willard, f.2.1, 5
Angela Willard, f.4.1, 5
Angela Willard, f.5, 5
Angela Willard, f.6.1, 5
Angela Willard, f.6.2, 5
Angela Willard, g.1, 4
Angela Willard, g.2.1, 4
Angela Willard, g.2.2, 4
Angela Willard, g.2.3, 4
Angela Willard, g.3.2, 3
Angela Willard, h.2.1, 1
Angela Willard, h.2.3, 1
Angela Willard, h.3, 1
Angela Willard, i.3.6, 5
Angela Willard, j.2.2, 5
Angela Willard, j.2.3, 5
Anthony Rick, a.1.2, 5
Anthony Rick, a.1.3, 5
Anthony Rick, a.2, 5
Anthony Rick, a.3.1, 5
Anthony Rick, a.3.2, 5
Anthony Rick, a.3.3, 5
Anthony Rick, a.3.4, 5
Anthony Rick, a.3.6, 5
Anthony Rick, b.1.4, 5
Anthony Rick, c.1, 5
Anthony Rick, c.2.10, 5
Anthony Rick, c.2.2, 5
Anthony Rick, c.2.3, 5
Anthony Rick, c.2.4, 5
Anthony Rick, c.2.7, 5
Anthony Rick, c.2.8, 5
Anthony Rick, c.2.9, 5
Anthony Rick, c.3.1, 5
Anthony Rick, c.3.2, 5
Anthony Rick, c.4.1, 5
Anthony Rick, c.4.2, 5
Anthony Rick, c.4.3, 5
Anthony Rick, c.4.4, 5
Anthony Rick, c.5.1, 5
Anthony Rick, d.1.1, 4
Anthony Rick, d.1.2, 4
Anthony Rick, d.2, 4
Anthony Rick, d.3, 4
Anthony Rick, d.4.1, 4
Anthony Rick, d.5.1, 4
Anthony Rick, d.5.2, 4
Anthony Rick, d.5.3, 4
Anthony Rick, d.5.4, 4
Anthony Rick, d.6, 4
Anthony Rick, g.1, 4
Anthony Rick, g.2.1, 2
Anthony Rick, g.2.2, 2
Anthony Rick, g.2.3, 2
Anthony Rick, g.3.2, 5
Anthony Rick, g.4.5, 5
Anthony Rick, h.2.1, 4
Anthony Rick, h.2.3, 4
Anthony Rick, h.3, 5
Anthony Rick, j.1.1, 5
Astrid Haynes, a.1.2, 5
Astrid Haynes, a.1.3, 5
Astrid Haynes, a.2, 5
Astrid Haynes, a.3.1, 5
Astrid Haynes, a.3.2, 5
Astrid Haynes, a.3.3, 5
Astrid Haynes, a.3.4, 5
Astrid Haynes, a.3.6, 5
Astrid Haynes, c.1, 5
Astrid Haynes, c.2.10, 5
Astrid Haynes, c.2.2, 5
Astrid Haynes, c.2.3, 5
Astrid Haynes, c.2.4, 5
Astrid Haynes, c.2.7, 5
Astrid Haynes, c.2.8, 5
Astrid Haynes, c.2.9, 5
Astrid Haynes, c.3.1, 5
Astrid Haynes, c.3.2, 5
Astrid Haynes, c.4.1, 5
Astrid Haynes, c.4.2, 5
Astrid Haynes, c.4.3, 5
Astrid Haynes, c.4.4, 5
Astrid Haynes, c.5.1, 5
Astrid Haynes, d.1.1, 5
Astrid Haynes, d.1.2, 5
Astrid Haynes, d.2, 5
Astrid Haynes, d.3, 5
Astrid Haynes, d.4.1, 5
Astrid Haynes, d.5.1, 5
Astrid Haynes, d.5.2, 5
Astrid Haynes, d.5.3, 5
Astrid Haynes, d.5.4, 5
Astrid Haynes, d.6, 5
Astrid Haynes, g.1, 4
Astrid Haynes, g.2.1, 2
Astrid Haynes, g.2.2, 2
Astrid Haynes, g.2.3, 2
Astrid Haynes, g.3.2, 2
Astrid Haynes, h.2.1, 0
Astrid Haynes, h.3, 5
Barbara Song, a.1.2, 5
Barbara Song, a.1.3, 5
Barbara Song, a.2, 5
Barbara Song, a.3.1, 5
Barbara Song, a.3.2, 5
Barbara Song, a.3.3, 5
Barbara Song, a.3.4, 5
Barbara Song, a.3.6, 4
Barbara Song, b.1.1, 5
Barbara Song, b.1.2, 5
Barbara Song, b.1.3, 4
Barbara Song, b.1.4, 5
Barbara Song, b.1.5, 4
Barbara Song, b.1.7, 5
Barbara Song, b.3.2, 5
Barbara Song, b.6.1, 5
Barbara Song, c.1, 4
Barbara Song, c.2.10, 4
Barbara Song, c.2.2, 4
Barbara Song, c.2.3, 5
Barbara Song, c.2.4, 4
Barbara Song, c.2.7, 4
Barbara Song, c.2.8, 4
Barbara Song, c.2.9, 4
Barbara Song, c.3.1, 5
Barbara Song, c.3.2, 4
Barbara Song, c.4.1, 4
Barbara Song, c.4.2, 4
Barbara Song, c.4.3, 4
Barbara Song, c.4.4, 5
Barbara Song, c.5.1, 4
Barbara Song, d.1.1, 5
Barbara Song, d.1.2, 5
Barbara Song, d.2, 5
Barbara Song, d.3, 5
Barbara Song, d.4.1, 5
Barbara Song, d.5.1, 5
Barbara Song, d.5.2, 5
Barbara Song, d.5.3, 5
Barbara Song, d.5.4, 5
Barbara Song, d.6, 5
Barbara Song, e.1.1, 3
Barbara Song, e.1.2, 5
Barbara Song, e.2, 4
Barbara Song, g.1, 5
Barbara Song, g.1.1, 4
Barbara Song, g.2.1, 5
Barbara Song, g.2.2, 5
Barbara Song, g.2.3, 5
Barbara Song, g.3.2, 5
Barbara Song, h.2.1, -1
Barbara Song, h.2.3, 5
Barbara Song, h.3, 3
Bill Leal, a.1.2, 5
Bill Leal, a.1.3, 5
Bill Leal, a.2, 5
Bill Leal, a.3.1, 5
Bill Leal, a.3.2, 5
Bill Leal, a.3.3, 5
Bill Leal, a.3.4, 5
Bill Leal, a.3.6, 5
Bill Leal, c.1, 5
Bill Leal, c.2.10, 5
Bill Leal, c.2.2, 5
Bill Leal, c.2.3, 5
Bill Leal, c.2.4, 5
Bill Leal, c.2.7, 5
Bill Leal, c.2.8, 5
Bill Leal, c.2.9, 5
Bill Leal, c.3.1, 5
Bill Leal, c.3.2, 5
Bill Leal, c.4.1, 5
Bill Leal, c.4.2, 5
Bill Leal, c.4.3, 5
Bill Leal, c.4.4, 5
Bill Leal, c.5.1, 5
Bill Leal, d.1.1, 5
Bill Leal, d.1.2, 5
Bill Leal, d.2, 5
Bill Leal, d.3, 5
Bill Leal, d.4.1, 5

Bill Leal, d.5.1, 5
Bill Leal, d.5.2, 5
Bill Leal, d.5.3, 5
Bill Leal, d.5.4, 5
Bill Leal, d.6, 5
Bill Leal, g.1, 4
Bill Leal, g.2.1, 0
Bill Leal, g.2.2, 0
Bill Leal, g.2.3, 5
Bill Leal, g.3.2, 2
Bill Leal, h.2.1, -1
Bill Leal, h.2.3, 2
Bill Leal, h.3, 0
Bob Alford, a.1.2, 5
Bob Alford, a.1.3, 5
Bob Alford, a.2, 5
Bob Alford, a.3.1, 5
Bob Alford, a.3.2, 5
Bob Alford, a.3.3, 5
Bob Alford, a.3.4, 5
Bob Alford, a.3.6, 5
Bob Alford, c.1, 4
Bob Alford, c.2.10, 4
Bob Alford, c.2.2, 4
Bob Alford, c.2.3, 4
Bob Alford, c.2.4, 4
Bob Alford, c.2.7, 4
Bob Alford, c.2.8, 4
Bob Alford, c.2.9, 4
Bob Alford, c.3.1, 4
Bob Alford, c.3.2, 4
Bob Alford, c.4.1, 4
Bob Alford, c.4.2, 4
Bob Alford, c.4.3, 4
Bob Alford, c.4.4, 4
Bob Alford, c.5.1, 4
Bob Alford, d.1.1, 4
Bob Alford, d.1.2, 4
Bob Alford, d.2, 4
Bob Alford, d.3, 4
Bob Alford, d.4.1, 4
Bob Alford, d.5.1, 5
Bob Alford, d.5.2, 5
Bob Alford, d.5.3, 5
Bob Alford, d.5.4, 5
Bob Alford, d.6, 4
Bob Alford, g.1, 3
Bob Alford, g.2.1, 5
Bob Alford, g.2.2, 2
Bob Alford, g.2.3, 5
Bob Alford, g.3.2, 3
Bob Alford, h.2.1, -1
Bob Alford, h.2.3, -1
Bob Alford, h.3, -1
Brahim Boyd, a.1.2, 5
Brahim Boyd, a.1.3, 5
Brahim Boyd, a.2, 5
Brahim Boyd, a.3.1, 4
Brahim Boyd, a.3.2, 3
Brahim Boyd, a.3.3, 3
Brahim Boyd, a.3.4, 3
Brahim Boyd, a.3.6, 3
Brahim Boyd, c.3.1, 5
Brahim Boyd, c.4.1, 5
Brahim Boyd, c.4.2, 5
Brahim Boyd, c.4.3, 5
Brahim Boyd, c.4.4, 5
Brahim Boyd, c.5.1, 5
Brahim Boyd, d.1.1, 3
Brahim Boyd, d.1.2, 5
Brahim Boyd, d.5.1, 3
Brahim Boyd, d.5.2, 3
Brahim Boyd, d.5.3, 3
Brahim Boyd, d.5.4, 3
Brahim Boyd, g.1, 4
Brahim Boyd, g.2.1, 5
Brahim Boyd, g.2.2, 5
Brahim Boyd, g.2.3, 5
Brahim Boyd, g.3.2, 3
Brahim Boyd, h.2.1, 2
Brahim Boyd, h.2.3, 1
Brahim Boyd, h.3, 5
Brian Aniston, a.1.2, 4
Brian Aniston, a.1.3, 4
Brian Aniston, a.2, 4
Brian Aniston, a.3.1, 5
Brian Aniston, a.3.2, 4
Brian Aniston, a.3.3, 4
Brian Aniston, a.3.4, 4
Brian Aniston, a.3.6, 4
Brian Aniston, b.1.2, 5
Brian Aniston, b.1.3, 5
Brian Aniston, c.1, 4
Brian Aniston, c.2.10, 4
Brian Aniston, c.2.2, 4
Brian Aniston, c.2.3, 4
Brian Aniston, c.2.4, 4
Brian Aniston, c.2.7, 4
Brian Aniston, c.2.8, 4
Brian Aniston, c.2.9, 4
Brian Aniston, c.3.1, 4
Brian Aniston, c.3.2, 4
Brian Aniston, c.4.1, 4
Brian Aniston, c.4.2, 4
Brian Aniston, c.4.3, 4
Brian Aniston, c.4.4, 4
Brian Aniston, c.5.1, 4
Brian Aniston, d.1.1, 4
Brian Aniston, d.1.2, 4
Brian Aniston, d.2, 4
Brian Aniston, d.3, 4
Brian Aniston, d.4.1, 4
Brian Aniston, d.5.1, 4
Brian Aniston, d.5.2, 4
Brian Aniston, d.5.3, 4
Brian Aniston, d.5.4, 4
Brian Aniston, d.6, 4
Brian Aniston, g.1, 4
Brian Aniston, g.2.1, 4
Brian Aniston, g.2.2, 4
Brian Aniston, g.2.3, 4
Brian Aniston, g.3.2, 3
Brian Aniston, g.4.1, 3
Brian Aniston, h.2.1, 3
Brian Aniston, h.2.3, 3
Brian Aniston, h.3, -1
Brian Ward, g.4.4, 4
Brian Ward, j.6.3, 4
Brian Ward, j.6.4, 5
Caroline Cook, a.1.2, 5
Caroline Cook, a.1.3, 5
Caroline Cook, a.2, 5
Caroline Cook, a.3.1, 5
Caroline Cook, a.3.2, 5
Caroline Cook, a.3.3, 5
Caroline Cook, a.3.4, 5
Caroline Cook, a.3.6, 5
Caroline Cook, c.1, 5
Caroline Cook, c.2.10, 5
Caroline Cook, c.2.2, 5
Caroline Cook, c.2.3, 5
Caroline Cook, c.2.4, 5
Caroline Cook, c.2.7, 5
Caroline Cook, c.2.8, 5
Caroline Cook, c.2.9, 5
Caroline Cook, c.3.1, 5
Caroline Cook, c.3.2, 5
Caroline Cook, c.4.1, 5
Caroline Cook, c.4.2, 5
Caroline Cook, c.4.3, 5
Caroline Cook, c.4.4, 5
Caroline Cook, c.5.1, 5
Caroline Cook, d.1.1, 5
Caroline Cook, d.1.2, 5
Caroline Cook, d.2, 5
Caroline Cook, d.3, 5
Caroline Cook, d.4.1, 5
Caroline Cook, d.5.1, 5
Caroline Cook, d.5.2, 5
Caroline Cook, d.5.3, 5
Caroline Cook, d.5.4, 5
Caroline Cook, d.6, 5
Caroline Cook, g.1, 5
Caroline Goodman, a.1.2, 3
Caroline Goodman, a.1.3, 3
Caroline Goodman, a.2, 3
Caroline Goodman, a.3.1, 4
Caroline Goodman, a.3.2, 4
Caroline Goodman, a.3.3, 3
Caroline Goodman, a.3.4, 3
Caroline Goodman, a.3.6, 3
Caroline Goodman, c.1, 4
Caroline Goodman, c.2.10, 4
Caroline Goodman, c.2.2, 4
Caroline Goodman, c.2.3, 4
Caroline Goodman, c.2.4, 4
Caroline Goodman, c.2.7, 4
Caroline Goodman, c.2.8, 4
Caroline Goodman, c.2.9, 4
Caroline Goodman, c.3.1, 4
Caroline Goodman, c.3.2, 4
Caroline Goodman, c.4.1, 4
Caroline Goodman, c.4.2, 4
Caroline Goodman, c.4.3, 4
Caroline Goodman, c.4.4, 4
Caroline Goodman, c.5.1, 4
Caroline Goodman, d.1.1, 4
Caroline Goodman, d.1.2, 4
Caroline Goodman, d.2, 4
Caroline Goodman, d.3, 4
Caroline Goodman, d.4.1, 4
Caroline Goodman, d.5.1, 4
Caroline Goodman, d.5.2, 4
Caroline Goodman, d.5.3, 4
Caroline Goodman, d.5.4, 4
Caroline Goodman, d.6, 4
Caroline Goodman, g.1, 4
Caroline Goodman, g.2.1, 4
Caroline Goodman, g.2.2, 4
Caroline Goodman, g.2.3, 4
Caroline Goodman, g.3.2, 4
Caroline Goodman, h.2.1, 4
Caroline Goodman, h.2.3, 3
Caroline Goodman, h.3, 4
Chris Randall, a.1.2, 5
Chris Randall, a.1.3, 5
Chris Randall, a.2, 5
Chris Randall, a.3.1, 5
Chris Randall, a.3.2, 5
Chris Randall, a.3.3, 5
Chris Randall, a.3.4, 5
Chris Randall, a.3.6, 5
Chris Randall, b.3.1, 5
Chris Randall, c.1, 5
Chris Randall, c.2.10, 5
Chris Randall, c.2.2, 5
Chris Randall, c.2.3, 5
Chris Randall, c.2.4, 5
Chris Randall, c.2.7, 5
Chris Randall, c.2.8, 5
Chris Randall, c.2.9, 5
Chris Randall, c.3.1, 5
Chris Randall, c.3.2, 5
Chris Randall, c.4.1, 5
Chris Randall, c.4.2, 5
Chris Randall, c.4.3, 5
Chris Randall, c.4.4, 5
Chris Randall, c.5.1, 5
Chris Randall, d.1.1, 5
Chris Randall, d.1.2, 5
Chris Randall, d.2, 5
Chris Randall, d.3, 5
Chris Randall, d.4.1, 5
Chris Randall, d.5.1, 5
Chris Randall, d.5.2, 5
Chris Randall, d.5.3, 5
Chris Randall, d.5.4, 5
Chris Randall, d.6, 5
Chris Randall, e.1.2, 3
Chris Randall, g.1, 4
Chris Randall, g.2.1, 3
Chris Randall, g.2.2, 3
Chris Randall, g.2.3, 3
Chris Randall, g.3.2, 4
Chris Randall, g.4.2, 4
Chris Randall, h.2.1, -1
Chris Randall, h.2.3, 5
Chris Randall, h.3, 3
Chris Randall, h.4, 4
Chris Randall, j.2.1, 4
Chris Randall, j.2.2, 4
Chris Randall, j.2.3, 4
Christina Solis, d.4.1, 1
Christopher Hall, a.1.2, 5
Christopher Hall, a.1.3, 5
Christopher Hall, a.2, 5
Christopher Hall, a.3.1, 5
Christopher Hall, a.3.2, 5
Christopher Hall, a.3.3, 5
Christopher Hall, a.3.4, 5
Christopher Hall, a.3.6, 5
Christopher Hall, b.6.1, 5
Christopher Hall, b.7, 3
Christopher Hall, c.1, 4
Christopher Hall, c.2.10, 4
Christopher Hall, c.2.2, 4
Christopher Hall, c.2.3, 4
Christopher Hall, c.2.4, 4
Christopher Hall, c.2.7, 4
Christopher Hall, c.2.8, 4
Christopher Hall, c.2.9, 4
Christopher Hall, c.3.1, 5
Christopher Hall, c.3.2, 4
Christopher Hall, c.4.1, 4
Christopher Hall, c.4.2, 4
Christopher Hall, c.4.3, 4
Christopher Hall, c.4.4, 4
Christopher Hall, c.5.1, 4
Christopher Hall, d.1.1, 5
Christopher Hall, d.1.2, 5
Christopher Hall, d.2, 5
Christopher Hall, d.3, 5
Christopher Hall, d.4.1, 5
Christopher Hall, d.5.1, 5
Christopher Hall, d.5.2, 5
Christopher Hall, d.5.3, 5
Christopher Hall, d.5.4, 5
Christopher Hall, d.6, 5
Christopher Hall, g.1, 5
Christopher Hall, g.2.1, 5
Christopher Hall, g.2.2, 4
Christopher Hall, g.2.3, 5
Christopher Hall, g.3.2, 5
Christopher Hall, h.2.1, 1
Christopher Hall, h.2.3, 3
Christopher Hall, h.3, 5
Colin Penn, a.1.2, 3
Colin Penn, a.1.3, 3
Colin Penn, a.2, 3
Colin Penn, a.3.1, 3
Colin Penn, a.3.2, 3
Colin Penn, a.3.3, 3
Colin Penn, a.3.4, 3
Colin Penn, a.3.6, 3
Colin Penn, c.3.1, 4
Colin Penn, c.4.1, 4
Colin Penn, c.4.2, 4
Colin Penn, c.4.3, 4
Colin Penn, c.4.4, 4
Colin Penn, c.5.1, 4
Colin Penn, d.1.1, 3
Colin Penn, d.1.2, 3
Colin Penn, d.2, 3
Colin Penn, d.3, 3
Colin Penn, d.4.1, 3
Colin Penn, d.5.1, 4
Colin Penn, d.5.2, 4
Colin Penn, d.5.3, 4
Colin Penn, d.5.4, 4
Colin Penn, d.6, 3
Colin Penn, g.1, 3
Colin Penn, g.2.1, 3
Colin Penn, g.2.2, 3
Colin Penn, g.2.3, 3
Colin Penn, g.3.2, 3
Colin Penn, g.4.4, 5
Colin Penn, g.4.5, 5
Colin Penn, h.2.1, 2
Colin Penn, h.2.3, 2
Colin Penn, h.3, 2
Colin Street, a.1.2, 4
Colin Street, a.1.3, 4
Colin Street, a.2, 4
Colin Street, a.3.1, 5
Colin Street, a.3.2, 5
Colin Street, a.3.3, 5
Colin Street, a.3.4, 5
Colin Street, a.3.6, 5
Colin Street, c.1, 5
Colin Street, c.2.10, 5
Colin Street, c.2.2, 5
Colin Street, c.2.3, 5
Colin Street, c.2.4, 5
Colin Street, c.2.7, 5
Colin Street, c.2.8, 5
Colin Street, c.2.9, 5
Colin Street, c.3.1, 5
Colin Street, c.3.2, 5
Colin Street, c.4.1, 5
Colin Street, c.4.2, 5
Colin Street, c.4.3, 5
Colin Street, c.4.4, 5
Colin Street, c.5.1, 5
Colin Street, d.1.1, 4
Colin Street, d.1.2, 5
Colin Street, d.2, 4
Colin Street, d.3, 4
Colin Street, d.4.1, 4
Colin Street, d.5.1, 4
Colin Street, d.5.2, 4
Colin Street, d.5.3, 4
Colin Street, d.5.4, 4
Colin Street, d.6, 4
Colin Street, g.1, 4
Colin Street, g.2.1, 3
Colin Street, g.2.2, 2
Colin Street, g.2.3, 3
Colin Street, g.3.2, 4
Colin Street, h.2.1, -1
Colin Street, h.2.2, -1
Colin Street, h.2.3, -1
Colin Street, h.2.4, -1
Colin Street, h.3, 2
Conrad Moore, a.1.2, 0
Conrad Moore, a.1.3, 0
Conrad Moore, a.2, 0
Conrad Moore, a.3.1, 0
Conrad Moore, a.3.2, 0
Conrad Moore, a.3.3, 0
Conrad Moore, a.3.4, 0
Conrad Moore, a.3.6, 0
Conrad Moore, c.1, 5
Conrad Moore, c.2.10, 5
Conrad Moore, c.2.2, 5
Conrad Moore, c.2.3, 5
Conrad Moore, c.2.4, 5
Conrad Moore, c.2.7, 5
Conrad Moore, c.2.8, 5
Conrad Moore, c.2.9, 5
Conrad Moore, c.3.1, 5
Conrad Moore, c.3.2, 5
Conrad Moore, c.4.1, 5
Conrad Moore, c.4.2, 5
Conrad Moore, c.4.3, 5
Conrad Moore, c.4.4, 5
Conrad Moore, c.5.1, 5
Conrad Moore, d.1.1, 5
Conrad Moore, d.1.2, 5
Conrad Moore, d.2, 5
Conrad Moore, d.3, 5
Conrad Moore, d.4.1, 5
Conrad Moore, d.5.1, 5
Conrad Moore, d.5.2, 5
Conrad Moore, d.5.3, 5
Conrad Moore, d.5.4, 5
Conrad Moore, d.6, 5
Conrad Moore, g.1, 5
Conrad Moore, g.2.1, 3
Conrad Moore, g.2.2, 3
Conrad Moore, g.2.3, 3
Conrad Moore, g.3.2, 3
Conrad Moore, h.2.1, 0
Conrad Moore, h.2.3, 0
Conrad Moore, h.3, 0
David Ainsley, a.1.2, 4
David Ainsley, a.1.3, 4
David Ainsley, a.2, 4
David Ainsley, a.3.1, 5
David Ainsley, a.3.2, 4
David Ainsley, a.3.3, 4
David Ainsley, a.3.4, 4
David Ainsley, a.3.6, 4
David Ainsley, c.2.10, 4
David Ainsley, c.3.1, 4
David Ainsley, c.4.1, 2
David Ainsley, c.4.2, 2
David Ainsley, c.4.3, 2
David Ainsley, c.4.4, 4
David Ainsley, c.5.1, 3
David Ainsley, d.1.1, 4
David Ainsley, d.1.2, 3
David Ainsley, d.2, 3
David Ainsley, d.3, 3
David Ainsley, d.4.1, 3
David Ainsley, d.5.1, 4
David Ainsley, d.5.2, 4
David Ainsley, d.5.3, 4
David Ainsley, d.5.4, 4
David Ainsley, d.6, 3
David Ainsley, g.1, 4
David Ainsley, g.2.1, 4
David Ainsley, g.2.2, 3
David Ainsley, g.2.3, 3
David Ainsley, g.3.2, 4
David Ainsley, h.2.1, 1
David Ainsley, h.2.3, 3
David Ainsley, h.3, 5
David Carne, a.1.2, 1
David Carne, a.1.3, 1
David Carne, a.2, 1
David Carne, a.3.1, 1
David Carne, a.3.2, 1
David Carne, a.3.3, 1
David Carne, a.3.4, 1
David Carne, a.3.6, 1
David Carne, c.1, 3
David Carne, c.2.10, 3
David Carne, c.2.2, 3
David Carne, c.2.3, 3
David Carne, c.2.4, 3
David Carne, c.2.7, 3
David Carne, c.2.8, 3
David Carne, c.2.9, 3
David Carne, c.3.1, 3
David Carne, c.3.2, 3
David Carne, c.4.1, 3
David Carne, c.4.2, 3
David Carne, c.4.3, 3
David Carne, c.4.4, 3
David Carne, c.5.1, 3
David Carne, d.1.1, 2
David Carne, d.1.2, 2
David Carne, d.2, 2
David Carne, d.3, 2
David Carne, d.4.1, 2
David Carne, d.5.1, 2
David Carne, d.5.2, 2
David Carne, d.5.3, 2
David Carne, d.5.4, 2
David Carne, d.6, 2
David Carne, g.1, 3
David Carne, g.2.1, 3
David Carne, g.2.2, 3
David Carne, g.2.3, 3
David Carne, g.3.2, 2
David Carne, g.4.4, 2
David Carne, h.2.1, 1
David Carne, h.2.3, 1
David Carne, h.3, 1
David Carne, i.2.3, 4
David Carne, j.6.3, 5
Diana Cates, a.1.2, 5
Diana Cates, a.1.3, 5
Diana Cates, a.2, 3
Diana Cates, a.3.1, 5
Diana Cates, a.3.2, 5
Diana Cates, a.3.3, 5
Diana Cates, a.3.4, 5
Diana Cates, c.3.1, 5
Diana Cates, c.4.1, 5
Diana Cates, c.4.2, 5
Diana Cates, c.4.3, 5
Diana Cates, c.4.4, 5
Diana Cates, c.5.1, 5
Diana Cates, d.1.1, 5

Diana Cates, d.1.2, -1
Diana Cates, d.5.1, 5
Diana Cates, d.5.2, 5
Diana Cates, d.5.3, 5
Diana Cates, d.5.4, 5
Diana Cates, g.1, 5
Diana Cates, g.2.1, 5
Diana Cates, g.2.2, 3
Diana Cates, g.2.3, 3
Diana Cates, g.3.2, 5
Diana Cates, h.2.1, -1
Diana Cates, h.2.3, 5
Diana Cates, h.3, 5
Ed Steele, a.1.2, 5
Ed Steele, a.1.3, 5
Ed Steele, a.2, 5
Ed Steele, a.3.1, 5
Ed Steele, a.3.2, 5
Ed Steele, a.3.3, 5
Ed Steele, a.3.4, 5
Ed Steele, a.3.6, 5
Ed Steele, c.1, 4
Ed Steele, c.2.10, 4
Ed Steele, c.2.2, 4
Ed Steele, c.2.3, 4
Ed Steele, c.2.4, 4
Ed Steele, c.2.7, 4
Ed Steele, c.2.8, 4
Ed Steele, c.2.9, 4
Ed Steele, c.3.1, 4
Ed Steele, c.3.2, 4
Ed Steele, c.4.1, 4
Ed Steele, c.4.2, 4
Ed Steele, c.4.3, 4
Ed Steele, c.4.4, 4
Ed Steele, c.5.1, 4
Ed Steele, d.1.1, 5
Ed Steele, d.1.2, 5
Ed Steele, d.2, 5
Ed Steele, d.3, 5
Ed Steele, d.4.1, 5
Ed Steele, d.5.1, 5
Ed Steele, d.5.2, 5
Ed Steele, d.5.3, 5
Ed Steele, d.5.4, 5
Ed Steele, d.6, 5
Ed Steele, g.1, 5
Ed Steele, g.2.1, 2
Ed Steele, g.2.2, 2
Ed Steele, g.2.3, 2
Ed Steele, g.3.2, 2
Ed Steele, h.2.1, 0
Ed Steele, h.2.3, 0
Ed Steele, h.2.4, 5
Ed Steele, h.3, 2
Farid Sonya, a.1.2, 5
Farid Sonya, a.1.3, 5
Farid Sonya, a.2, 5
Farid Sonya, a.3.1, 5
Farid Sonya, a.3.2, 5
Farid Sonya, a.3.3, 5
Farid Sonya, a.3.4, 5
Farid Sonya, a.3.6, 5
Farid Sonya, c.1, 5
Farid Sonya, c.2.10, 5
Farid Sonya, c.2.2, 5
Farid Sonya, c.2.3, 5
Farid Sonya, c.2.4, 5
Farid Sonya, c.2.7, 5
Farid Sonya, c.2.8, 5
Farid Sonya, c.2.9, 5
Farid Sonya, c.3.1, 5
Farid Sonya, c.3.2, 5
Farid Sonya, c.4.1, 5
Farid Sonya, c.4.2, 5
Farid Sonya, c.4.3, 5
Farid Sonya, c.4.4, 5
Farid Sonya, c.5.1, 5
Farid Sonya, d.1.1, 5
Farid Sonya, d.1.2, 5
Farid Sonya, d.2, 5
Farid Sonya, d.3, 5
Farid Sonya, d.4.1, 5
Farid Sonya, d.5.1, 5
Farid Sonya, d.5.2, 5
Farid Sonya, d.5.3, 5
Farid Sonya, d.5.4, 5
Farid Sonya, d.6, 5
Farid Sonya, g.1, 5
Farid Sonya, g.2.1, 5
Farid Sonya, g.2.2, 5
Farid Sonya, g.2.3, 5
Farid Sonya, g.3.2, 5
Farid Sonya, h.2.1, -1
Farid Sonya, h.2.3, -1
Farid Sonya, h.3, 5
Fickle Andrews, a.1.2, 4
Fickle Andrews, a.1.3, 4
Fickle Andrews, a.2, 4
Fickle Andrews, a.3.1, 4
Fickle Andrews, a.3.2, 4
Fickle Andrews, a.3.3, 4
Fickle Andrews, a.3.4, 4
Fickle Andrews, a.3.6, 4
Fickle Andrews, c.3.1, 3
Fickle Andrews, c.4.1, 3
Fickle Andrews, c.4.2, 3
Fickle Andrews, c.4.3, 3
Fickle Andrews, c.4.4, 3
Fickle Andrews, c.5.1, 3
Fickle Andrews, d.1.1, 5
Fickle Andrews, d.1.2, 5
Fickle Andrews, d.5.1, 3
Fickle Andrews, d.5.2, 3
Fickle Andrews, d.5.3, 3
Fickle Andrews, d.5.4, 3
Fickle Andrews, g.1, 4
Fickle Andrews, g.2.1, 4
Fickle Andrews, g.2.2, 4
Fickle Andrews, g.2.3, 4
Fickle Andrews, g.3.2, 5
Ian More, a.1.2, 3
Ian More, a.1.3, 3
Ian More, a.2, 3
Ian More, a.3.1, 5
Ian More, a.3.2, 5
Ian More, a.3.3, 5
Ian More, a.3.4, 5
Ian More, a.3.6, 5
Ian More, c.1, 4
Ian More, c.2.10, 4
Ian More, c.2.2, 4
Ian More, c.2.3, 4
Ian More, c.2.4, 4
Ian More, c.2.7, 4
Ian More, c.2.8, 4
Ian More, c.2.9, 4
Ian More, c.3.1, 4
Ian More, c.3.2, 4
Ian More, c.4.1, 4
Ian More, c.4.2, 4
Ian More, c.4.3, 4
Ian More, c.4.4, 4
Ian More, c.5.1, 4
Ian More, d.1.1, 5
Ian More, d.1.2, 5
Ian More, d.2, 5
Ian More, d.3, 5
Ian More, d.4.1, 5
Ian More, d.5.1, 5
Ian More, d.5.2, 5
Ian More, d.5.3, 5
Ian More, d.5.4, 5
Ian More, d.6, 5
Ian More, e.1.1, -1
Ian More, e.1.2, -1
Ian More, f.1, 3
Ian More, g.1, 3
Ian More, g.2.1, 4
Ian More, g.2.2, 4
Ian More, g.2.3, 4
Ian More, g.3.2, 3
Ian More, h.2.1, 1
Ian More, h.2.3, 1
Ian More, h.3, 1
Ian More, i.3.5, 3
Ian More, j.4.1, 2
Jan Crowe, a.1.2, 4
Jan Crowe, a.1.3, 4
Jan Crowe, a.2, 5
Jan Crowe, a.3.1, 5
Jan Crowe, a.3.2, 5
Jan Crowe, a.3.3, 5
Jan Crowe, a.3.4, 5
Jan Crowe, a.3.6, 5
Jan Crowe, b.1.2, 5
Jan Crowe, b.2, 5
Jan Crowe, b.3.3, 5
Jan Crowe, c.1, 4
Jan Crowe, c.2.10, 4
Jan Crowe, c.2.2, 4
Jan Crowe, c.2.3, 4
Jan Crowe, c.2.4, 4
Jan Crowe, c.2.7, 4
Jan Crowe, c.2.8, 4
Jan Crowe, c.2.9, 4
Jan Crowe, c.3.1, 4
Jan Crowe, c.3.2, 4
Jan Crowe, c.4.1, 4
Jan Crowe, c.4.2, 4
Jan Crowe, c.4.3, 4
Jan Crowe, c.4.4, 4
Jan Crowe, c.5.1, 4
Jan Crowe, d.1.1, 5
Jan Crowe, d.1.2, 5
Jan Crowe, d.2, 5
Jan Crowe, d.3, 5
Jan Crowe, d.4.1, 5
Jan Crowe, d.5.1, 5
Jan Crowe, d.5.2, 5
Jan Crowe, d.5.3, 5
Jan Crowe, d.5.4, 5
Jan Crowe, d.6, 5
Jan Crowe, g.1, 5
Jan Crowe, g.1.1, 5
Jan Crowe, g.2.1, 2
Jan Crowe, g.2.2, 5
Jan Crowe, g.2.3, 2
Jan Crowe, g.3.2, 4
Jan Crowe, h.2.1, 4
Jan Crowe, h.2.2, 4
Jan Crowe, h.2.3, 4
Jan Crowe, h.2.4, 4
Jan Crowe, h.3, 2
Jason Ortiz, a.1.2, 5
Jason Ortiz, a.1.3, 5
Jason Ortiz, a.2, 3
Jason Ortiz, a.3.1, 5
Jason Ortiz, a.3.2, 3
Jason Ortiz, a.3.3, 3
Jason Ortiz, a.3.4, 3
Jason Ortiz, a.3.6, 3
Jason Ortiz, c.1, 3
Jason Ortiz, c.2.10, 3
Jason Ortiz, c.2.2, 3
Jason Ortiz, c.2.3, 3
Jason Ortiz, c.2.4, 3
Jason Ortiz, c.2.7, 3
Jason Ortiz, c.2.8, 3
Jason Ortiz, c.2.9, 3
Jason Ortiz, c.3.1, 4
Jason Ortiz, c.3.2, 3
Jason Ortiz, c.4.1, 3
Jason Ortiz, c.4.2, 3
Jason Ortiz, c.4.3, 3
Jason Ortiz, c.4.4, 3
Jason Ortiz, c.5.1, 3
Jason Ortiz, d.1.1, 5
Jason Ortiz, d.1.2, 3
Jason Ortiz, d.2, 3
Jason Ortiz, d.3, 3
Jason Ortiz, d.4.1, 3
Jason Ortiz, d.5.1, 5
Jason Ortiz, d.5.2, 5
Jason Ortiz, d.5.3, 5
Jason Ortiz, d.5.4, 5
Jason Ortiz, d.6, 4
Jason Ortiz, g.1, 3
Jason Ortiz, g.2.1, 1
Jason Ortiz, g.2.2, 1
Jason Ortiz, g.2.3, 1
Jason Ortiz, g.3.2, 5
Jason Ortiz, h.2.1, 0
Jason Ortiz, h.2.3, 1
Jason Ortiz, h.3, 2
Jason Ortiz, i.3.3, 4
Jeremy Spain, a.1.2, 5
Jeremy Spain, a.1.3, 5
Jeremy Spain, a.2, 4
Jeremy Spain, a.3.1, 4
Jeremy Spain, a.3.2, 4
Jeremy Spain, a.3.3, 4
Jeremy Spain, a.3.4, 4
Jeremy Spain, a.3.6, 4
Jeremy Spain, c.1, 5
Jeremy Spain, c.2.10, 5
Jeremy Spain, c.2.2, 5
Jeremy Spain, c.2.3, 5
Jeremy Spain, c.2.4, 5
Jeremy Spain, c.2.7, 5
Jeremy Spain, c.2.8, 5
Jeremy Spain, c.2.9, 5
Jeremy Spain, c.3.1, 5
Jeremy Spain, c.3.2, 5
Jeremy Spain, c.4.1, 5
Jeremy Spain, c.4.2, 5
Jeremy Spain, c.4.3, 5
Jeremy Spain, c.4.4, 5
Jeremy Spain, c.5.1, 5
Jeremy Spain, d.1.1, 4
Jeremy Spain, d.1.2, 4
Jeremy Spain, d.2, 4
Jeremy Spain, d.3, 4
Jeremy Spain, d.4.1, 4
Jeremy Spain, d.5.1, 5
Jeremy Spain, d.5.2, 5
Jeremy Spain, d.5.3, 5
Jeremy Spain, d.5.4, 5
Jeremy Spain, d.6, 4
Jeremy Spain, g.1, 5
Jeremy Spain, g.2.1, 5
Jeremy Spain, g.2.2, 2
Jeremy Spain, g.2.3, 5
Jeremy Spain, g.3.2, 4
Jeremy Spain, h.2.1, -1
Jeremy Spain, h.2.3, 2
Jeremy Spain, h.3, 1
Jim Howe, a.1.2, 4
Jim Howe, a.1.3, 4
Jim Howe, a.2, 4
Jim Howe, a.3.1, 4
Jim Howe, a.3.2, 4
Jim Howe, a.3.3, 4
Jim Howe, a.3.4, 4
Jim Howe, a.3.6, 4
Jim Howe, b.1.4, 3
Jim Howe, c.1, 5
Jim Howe, c.2.10, 5
Jim Howe, c.2.2, 5
Jim Howe, c.2.3, 5
Jim Howe, c.2.4, 5
Jim Howe, c.2.7, 5
Jim Howe, c.2.8, 5
Jim Howe, c.2.9, 5
Jim Howe, c.3.1, 5
Jim Howe, c.3.2, 5
Jim Howe, c.4.1, 5
Jim Howe, c.4.2, 5
Jim Howe, c.4.3, 5
Jim Howe, c.4.4, 5
Jim Howe, c.5.1, 5
Jim Howe, d.1.1, 4
Jim Howe, d.1.2, 4
Jim Howe, d.2, 4
Jim Howe, d.3, 4
Jim Howe, d.4.1, 4
Jim Howe, d.5.1, 4
Jim Howe, d.5.2, 4
Jim Howe, d.5.3, 4
Jim Howe, d.5.4, 4
Jim Howe, d.6, 4
Jim Howe, g.1, 4
Jim Howe, g.2.1, 4
Jim Howe, g.2.2, 4
Jim Howe, g.2.3, 4
Jim Howe, g.3.2, 4
Jim Howe, h.2.1, 0
Jim Howe, h.2.3, 2
Jim Howe, h.3, 2
Johnny Glenn, a.1.2, 5
Johnny Glenn, a.1.3, 5
Johnny Glenn, a.2, 5
Johnny Glenn, a.3.1, 5
Johnny Glenn, a.3.2, 5
Johnny Glenn, a.3.3, 5
Johnny Glenn, a.3.4, 5
Johnny Glenn, a.3.6, 5
Johnny Glenn, c.1, 4
Johnny Glenn, c.2.10, 4
Johnny Glenn, c.2.2, 4
Johnny Glenn, c.2.3, 4
Johnny Glenn, c.2.4, 4
Johnny Glenn, c.2.7, 4
Johnny Glenn, c.2.8, 4
Johnny Glenn, c.2.9, 4
Johnny Glenn, c.3.1, 4
Johnny Glenn, c.3.2, 4
Johnny Glenn, c.4.1, 4
Johnny Glenn, c.4.2, 4
Johnny Glenn, c.4.3, 4
Johnny Glenn, c.4.4, 4
Johnny Glenn, c.5.1, 4
Johnny Glenn, d.1.1, 4
Johnny Glenn, d.1.2, 4
Johnny Glenn, d.2, 4
Johnny Glenn, d.3, 4
Johnny Glenn, d.4.1, 4
Johnny Glenn, d.5.1, 4
Johnny Glenn, d.5.2, 4
Johnny Glenn, d.5.3, 4
Johnny Glenn, d.5.4, 4
Johnny Glenn, d.6, 4
Johnny Glenn, g.1, 4
Johnny Glenn, g.2.1, 3
Johnny Glenn, g.2.2, 2
Johnny Glenn, g.2.3, 3
Johnny Glenn, g.3.2, 4
Johnny Glenn, h.2.1, 2
Johnny Glenn, h.2.3, 3
Johnny Glenn, h.3, 4
Jots Semb, a.1.2, 5
Jots Semb, a.1.3, 5
Jots Semb, a.2, 5
Jots Semb, a.3.1, 5
Jots Semb, a.3.2, 5
Jots Semb, a.3.3, 5
Jots Semb, a.3.4, 5
Jots Semb, a.3.6, 5
Jots Semb, b.3.1, 4
Jots Semb, b.4, 4
Jots Semb, b.5, -1
Jots Semb, c.1, 5
Jots Semb, c.2.10, 5
Jots Semb, c.2.2, 5
Jots Semb, c.2.3, 5
Jots Semb, c.2.4, 5
Jots Semb, c.2.7, 5
Jots Semb, c.2.8, 5
Jots Semb, c.2.9, 5
Jots Semb, c.3.1, 5
Jots Semb, c.3.2, 5
Jots Semb, c.4.1, 5
Jots Semb, c.4.2, 5
Jots Semb, c.4.3, 5
Jots Semb, c.4.4, 5
Jots Semb, c.5.1, 5
Jots Semb, d.1.1, 4
Jots Semb, d.1.2, 3
Jots Semb, d.2, 3
Jots Semb, d.3, 3
Jots Semb, d.4.1, 3
Jots Semb, d.5.1, 4
Jots Semb, d.5.2, 4
Jots Semb, d.5.3, 4
Jots Semb, d.5.4, 4
Jots Semb, d.6, 3
Jots Semb, f.1, 2
Jots Semb, f.2.1, 2
Jots Semb, f.4.1, 2
Jots Semb, f.5, 2
Jots Semb, f.6.1, 2
Jots Semb, f.6.2, 2
Jots Semb, g.1, -1
Jots Semb, g.2.1, 4
Jots Semb, g.2.2, 3
Jots Semb, g.2.3, 4
Jots Semb, g.3.2, 1
Jots Semb, g.4.4, 5
Jots Semb, h.2.1, -1
Jots Semb, h.2.3, 2
Jots Semb, h.3, 2
Jots Semb, i.2.3, -1
Jots Semb, i.3.6, 3
Jots Semb, j.2.2, 3
Jots Semb, j.2.3, 5
Jots Semb, j.6.3, 3
Kathleen Niche, a.1.2, 5
Kathleen Niche, a.1.3, 5
Kathleen Niche, a.2, 5
Kathleen Niche, a.3.1, 5
Kathleen Niche, a.3.2, 5
Kathleen Niche, a.3.3, 5
Kathleen Niche, a.3.4, 5
Kathleen Niche, a.3.6, 5
Kathleen Niche, b.6.1, 3
Kathleen Niche, c.1, 5
Kathleen Niche, c.2.10, 5
Kathleen Niche, c.2.2, 5
Kathleen Niche, c.2.3, 5
Kathleen Niche, c.2.4, 5
Kathleen Niche, c.2.7, 5
Kathleen Niche, c.2.8, 5
Kathleen Niche, c.2.9, 5
Kathleen Niche, c.3.1, 5
Kathleen Niche, c.3.2, 5
Kathleen Niche, c.4.1, 5
Kathleen Niche, c.4.2, 5
Kathleen Niche, c.4.3, 5
Kathleen Niche, c.4.4, 5
Kathleen Niche, c.5.1, 5
Kathleen Niche, d.1.1, 5
Kathleen Niche, d.1.2, 5
Kathleen Niche, d.2, 5
Kathleen Niche, d.3, 5
Kathleen Niche, d.4.1, 5
Kathleen Niche, d.5.1, 5
Kathleen Niche, d.5.2, 5
Kathleen Niche, d.5.3, 5
Kathleen Niche, d.5.4, 5
Kathleen Niche, d.6, 5
Kathleen Niche, g.1, 5
Kathleen Niche, g.2.1, 4
Kathleen Niche, g.2.2, 4
Kathleen Niche, g.2.3, 4
Kathleen Niche, g.3.2, 5
Kathleen Niche, h.2.1, 0
Kathleen Niche, h.2.3, 4
Kathleen Niche, h.3, -1
Kathryn Lester, a.1.2, 3
Kathryn Lester, a.1.3, 3
Kathryn Lester, a.2, 4
Kathryn Lester, a.3.1, 5
Kathryn Lester, a.3.2, 5
Kathryn Lester, a.3.3, 5
Kathryn Lester, a.3.4, 5
Kathryn Lester, a.3.6, 5
Kathryn Lester, b.3.1, 5
Kathryn Lester, b.4, 5
Kathryn Lester, b.5, 2
Kathryn Lester, c.2.10, 3
Kathryn Lester, c.2.2, 3
Kathryn Lester, c.2.3, 3
Kathryn Lester, c.2.4, 3
Kathryn Lester, c.2.7, 3
Kathryn Lester, c.2.8, 3
Kathryn Lester, c.2.9, 3
Kathryn Lester, c.3.1, 2
Kathryn Lester, c.4.1, 3
Kathryn Lester, c.4.2, 3
Kathryn Lester, c.4.3, 3
Kathryn Lester, c.4.4, 4
Kathryn Lester, c.5.1, 3
Kathryn Lester, d.1.1, 4
Kathryn Lester, d.1.2, 1
Kathryn Lester, d.2, 3

Kathryn Lester, d.3, 3
Kathryn Lester, d.4.1, 3
Kathryn Lester, d.5.1, 3
Kathryn Lester, d.5.2, 3
Kathryn Lester, d.5.3, 3
Kathryn Lester, d.5.4, 3
Kathryn Lester, d.6, 3
Kathryn Lester, f.1, 4
Kathryn Lester, f.2.1, 4
Kathryn Lester, f.4.1, 4
Kathryn Lester, f.5, 4
Kathryn Lester, f.6.1, 4
Kathryn Lester, f.6.2, 4
Kathryn Lester, g.1, 5
Kathryn Lester, g.2.1, 4
Kathryn Lester, g.2.2, 4
Kathryn Lester, g.2.3, 4
Kathryn Lester, g.3.2, 4
Kathryn Lester, g.4.4, 4
Kathryn Lester, h.2.1, 0
Kathryn Lester, h.2.3, 3
Kathryn Lester, h.3, 3
Kathryn Lester, i.2.3, 3
Kathryn Lester, i.3.6, 4
Kathryn Lester, j.2.2, 0
Kathryn Lester, j.2.3, 3
Kathryn Lester, j.6.3, 5
Kathryn Lester, j.6.4, 4
Kerstin Michel, a.1.2, 5
Kerstin Michel, a.1.3, 5
Kerstin Michel, a.2, 5
Kerstin Michel, a.3.1, 5
Kerstin Michel, a.3.2, 5
Kerstin Michel, a.3.3, 5
Kerstin Michel, a.3.4, 5
Kerstin Michel, a.3.6, 5
Kerstin Michel, c.1, 4
Kerstin Michel, c.2.10, 4
Kerstin Michel, c.2.2, 4
Kerstin Michel, c.2.3, 4
Kerstin Michel, c.2.4, 4
Kerstin Michel, c.2.7, 4
Kerstin Michel, c.2.8, 4
Kerstin Michel, c.2.9, 4
Kerstin Michel, c.3.1, 4
Kerstin Michel, c.3.2, 4
Kerstin Michel, c.4.1, 4
Kerstin Michel, c.4.2, 4
Kerstin Michel, c.4.3, 4
Kerstin Michel, c.4.4, 5
Kerstin Michel, c.5.1, 4
Kerstin Michel, d.1.1, 5
Kerstin Michel, d.1.2, 5
Kerstin Michel, d.2, 5
Kerstin Michel, d.3, 5
Kerstin Michel, d.4.1, 5
Kerstin Michel, d.5.1, 5
Kerstin Michel, d.5.2, 5
Kerstin Michel, d.5.3, 5
Kerstin Michel, d.5.4, 5
Kerstin Michel, d.6, 5
Kerstin Michel, g.1, 5
Kerstin Michel, g.2.1, 5
Kerstin Michel, g.2.2, 5
Kerstin Michel, g.2.3, 5
Kerstin Michel, g.3.2, 5
Kerstin Michel, h.2.1, 5
Kerstin Michel, h.2.3, 5
Kerstin Michel, h.3, 5
Liz Hopper, a.1.2, 5
Liz Hopper, a.1.3, 5
Liz Hopper, a.2, 5
Liz Hopper, a.3.1, 5
Liz Hopper, a.3.2, 5
Liz Hopper, a.3.3, 5
Liz Hopper, a.3.4, 5
Liz Hopper, a.3.6, 5
Liz Hopper, c.1, 4
Liz Hopper, c.2.10, 4
Liz Hopper, c.2.2, 5
Liz Hopper, c.2.3, 4
Liz Hopper, c.2.4, 4
Liz Hopper, c.2.7, 4
Liz Hopper, c.2.8, 4
Liz Hopper, c.2.9, 4
Liz Hopper, c.3.1, 4
Liz Hopper, c.3.2, 4
Liz Hopper, c.4.1, 4
Liz Hopper, c.4.2, 5
Liz Hopper, c.4.3, 4
Liz Hopper, c.4.4, 4
Liz Hopper, c.5.1, 4
Liz Hopper, d.1.1, 4
Liz Hopper, d.1.2, 4
Liz Hopper, d.2, 4
Liz Hopper, d.3, 4
Liz Hopper, d.4.1, 4
Liz Hopper, d.5.1, 4
Liz Hopper, d.5.2, 4
Liz Hopper, d.5.3, 4
Liz Hopper, d.5.4, 4
Liz Hopper, d.6, 4
Liz Hopper, g.1, 4
Liz Hopper, g.2.1, 3
Liz Hopper, g.2.2, 3
Liz Hopper, g.2.3, 3
Liz Hopper, g.3.2, 4
Liz Hopper, g.4.5, 5
Liz Hopper, h.2.1, 2
Liz Hopper, h.2.2, 3
Liz Hopper, h.2.3, 4
Liz Hopper, h.3, -1
Magali Persi, a.1.2, 5
Magali Persi, a.1.3, 5
Magali Persi, a.2, 5
Magali Persi, a.3.1, 5
Magali Persi, a.3.2, 5
Magali Persi, a.3.3, 5
Magali Persi, a.3.4, 5
Magali Persi, a.3.6, 5
Magali Persi, c.3.1, 2
Magali Persi, c.4.1, 5
Magali Persi, c.4.2, 5
Magali Persi, c.4.3, 5
Magali Persi, c.4.4, 5
Magali Persi, c.5.1, 5
Magali Persi, d.1.1, 5
Magali Persi, d.1.2, 3
Magali Persi, d.2, 3
Magali Persi, d.3, 3
Magali Persi, d.4.1, 3
Magali Persi, d.5.1, 5
Magali Persi, d.5.2, 5
Magali Persi, d.5.3, 5
Magali Persi, d.5.4, 5
Magali Persi, d.6, 3
Magali Persi, g.1, 2
Magali Persi, g.2.1, 1
Magali Persi, g.2.2, 1
Magali Persi, g.2.3, 1
Magali Persi, g.3.2, 3
Magali Persi, h.2.1, -1
Magali Persi, h.2.3, -1
Magali Persi, h.3, -1
Majid Khande, a.1.2, 5
Majid Khande, a.1.3, 5
Majid Khande, a.2, 4
Majid Khande, a.3.1, 5
Majid Khande, a.3.2, 5
Majid Khande, a.3.3, 4
Majid Khande, a.3.4, 4
Majid Khande, a.3.6, 4
Majid Khande, c.3.1, 3
Majid Khande, c.4.1, 5
Majid Khande, c.4.2, 5
Majid Khande, c.4.3, 5
Majid Khande, c.4.4, 5
Majid Khande, c.5.1, 0
Majid Khande, d.1.1, 5
Majid Khande, d.1.2, 5
Majid Khande, d.5.1, 5
Majid Khande, d.5.2, 5
Majid Khande, d.5.3, 5
Majid Khande, d.5.4, 5
Majid Khande, g.1, 5
Majid Khande, g.2.1, 5
Majid Khande, g.2.2, 5
Majid Khande, g.2.3, 5
Majid Khande, g.3.2, 5
Majid Khande, h.2.1, -1
Majid Khande, h.2.3, -1
Majid Khande, h.3, -1
Malcolm Bain, a.1.2, 5
Malcolm Bain, a.1.3, 5
Malcolm Bain, a.2, 5
Malcolm Bain, a.3.1, 5
Malcolm Bain, a.3.2, 5
Malcolm Bain, a.3.3, 5
Malcolm Bain, a.3.4, 5
Malcolm Bain, a.3.6, 5
Malcolm Bain, c.1, 4
Malcolm Bain, c.2.10, 4
Malcolm Bain, c.2.2, 4
Malcolm Bain, c.2.3, 4
Malcolm Bain, c.2.4, 4
Malcolm Bain, c.2.7, 4
Malcolm Bain, c.2.8, 4
Malcolm Bain, c.2.9, 4
Malcolm Bain, c.3.1, 4
Malcolm Bain, c.3.2, 4
Malcolm Bain, c.4.1, 4
Malcolm Bain, c.4.2, 4
Malcolm Bain, c.4.3, 4
Malcolm Bain, c.4.4, 4
Malcolm Bain, c.5.1, 4
Malcolm Bain, d.1.1, 5
Malcolm Bain, d.1.2, 5
Malcolm Bain, d.2, 5
Malcolm Bain, d.3, 5
Malcolm Bain, d.4.1, 5
Malcolm Bain, d.5.1, 5
Malcolm Bain, d.5.2, 5
Malcolm Bain, d.5.3, 5
Malcolm Bain, d.5.4, 5
Malcolm Bain, d.6, 5
Malcolm Bain, i.2.3, 4
Malcolm Bain, i.2.5, 5
Malcolm Bain, i.3.1, 5
Malcolm Bain, i.3.3, 5
Maria Damon, a.1.2, 4
Maria Damon, a.1.3, 4
Maria Damon, a.2, 4
Maria Damon, a.3.1, 4
Maria Damon, a.3.2, 4
Maria Damon, a.3.3, 4
Maria Damon, a.3.4, 4
Maria Damon, a.3.6, 4
Maria Damon, c.1, 5
Maria Damon, c.2.10, 5
Maria Damon, c.2.2, 5
Maria Damon, c.2.3, 5
Maria Damon, c.2.4, 5
Maria Damon, c.2.7, 5
Maria Damon, c.2.8, 5
Maria Damon, c.2.9, 5
Maria Damon, c.3.1, 5
Maria Damon, c.3.2, 5
Maria Damon, c.4.1, 5
Maria Damon, c.4.2, 5
Maria Damon, c.4.3, 5
Maria Damon, c.4.4, 5
Maria Damon, c.5.1, 5
Maria Damon, d.1.1, 5
Maria Damon, d.1.2, 5
Maria Damon, d.2, 5
Maria Damon, d.3, 5
Maria Damon, d.4.1, 5
Maria Damon, d.5.1, 5
Maria Damon, d.5.2, 5
Maria Damon, d.5.3, 5
Maria Damon, d.5.4, 5
Maria Damon, d.6, 5
Maria Damon, f.1, 5
Maria Damon, f.2.1, 5
Maria Damon, f.4.1, 5
Maria Damon, f.5, 5
Maria Damon, f.6.1, 5
Maria Damon, f.6.2, 5
Maria Damon, g.1, 5
Maria Damon, g.2.1, 5
Maria Damon, g.2.2, 5
Maria Damon, g.2.3, 5
Maria Damon, g.3.2, 5
Maria Damon, h.1, 5
Maria Damon, h.2.1, 5
Maria Damon, h.2.2, 5
Maria Damon, h.2.3, 5
Maria Damon, h.2.4, 5
Maria Damon, h.3, 5
Maria Damon, h.4, 5
Maria Damon, h.5, 5
Marilyn Gallo, a.1.2, 5
Marilyn Gallo, a.1.3, 5
Marilyn Gallo, a.2, 5
Marilyn Gallo, a.3.1, 5
Marilyn Gallo, a.3.2, 5
Marilyn Gallo, a.3.3, 5
Marilyn Gallo, a.3.4, 5
Marilyn Gallo, a.3.6, 5
Marilyn Gallo, c.1, 4
Marilyn Gallo, c.2.10, 4
Marilyn Gallo, c.2.2, 4
Marilyn Gallo, c.2.3, 4
Marilyn Gallo, c.2.4, 4
Marilyn Gallo, c.2.7, 4
Marilyn Gallo, c.2.8, 4
Marilyn Gallo, c.2.9, 4
Marilyn Gallo, c.3.1, 4
Marilyn Gallo, c.3.2, 4
Marilyn Gallo, c.4.1, 4
Marilyn Gallo, c.4.2, 4
Marilyn Gallo, c.4.3, 4
Marilyn Gallo, c.4.4, 4
Marilyn Gallo, c.5.1, 4
Marilyn Gallo, d.1.1, 5
Marilyn Gallo, d.1.2, 4
Marilyn Gallo, d.2, 4
Marilyn Gallo, d.3, 4
Marilyn Gallo, d.4.1, 4
Marilyn Gallo, d.5.1, 4
Marilyn Gallo, d.5.2, 4
Marilyn Gallo, d.5.3, 4
Marilyn Gallo, d.5.4, 4
Marilyn Gallo, d.6, 4
Marilyn Gallo, e.1.1, 4
Marilyn Gallo, e.1.2, 4
Marilyn Gallo, e.2, 4
Marilyn Gallo, f.1, 3
Marilyn Gallo, f.2.1, 3
Marilyn Gallo, f.4.1, 3
Marilyn Gallo, f.5, 3
Marilyn Gallo, f.6.1, 3
Marilyn Gallo, f.6.2, 3
Marilyn Gallo, g.1, 5
Marilyn Gallo, g.2.1, 4
Marilyn Gallo, g.2.2, 4
Marilyn Gallo, g.2.3, 4
Marilyn Gallo, g.3.2, 5
Marilyn Gallo, h.2.1, 0
Marilyn Gallo, h.2.3, 3
Marilyn Gallo, h.3, 5
Marilyn Gallo, j.5.1, 4
Marilyn Gallo, j.5.4, 4
Marilyn Gallo, j.5.5, 4
Marion Lam, a.1.2, 5
Marion Lam, a.1.3, 5
Marion Lam, a.2, 5
Marion Lam, a.3.1, 5
Marion Lam, a.3.2, 5
Marion Lam, a.3.3, 5
Marion Lam, a.3.4, 5
Marion Lam, a.3.6, 5
Marion Lam, c.1, 3
Marion Lam, c.2.10, 3
Marion Lam, c.2.2, 3
Marion Lam, c.2.3, 3
Marion Lam, c.2.4, 3
Marion Lam, c.2.7, 3
Marion Lam, c.2.8, 5
Marion Lam, c.2.9, 3
Marion Lam, c.3.1, 3
Marion Lam, c.3.2, 3
Marion Lam, c.4.1, 3
Marion Lam, c.4.2, 3
Marion Lam, c.4.3, 3
Marion Lam, c.4.4, 3
Marion Lam, c.5.1, 3
Marion Lam, d.1.1, 5
Marion Lam, d.1.2, 5
Marion Lam, d.2, 5
Marion Lam, d.3, 5
Marion Lam, d.4.1, 5
Marion Lam, d.5.1, 5
Marion Lam, d.5.2, 5
Marion Lam, d.5.3, 5
Marion Lam, d.5.4, 5
Marion Lam, d.6, 5
Marion Lam, g.1, 4
Marion Lam, g.2.1, 4
Marion Lam, g.2.2, 4
Marion Lam, g.2.3, 4
Marion Lam, g.3.2, 4
Marion Lam, h.2.1, 2
Marion Lam, h.2.3, 4
Marion Lam, h.3, 2
Marion Ross, a.1.2, 4
Marion Ross, a.1.3, 4
Marion Ross, a.2, 4
Marion Ross, a.3.1, 5
Marion Ross, a.3.2, 5
Marion Ross, a.3.3, 5
Marion Ross, a.3.4, 5
Marion Ross, a.3.6, 5
Marion Ross, b.3.2, 5
Marion Ross, c.1, 5
Marion Ross, c.2.10, 5
Marion Ross, c.2.2, 5
Marion Ross, c.2.3, 5
Marion Ross, c.2.4, 5
Marion Ross, c.2.7, 5
Marion Ross, c.2.8, 5
Marion Ross, c.2.9, 5
Marion Ross, c.3.1, 5
Marion Ross, c.3.2, 5
Marion Ross, c.4.1, 5
Marion Ross, c.4.2, 5
Marion Ross, c.4.3, 5
Marion Ross, c.4.4, 5
Marion Ross, c.5.1, 5
Marion Ross, d.1.1, 5
Marion Ross, d.1.2, 5
Marion Ross, d.2, 5
Marion Ross, d.3, 5
Marion Ross, d.4.1, 5
Marion Ross, d.5.1, 5
Marion Ross, d.5.2, 5
Marion Ross, d.5.3, 5
Marion Ross, d.5.4, 5
Marion Ross, d.6, 5
Marion Ross, g.1, 5
Marion Ross, g.2.1, 3
Marion Ross, g.2.2, 3
Marion Ross, g.2.3, 3
Marion Ross, g.3.2, 4
Marion Ross, h.2.1, -1
Marion Ross, h.2.3, 2
Marion Ross, h.3, 4
Mark Wesley, a.1.2, 2
Mark Wesley, a.1.3, 2
Mark Wesley, a.2, 2
Mark Wesley, a.3.1, 4
Mark Wesley, a.3.2, 4
Mark Wesley, a.3.3, 4
Mark Wesley, a.3.4, 4
Mark Wesley, a.3.6, 4
Mark Wesley, b.4, 5
Mark Wesley, c.1, 4
Mark Wesley, c.2.10, 4
Mark Wesley, c.2.2, 4
Mark Wesley, c.2.3, 4
Mark Wesley, c.2.4, 4
Mark Wesley, c.2.7, 4
Mark Wesley, c.2.8, 4
Mark Wesley, c.2.9, 4
Mark Wesley, c.3.1, 4
Mark Wesley, c.3.2, 4
Mark Wesley, c.4.1, 4
Mark Wesley, c.4.2, 4
Mark Wesley, c.4.3, 4
Mark Wesley, c.4.4, 4
Mark Wesley, c.5.1, 4
Mark Wesley, d.1.1, 3
Mark Wesley, d.1.2, 3
Mark Wesley, d.2, 3
Mark Wesley, d.3, 3
Mark Wesley, d.4.1, 3
Mark Wesley, d.5.1, 4
Mark Wesley, d.5.2, 4
Mark Wesley, d.5.3, 4
Mark Wesley, d.5.4, 4
Mark Wesley, d.6, 3
Mark Wesley, g.1, 4
Mark Wesley, g.2.1, 4
Mark Wesley, g.2.2, 2
Mark Wesley, g.2.3, 4
Mark Wesley, g.4.3, 3
Mark Wesley, i.3.3, 4
Martin Payne, a.1.2, 5
Martin Payne, a.1.3, 5
Martin Payne, a.2, 5
Martin Payne, a.3.1, 5
Martin Payne, a.3.2, 5
Martin Payne, a.3.3, 5
Martin Payne, a.3.4, 5
Martin Payne, a.3.6, 5
Martin Payne, c.1, 5
Martin Payne, c.2.10, 5
Martin Payne, c.2.2, 5
Martin Payne, c.2.3, 5
Martin Payne, c.2.4, 5
Martin Payne, c.2.7, 5
Martin Payne, c.2.8, 5
Martin Payne, c.2.9, 5
Martin Payne, c.3.1, 5
Martin Payne, c.3.2, 5
Martin Payne, c.4.1, 5
Martin Payne, c.4.2, 5
Martin Payne, c.4.3, 5
Martin Payne, c.4.4, 5
Martin Payne, c.5.1, 5
Martin Payne, d.1.1, 5
Martin Payne, d.1.2, 5
Martin Payne, d.2, 5
Martin Payne, d.3, 5
Martin Payne, d.4.1, 5
Martin Payne, d.5.1, 5
Martin Payne, d.5.2, 5
Martin Payne, d.5.3, 5
Martin Payne, d.5.4, 5
Martin Payne, d.6, 5
Martin Payne, g.1, 5
Martin Payne, g.2.1, 5
Martin Payne, g.2.2, 5
Martin Payne, g.2.3, 5
Martin Payne, g.3.2, 0
Martin Payne, h.2.1, -1
Martin Payne, h.2.3, -1
Martin Payne, h.3, -1
Mat Reed, a.1.2, 5
Mat Reed, a.1.3, 5
Mat Reed, a.2, 5
Mat Reed, a.3.1, 5
Mat Reed, a.3.2, 5
Mat Reed, a.3.3, 5
Mat Reed, a.3.4, 5
Mat Reed, a.3.6, 5
Mat Reed, b.1.4, 4
Mat Reed, c.1, 5
Mat Reed, c.2.10, 5
Mat Reed, c.2.2, 5
Mat Reed, c.2.3, 5
Mat Reed, c.2.4, 5
Mat Reed, c.2.7, 5
Mat Reed, c.2.8, 5
Mat Reed, c.2.9, 5
Mat Reed, c.3.1, 5
Mat Reed, c.3.2, 5
Mat Reed, c.4.1, 5
Mat Reed, c.4.2, 5
Mat Reed, c.4.3, 5
Mat Reed, c.4.4, 5
Mat Reed, c.5.1, 5
Mat Reed, d.1.1, 5
Mat Reed, d.1.2, 5
Mat Reed, d.2, 5

Mat Reed, d.3, 5
Mat Reed, d.4.1, 5
Mat Reed, d.5.1, 5
Mat Reed, d.5.2, 5
Mat Reed, d.5.3, 5
Mat Reed, d.5.4, 5
Mat Reed, d.6, 5
Mat Reed, f.2.1, 5
Mat Reed, g.1, 4
Mat Reed, g.2.1, 0
Mat Reed, g.2.2, 4
Mat Reed, g.2.3, 0
Mat Reed, g.3.2, 3
Mat Reed, h.2.1, 0
Mat Reed, h.2.3, 1
Mat Reed, h.3, 2
Mike Dawson, a.1.2, 5
Mike Dawson, a.1.3, 5
Mike Dawson, a.2, 4
Mike Dawson, a.3.1, 5
Mike Dawson, a.3.2, 5
Mike Dawson, a.3.3, 5
Mike Dawson, a.3.4, 5
Mike Dawson, a.3.6, 5
Mike Dawson, b.3.1, 4
Mike Dawson, c.1, 5
Mike Dawson, c.2.10, 5
Mike Dawson, c.2.2, 5
Mike Dawson, c.2.3, 5
Mike Dawson, c.2.4, 5
Mike Dawson, c.2.7, 5
Mike Dawson, c.2.8, 5
Mike Dawson, c.2.9, 5
Mike Dawson, c.3.1, 5
Mike Dawson, c.3.2, 5
Mike Dawson, c.4.1, 5
Mike Dawson, c.4.2, 5
Mike Dawson, c.4.3, 5
Mike Dawson, c.4.4, 5
Mike Dawson, c.5.1, 5
Mike Dawson, d.1.1, 5
Mike Dawson, d.1.2, 5
Mike Dawson, d.2, 5
Mike Dawson, d.3, 5
Mike Dawson, d.4.1, 5
Mike Dawson, d.5.1, 5
Mike Dawson, d.5.2, 5
Mike Dawson, d.5.3, 5
Mike Dawson, d.5.4, 5
Mike Dawson, d.6, 5
Mike Dawson, g.1, 4
Mike Dawson, g.2.1, 5
Mike Dawson, g.2.2, 5
Mike Dawson, g.2.3, 5
Mike Dawson, g.3.2, 5
Mike Dawson, h.2.1, 0
Mike Dawson, h.2.3, 1
Mike Dawson, h.3, 1
Nicolas Curry, a.1.2, 5
Nicolas Curry, a.1.3, 5
Nicolas Curry, a.2, 5
Nicolas Curry, a.3.1, 5
Nicolas Curry, a.3.2, 5
Nicolas Curry, a.3.3, 5
Nicolas Curry, a.3.4, 5
Nicolas Curry, a.3.6, 5
Nicolas Curry, c.1, 5
Nicolas Curry, c.2.10, 5
Nicolas Curry, c.2.2, 5
Nicolas Curry, c.2.3, 5
Nicolas Curry, c.2.4, 5
Nicolas Curry, c.2.7, 5
Nicolas Curry, c.2.8, 5
Nicolas Curry, c.2.9, 5
Nicolas Curry, c.3.1, 5
Nicolas Curry, c.3.2, 5
Nicolas Curry, c.4.1, 5
Nicolas Curry, c.4.2, 5
Nicolas Curry, c.4.3, 5
Nicolas Curry, c.4.4, 5
Nicolas Curry, c.5.1, 5
Nicolas Curry, d.1.1, 5
Nicolas Curry, d.1.2, 5
Nicolas Curry, d.2, 5
Nicolas Curry, d.3, 5
Nicolas Curry, d.4.1, 5
Nicolas Curry, d.5.1, 5
Nicolas Curry, d.5.2, 5
Nicolas Curry, d.5.3, 5
Nicolas Curry, d.5.4, 5
Nicolas Curry, d.6, 5
Nicolas Curry, g.1, 5
Nicolas Curry, g.2.1, 5
Nicolas Curry, g.2.2, 5
Nicolas Curry, g.2.3, 5
Nicolas Curry, g.3.2, -1
Nicolas Curry, h.2.1, 5
Nicolas Curry, h.2.3, -1
Nicolas Curry, h.3, 5
Nicolas Curry, h.5, 4
Niyi Akers, a.1.2, 5
Niyi Akers, a.1.3, 5
Niyi Akers, a.2, 5
Niyi Akers, a.3.1, 5
Niyi Akers, a.3.2, 5
Niyi Akers, a.3.3, 5
Niyi Akers, a.3.4, 5
Niyi Akers, a.3.6, 5
Niyi Akers, b.1.5, 3
Niyi Akers, c.1, 5
Niyi Akers, c.2.10, 5
Niyi Akers, c.2.2, 5
Niyi Akers, c.2.3, 5
Niyi Akers, c.2.4, 5
Niyi Akers, c.2.7, 5
Niyi Akers, c.2.8, 5
Niyi Akers, c.2.9, 5
Niyi Akers, c.3.1, 5
Niyi Akers, c.3.2, 5
Niyi Akers, c.4.1, 5
Niyi Akers, c.4.2, 5
Niyi Akers, c.4.3, 5
Niyi Akers, c.4.4, 5
Niyi Akers, c.5.1, 5
Niyi Akers, d.1.1, 4
Niyi Akers, d.1.2, 4
Niyi Akers, d.2, 4
Niyi Akers, d.3, 4
Niyi Akers, d.4.1, 4
Niyi Akers, d.5.1, 4
Niyi Akers, d.5.2, 4
Niyi Akers, d.5.3, 4
Niyi Akers, d.5.4, 4
Niyi Akers, d.6, 4
Niyi Akers, g.1, 4
Niyi Akers, g.2.1, 3
Niyi Akers, g.2.2, 3
Niyi Akers, g.2.3, 3
Niyi Akers, g.3.2, 3
Niyi Akers, h.2.1, 0
Niyi Akers, h.2.3, 3
Niyi Akers, h.3, 3
Noshir Holmes, a.1.2, 5
Noshir Holmes, a.1.3, 5
Noshir Holmes, a.2, 5
Noshir Holmes, a.3.1, 5
Noshir Holmes, a.3.2, 5
Noshir Holmes, a.3.3, 5
Noshir Holmes, a.3.4, 5
Noshir Holmes, a.3.6, 5
Noshir Holmes, b.4, 2
Noshir Holmes, c.1, 4
Noshir Holmes, c.2.10, 4
Noshir Holmes, c.2.2, 4
Noshir Holmes, c.2.3, 4
Noshir Holmes, c.2.4, 4
Noshir Holmes, c.2.7, 4
Noshir Holmes, c.2.8, 4
Noshir Holmes, c.2.9, 4
Noshir Holmes, c.3.1, 4
Noshir Holmes, c.3.2, 4
Noshir Holmes, c.4.1, 4
Noshir Holmes, c.4.2, 4
Noshir Holmes, c.4.3, 4
Noshir Holmes, c.4.4, 4
Noshir Holmes, c.5.1, 4
Noshir Holmes, d.1.1, 4
Noshir Holmes, d.1.2, 4
Noshir Holmes, d.2, 4
Noshir Holmes, d.3, 4
Noshir Holmes, d.4.1, 4
Noshir Holmes, d.5.1, 4
Noshir Holmes, d.5.2, 4
Noshir Holmes, d.5.3, 4
Noshir Holmes, d.5.4, 4
Noshir Holmes, d.6, 4
Noshir Holmes, f.4.1, 4
Noshir Holmes, g.1, 4
Noshir Holmes, g.2.1, 4
Noshir Holmes, g.2.2, 4
Noshir Holmes, g.2.3, 4
Noshir Holmes, g.3.2, 4
Noshir Holmes, h.2.1, -1
Noshir Holmes, h.2.3, 2
Noshir Holmes, h.3, 2
Oliver Cullen, a.1.2, 3
Oliver Cullen, a.1.3, 3
Oliver Cullen, a.2, 3
Oliver Cullen, a.3.1, 4
Oliver Cullen, a.3.2, 4
Oliver Cullen, a.3.3, 4
Oliver Cullen, a.3.4, 4
Oliver Cullen, a.3.6, 4
Oliver Cullen, c.1, 5
Oliver Cullen, c.2.10, 5
Oliver Cullen, c.2.2, 5
Oliver Cullen, c.2.3, 5
Oliver Cullen, c.2.4, 5
Oliver Cullen, c.2.7, 5
Oliver Cullen, c.2.8, 5
Oliver Cullen, c.2.9, 5
Oliver Cullen, c.3.1, 5
Oliver Cullen, c.3.2, 5
Oliver Cullen, c.4.1, 5
Oliver Cullen, c.4.2, 5
Oliver Cullen, c.4.3, 5
Oliver Cullen, c.4.4, 5
Oliver Cullen, c.5.1, 5
Oliver Cullen, d.1.1, 2
Oliver Cullen, d.1.2, 2
Oliver Cullen, d.2, 2
Oliver Cullen, d.3, 2
Oliver Cullen, d.4.1, 2
Oliver Cullen, d.5.1, 5
Oliver Cullen, d.5.2, 5
Oliver Cullen, d.5.3, 5
Oliver Cullen, d.5.4, 5
Oliver Cullen, d.6, 2
Oliver Cullen, g.1, 4
Oliver Cullen, g.2.1, -1
Oliver Cullen, g.2.2, -1
Oliver Cullen, g.2.3, -1
Oliver Cullen, g.3.2, 1
Oliver Cullen, h.2.1, 2
Oliver Cullen, h.2.3, 3
Oliver Cullen, h.3, 2
Pepi Sands, a.1.2, 5
Pepi Sands, a.1.3, 5
Pepi Sands, a.2, 5
Pepi Sands, a.3.1, 4
Pepi Sands, a.3.2, 4
Pepi Sands, a.3.3, -1
Pepi Sands, a.3.4, 0
Pepi Sands, c.3.1, 0
Pepi Sands, c.4.1, -1
Pepi Sands, c.4.2, -1
Pepi Sands, c.4.3, -1
Pepi Sands, c.4.4, -1
Pepi Sands, c.5.1, 0
Pepi Sands, d.1.1, 5
Pepi Sands, d.1.2, 1
Pepi Sands, g.1, 3
Pepi Sands, g.2.1, -1
Pepi Sands, g.2.2, -1
Pepi Sands, g.2.3, -1
Pepi Sands, g.3.2, 2
Pepi Sands, h.2.1, -1
Pepi Sands, h.2.3, -1
Pepi Sands, h.3, -1
Rachna Kaplan, a.1.2, 5
Rachna Kaplan, a.1.3, 5
Rachna Kaplan, a.2, 5
Rachna Kaplan, a.3.1, 5
Rachna Kaplan, a.3.2, 5
Rachna Kaplan, a.3.3, 5
Rachna Kaplan, a.3.4, 5
Rachna Kaplan, a.3.6, 5
Rachna Kaplan, c.1, 5
Rachna Kaplan, c.2.10, 5
Rachna Kaplan, c.2.2, 5
Rachna Kaplan, c.2.3, 5
Rachna Kaplan, c.2.4, 5
Rachna Kaplan, c.2.7, 5
Rachna Kaplan, c.2.8, 5
Rachna Kaplan, c.2.9, 5
Rachna Kaplan, c.3.1, 5
Rachna Kaplan, c.3.2, 5
Rachna Kaplan, c.4.1, 5
Rachna Kaplan, c.4.2, 5
Rachna Kaplan, c.4.3, 5
Rachna Kaplan, c.4.4, 5
Rachna Kaplan, c.5.1, 5
Rachna Kaplan, d.1.1, 5
Rachna Kaplan, d.1.2, 5
Rachna Kaplan, d.2, 5
Rachna Kaplan, d.3, 5
Rachna Kaplan, d.4.1, 5
Rachna Kaplan, d.5.1, 5
Rachna Kaplan, d.5.2, 5
Rachna Kaplan, d.5.3, 5
Rachna Kaplan, d.5.4, 5
Rachna Kaplan, d.6, 5
Rachna Kaplan, g.1, 5
Rachna Kaplan, g.2.1, 5
Rachna Kaplan, g.2.2, 4
Rachna Kaplan, g.2.3, 5
Rachna Kaplan, g.3.2, 1
Rachna Kaplan, h.2.1, 0
Rachna Kaplan, h.2.3, 1
Rachna Kaplan, h.3, 3
Ray Hardy, a.1.2, 4
Ray Hardy, a.1.3, 4
Ray Hardy, a.2, 4
Ray Hardy, a.3.1, 5
Ray Hardy, a.3.2, 5
Ray Hardy, a.3.3, 5
Ray Hardy, a.3.4, 5
Ray Hardy, a.3.6, 5
Ray Hardy, c.1, 4
Ray Hardy, c.2.10, 4
Ray Hardy, c.2.2, 4
Ray Hardy, c.2.3, 4
Ray Hardy, c.2.4, 4
Ray Hardy, c.2.7, 4
Ray Hardy, c.2.8, 4
Ray Hardy, c.2.9, 4
Ray Hardy, c.3.1, 4
Ray Hardy, c.3.2, 4
Ray Hardy, c.4.1, 4
Ray Hardy, c.4.2, 4
Ray Hardy, c.4.3, 4
Ray Hardy, c.4.4, 4
Ray Hardy, c.5.1, 4
Ray Hardy, d.1.1, 4
Ray Hardy, d.1.2, 4
Ray Hardy, d.2, 4
Ray Hardy, d.3, 4
Ray Hardy, d.4.1, 4
Ray Hardy, d.5.1, 4
Ray Hardy, d.5.2, 4
Ray Hardy, d.5.3, 4
Ray Hardy, d.5.4, 4
Ray Hardy, d.6, 4
Ray Hardy, g.1, 3
Ray Hardy, g.2.1, -1
Ray Hardy, g.2.2, -1
Ray Hardy, g.2.3, -1
Ray Hardy, g.3.2, 4
Ray Hardy, h.2.1, -1
Ray Hardy, h.2.3, -1
Ray Hardy, h.3, 3
Richard Fuller, a.1.2, 4
Richard Fuller, a.1.3, 4
Richard Fuller, a.2, 4
Richard Fuller, a.3.1, 5
Richard Fuller, a.3.2, 5
Richard Fuller, a.3.3, 5
Richard Fuller, a.3.4, 5
Richard Fuller, a.3.6, 5
Richard Fuller, c.1, 5
Richard Fuller, c.2.10, 5
Richard Fuller, c.2.2, 5
Richard Fuller, c.2.3, 5
Richard Fuller, c.2.4, 5
Richard Fuller, c.2.7, 5
Richard Fuller, c.2.8, 5
Richard Fuller, c.2.9, 5
Richard Fuller, c.3.1, 5
Richard Fuller, c.3.2, 5
Richard Fuller, c.4.1, 5
Richard Fuller, c.4.2, 5
Richard Fuller, c.4.3, 5
Richard Fuller, c.4.4, 5
Richard Fuller, c.5.1, 5
Richard Fuller, d.1.1, 4
Richard Fuller, d.1.2, 4
Richard Fuller, d.2, 4
Richard Fuller, d.3, 4
Richard Fuller, d.4.1, 4
Richard Fuller, d.5.1, 4
Richard Fuller, d.5.2, 4
Richard Fuller, d.5.3, 4
Richard Fuller, d.5.4, 4
Richard Fuller, d.6, 4
Richard Fuller, e.2, 3
Richard Fuller, g.1, 4
Richard Fuller, g.2.1, 4
Richard Fuller, g.2.2, 4
Richard Fuller, g.2.3, 4
Richard Fuller, g.3.2, 2
Richard Fuller, h.2.1, 0
Richard Fuller, h.2.3, 2
Richard Fuller, h.3, 2
Richard Marsh, a.1.2, 5
Richard Marsh, a.1.3, 5
Richard Marsh, a.2, 5
Richard Marsh, a.3.1, 5
Richard Marsh, a.3.2, 5
Richard Marsh, a.3.3, 5
Richard Marsh, a.3.4, 5
Richard Marsh, a.3.6, 5
Richard Marsh, c.1, 5
Richard Marsh, c.2.10, 5
Richard Marsh, c.2.2, 5
Richard Marsh, c.2.3, 5
Richard Marsh, c.2.4, 5
Richard Marsh, c.2.7, 5
Richard Marsh, c.2.8, 5
Richard Marsh, c.2.9, 5
Richard Marsh, c.3.1, 5
Richard Marsh, c.3.2, 5
Richard Marsh, c.4.1, 5
Richard Marsh, c.4.2, 5
Richard Marsh, c.4.3, 5
Richard Marsh, c.4.4, 5
Richard Marsh, c.5.1, 5
Richard Marsh, d.1.1, 5
Richard Marsh, d.1.2, 5
Richard Marsh, d.2, 5
Richard Marsh, d.3, 5
Richard Marsh, d.4.1, 5
Richard Marsh, d.5.1, 5
Richard Marsh, d.5.2, 5
Richard Marsh, d.5.3, 5
Richard Marsh, d.5.4, 5
Richard Marsh, d.6, 5
Richard Marsh, g.1, 3
Richard Marsh, g.2.1, 5
Richard Marsh, g.2.2, 5
Richard Marsh, g.2.3, 5
Richard Marsh, g.3.2, 2
Robert Clarke, a.1.2, 4
Robert Clarke, a.1.3, 4
Robert Clarke, a.2, 4
Robert Clarke, a.3.1, 5
Robert Clarke, a.3.2, 5
Robert Clarke, a.3.3, 5
Robert Clarke, a.3.4, 5
Robert Clarke, a.3.6, 5
Robert Clarke, c.1, 5
Robert Clarke, c.2.10, 5
Robert Clarke, c.2.2, 5
Robert Clarke, c.2.3, 5
Robert Clarke, c.2.4, 5
Robert Clarke, c.2.7, 5
Robert Clarke, c.2.8, 5
Robert Clarke, c.2.9, 5
Robert Clarke, c.3.1, 5
Robert Clarke, c.3.2, 5
Robert Clarke, c.4.1, 5
Robert Clarke, c.4.2, 5
Robert Clarke, c.4.3, 5
Robert Clarke, c.4.4, 5
Robert Clarke, c.5.1, 5
Robert Clarke, d.1.1, 5
Robert Clarke, d.1.2, 5
Robert Clarke, d.2, 5
Robert Clarke, d.3, 5
Robert Clarke, d.4.1, 5
Robert Clarke, d.5.1, 5
Robert Clarke, d.5.2, 5
Robert Clarke, d.5.3, 5
Robert Clarke, d.5.4, 5
Robert Clarke, d.6, 5
Robert Clarke, f.5, 3
Robert Clarke, g.1, 4
Robert Clarke, g.2.1, 2
Robert Clarke, g.2.2, 2
Robert Clarke, g.2.3, 2
Robert Clarke, g.3.2, 4
Robert Clarke, h.2.1, -1
Robert Clarke, h.2.3, 4
Robert Clarke, h.3, 4
Robert Clarke, i.1.3, 3
Robert Clarke, i.1.4, 3
Robert Clarke, i.3.3, 4
Robert Clarke, i.3.4, 4
Robert Clarke, i.3.5, 4
Robert Clarke, j.2.1, 4
Robert Clarke, j.3.4, 5
Robert Clarke, j.5.5, 5
Roger All, a.1.2, 5
Roger All, a.1.3, 5
Roger All, a.2, 4
Roger All, a.3.1, 5
Roger All, a.3.2, 5
Roger All, a.3.3, 5
Roger All, a.3.4, 5
Roger All, a.3.6, 5
Roger All, c.1, 2
Roger All, c.2.10, 2
Roger All, c.2.2, 2
Roger All, c.2.3, 2
Roger All, c.2.4, 2
Roger All, c.2.7, 2
Roger All, c.2.8, 2
Roger All, c.2.9, 2
Roger All, c.3.1, 2
Roger All, c.3.2, 2
Roger All, c.4.1, 2
Roger All, c.4.2, 2
Roger All, c.4.3, 2
Roger All, c.4.4, 5
Roger All, c.5.1, 5
Roger All, d.1.1, 2
Roger All, d.1.2, 4
Roger All, d.2, 2
Roger All, d.3, 2
Roger All, d.4.1, 2
Roger All, d.5.1, 5
Roger All, d.5.2, 5
Roger All, d.5.3, 5
Roger All, d.5.4, 5
Roger All, d.6, 2
Roger All, g.1, 5
Roger All, g.2.1, 2
Roger All, g.2.2, 2
Roger All, g.2.3, 2
Roger All, g.3.2, 2
Roger All, h.2.1, -1
Roger All, h.2.3, -1
Roger All, h.3, 1
Ruth Simon, a.1.2, 5
Ruth Simon, a.1.3, 5
Ruth Simon, a.2, 5

Ruth Simon, a.3.1, 5
Ruth Simon, a.3.2, 5
Ruth Simon, a.3.3, 5
Ruth Simon, a.3.4, 5
Ruth Simon, a.3.6, 5
Ruth Simon, c.1, 5
Ruth Simon, c.2.10, 5
Ruth Simon, c.2.2, 5
Ruth Simon, c.2.3, 5
Ruth Simon, c.2.4, 5
Ruth Simon, c.2.7, 5
Ruth Simon, c.2.8, 5
Ruth Simon, c.2.9, 5
Ruth Simon, c.3.1, 5
Ruth Simon, c.3.2, 5
Ruth Simon, c.4.1, 5
Ruth Simon, c.4.2, 5
Ruth Simon, c.4.3, 5
Ruth Simon, c.4.4, 5
Ruth Simon, c.5.1, 5
Ruth Simon, d.1.1, 5
Ruth Simon, d.1.2, 3
Ruth Simon, d.2, 3
Ruth Simon, d.3, 3
Ruth Simon, d.4.1, 3
Ruth Simon, d.5.1, 5
Ruth Simon, d.5.2, 5
Ruth Simon, d.5.3, 5
Ruth Simon, d.5.4, 5
Ruth Simon, d.6, 3
Ruth Simon, g.1, 5
Ruth Simon, g.2.1, -1
Ruth Simon, g.2.2, -1
Ruth Simon, g.2.3, -1
Ruth Simon, g.3.2, 5
Ruth Simon, h.2.1, 0
Ruth Simon, h.2.3, 2
Ruth Simon, h.3, 5
Samuel Mackey, a.1.2, 2
Samuel Mackey, a.1.3, 2
Samuel Mackey, a.2, 2
Samuel Mackey, a.3.1, 4
Samuel Mackey, a.3.2, 4
Samuel Mackey, a.3.3, 4
Samuel Mackey, a.3.4, 4
Samuel Mackey, a.3.6, 4
Samuel Mackey, c.1, 1
Samuel Mackey, c.2.10, 1
Samuel Mackey, c.2.2, 1
Samuel Mackey, c.2.3, 1
Samuel Mackey, c.2.4, 1
Samuel Mackey, c.2.7, 1
Samuel Mackey, c.2.8, 1
Samuel Mackey, c.2.9, 1
Samuel Mackey, c.3.1, 1
Samuel Mackey, c.3.2, 1
Samuel Mackey, c.4.1, 2
Samuel Mackey, c.4.2, 2
Samuel Mackey, c.4.3, 2
Samuel Mackey, c.4.4, 2
Samuel Mackey, c.5.1, 1
Samuel Mackey, d.1.1, 0
Samuel Mackey, d.1.2, 0
Samuel Mackey, d.2, 0
Samuel Mackey, d.3, 0
Samuel Mackey, d.4.1, 0
Samuel Mackey, d.5.1, 1
Samuel Mackey, d.5.2, 1
Samuel Mackey, d.5.3, 1
Samuel Mackey, d.5.4, 1
Samuel Mackey, d.6, 0
Samuel Mackey, g.1, 0
Samuel Mackey, g.2.1, 1
Samuel Mackey, g.2.2, 1
Samuel Mackey, g.2.3, 1
Samuel Mackey, g.3.2, 0
Samuel Mackey, h.2.1, 0
Samuel Mackey, h.2.3, 0
Samuel Mackey, h.3, 0
Sarah Brante, a.1.2, 4
Sarah Brante, a.1.3, 4
Sarah Brante, a.2, 4
Sarah Brante, a.3.1, 4
Sarah Brante, a.3.2, 4
Sarah Brante, a.3.3, 4
Sarah Brante, a.3.4, 4
Sarah Brante, a.3.6, 4
Sarah Brante, c.1, 4
Sarah Brante, c.2.10, 4
Sarah Brante, c.2.2, 4
Sarah Brante, c.2.3, 4
Sarah Brante, c.2.4, 4
Sarah Brante, c.2.7, 4
Sarah Brante, c.2.8, 4
Sarah Brante, c.2.9, 4
Sarah Brante, c.3.1, 4
Sarah Brante, c.3.2, 4
Sarah Brante, c.4.1, 4
Sarah Brante, c.4.2, 4
Sarah Brante, c.4.3, 4
Sarah Brante, c.4.4, 4
Sarah Brante, c.5.1, 4
Sarah Brante, d.1.1, 4
Sarah Brante, d.1.2, 4
Sarah Brante, d.2, 4
Sarah Brante, d.3, 4
Sarah Brante, d.4.1, 4
Sarah Brante, d.5.1, 5
Sarah Brante, d.5.2, 5
Sarah Brante, d.5.3, 5
Sarah Brante, d.5.4, 5
Sarah Brante, d.6, 4
Sarah Brante, g.1, 4
Sarah Brante, g.2.1, 4
Sarah Brante, g.2.2, 4
Sarah Brante, g.2.3, 4
Sarah Brante, g.3.2, 4
Sarah Brante, h.2.1, 0
Sarah Brante, h.2.3, 3
Sean Wall, a.1.2, 2
Sean Wall, a.1.3, 2
Sean Wall, a.2, 2
Sean Wall, a.3.1, 2
Sean Wall, a.3.2, 2
Sean Wall, a.3.3, 2
Sean Wall, a.3.4, 2
Sean Wall, a.3.6, 2
Sean Wall, c.1, 2
Sean Wall, c.2.10, 2
Sean Wall, c.2.2, 2
Sean Wall, c.2.3, 2
Sean Wall, c.2.4, 2
Sean Wall, c.2.7, 2
Sean Wall, c.2.8, 2
Sean Wall, c.2.9, 2
Sean Wall, c.3.1, 2
Sean Wall, c.3.2, 2
Sean Wall, c.4.1, 2
Sean Wall, c.4.2, 2
Sean Wall, c.4.3, 2
Sean Wall, c.4.4, 2
Sean Wall, c.5.1, 2
Sean Wall, d.1.1, 2
Sean Wall, d.1.2, 2
Sean Wall, d.2, 2
Sean Wall, d.3, 2
Sean Wall, d.4.1, 2
Sean Wall, d.5.1, 2
Sean Wall, d.5.2, 2
Sean Wall, d.5.3, 2
Sean Wall, d.5.4, 2
Sean Wall, d.6, 2
Sean Wall, e.1.1, 3
Sean Wall, e.1.2, 3
Sean Wall, e.2, 3
Sean Wall, g.1, -1
Sean Wall, g.2.1, 1
Sean Wall, g.2.2, 1
Sean Wall, g.2.3, 1
Sean Wall, g.3.2, 2
Sean Wall, g.4.5, 5
Sean Wall, g.5, 5
Sean Wall, h.1, 2
Sean Wall, h.2.1, 2
Sean Wall, h.2.2, 2
Sean Wall, h.2.3, 2
Sean Wall, h.2.4, 2
Sean Wall, h.3, 2
Sean Wall, h.4, 2
Sean Wall, h.5, 2
Sean Wall, j.1.1, 5
Sean Wall, j.5.1, 5
Sean Wall, j.5.4, 5
Sean Wall, j.5.5, 5
Shawn Wills, a.1.2, 5
Shawn Wills, a.1.3, 5
Shawn Wills, a.2, 5
Shawn Wills, a.3.1, 5
Shawn Wills, a.3.2, 5
Shawn Wills, a.3.3, 5
Shawn Wills, a.3.4, 5
Shawn Wills, a.3.6, 5
Shawn Wills, c.3.1, 5
Shawn Wills, c.4.1, 2
Shawn Wills, c.4.2, 5
Shawn Wills, c.4.3, 0
Shawn Wills, c.4.4, 0
Shawn Wills, c.5.1, 1
Shawn Wills, d.1.1, 5
Shawn Wills, d.1.2, 5
Shawn Wills, d.5.1, 5
Shawn Wills, d.5.2, 5
Shawn Wills, d.5.3, 5
Shawn Wills, d.5.4, 5
Shawn Wills, g.1, 5
Shawn Wills, g.2.1, 5
Shawn Wills, g.2.3, 5
Shawn Wills, g.3.2, 5
Shawn Wills, h.2.1, -1
Shawn Wills, h.2.3, -1
Shawn Wills, h.3, 5
Simon Farmer, a.1.2, 4
Simon Farmer, a.1.3, 4
Simon Farmer, a.2, 1
Simon Farmer, a.3.1, 5
Simon Farmer, a.3.2, 5
Simon Farmer, a.3.3, 5
Simon Farmer, a.3.4, 5
Simon Farmer, a.3.6, 5
Simon Farmer, b.1.4, 3
Simon Farmer, b.3.1, 4
Simon Farmer, b.4, 4
Simon Farmer, b.5, 1
Simon Farmer, c.1, 4
Simon Farmer, c.2.10, 2
Simon Farmer, c.2.2, 2
Simon Farmer, c.2.3, 2
Simon Farmer, c.2.4, 2
Simon Farmer, c.2.7, 2
Simon Farmer, c.2.8, 2
Simon Farmer, c.2.9, 2
Simon Farmer, c.3.1, 3
Simon Farmer, c.4.1, 3
Simon Farmer, c.4.2, 3
Simon Farmer, c.4.3, 3
Simon Farmer, c.4.4, 3
Simon Farmer, c.5.1, 2
Simon Farmer, d.1.1, 5
Simon Farmer, d.1.2, 1
Simon Farmer, d.2, 3
Simon Farmer, d.3, 4
Simon Farmer, d.4.1, 1
Simon Farmer, d.5.1, 4
Simon Farmer, d.5.2, 1
Simon Farmer, d.5.3, 1
Simon Farmer, d.5.4, 1
Simon Farmer, d.6, 3
Simon Farmer, e.1.1, 4
Simon Farmer, e.1.2, 4
Simon Farmer, e.2, 4
Simon Farmer, f.1, 5
Simon Farmer, f.2.1, 5
Simon Farmer, f.4.1, 5
Simon Farmer, f.5, 5
Simon Farmer, f.6.1, 5
Simon Farmer, f.6.2, 5
Simon Farmer, g.1, 5
Simon Farmer, g.2.1, 4
Simon Farmer, g.2.2, 4
Simon Farmer, g.2.3, 4
Simon Farmer, g.3.2, 5
Simon Farmer, g.4.4, 5
Simon Farmer, h.1, 2
Simon Farmer, h.2.1, 2
Simon Farmer, h.2.2, 2
Simon Farmer, h.2.3, 3
Simon Farmer, h.2.4, 2
Simon Farmer, h.3, 2
Simon Farmer, h.4, 2
Simon Farmer, h.5, 2
Simon Farmer, i.2.3, 2
Simon Farmer, i.3.6, 4
Simon Farmer, j.2.1, 3
Simon Farmer, j.2.2, 3
Simon Farmer, j.2.3, 5
Simon Farmer, j.6.2, 5
Simon Farmer, j.6.3, 5
Simon Farmer, j.6.4, 3
Simon Mann, a.1.2, 5
Simon Mann, a.1.3, 5
Simon Mann, a.2, 3
Simon Mann, a.3.1, 5
Simon Mann, a.3.2, 3
Simon Mann, a.3.3, 3
Simon Mann, a.3.4, 3
Simon Mann, a.3.6, 3
Simon Mann, c.1, 5
Simon Mann, c.2.10, 5
Simon Mann, c.2.2, 5
Simon Mann, c.2.3, 5
Simon Mann, c.2.4, 5
Simon Mann, c.2.7, 5
Simon Mann, c.2.8, 5
Simon Mann, c.2.9, 5
Simon Mann, c.3.1, 5
Simon Mann, c.3.2, 5
Simon Mann, c.4.1, 5
Simon Mann, c.4.2, 5
Simon Mann, c.4.3, 5
Simon Mann, c.4.4, 5
Simon Mann, c.5.1, 5
Simon Mann, d.1.1, 3
Simon Mann, d.1.2, 3
Simon Mann, d.2, 3
Simon Mann, d.3, 3
Simon Mann, d.4.1, 3
Simon Mann, d.5.1, 5
Simon Mann, d.5.2, 5
Simon Mann, d.5.3, 5
Simon Mann, d.5.4, 5
Simon Mann, d.6, 3
Simon Mann, g.1, 5
Simon Mann, g.2.1, 4
Simon Mann, g.2.2, 4
Simon Mann, g.2.3, 5
Simon Mann, g.3.2, 2
Simon Mann, h.2.1, 0
Simon Mann, h.2.3, 0
Simon Mann, h.3, 3
Steve Curry, a.1.2, 4
Steve Curry, a.1.3, 4
Steve Curry, a.2, 4
Steve Curry, a.3.1, 4
Steve Curry, a.3.2, 4
Steve Curry, a.3.3, 4
Steve Curry, a.3.4, 4
Steve Curry, a.3.6, 4
Steve Curry, c.1, 4
Steve Curry, c.2.10, 4
Steve Curry, c.2.2, 4
Steve Curry, c.2.3, 4
Steve Curry, c.2.4, 4
Steve Curry, c.2.7, 4
Steve Curry, c.2.8, 4
Steve Curry, c.2.9, 4
Steve Curry, c.3.1, 4
Steve Curry, c.3.2, 4
Steve Curry, c.4.1, 4
Steve Curry, c.4.2, 4
Steve Curry, c.4.3, 4
Steve Curry, c.4.4, 4
Steve Curry, c.5.1, 4
Steve Curry, d.1.1, 4
Steve Curry, d.1.2, 4
Steve Curry, d.2, 4
Steve Curry, d.3, 4
Steve Curry, d.4.1, 4
Steve Curry, d.5.1, 4
Steve Curry, d.5.2, 4
Steve Curry, d.5.3, 4
Steve Curry, d.5.4, 4
Steve Curry, d.6, 4
Steve Curry, g.1, 4
Steve Curry, g.2.1, 4
Steve Curry, g.2.2, 4
Steve Curry, g.2.3, 4
Steve Curry, g.3.2, 4
Steve Curry, h.2.1, 0
Steve Curry, h.2.3, 0
Steve Curry, h.3, 4
Tariq Haines, a.1.2, 5
Tariq Haines, a.1.3, 5
Tariq Haines, a.2, 5
Tariq Haines, a.3.1, 5
Tariq Haines, a.3.2, 5
Tariq Haines, a.3.3, 5
Tariq Haines, a.3.4, 5
Tariq Haines, a.3.6, 5
Tariq Haines, c.1, 5
Tariq Haines, c.2.10, 5
Tariq Haines, c.2.2, 5
Tariq Haines, c.2.3, 5
Tariq Haines, c.2.4, 5
Tariq Haines, c.2.7, 5
Tariq Haines, c.2.8, 5
Tariq Haines, c.2.9, 5
Tariq Haines, c.3.1, 5
Tariq Haines, c.3.2, 5
Tariq Haines, c.4.1, 5
Tariq Haines, c.4.2, 5
Tariq Haines, c.4.3, 5
Tariq Haines, c.4.4, 5
Tariq Haines, c.5.1, 5
Tariq Haines, d.1.1, 5
Tariq Haines, d.1.2, 5
Tariq Haines, d.2, 3
Tariq Haines, d.3, 3
Tariq Haines, d.4.1, 3
Tariq Haines, d.5.1, 5
Tariq Haines, d.5.2, 5
Tariq Haines, d.5.3, 5
Tariq Haines, d.5.4, 5
Tariq Haines, d.6, 3
Tariq Haines, g.1, 5
Tariq Haines, g.2.1, 5
Tariq Haines, g.2.2, 5
Tariq Haines, g.2.3, 5
Tariq Haines, g.3.2, 5
Tariq Haines, g.4.4, 5
Tariq Haines, h.2.1, 2
Tariq Haines, h.2.3, 2
Tariq Haines, h.3, 5
Tariq Haines, i.3.6, 5
Tariq Haines, j.5.1, 5
Tariq Haines, j.6.3, 5
Tariq Haines, j.7.1, 5
Tariq Haines, j.7.2, 5
Tim Pugh, a.1.2, 0
Tim Pugh, a.1.3, 0
Tim Pugh, a.2, 0
Tim Pugh, a.3.1, 0
Tim Pugh, a.3.2, 0
Tim Pugh, a.3.3, 0
Tim Pugh, a.3.4, 0
Tim Pugh, a.3.6, 0
Tim Pugh, c.1, 1
Tim Pugh, c.2.10, 1
Tim Pugh, c.2.2, 1
Tim Pugh, c.2.3, 1
Tim Pugh, c.2.4, 1
Tim Pugh, c.2.7, 1
Tim Pugh, c.2.8, 1
Tim Pugh, c.2.9, 1
Tim Pugh, c.3.1, 1
Tim Pugh, c.3.2, 1
Tim Pugh, c.4.1, 1
Tim Pugh, c.4.2, 1
Tim Pugh, c.4.3, 1
Tim Pugh, c.4.4, 1
Tim Pugh, c.5.1, 1
Tim Pugh, d.1.1, 2
Tim Pugh, d.1.2, 2
Tim Pugh, d.2, 2
Tim Pugh, d.3, 2
Tim Pugh, d.4.1, 2
Tim Pugh, d.5.1, 3
Tim Pugh, d.5.2, 3
Tim Pugh, d.5.3, 3
Tim Pugh, d.5.4, 3
Tim Pugh, d.6, 4
Tim Pugh, f.6.1, -1
Tim Pugh, g.1, 3
Tim Pugh, g.2.1, 1
Tim Pugh, g.2.2, 1
Tim Pugh, g.2.3, 1
Tim Pugh, g.3.2, 0
Tim Pugh, h.2.1, 0
Tim Pugh, h.2.3, 0
Tim Pugh, h.3, 0
Tony Boston, a.1.2, 4
Tony Boston, a.1.3, 4
Tony Boston, a.2, 4
Tony Boston, a.3.1, 4
Tony Boston, a.3.2, 4
Tony Boston, a.3.3, 4
Tony Boston, a.3.4, 4
Tony Boston, a.3.6, 4
Tony Boston, b.3.4, 5
Tony Boston, c.1, 5
Tony Boston, c.2.10, 5
Tony Boston, c.2.2, 5
Tony Boston, c.2.3, 5
Tony Boston, c.2.4, 5
Tony Boston, c.2.7, 5
Tony Boston, c.2.8, 5
Tony Boston, c.2.9, 5
Tony Boston, c.3.1, 5
Tony Boston, c.3.2, 5
Tony Boston, c.4.1, 5
Tony Boston, c.4.2, 5
Tony Boston, c.4.3, 5
Tony Boston, c.4.4, 5
Tony Boston, c.5.1, 5
Tony Boston, d.1.1, 3
Tony Boston, d.1.2, 1
Tony Boston, d.2, 1
Tony Boston, d.3, 1
Tony Boston, d.4.1, 1
Tony Boston, d.5.1, 5
Tony Boston, d.5.2, 5
Tony Boston, d.5.3, 5
Tony Boston, d.5.4, 5
Tony Boston, d.6, 1
Tony Boston, g.1, 3
Tony Boston, g.2.1, -1
Tony Boston, g.2.2, -1
Tony Boston, g.2.3, -1
Tony Boston, g.3.2, 3
Tony Boston, g.4.4, 4
Tony Boston, h.1, 2
Tony Boston, h.2.1, 4
Tony Boston, h.2.2, 2
Tony Boston, h.2.3, 4
Tony Boston, h.2.4, 2
Tony Boston, h.3, 4
Tony Boston, h.4, 2
Tony Boston, h.5, 2
Tony Boston, j.1.1, 5
Tony Boston, j.3.3, 2
Tony Boston, j.6.3, 5
Will Miles, a.1.2, 5
Will Miles, a.1.3, 5
Will Miles, a.2, 4
Will Miles, a.3.1, 5
Will Miles, a.3.2, 5
Will Miles, a.3.3, 5
Will Miles, a.3.4, 5
Will Miles, a.3.6, 5
Will Miles, c.1, 5
Will Miles, c.2.10, 5
Will Miles, c.2.2, 5
Will Miles, c.2.3, 5
Will Miles, c.2.4, 5
Will Miles, c.2.7, 5
Will Miles, c.2.8, 5

Will Miles, c.2.9, 5
Will Miles, c.3.1, 5
Will Miles, c.3.2, 5
Will Miles, c.4.1, 5
Will Miles, c.4.2, 5
Will Miles, c.4.3, 5
Will Miles, c.4.4, 5
Will Miles, c.5.1, 5
Will Miles, d.1.1, 5
Will Miles, d.1.2, 5
Will Miles, d.2, 5
Will Miles, d.3, 5
Will Miles, d.4.1, 5
Will Miles, d.5.1, 5
Will Miles, d.5.2, 5
Will Miles, d.5.3, 5
Will Miles, d.5.4, 5
Will Miles, d.6, 5
Will Miles, e.1.1, 5
Will Miles, e.1.2, 5
Will Miles, e.2, 5
Will Miles, f.1, 4
Will Miles, f.2.1, 4
Will Miles, f.4.1, 4
Will Miles, f.5, 4
Will Miles, f.6.1, 4
Will Miles, f.6.2, 4
Will Miles, g.1, 5
Will Miles, g.2.1, 4
Will Miles, g.2.2, 4
Will Miles, g.2.3, 4
Will Miles, g.3.2, 5
Will Miles, h.2.1, 0
Will Miles, h.2.3, 3
Will Miles, h.3, 0
Will Miles, i.1.1, 5
Will Miles, i.1.3, 5
Will Miles, i.1.4, 5
Will Miles, i.3.2, 5
Will Miles, i.3.3, 4
Will Miles, j.1.1, 5
Will Miles, j.2.1, 5
Will Miles, j.2.2, 5
Will Miles, j.2.3, 5
Will Miles, j.6.3, 5
Yogesh Katz, a.1.2, 4
Yogesh Katz, a.1.3, 4
Yogesh Katz, a.2, 4
Yogesh Katz, a.3.1, 5
Yogesh Katz, a.3.2, 5
Yogesh Katz, a.3.3, 5
Yogesh Katz, a.3.4, 5
Yogesh Katz, a.3.6, 5
Yogesh Katz, c.1, 5
Yogesh Katz, c.2.10, 5
Yogesh Katz, c.2.2, 5
Yogesh Katz, c.2.3, 5
Yogesh Katz, c.2.4, 5
Yogesh Katz, c.2.7, 5
Yogesh Katz, c.2.8, 5
Yogesh Katz, c.2.9, 5
Yogesh Katz, c.3.1, 5
Yogesh Katz, c.3.2, 5
Yogesh Katz, c.4.1, 5
Yogesh Katz, c.4.2, 5
Yogesh Katz, c.4.3, 5
Yogesh Katz, c.4.4, 5
Yogesh Katz, c.5.1, 5
Yogesh Katz, d.1.1, 5
Yogesh Katz, d.1.2, 5
Yogesh Katz, d.2, 5
Yogesh Katz, d.3, 5
Yogesh Katz, d.4.1, 5
Yogesh Katz, d.5.1, 5
Yogesh Katz, d.5.2, 5
Yogesh Katz, d.5.3, 5
Yogesh Katz, d.5.4, 5
Yogesh Katz, d.6, 5
Yogesh Katz, g.1, 5
Yogesh Katz, g.2.1, 5
Yogesh Katz, g.2.2, 5
Yogesh Katz, g.2.3, 5
Yogesh Katz, g.3.2, 5
Yogesh Katz, h.2.1, 0
Yogesh Katz, h.2.3, 5
Yogesh Katz, h.3, 5

PointP

Project Objectives

Aaron Toms, f, 90
Aaron Toms, i, 10
Adrian Bank, g, 50
Adrian Bank, h, 50
Alison Crane, a, 100
Andrew Dawn, f, 25
Andrew Dawn, h, 10
Andrew Dawn, i, 20
Andrew Dawn, j, 45
Andy Faulk, a, 45
Andy Faulk, b, 5
Andy Faulk, c, 17
Andy Faulk, d, 19
Andy Faulk, g, 14
Andy Hicks, a, 50
Andy Hicks, c, 5
Andy Hicks, d, 40
Andy Hicks, g, 5
Andy Kirb, c, 100
Angela Willard, f, 20
Angela Willard, g, 25
Angela Willard, i, 25
Angela Willard, j, 30
Anthony Rick, a, 40
Anthony Rick, c, 40
Anthony Rick, j, 20
Astrid Haynes, a, 62
Astrid Haynes, c, 8.000000005
Astrid Haynes, d, 30
Barbara Song, a, 30
Barbara Song, b, 18
Barbara Song, c, 36
Barbara Song, d, 5
Barbara Song, e, 6
Barbara Song, h, 5
Bill Leal, a, 36.45833333
Bill Leal, c, 22.91666667
Bill Leal, d, 27.08333333
Bill Leal, g, 13.54166667
Brahim Boyd, a, 28.28282828
Brahim Boyd, c, 30.3030303
Brahim Boyd, d, 13.13131313
Brahim Boyd, g, 18.18181818
Brahim Boyd, h, 10.1010101
Brian Aniston, a, 25
Brian Aniston, c, 40
Brian Aniston, d, 10
Brian Aniston, g, 25
Brian Ward, g, 15
Brian Ward, j, 85
Caroline Cook, a, 50
Caroline Cook, g, 50
Caroline Goodman, a, 20
Caroline Goodman, c, 40
Caroline Goodman, d, 40
Chris Randall, a, 30
Chris Randall, c, 30
Chris Randall, d, 25
Chris Randall, e, 5
Chris Randall, h, 10
Christopher Hall, a, 60
Christopher Hall, c, 9.999999999
Christopher Hall, d, 30
Colin Penn, a, 20
Colin Penn, c, 50
Colin Penn, d, 30
Colin Street, a, 50
Colin Street, c, 25
Colin Street, d, 25
Conrad Moore, c, 24.50980392
Conrad Moore, d, 51.47058824
Conrad Moore, g, 24.01960784
David Ainsley, a, 20
David Ainsley, c, 30
David Ainsley, d, 20
David Ainsley, h, 30
David Carne, g, 30
David Carne, i, 50
David Carne, j, 20
Diana Cates, c, 50
Diana Cates, g, 50
Ed Steele, a, 45
Ed Steele, c, 15
Ed Steele, g, 30
Ed Steele, h, 10
Farid Sonya, a, 35
Farid Sonya, c, 65
Harry Gore, a, 66.66666667
Harry Gore, d, 26.66666667
Harry Gore, g, 6.666666667
Ian More, a, 50
Ian More, c, 20
Ian More, f, 10
Ian More, i, 15
Ian More, j, 5
Jan Crowe, a, 18
Jan Crowe, c, 18
Jan Crowe, d, 32
Jan Crowe, g, 18
Jan Crowe, h, 14
Jason Ortiz, a, 25
Jason Ortiz, c, 5
Jason Ortiz, d, 30
Jason Ortiz, g, 40
Jeremy Spain, a, 40
Jeremy Spain, c, 45
Jeremy Spain, d, 15
Jim Howe, a, 25
Jim Howe, b, 5
Jim Howe, c, 35
Jim Howe, d, 25
Jim Howe, g, 10
Johnny Glenn, a, 60
Johnny Glenn, c, 10
Johnny Glenn, g, 10
Johnny Glenn, h, 20
Jots Semb, f, 30
Jots Semb, g, 20
Jots Semb, i, 50
Kathleen Niche, a, 40
Kathleen Niche, d, 60
Kathryn Lester, a, 40
Kathryn Lester, c, 30
Kathryn Lester, d, 30
Kerstin Michel, a, 40
Kerstin Michel, c, 9.999999999
Kerstin Michel, d, 50
Liz Hopper, a, 50
Liz Hopper, c, 10
Liz Hopper, d, 20
Liz Hopper, g, 10
Liz Hopper, h, 10
Magali Persi, a, 15
Magali Persi, c, 70
Magali Persi, d, 15
Majid Khande, a, 44.44444444
Majid Khande, c, 22.22222222
Majid Khande, d, 22.22222222
Majid Khande, g, 11.11111111
Malcolm Bain, d, 10
Malcolm Bain, g, 15
Malcolm Bain, i, 75
Maria Damon, a, 15
Maria Damon, d, 15
Maria Damon, g, 70
Marilyn Gallo, a, 30
Marilyn Gallo, c, 20
Marilyn Gallo, d, 20
Marilyn Gallo, e, 25
Marilyn Gallo, j, 5.000000001
Marion Lam, a, 45
Marion Lam, c, 4
Marion Lam, d, 27
Marion Lam, g, 24
Marion Ross, b, 100
Mark Wesley, a, 23.63636364
Mark Wesley, b, 18.18181818
Mark Wesley, c, 30
Mark Wesley, d, 13.63636364
Mark Wesley, g, 7.272727272
Mark Wesley, i, 7.272727272
Martin Payne, a, 10
Martin Payne, c, 60
Martin Payne, d, 30
Mat Reed, b, 20
Mat Reed, f, 40
Mat Reed, g, 40
Mick Carin, a, 34.87179487
Mick Carin, c, 24.1025641
Mick Carin, d, 16.92307692
Mick Carin, f, 12.82051282
Mick Carin, g, 8.205128205
Mick Carin, h, 3.076923077
Mike Dawson, a, 25
Mike Dawson, b, 10
Mike Dawson, d, 40
Mike Dawson, g, 20
Mike Dawson, h, 4.999999998
Neil Roper, a, 38.29787234
Neil Roper, b, 27.65957447
Neil Roper, c, 27.65957447
Neil Roper, h, 6.382978723
Nicolas Curry, a, 20
Nicolas Curry, c, 30
Nicolas Curry, h, 50
Niyi Akers, c, 70
Niyi Akers, d, 10
Niyi Akers, g, 20
Noshir Holmes, a, 15
Noshir Holmes, b, 10
Noshir Holmes, c, 30
Noshir Holmes, d, 25
Noshir Holmes, f, 20
Oliver Cullen, a, 30
Oliver Cullen, c, 45
Oliver Cullen, d, 10
Oliver Cullen, g, 15
Paul Ayers, a, 30
Paul Ayers, c, 25
Paul Ayers, d, 25
Paul Ayers, g, 20
Rachna Kaplan, a, 50
Rachna Kaplan, c, 20
Rachna Kaplan, d, 10
Rachna Kaplan, g, 20
Ray Hardy, a, 33.33333333
Ray Hardy, c, 35.41666667
Ray Hardy, d, 14.16666667
Ray Hardy, g, 15
Ray Hardy, h, 2.083333333
Richard Fuller, a, 30
Richard Fuller, b, 10
Richard Fuller, c, 9.999999999
Richard Fuller, d, 15
Richard Fuller, g, 20
Richard Fuller, h, 15
Richard Marsh, a, 10
Richard Marsh, c, 25
Richard Marsh, d, 60
Richard Marsh, g, 5.000000001
Robert Clarke, i, 30
Robert Clarke, j, 70
Roger All, a, 90
Roger All, c, 10
Ruth Simon, a, 40
Ruth Simon, c, 30
Ruth Simon, d, 10
Ruth Simon, g, 20
Samuel Mackey, a, 100
Sarah Brante, a, 25
Sarah Brante, c, 45
Sarah Brante, d, 30
Sean Wall, a, 6.315789473
Sean Wall, c, 7.368421049
Sean Wall, d, 5.263157895
Sean Wall, e, 5.263157895
Sean Wall, g, 52.63157895
Sean Wall, h, 2.10526316
Sean Wall, j, 21.05263158
Simon Farmer, a, 5
Simon Farmer, d, 10
Simon Farmer, f, 20
Simon Farmer, g, 30
Simon Farmer, j, 35
Simon Mann, a, 20
Simon Mann, c, 45
Simon Mann, d, 10
Simon Mann, g, 20
Simon Mann, h, 5
Steve Curry, c, 100
Tamsin Pitts, a, 20
Tamsin Pitts, c, 60
Tamsin Pitts, d, 20
Tariq Haines, g, 15.78947368
Tariq Haines, i, 5.263157895
Tariq Haines, j, 78.94736842
Tim Pugh, c, 20
Tim Pugh, d, 80
Tony Boston, b, 20
Tony Boston, c, 15
Tony Boston, g, 15
Tony Boston, h, 4.999999998
Tony Boston, j, 45
Wendy Richey, a, 50
Wendy Richey, c, 10.86956522
Wendy Richey, d, 26.08695652
Wendy Richey, g, 8.695652175
Wendy Richey, h, 4.347826087
Will Miles, a, 10
Will Miles, c, 20
Will Miles, d, 10
Will Miles, e, 15
Will Miles, f, 10
Will Miles, g, 15
Will Miles, j, 20
Yogesh Katz, a, 100

Requirements

Aaron Toms, f.4, 25
Aaron Toms, f.6, 65
Aaron Toms, i.3, 10
Adrian Bank, g.1.2, 50
Adrian Bank, h.1, 50
Alison Crane, a.3, 100
Andrew Dawn, f.1, 5
Andrew Dawn, f.2, 5
Andrew Dawn, f.4, 5
Andrew Dawn, f.6, 10
Andrew Dawn, h.1, 1.428571429
Andrew Dawn, h.2, 4.285714287
Andrew Dawn, h.3, 1.428571429
Andrew Dawn, h.4, 1.428571429
Andrew Dawn, h.5, 1.428571429
Andrew Dawn, i.1, 10
Andrew Dawn, i.3, 10
Andrew Dawn, j.2, 10
Andrew Dawn, j.5, 15
Andrew Dawn, j.6, 20
Andy Faulk, a.1, 15
Andy Faulk, a.3, 30
Andy Faulk, b.1, 5
Andy Faulk, c.3, 6
Andy Faulk, c.5, 11
Andy Faulk, d.1, 7
Andy Faulk, d.5, 12
Andy Faulk, g.1.2, 7
Andy Faulk, g.3, 7
Andy Hicks, a.3, 50
Andy Hicks, c.3, 5
Andy Hicks, d.1, 15
Andy Hicks, d.3, 5
Andy Hicks, d.4, 5
Andy Hicks, d.5, 10
Andy Hicks, d.6, 5
Andy Hicks, g.2, 5
Andy Kirb, c.2, 100
Angela Willard, f.1, 4
Angela Willard, f.2, 4
Angela Willard, f.4, 4
Angela Willard, f.6, 8
Angela Willard, g.1.2, 25
Angela Willard, i.3, 25
Angela Willard, j.2, 30
Anthony Rick, a.1, 20
Anthony Rick, a.3, 20
Anthony Rick, c.2, 10
Anthony Rick, c.3, 30
Anthony Rick, j.1, 20
Astrid Haynes, a.1, 20
Astrid Haynes, a.2, 2
Astrid Haynes, a.3, 40
Astrid Haynes, c.1, 0.454545455
Astrid Haynes, c.2, 1.81818182
Astrid Haynes, c.3, 0.454545455
Astrid Haynes, c.4, 1.81818182
Astrid Haynes, c.5, 3.454545455
Astrid Haynes, d.1, 11.25
Astrid Haynes, d.3, 3.75
Astrid Haynes, d.4, 3.75
Astrid Haynes, d.5, 7.5
Astrid Haynes, d.6, 3.75
Barbara Song, a.3, 30
Barbara Song, b.1, 6
Barbara Song, b.3, 12
Barbara Song, c.2, 12
Barbara Song, c.3, 12
Barbara Song, c.4, 12
Barbara Song, d.4, 5
Barbara Song, e.2, 6
Barbara Song, h.2, 5
Bill Leal, a.1, 7.886904761
Bill Leal, a.2, 4.761904761
Bill Leal, a.3, 23.80952381
Bill Leal, c.1, 0.473484849
Bill Leal, c.2, 1.893939396
Bill Leal, c.3, 3.598484849
Bill Leal, c.4, 14.3939394
Bill Leal, c.5, 2.556818182
Bill Leal, d.1, 16.40625
Bill Leal, d.3, 1.302083333
Bill Leal, d.4, 1.302083333
Bill Leal, d.5, 6.770833333
Bill Leal, d.6, 1.302083333
Bill Leal, g.1.2, 3.125
Bill Leal, g.2, 10.41666667
Brahim Boyd, a.1, 10.1010101
Brahim Boyd, a.2, 10.1010101
Brahim Boyd, a.3, 8.080808081
Brahim Boyd, c.3, 10.1010101
Brahim Boyd, c.4, 10.1010101
Brahim Boyd, c.5, 10.1010101
Brahim Boyd, d.1, 13.13131313
Brahim Boyd, g.1.2, 8.080808081
Brahim Boyd, g.2, 10.1010101
Brahim Boyd, h.3, 10.1010101
Brian Aniston, a.3, 25
Brian Aniston, c.3, 20
Brian Aniston, c.5, 20
Brian Aniston, d.1, 10
Brian Aniston, g.1.2, 10
Brian Aniston, g.2, 15
Brian Ward, g.4, 15
Brian Ward, j.6, 85
Caroline Cook, a.3, 50
Caroline Cook, g.1.2, 50
Caroline Goodman, a.1, 2.857142857
Caroline Goodman, a.2, 2.857142857
Caroline Goodman, a.3, 14.28571429
Caroline Goodman, c.1, 3.636363636
Caroline Goodman, c.2, 14.54545454
Caroline Goodman, c.3, 3.636363636
Caroline Goodman, c.4, 14.54545454
Caroline Goodman, c.5, 3.636363636
Caroline Goodman, d.1, 15
Caroline Goodman, d.3, 5
Caroline Goodman, d.4, 5
Caroline Goodman, d.5, 10
Caroline Goodman, d.6, 5
Chris Randall, a.1, 3.571428571
Chris Randall, a.2, 3.571428571
Chris Randall, a.3, 22.85714286
Chris Randall, c.1, 2.727272727
Chris Randall, c.2, 10.90909091
Chris Randall, c.3, 2.727272727
Chris Randall, c.4, 10.90909091
Chris Randall, c.5, 2.727272727
Chris Randall, d.1, 9.375000001
Chris Randall, d.3, 3.125
Chris Randall, d.4, 3.125
Chris Randall, d.5, 6.25
Chris Randall, d.6, 3.125
Chris Randall, e.1, 5
Chris Randall, h.4, 10
Christopher Hall, a.1, 8.571428571
Christopher Hall, a.2, 8.571428571
Christopher Hall, a.3, 42.85714286
Christopher Hall, c.1, 0.909090909
Christopher Hall, c.2, 3.636363636
Christopher Hall, c.3, 0.909090909

Christopher Hall, c.4, 3.636363636
Christopher Hall, c.5, 0.909090909
Christopher Hall, d.1, 11.25
Christopher Hall, d.3, 3.75
Christopher Hall, d.4, 3.75
Christopher Hall, d.5, 7.5
Christopher Hall, d.6, 3.75
Colin Penn, a.1, 2.857142857
Colin Penn, a.2, 2.857142857
Colin Penn, a.3, 14.28571429
Colin Penn, c.1, 4.545454545
Colin Penn, c.2, 18.18181818
Colin Penn, c.3, 4.545454545
Colin Penn, c.4, 18.18181818
Colin Penn, c.5, 4.545454545
Colin Penn, d.1, 11.25
Colin Penn, d.3, 3.75
Colin Penn, d.4, 3.75
Colin Penn, d.5, 7.5
Colin Penn, d.6, 3.75
Colin Street, a.1, 7.142857143
Colin Street, a.2, 7.142857143
Colin Street, a.3, 35.71428571
Colin Street, c.1, 2.272727273
Colin Street, c.2, 9.090909092
Colin Street, c.3, 2.272727273
Colin Street, c.4, 9.090909092
Colin Street, c.5, 2.272727273
Colin Street, d.1, 9.375
Colin Street, d.3, 3.125
Colin Street, d.4, 3.125
Colin Street, d.5, 6.25
Colin Street, d.6, 3.125
Conrad Moore, c.1, 2.228163993
Conrad Moore, c.2, 8.912655971
Conrad Moore, c.3, 2.228163993
Conrad Moore, c.4, 8.912655971
Conrad Moore, c.5, 2.228163993
Conrad Moore, d.1, 11.64215686
Conrad Moore, d.3, 3.06372549
Conrad Moore, d.4, 3.06372549
Conrad Moore, d.5, 30.6372549
Conrad Moore, d.6, 3.06372549
Conrad Moore, g.1.2, 17.64705882
Conrad Moore, g.2, 3.921568627
Conrad Moore, g.3, 2.450980392
David Ainsley, a.1, 2.857142857
David Ainsley, a.2, 2.857142857
David Ainsley, a.3, 14.28571429
David Ainsley, c.1, 0.909090909
David Ainsley, c.2, 23.63636364
David Ainsley, c.3, 0.909090909
David Ainsley, c.4, 3.636363636
David Ainsley, c.5, 0.909090909
David Ainsley, d.1, 5.625
David Ainsley, d.3, 1.875
David Ainsley, d.4, 1.875
David Ainsley, d.5, 8.75
David Ainsley, d.6, 1.875
David Ainsley, h.2, 5
David Ainsley, h.3, 25
David Carne, g.2, 20
David Carne, g.4, 10
David Carne, i.2, 50
David Carne, j.6, 20
Diana Cates, c.3, 30
Diana Cates, c.4, 20
Diana Cates, g.1.2, 40
Diana Cates, g.3, 10
Ed Steele, a.1, 0.714285714
Ed Steele, a.2, 0.714285714
Ed Steele, a.3, 43.57142857
Ed Steele, c.1, 0.454545455
Ed Steele, c.2, 1.81818182
Ed Steele, c.3, 0.454545455
Ed Steele, c.4, 11.81818182
Ed Steele, c.5, 0.454545455
Ed Steele, g.1.2, 30
Ed Steele, h.2, 10
Farid Sonya, a.1, 10
Farid Sonya, a.3, 25
Farid Sonya, c.3, 25
Farid Sonya, c.5, 40
Harry Gore, a.1, 16.66666667
Harry Gore, a.2, 16.66666667
Harry Gore, a.3, 33.33333333
Harry Gore, d.1, 16.25
Harry Gore, d.3, 2.083333333
Harry Gore, d.4, 2.083333333
Harry Gore, d.5, 4.166666667
Harry Gore, d.6, 2.083333333
Harry Gore, g.2, 6.666666667
Ian More, a.3, 50
Ian More, c.3, 10
Ian More, c.4, 10
Ian More, f.1, 10
Ian More, i.3, 15
Ian More, j.4, 5
Jan Crowe, a.1, 2.571428571
Jan Crowe, a.2, 2.571428571
Jan Crowe, a.3, 12.85714286
Jan Crowe, c.1, 1.636363636
Jan Crowe, c.2, 6.545454544
Jan Crowe, c.3, 1.636363636
Jan Crowe, c.4, 6.545454544
Jan Crowe, c.5, 1.636363636
Jan Crowe, d.1, 20.75
Jan Crowe, d.3, 2.25
Jan Crowe, d.4, 2.25
Jan Crowe, d.5, 4.5
Jan Crowe, d.6, 2.25
Jan Crowe, g.1.2, 18
Jan Crowe, h.2, 14
Jason Ortiz, a.1, 10
Jason Ortiz, a.3, 15
Jason Ortiz, c.1, 5
Jason Ortiz, d.1, 20
Jason Ortiz, d.5, 5
Jason Ortiz, d.6, 5
Jason Ortiz, g.3, 40
Jeremy Spain, a.3, 40
Jeremy Spain, c.1, 2.727272727
Jeremy Spain, c.2, 15.90909091
Jeremy Spain, c.3, 2.727272727
Jeremy Spain, c.4, 20.90909091
Jeremy Spain, c.5, 2.727272727
Jeremy Spain, d.5, 15
Jim Howe, a.1, 3.571428571
Jim Howe, a.2, 3.571428571
Jim Howe, a.3, 17.85714286
Jim Howe, b.1, 5
Jim Howe, c.1, 3.181818182
Jim Howe, c.2, 12.72727273
Jim Howe, c.3, 3.181818182
Jim Howe, c.4, 12.72727273
Jim Howe, c.5, 3.181818182
Jim Howe, d.1, 9.375
Jim Howe, d.3, 3.125
Jim Howe, d.4, 3.125
Jim Howe, d.5, 6.25
Jim Howe, d.6, 3.125
Jim Howe, g.3, 10
Johnny Glenn, a.3, 60
Johnny Glenn, c.3, 10
Johnny Glenn, g.1.2, 10
Johnny Glenn, h.3, 20
Jots Semb, f.1, 6
Jots Semb, f.2, 6
Jots Semb, f.4, 6
Jots Semb, f.6, 12
Jots Semb, g.4, 20
Jots Semb, i.1, 20
Jots Semb, i.2, 30
Kathleen Niche, a.3, 40
Kathleen Niche, d.5, 60
Kathryn Lester, a.3, 40
Kathryn Lester, c.1, 2.727272727
Kathryn Lester, c.2, 10.90909091
Kathryn Lester, c.3, 2.727272727
Kathryn Lester, c.4, 10.90909091
Kathryn Lester, c.5, 2.727272727
Kathryn Lester, d.1, 11.25
Kathryn Lester, d.3, 3.75
Kathryn Lester, d.4, 3.75
Kathryn Lester, d.5, 7.5
Kathryn Lester, d.6, 3.75
Kerstin Michel, a.1, 5.714285714
Kerstin Michel, a.2, 5.714285714
Kerstin Michel, a.3, 28.57142857
Kerstin Michel, c.1, 0.909090909
Kerstin Michel, c.2, 3.636363636
Kerstin Michel, c.3, 0.909090909
Kerstin Michel, c.4, 3.636363636
Kerstin Michel, c.5, 0.909090909
Kerstin Michel, d.1, 18.75
Kerstin Michel, d.3, 6.25
Kerstin Michel, d.4, 6.25
Kerstin Michel, d.5, 12.5
Kerstin Michel, d.6, 6.25
Liz Hopper, a.1, 20
Liz Hopper, a.2, 10
Liz Hopper, a.3, 20
Liz Hopper, c.4, 5
Liz Hopper, c.5, 5
Liz Hopper, d.1, 20
Liz Hopper, g.1.2, 10
Liz Hopper, h.2, 10
Magali Persi, a.1, 2.142857143
Magali Persi, a.2, 2.142857143
Magali Persi, a.3, 10.71428571
Magali Persi, c.1, 6.363636364
Magali Persi, c.2, 25.45454545
Magali Persi, c.3, 6.363636364
Magali Persi, c.4, 25.45454545
Magali Persi, c.5, 6.363636364
Magali Persi, d.1, 5.625
Magali Persi, d.3, 1.875
Magali Persi, d.4, 1.875
Magali Persi, d.5, 3.75
Magali Persi, d.6, 1.875
Majid Khande, a.1, 22.22222222
Majid Khande, a.3, 22.22222222
Majid Khande, c.3, 11.11111111
Majid Khande, c.4, 11.11111111
Majid Khande, d.1, 22.22222222
Majid Khande, g.3, 11.11111111
Malcolm Bain, d.1, 10
Malcolm Bain, g.1.2, 5
Malcolm Bain, g.3, 10
Malcolm Bain, i.2, 35
Malcolm Bain, i.3, 40
Maria Damon, a.3, 15
Maria Damon, d.5, 15
Maria Damon, g.1.2, 30
Maria Damon, g.2, 20
Maria Damon, g.3, 20
Marilyn Gallo, a.1, 4.285714286
Marilyn Gallo, a.2, 4.285714286
Marilyn Gallo, a.3, 21.42857143
Marilyn Gallo, c.1, 1.818181818
Marilyn Gallo, c.2, 7.272727272
Marilyn Gallo, c.3, 1.818181818
Marilyn Gallo, c.4, 7.272727272
Marilyn Gallo, c.5, 1.818181818
Marilyn Gallo, d.1, 7.5
Marilyn Gallo, d.3, 2.5
Marilyn Gallo, d.4, 2.5
Marilyn Gallo, d.5, 5
Marilyn Gallo, d.6, 2.5
Marilyn Gallo, e.1, 12.5
Marilyn Gallo, e.2, 12.5
Marilyn Gallo, j.5, 5.000000001
Marion Lam, a.1, 16
Marion Lam, a.2, 16
Marion Lam, a.3, 13
Marion Lam, c.3, 2
Marion Lam, c.5, 2
Marion Lam, d.1, 21
Marion Lam, d.5, 6
Marion Lam, g.1.2, 8
Marion Lam, g.2, 8.000000001
Marion Lam, g.3, 8
Marion Ross, b.3, 100
Mark Wesley, a.1, 1.298701299
Mark Wesley, a.2, 1.298701299
Mark Wesley, a.3, 21.03896104
Mark Wesley, b.4, 18.18181818
Mark Wesley, c.1, 2.066115703
Mark Wesley, c.2, 15.53719008
Mark Wesley, c.3, 2.066115703
Mark Wesley, c.4, 8.26446281
Mark Wesley, c.5, 2.066115703
Mark Wesley, d.1, 5.113636363
Mark Wesley, d.3, 1.704545454
Mark Wesley, d.4, 1.704545454
Mark Wesley, d.5, 3.409090909
Mark Wesley, d.6, 1.704545454
Mark Wesley, g.4, 7.272727272
Mark Wesley, i.3, 7.272727272
Martin Payne, a.1, 1.428571429
Martin Payne, a.2, 1.428571429
Martin Payne, a.3, 7.142857144
Martin Payne, c.1, 5.454545455
Martin Payne, c.2, 21.81818182
Martin Payne, c.3, 5.454545455
Martin Payne, c.4, 21.81818182
Martin Payne, c.5, 5.454545455
Martin Payne, d.1, 5
Martin Payne, d.2, 12.5
Martin Payne, d.3, 2.5
Martin Payne, d.4, 2.5
Martin Payne, d.5, 5
Martin Payne, d.6, 2.5
Mat Reed, b.1, 20
Mat Reed, f.2, 40
Mat Reed, g.2, 40
Mick Carin, a.1, 9.377289379
Mick Carin, a.2, 3.223443224
Mick Carin, a.3, 22.27106227
Mick Carin, c.1, 1.165501166
Mick Carin, c.2, 4.662004663
Mick Carin, c.3, 6.293706292
Mick Carin, c.4, 5.687645688
Mick Carin, c.5, 6.293706292
Mick Carin, d.1, 7.948717949
Mick Carin, d.3, 1.282051282
Mick Carin, d.4, 1.282051282
Mick Carin, d.5, 5.128205128
Mick Carin, d.6, 1.282051282
Mick Carin, f.6, 12.82051282
Mick Carin, g.1.2, 2.051282051
Mick Carin, g.2, 4.102564102
Mick Carin, g.3, 2.051282051
Mick Carin, h.2, 2.051282051
Mick Carin, h.3, 1.025641026
Mike Dawson, a.3, 25
Mike Dawson, b.3, 5
Mike Dawson, b.7, 5
Mike Dawson, d.1, 25
Mike Dawson, d.5, 15
Mike Dawson, g.3, 20
Mike Dawson, h.1, 0.714285714
Mike Dawson, h.2, 2.142857142
Mike Dawson, h.3, 0.714285714
Mike Dawson, h.4, 0.714285714
Mike Dawson, h.5, 0.714285714
Neil Roper, a.3, 38.29787234
Neil Roper, b.1, 5.319148936
Neil Roper, b.4, 21.27659574
Neil Roper, b.5, 1.063829787
Neil Roper, c.4, 27.65957447
Neil Roper, h.2, 6.382978723
Nicolas Curry, a.1, 20
Nicolas Curry, c.3, 20
Nicolas Curry, c.4, 10
Nicolas Curry, h.5, 50
Niyi Akers, c.1, 4.545454545
Niyi Akers, c.2, 18.18181818
Niyi Akers, c.3, 4.545454545
Niyi Akers, c.4, 38.18181818
Niyi Akers, c.5, 4.545454545
Niyi Akers, d.1, 10
Niyi Akers, g.1.2, 10
Niyi Akers, g.2, 10
Noshir Holmes, a.1, 2.142857143
Noshir Holmes, a.2, 2.142857143
Noshir Holmes, a.3, 10.71428572
Noshir Holmes, b.4, 10
Noshir Holmes, c.1, 2.727272727
Noshir Holmes, c.2, 10.90909091
Noshir Holmes, c.3, 2.727272727
Noshir Holmes, c.4, 10.90909091
Noshir Holmes, c.5, 2.727272727
Noshir Holmes, d.1, 5.625
Noshir Holmes, d.3, 11.875
Noshir Holmes, d.4, 1.875
Noshir Holmes, d.5, 3.75
Noshir Holmes, d.6, 1.875
Noshir Holmes, f.4, 20
Oliver Cullen, a.1, 11.42857143
Oliver Cullen, a.2, 11.42857143
Oliver Cullen, a.3, 7.142857145
Oliver Cullen, c.3, 20
Oliver Cullen, c.4, 20
Oliver Cullen, c.5, 5
Oliver Cullen, d.5, 10
Oliver Cullen, g.1.2, 15
Paul Ayers, a.1, 5
Paul Ayers, a.2, 5
Paul Ayers, a.3, 20
Paul Ayers, c.4, 25
Paul Ayers, d.1, 15
Paul Ayers, d.5, 10
Paul Ayers, g.1.2, 10
Paul Ayers, g.2, 10
Rachna Kaplan, a.1, 30
Rachna Kaplan, a.3, 20
Rachna Kaplan, c.3, 20
Rachna Kaplan, d.5, 10
Rachna Kaplan, g.1.2, 10
Rachna Kaplan, g.3, 10
Ray Hardy, a.1, 4.166666667
Ray Hardy, a.2, 8.333333333
Ray Hardy, a.3, 20.83333333
Ray Hardy, c.3, 12.5
Ray Hardy, c.4, 10.41666667
Ray Hardy, c.5, 12.5
Ray Hardy, d.1, 10
Ray Hardy, d.5, 4.166666667
Ray Hardy, g.1.2, 5
Ray Hardy, g.3, 10
Ray Hardy, h.3, 2.083333333
Richard Fuller, a.3, 30
Richard Fuller, b.3, 5
Richard Fuller, b.7, 5
Richard Fuller, c.1, 0.909090909
Richard Fuller, c.2, 3.636363636
Richard Fuller, c.3, 0.909090909
Richard Fuller, c.4, 3.636363636
Richard Fuller, c.5, 0.909090909
Richard Fuller, d.5, 15
Richard Fuller, g.3, 20
Richard Fuller, h.1, 2.142857143
Richard Fuller, h.2, 6.428571429
Richard Fuller, h.3, 2.142857143
Richard Fuller, h.4, 2.142857143
Richard Fuller, h.5, 2.142857143
Richard Marsh, a.1, 10
Richard Marsh, c.5, 25
Richard Marsh, d.1, 28.75
Richard Marsh, d.3, 6.25
Richard Marsh, d.4, 6.25
Richard Marsh, d.5, 12.5
Richard Marsh, d.6, 6.25
Richard Marsh, g.2, 5.000000001
Robert Clarke, i.3, 30
Robert Clarke, j.2, 10
Robert Clarke, j.3, 30
Robert Clarke, j.5, 30
Roger All, a.3, 90
Roger All, c.5, 10
Ruth Simon, a.3, 40
Ruth Simon, c.3, 10
Ruth Simon, c.4, 10

Ruth Simon, c.5, 10
Ruth Simon, d.5, 10
Ruth Simon, g.1.2, 20
Samuel Mackey, a.3, 100
Sarah Brante, a.1, 10
Sarah Brante, a.3, 15
Sarah Brante, c.3, 15
Sarah Brante, c.4, 15
Sarah Brante, c.5, 15
Sarah Brante, d.1, 5.625
Sarah Brante, d.3, 1.875
Sarah Brante, d.4, 1.875
Sarah Brante, d.5, 18.75
Sarah Brante, d.6, 1.875
Sean Wall, a.1, 0.902255639
Sean Wall, a.2, 0.902255639
Sean Wall, a.3, 4.511278195
Sean Wall, c.1, 0.669856459
Sean Wall, c.2, 2.679425836
Sean Wall, c.3, 0.669856459
Sean Wall, c.4, 2.679425836
Sean Wall, c.5, 0.669856459
Sean Wall, d.1, 1.973684211
Sean Wall, d.3, 0.657894737
Sean Wall, d.4, 0.657894737
Sean Wall, d.5, 1.315789474
Sean Wall, d.6, 0.657894737
Sean Wall, e.1, 2.631578947
Sean Wall, e.2, 2.631578947
Sean Wall, g.4, 26.31578947
Sean Wall, g.5, 26.31578947
Sean Wall, h.1, 0.30075188
Sean Wall, h.2, 0.90225564
Sean Wall, h.3, 0.30075188
Sean Wall, h.4, 0.30075188
Sean Wall, h.5, 0.30075188
Sean Wall, j.1, 13.15789474
Sean Wall, j.5, 7.894736842
Simon Farmer, a.1, 5
Simon Farmer, d.1, 10
Simon Farmer, f.4, 20
Simon Farmer, g.1.2, 15
Simon Farmer, g.4, 15
Simon Farmer, j.2, 5
Simon Farmer, j.6, 30
Simon Mann, a.1, 10
Simon Mann, a.3, 10
Simon Mann, c.3, 10
Simon Mann, c.4, 20
Simon Mann, c.5, 15
Simon Mann, d.5, 10
Simon Mann, g.1.2, 15
Simon Mann, g.2, 5
Simon Mann, h.3, 5
Steve Curry, c.2, 100
Tamsin Pitts, a.3, 20
Tamsin Pitts, c.3, 20
Tamsin Pitts, c.4, 20
Tamsin Pitts, c.5, 20
Tamsin Pitts, d.5, 20
Tariq Haines, g.4, 15.78947368
Tariq Haines, i.3, 5.263157895
Tariq Haines, j.5, 10.52631579
Tariq Haines, j.6, 31.57894737
Tariq Haines, j.7, 36.84210526
Tim Pugh, c.1, 1.818181818
Tim Pugh, c.2, 7.272727272
Tim Pugh, c.3, 1.818181818
Tim Pugh, c.4, 7.272727272
Tim Pugh, c.5, 1.818181818
Tim Pugh, d.1, 11.25
Tim Pugh, d.3, 3.75
Tim Pugh, d.4, 3.75
Tim Pugh, d.5, 7.5
Tim Pugh, d.6, 53.75
Tony Boston, b.3, 20
Tony Boston, c.2, 10
Tony Boston, c.4, 5
Tony Boston, g.4, 15
Tony Boston, h.1, 0.714285714
Tony Boston, h.2, 2.142857142
Tony Boston, h.3, 0.714285714
Tony Boston, h.4, 0.714285714
Tony Boston, h.5, 0.714285714
Tony Boston, j.1, 30
Tony Boston, j.3, 5
Tony Boston, j.6, 10
Wendy Richey, a.1, 7.453416149
Wendy Richey, a.2, 7.453416149
Wendy Richey, a.3, 35.0931677
Wendy Richey, c.1, 0.395256917
Wendy Richey, c.2, 1.581027668
Wendy Richey, c.3, 0.395256917
Wendy Richey, c.4, 8.102766799
Wendy Richey, c.5, 0.395256917
Wendy Richey, d.1, 15.21739131
Wendy Richey, d.3, 2.173913044
Wendy Richey, d.4, 2.173913044
Wendy Richey, d.5, 4.347826087
Wendy Richey, d.6, 2.173913044
Wendy Richey, g.3, 8.695652175
Wendy Richey, h.2, 2.173913044
Wendy Richey, h.3, 2.173913044
Will Miles, a.1, 1.428571429
Will Miles, a.2, 1.428571429
Will Miles, a.3, 7.142857145
Will Miles, c.1, 1.818181818
Will Miles, c.2, 7.272727272
Will Miles, c.3, 1.818181818
Will Miles, c.4, 7.272727272
Will Miles, c.5, 1.818181818
Will Miles, d.1, 3.75
Will Miles, d.3, 1.25
Will Miles, d.4, 1.25
Will Miles, d.5, 2.5
Will Miles, d.6, 1.25
Will Miles, e.1, 7.5
Will Miles, e.2, 7.5
Will Miles, f.1, 2
Will Miles, f.2, 2
Will Miles, f.4, 2
Will Miles, f.6, 4
Will Miles, g.1.2, 15
Will Miles, j.6, 20
Yogesh Katz, a.3, 100

Specific Requirements

Aaron Toms, f.4.1, 25
Aaron Toms, f.6.1, 65
Aaron Toms, i.3.6, 10
Adrian Bank, g.1, 50
Adrian Bank, h.1, 50
Alison Crane, a.3.1, 20
Alison Crane, a.3.2, 20
Alison Crane, a.3.3, 20
Alison Crane, a.3.4, 20
Alison Crane, a.3.6, 20
Andrew Dawn, f.1, 5
Andrew Dawn, f.2.1, 5
Andrew Dawn, f.4.1, 5
Andrew Dawn, f.6.1, 5
Andrew Dawn, f.6.2, 5
Andrew Dawn, h.1, 1.428571429
Andrew Dawn, h.2.1, 1.428571429
Andrew Dawn, h.2.3, 1.428571429
Andrew Dawn, h.2.4, 1.428571429
Andrew Dawn, h.3, 1.428571429
Andrew Dawn, h.4, 1.428571429
Andrew Dawn, h.5, 1.428571429
Andrew Dawn, i.1.1, 10
Andrew Dawn, i.3.6, 10
Andrew Dawn, j.2.1, 10
Andrew Dawn, j.5.4, 15
Andrew Dawn, j.6.1, 10
Andrew Dawn, j.6.3, 10
Andy Faulk, a.1, 15
Andy Faulk, a.3.1, 15
Andy Faulk, a.3.2, 15
Andy Faulk, b.1.4, 5
Andy Faulk, c.3.1, 6
Andy Faulk, c.5.1, 11
Andy Faulk, d.1.1, 7
Andy Faulk, d.5.2, 6
Andy Faulk, d.5.3, 6
Andy Faulk, g.1, 7
Andy Faulk, g.3.2, 7
Andy Hicks, a.3.1, 10
Andy Hicks, a.3.2, 10
Andy Hicks, a.3.3, 10
Andy Hicks, a.3.4, 10
Andy Hicks, a.3.6, 10
Andy Hicks, c.3.1, 5
Andy Hicks, d.1.1, 5
Andy Hicks, d.1.2, 5
Andy Hicks, d.2, 5
Andy Hicks, d.3, 5
Andy Hicks, d.4.1, 5
Andy Hicks, d.5.2, 5
Andy Hicks, d.5.3, 5
Andy Hicks, d.6, 5
Andy Hicks, g.2.1, 5
Andy Kirb, c.2.1, 25
Andy Kirb, c.2.10, 25
Andy Kirb, c.2.7, 25
Andy Kirb, c.2.9, 25
Angela Willard, f.1, 4
Angela Willard, f.2.1, 4
Angela Willard, f.4.1, 4
Angela Willard, f.6.1, 4
Angela Willard, f.6.2, 4
Angela Willard, g.1, 25
Angela Willard, i.3.6, 25
Angela Willard, j.2.2, 15
Angela Willard, j.2.3, 15
Anthony Rick, a.1, 20
Anthony Rick, a.3.1, 4
Anthony Rick, a.3.2, 4
Anthony Rick, a.3.3, 4
Anthony Rick, a.3.4, 4
Anthony Rick, a.3.6, 4
Anthony Rick, c.2.1, 2.5
Anthony Rick, c.2.10, 2.5
Anthony Rick, c.2.7, 2.5
Anthony Rick, c.2.9, 2.5
Anthony Rick, c.3.1, 30
Anthony Rick, j.1.1, 20
Astrid Haynes, a.1, 20
Astrid Haynes, a.2, 2
Astrid Haynes, a.3.1, 8
Astrid Haynes, a.3.2, 8
Astrid Haynes, a.3.3, 8
Astrid Haynes, a.3.4, 8
Astrid Haynes, a.3.6, 8
Astrid Haynes, c.1, 0.454545455
Astrid Haynes, c.2.1, 0.454545455
Astrid Haynes, c.2.10, 0.454545455
Astrid Haynes, c.2.7, 0.454545455
Astrid Haynes, c.2.9, 0.454545455
Astrid Haynes, c.3.1, 0.454545455
Astrid Haynes, c.4.1, 0.454545455
Astrid Haynes, c.4.2, 0.454545455
Astrid Haynes, c.4.3, 0.454545455
Astrid Haynes, c.4.4, 0.454545455
Astrid Haynes, c.5.1, 3.454545455
Astrid Haynes, d.1.1, 3.75
Astrid Haynes, d.1.2, 3.75
Astrid Haynes, d.2, 3.75
Astrid Haynes, d.3, 3.75
Astrid Haynes, d.4.1, 3.75
Astrid Haynes, d.5.2, 3.75
Astrid Haynes, d.5.3, 3.75
Astrid Haynes, d.6, 3.75
Barbara Song, a.3.1, 2.4
Barbara Song, a.3.2, 2.4
Barbara Song, a.3.3, 8.4
Barbara Song, a.3.4, 8.4
Barbara Song, a.3.6, 8.4
Barbara Song, b.1.1, 2
Barbara Song, b.1.4, 2
Barbara Song, b.1.6, 2
Barbara Song, b.3.2, 12
Barbara Song, c.2.1, 3
Barbara Song, c.2.10, 3
Barbara Song, c.2.7, 3
Barbara Song, c.2.9, 3
Barbara Song, c.3.1, 12
Barbara Song, c.4.4, 12
Barbara Song, d.4.1, 5
Barbara Song, e.2, 6
Barbara Song, h.2.3, 5
Bill Leal, a.1, 7.886904761
Bill Leal, a.2, 4.761904761
Bill Leal, a.3.1, 5.595238095
Bill Leal, a.3.2, 5.595238095
Bill Leal, a.3.3, 1.428571428
Bill Leal, a.3.4, 9.761904761
Bill Leal, a.3.6, 1.428571428
Bill Leal, c.1, 0.473484849
Bill Leal, c.2.1, 0.473484849
Bill Leal, c.2.10, 0.473484849
Bill Leal, c.2.7, 0.473484849
Bill Leal, c.2.9, 0.473484849
Bill Leal, c.3.1, 3.598484849
Bill Leal, c.4.1, 5.681818182
Bill Leal, c.4.2, 5.681818182
Bill Leal, c.4.3, 1.515151516
Bill Leal, c.4.4, 1.515151516
Bill Leal, c.5.1, 2.556818182
Bill Leal, d.1.1, 11.71875
Bill Leal, d.1.2, 3.385416667
Bill Leal, d.2, 1.302083333
Bill Leal, d.3, 1.302083333
Bill Leal, d.4.1, 1.302083333
Bill Leal, d.5.2, 3.385416667
Bill Leal, d.5.3, 3.385416667
Bill Leal, d.6, 1.302083333
Bill Leal, g.1, 3.125
Bill Leal, g.2.3, 10.41666667
Brahim Boyd, a.1, 10.1010101
Brahim Boyd, a.2, 10.1010101
Brahim Boyd, a.3.1, 5.656565657
Brahim Boyd, a.3.2, 0.606060606
Brahim Boyd, a.3.3, 0.606060606
Brahim Boyd, a.3.4, 0.606060606
Brahim Boyd, a.3.6, 0.606060606
Brahim Boyd, c.3.1, 10.1010101
Brahim Boyd, c.4.1, 2.525252525
Brahim Boyd, c.4.2, 2.525252525
Brahim Boyd, c.4.3, 2.525252525
Brahim Boyd, c.4.4, 2.525252525
Brahim Boyd, c.5.1, 10.1010101
Brahim Boyd, d.1.1, 3.03030303
Brahim Boyd, d.1.2, 10.1010101
Brahim Boyd, g.1, 8.080808081
Brahim Boyd, g.2.1, 3.367003367
Brahim Boyd, g.2.2, 3.367003367
Brahim Boyd, g.2.3, 3.367003367
Brahim Boyd, h.3, 10.1010101
Brian Aniston, a.3.1, 5
Brian Aniston, a.3.2, 5
Brian Aniston, a.3.3, 5
Brian Aniston, a.3.4, 5
Brian Aniston, a.3.6, 5
Brian Aniston, c.3.1, 20
Brian Aniston, c.5.1, 20
Brian Aniston, d.1.2, 10
Brian Aniston, g.1, 10
Brian Aniston, g.2.1, 5
Brian Aniston, g.2.2, 5
Brian Aniston, g.2.3, 5
Brian Ward, g.4.4, 15
Brian Ward, j.6.3, 45
Brian Ward, j.6.4, 40
Caroline Cook, a.3.1, 10
Caroline Cook, a.3.2, 10
Caroline Cook, a.3.3, 10
Caroline Cook, a.3.4, 10
Caroline Cook, a.3.6, 10
Caroline Cook, g.1, 50
Caroline Goodman, a.1, 2.857142857
Caroline Goodman, a.2, 2.857142857
Caroline Goodman, a.3.1, 2.857142857
Caroline Goodman, a.3.2, 2.857142857
Caroline Goodman, a.3.3, 2.857142857
Caroline Goodman, a.3.4, 2.857142857
Caroline Goodman, a.3.6, 2.857142857
Caroline Goodman, c.1, 3.636363636
Caroline Goodman, c.2.1, 3.636363636
Caroline Goodman, c.2.10, 3.636363636
Caroline Goodman, c.2.7, 3.636363636
Caroline Goodman, c.2.9, 3.636363636
Caroline Goodman, c.3.1, 3.636363636
Caroline Goodman, c.4.1, 3.636363636
Caroline Goodman, c.4.2, 3.636363636
Caroline Goodman, c.4.3, 3.636363636
Caroline Goodman, c.4.4, 3.636363636
Caroline Goodman, c.5.1, 3.636363636
Caroline Goodman, d.1.1, 5
Caroline Goodman, d.1.2, 5
Caroline Goodman, d.2, 5
Caroline Goodman, d.3, 5
Caroline Goodman, d.4.1, 5
Caroline Goodman, d.5.2, 5
Caroline Goodman, d.5.3, 5
Caroline Goodman, d.6, 5
Chris Randall, a.1, 3.571428571
Chris Randall, a.2, 3.571428571
Chris Randall, a.3.1, 4.571428571
Chris Randall, a.3.2, 4.571428571
Chris Randall, a.3.3, 4.571428571
Chris Randall, a.3.4, 4.571428571
Chris Randall, a.3.6, 4.571428571
Chris Randall, c.1, 2.727272727
Chris Randall, c.2.1, 2.727272727
Chris Randall, c.2.10, 2.727272727
Chris Randall, c.2.7, 2.727272727
Chris Randall, c.2.9, 2.727272727
Chris Randall, c.3.1, 2.727272727
Chris Randall, c.4.1, 2.727272727
Chris Randall, c.4.2, 2.727272727
Chris Randall, c.4.3, 2.727272727
Chris Randall, c.4.4, 2.727272727
Chris Randall, c.5.1, 2.727272727
Chris Randall, d.1.1, 3.125
Chris Randall, d.1.2, 3.125
Chris Randall, d.2, 3.125
Chris Randall, d.3, 3.125
Chris Randall, d.4.1, 3.125
Chris Randall, d.5.2, 3.125
Chris Randall, d.5.3, 3.125
Chris Randall, d.6, 3.125
Chris Randall, e.1.2, 5
Chris Randall, h.4, 10
Christopher Hall, a.1, 8.571428571
Christopher Hall, a.2, 8.571428571
Christopher Hall, a.3.1, 8.571428571
Christopher Hall, a.3.2, 8.571428571

Christopher Hall, a.3.3, 8.571428571
Christopher Hall, a.3.4, 8.571428571
Christopher Hall, a.3.6, 8.571428571
Christopher Hall, c.1, 0.909090909
Christopher Hall, c.2.1, 0.909090909
Christopher Hall, c.2.10, 0.909090909
Christopher Hall, c.2.7, 0.909090909
Christopher Hall, c.2.9, 0.909090909
Christopher Hall, c.3.1, 0.909090909
Christopher Hall, c.4.1, 0.909090909
Christopher Hall, c.4.2, 0.909090909
Christopher Hall, c.4.3, 0.909090909
Christopher Hall, c.4.4, 0.909090909
Christopher Hall, c.5.1, 0.909090909
Christopher Hall, d.1.1, 3.75
Christopher Hall, d.1.2, 3.75
Christopher Hall, d.2, 3.75
Christopher Hall, d.3, 3.75
Christopher Hall, d.4.1, 3.75
Christopher Hall, d.5.2, 3.75
Christopher Hall, d.5.3, 3.75
Christopher Hall, d.6, 3.75
Colin Penn, a.1, 2.857142857
Colin Penn, a.2, 2.857142857
Colin Penn, a.3.1, 2.857142857
Colin Penn, a.3.2, 2.857142857
Colin Penn, a.3.3, 2.857142857
Colin Penn, a.3.4, 2.857142857
Colin Penn, a.3.6, 2.857142857
Colin Penn, c.1, 4.545454545
Colin Penn, c.2.1, 4.545454545
Colin Penn, c.2.10, 4.545454545
Colin Penn, c.2.7, 4.545454545
Colin Penn, c.2.9, 4.545454545
Colin Penn, c.3.1, 4.545454545
Colin Penn, c.4.1, 4.545454545
Colin Penn, c.4.2, 4.545454545
Colin Penn, c.4.3, 4.545454545
Colin Penn, c.4.4, 4.545454545
Colin Penn, c.5.1, 4.545454545
Colin Penn, d.1.1, 3.75
Colin Penn, d.1.2, 3.75
Colin Penn, d.2, 3.75
Colin Penn, d.3, 3.75
Colin Penn, d.4.1, 3.75
Colin Penn, d.5.2, 3.75
Colin Penn, d.5.3, 3.75
Colin Penn, d.6, 3.75
Colin Street, a.1, 7.142857143
Colin Street, a.2, 7.142857143
Colin Street, a.3.1, 7.142857143
Colin Street, a.3.2, 7.142857143
Colin Street, a.3.3, 7.142857143
Colin Street, a.3.4, 7.142857143
Colin Street, a.3.6, 7.142857143
Colin Street, c.1, 2.272727273
Colin Street, c.2.1, 2.272727273
Colin Street, c.2.10, 2.272727273
Colin Street, c.2.7, 2.272727273
Colin Street, c.2.9, 2.272727273
Colin Street, c.3.1, 2.272727273
Colin Street, c.4.1, 2.272727273
Colin Street, c.4.2, 2.272727273
Colin Street, c.4.3, 2.272727273
Colin Street, c.4.4, 2.272727273
Colin Street, c.5.1, 2.272727273
Colin Street, d.1.1, 3.125
Colin Street, d.1.2, 3.125
Colin Street, d.2, 3.125
Colin Street, d.3, 3.125
Colin Street, d.4.1, 3.125
Colin Street, d.5.2, 3.125
Colin Street, d.5.3, 3.125
Colin Street, d.6, 3.125
Conrad Moore, c.1, 2.228163993
Conrad Moore, c.2.1, 2.228163993
Conrad Moore, c.2.10, 2.228163993
Conrad Moore, c.2.7, 2.228163993
Conrad Moore, c.2.9, 2.228163993
Conrad Moore, c.3.1, 2.228163993
Conrad Moore, c.4.1, 2.228163993
Conrad Moore, c.4.2, 2.228163993
Conrad Moore, c.4.3, 2.228163993
Conrad Moore, c.4.4, 2.228163993
Conrad Moore, c.5.1, 2.228163993
Conrad Moore, d.1.1, 5.514705883
Conrad Moore, d.1.2, 3.06372549
Conrad Moore, d.2, 3.06372549
Conrad Moore, d.3, 3.06372549
Conrad Moore, d.4.1, 3.06372549
Conrad Moore, d.5.2, 15.31862745
Conrad Moore, d.5.3, 15.31862745
Conrad Moore, d.6, 3.06372549
Conrad Moore, g.1, 17.64705882
Conrad Moore, g.2.1, 1.633986928
Conrad Moore, g.2.2, 0.653594771
Conrad Moore, g.2.3, 1.633986928
Conrad Moore, g.3.2, 2.450980392
David Ainsley, a.1, 2.857142857
David Ainsley, a.2, 2.857142857
David Ainsley, a.3.1, 2.857142857
David Ainsley, a.3.2, 2.857142857
David Ainsley, a.3.3, 2.857142857
David Ainsley, a.3.4, 2.857142857
David Ainsley, a.3.6, 2.857142857
David Ainsley, c.1, 0.909090909
David Ainsley, c.2.1, 0.909090909
David Ainsley, c.2.10, 20.90909091
David Ainsley, c.2.7, 0.909090909
David Ainsley, c.2.9, 0.909090909
David Ainsley, c.3.1, 0.909090909
David Ainsley, c.4.1, 0.909090909
David Ainsley, c.4.2, 0.909090909
David Ainsley, c.4.3, 0.909090909
David Ainsley, c.4.4, 0.909090909
David Ainsley, c.5.1, 0.909090909
David Ainsley, d.1.1, 1.875
David Ainsley, d.1.2, 1.875
David Ainsley, d.2, 1.875
David Ainsley, d.3, 1.875
David Ainsley, d.4.1, 1.875
David Ainsley, d.5.2, 6.875
David Ainsley, d.5.3, 1.875
David Ainsley, d.6, 1.875
David Ainsley, h.2.3, 5
David Ainsley, h.3, 25
David Carne, g.2.1, 6.666666667
David Carne, g.2.2, 6.666666667
David Carne, g.2.3, 6.666666667
David Carne, g.4.4, 10
David Carne, i.2.3, 50
David Carne, j.6.3, 20
Diana Cates, c.3.1, 30
Diana Cates, c.4.1, 5
Diana Cates, c.4.2, 5
Diana Cates, c.4.3, 5
Diana Cates, c.4.4, 5
Diana Cates, g.1, 40
Diana Cates, g.3.2, 10
Ed Steele, a.1, 0.714285714
Ed Steele, a.2, 0.714285714
Ed Steele, a.3.1, 4.714285714
Ed Steele, a.3.2, 4.714285714
Ed Steele, a.3.3, 4.714285714
Ed Steele, a.3.4, 24.71428571
Ed Steele, a.3.6, 4.714285714
Ed Steele, c.1, 0.454545455
Ed Steele, c.2.1, 0.454545455
Ed Steele, c.2.10, 0.454545455
Ed Steele, c.2.7, 0.454545455
Ed Steele, c.2.9, 0.454545455
Ed Steele, c.3.1, 0.454545455
Ed Steele, c.4.1, 0.454545455
Ed Steele, c.4.2, 10.45454545
Ed Steele, c.4.3, 0.454545455
Ed Steele, c.4.4, 0.454545455
Ed Steele, c.5.1, 0.454545455
Ed Steele, g.1, 30
Ed Steele, h.2.4, 10
Farid Sonya, a.1, 10
Farid Sonya, a.3.1, 5
Farid Sonya, a.3.2, 5
Farid Sonya, a.3.3, 5
Farid Sonya, a.3.4, 5
Farid Sonya, a.3.6, 5
Farid Sonya, c.3.1, 25
Farid Sonya, c.5.1, 40
Harry Gore, a.1, 16.66666667
Harry Gore, a.2, 16.66666667
Harry Gore, a.3.1, 3.333333333
Harry Gore, a.3.2, 20
Harry Gore, a.3.3, 3.333333333
Harry Gore, a.3.4, 3.333333333
Harry Gore, a.3.6, 3.333333333
Harry Gore, d.1.1, 12.08333333
Harry Gore, d.1.2, 2.083333333
Harry Gore, d.2, 2.083333333
Harry Gore, d.3, 2.083333333
Harry Gore, d.4.1, 2.083333333
Harry Gore, d.5.2, 2.083333333
Harry Gore, d.5.3, 2.083333333
Harry Gore, d.6, 2.083333333
Harry Gore, g.2.3, 6.666666667
Ian More, a.3.3, 50
Ian More, c.3.1, 10
Ian More, c.4.1, 10
Ian More, f.1, 10
Ian More, i.3.5, 15
Ian More, j.4.1, 5
Jan Crowe, a.1, 2.571428571
Jan Crowe, a.2, 2.571428571
Jan Crowe, a.3.1, 2.571428571
Jan Crowe, a.3.2, 2.571428571
Jan Crowe, a.3.3, 2.571428571
Jan Crowe, a.3.4, 2.571428571
Jan Crowe, a.3.6, 2.571428571
Jan Crowe, c.1, 1.636363636
Jan Crowe, c.2.1, 1.636363636
Jan Crowe, c.2.10, 1.636363636
Jan Crowe, c.2.7, 1.636363636
Jan Crowe, c.2.9, 1.636363636
Jan Crowe, c.3.1, 1.636363636
Jan Crowe, c.4.1, 1.636363636
Jan Crowe, c.4.2, 1.636363636
Jan Crowe, c.4.3, 1.636363636
Jan Crowe, c.4.4, 1.636363636
Jan Crowe, c.5.1, 1.636363636
Jan Crowe, d.1.1, 2.25
Jan Crowe, d.1.2, 16.25
Jan Crowe, d.2, 2.25
Jan Crowe, d.3, 2.25
Jan Crowe, d.4.1, 2.25
Jan Crowe, d.5.2, 2.25
Jan Crowe, d.5.3, 2.25
Jan Crowe, d.6, 2.25
Jan Crowe, g.1.1, 18
Jan Crowe, h.2.1, 4.666666667
Jan Crowe, h.2.3, 4.666666667
Jan Crowe, h.2.4, 4.666666667
Jason Ortiz, a.1, 10
Jason Ortiz, a.3.1, 15
Jason Ortiz, c.1, 5
Jason Ortiz, d.1.1, 20
Jason Ortiz, d.5.2, 2.5
Jason Ortiz, d.5.3, 2.5
Jason Ortiz, d.6, 5
Jason Ortiz, g.3.2, 40
Jeremy Spain, a.3.1, 8
Jeremy Spain, a.3.2, 8
Jeremy Spain, a.3.3, 8
Jeremy Spain, a.3.4, 8
Jeremy Spain, a.3.6, 8
Jeremy Spain, c.1, 2.727272727
Jeremy Spain, c.2.1, 2.727272727
Jeremy Spain, c.2.10, 2.727272727
Jeremy Spain, c.2.7, 2.727272727
Jeremy Spain, c.2.9, 7.727272727
Jeremy Spain, c.3.1, 2.727272727
Jeremy Spain, c.4.1, 5.227272727
Jeremy Spain, c.4.2, 5.227272727
Jeremy Spain, c.4.3, 5.227272727
Jeremy Spain, c.4.4, 5.227272727
Jeremy Spain, c.5.1, 2.727272727
Jeremy Spain, d.5.2, 15
Jim Howe, a.1, 3.571428571
Jim Howe, a.2, 3.571428571
Jim Howe, a.3.1, 3.571428571
Jim Howe, a.3.2, 3.571428571
Jim Howe, a.3.3, 3.571428571
Jim Howe, a.3.4, 3.571428571
Jim Howe, a.3.6, 3.571428571
Jim Howe, b.1.4, 5
Jim Howe, c.1, 3.181818182
Jim Howe, c.2.1, 3.181818182
Jim Howe, c.2.10, 3.181818182
Jim Howe, c.2.7, 3.181818182
Jim Howe, c.2.9, 3.181818182
Jim Howe, c.3.1, 3.181818182
Jim Howe, c.4.1, 3.181818182
Jim Howe, c.4.2, 3.181818182
Jim Howe, c.4.3, 3.181818182
Jim Howe, c.4.4, 3.181818182
Jim Howe, c.5.1, 3.181818182
Jim Howe, d.1.1, 3.125
Jim Howe, d.1.2, 3.125
Jim Howe, d.2, 3.125
Jim Howe, d.3, 3.125
Jim Howe, d.4.1, 3.125
Jim Howe, d.5.2, 3.125
Jim Howe, d.5.3, 3.125
Jim Howe, d.6, 3.125
Jim Howe, g.3.2, 10
Johnny Glenn, a.3.3, 20
Johnny Glenn, a.3.4, 40
Johnny Glenn, c.3.1, 10
Johnny Glenn, g.1, 10
Johnny Glenn, h.3, 20
Jots Semb, f.1, 6
Jots Semb, f.2.1, 6
Jots Semb, f.4.1, 6
Jots Semb, f.6.1, 6
Jots Semb, f.6.2, 6
Jots Semb, g.4.4, 20
Jots Semb, i.1.1, 20
Jots Semb, i.2.3, 30
Kathleen Niche, a.3.1, 8
Kathleen Niche, a.3.2, 8
Kathleen Niche, a.3.3, 8
Kathleen Niche, a.3.4, 8
Kathleen Niche, a.3.6, 8
Kathleen Niche, d.5.2, 60
Kathryn Lester, a.3.1, 8
Kathryn Lester, a.3.2, 8
Kathryn Lester, a.3.3, 8
Kathryn Lester, a.3.4, 8
Kathryn Lester, a.3.6, 8
Kathryn Lester, c.1, 2.727272727
Kathryn Lester, c.2.1, 2.727272727
Kathryn Lester, c.2.10, 2.727272727
Kathryn Lester, c.2.7, 2.727272727
Kathryn Lester, c.2.9, 2.727272727
Kathryn Lester, c.3.1, 2.727272727
Kathryn Lester, c.4.1, 2.727272727
Kathryn Lester, c.4.2, 2.727272727
Kathryn Lester, c.4.3, 2.727272727
Kathryn Lester, c.4.4, 2.727272727
Kathryn Lester, c.5.1, 2.727272727
Kathryn Lester, d.1.1, 3.75
Kathryn Lester, d.1.2, 3.75
Kathryn Lester, d.2, 3.75
Kathryn Lester, d.3, 3.75
Kathryn Lester, d.4.1, 3.75
Kathryn Lester, d.5.2, 3.75
Kathryn Lester, d.5.3, 3.75
Kathryn Lester, d.6, 3.75
Kerstin Michel, a.1, 5.714285714
Kerstin Michel, a.2, 5.714285714
Kerstin Michel, a.3.1, 5.714285714
Kerstin Michel, a.3.2, 5.714285714
Kerstin Michel, a.3.3, 5.714285714
Kerstin Michel, a.3.4, 5.714285714
Kerstin Michel, a.3.6, 5.714285714
Kerstin Michel, c.1, 0.909090909
Kerstin Michel, c.2.1, 0.909090909
Kerstin Michel, c.2.10, 0.909090909
Kerstin Michel, c.2.7, 0.909090909
Kerstin Michel, c.2.9, 0.909090909
Kerstin Michel, c.3.1, 0.909090909
Kerstin Michel, c.4.1, 0.909090909
Kerstin Michel, c.4.2, 0.909090909
Kerstin Michel, c.4.3, 0.909090909
Kerstin Michel, c.4.4, 0.909090909
Kerstin Michel, c.5.1, 0.909090909
Kerstin Michel, d.1.1, 6.25
Kerstin Michel, d.1.2, 6.25
Kerstin Michel, d.2, 6.25
Kerstin Michel, d.3, 6.25
Kerstin Michel, d.4.1, 6.25
Kerstin Michel, d.5.2, 6.25
Kerstin Michel, d.5.3, 6.25
Kerstin Michel, d.6, 6.25
Liz Hopper, a.1, 20
Liz Hopper, a.2, 10
Liz Hopper, a.3.1, 10
Liz Hopper, a.3.2, 10
Liz Hopper, c.4.1, 1.25
Liz Hopper, c.4.2, 1.25
Liz Hopper, c.4.3, 1.25
Liz Hopper, c.4.4, 1.25
Liz Hopper, c.5.1, 5
Liz Hopper, d.1.1, 10
Liz Hopper, d.1.2, 10
Liz Hopper, g.1, 10
Liz Hopper, h.2.3, 10
Magali Persi, a.1, 2.142857143
Magali Persi, a.2, 2.142857143
Magali Persi, a.3.1, 2.142857143
Magali Persi, a.3.2, 2.142857143
Magali Persi, a.3.3, 2.142857143
Magali Persi, a.3.4, 2.142857143
Magali Persi, a.3.6, 2.142857143
Magali Persi, c.1, 6.363636364
Magali Persi, c.2.1, 6.363636364
Magali Persi, c.2.10, 6.363636364
Magali Persi, c.2.7, 6.363636364
Magali Persi, c.2.9, 6.363636364
Magali Persi, c.3.1, 6.363636364
Magali Persi, c.4.1, 6.363636364
Magali Persi, c.4.2, 6.363636364
Magali Persi, c.4.3, 6.363636364
Magali Persi, c.4.4, 6.363636364
Magali Persi, c.5.1, 6.363636364
Magali Persi, d.1.1, 1.875
Magali Persi, d.1.2, 1.875
Magali Persi, d.2, 1.875
Magali Persi, d.3, 1.875
Magali Persi, d.4.1, 1.875
Magali Persi, d.5.2, 1.875
Magali Persi, d.5.3, 1.875
Magali Persi, d.6, 1.875
Majid Khande, a.1, 22.22222222
Majid Khande, a.3.1, 11.11111111
Majid Khande, a.3.2, 11.11111111
Majid Khande, c.3.1, 11.11111111
Majid Khande, c.4.2, 11.11111111
Majid Khande, d.1.1, 11.11111111
Majid Khande, d.1.2, 11.11111111
Majid Khande, g.3.2, 11.11111111
Malcolm Bain, d.1.1, 10
Malcolm Bain, g.1, 5
Malcolm Bain, g.3.2, 10
Malcolm Bain, i.2.3, 15
Malcolm Bain, i.2.5, 20
Malcolm Bain, i.3.1, 15
Malcolm Bain, i.3.3, 25
Maria Damon, a.3.1, 3
Maria Damon, a.3.2, 3
Maria Damon, a.3.3, 3
Maria Damon, a.3.4, 3
Maria Damon, a.3.6, 3
Maria Damon, d.5.2, 7.5
Maria Damon, d.5.3, 7.5
Maria Damon, g.1, 30
Maria Damon, g.2.1, 6.666666667

Maria Damon, g.2.2, 6.666666667
Maria Damon, g.2.3, 6.666666667
Maria Damon, g.3.2, 20
Marilyn Gallo, a.1, 4.285714286
Marilyn Gallo, a.2, 4.285714286
Marilyn Gallo, a.3.1, 4.285714286
Marilyn Gallo, a.3.2, 4.285714286
Marilyn Gallo, a.3.3, 4.285714286
Marilyn Gallo, a.3.4, 4.285714286
Marilyn Gallo, a.3.6, 4.285714286
Marilyn Gallo, c.1, 1.818181818
Marilyn Gallo, c.2.1, 1.818181818
Marilyn Gallo, c.2.10, 1.818181818
Marilyn Gallo, c.2.7, 1.818181818
Marilyn Gallo, c.2.9, 1.818181818
Marilyn Gallo, c.3.1, 1.818181818
Marilyn Gallo, c.4.1, 1.818181818
Marilyn Gallo, c.4.2, 1.818181818
Marilyn Gallo, c.4.3, 1.818181818
Marilyn Gallo, c.4.4, 1.818181818
Marilyn Gallo, c.5.1, 1.818181818
Marilyn Gallo, d.1.1, 2.5
Marilyn Gallo, d.1.2, 2.5
Marilyn Gallo, d.2, 2.5
Marilyn Gallo, d.3, 2.5
Marilyn Gallo, d.4.1, 2.5
Marilyn Gallo, d.5.2, 2.5
Marilyn Gallo, d.5.3, 2.5
Marilyn Gallo, d.6, 2.5
Marilyn Gallo, e.1.2, 12.5
Marilyn Gallo, e.2, 12.5
Marilyn Gallo, j.5.1, 1.666666667
Marilyn Gallo, j.5.4, 1.666666667
Marilyn Gallo, j.5.5, 1.666666667
Marion Lam, a.1, 16
Marion Lam, a.2, 16
Marion Lam, a.3.1, 2.6
Marion Lam, a.3.2, 2.6
Marion Lam, a.3.3, 2.6
Marion Lam, a.3.4, 2.6
Marion Lam, a.3.6, 2.6
Marion Lam, c.3.1, 2
Marion Lam, c.5.1, 2
Marion Lam, d.1.1, 8
Marion Lam, d.1.2, 13
Marion Lam, d.5.2, 3
Marion Lam, d.5.3, 3
Marion Lam, g.1, 8
Marion Lam, g.2.1, 2.666666667
Marion Lam, g.2.2, 2.666666667
Marion Lam, g.2.3, 2.666666667
Marion Lam, g.3.2, 8
Marion Ross, b.3.2, 100
Mark Wesley, a.1, 1.298701299
Mark Wesley, a.2, 1.298701299
Mark Wesley, a.3.1, 4.207792208
Mark Wesley, a.3.2, 4.207792208
Mark Wesley, a.3.3, 4.207792208
Mark Wesley, a.3.4, 4.207792208
Mark Wesley, a.3.6, 4.207792208
Mark Wesley, b.4, 18.18181818
Mark Wesley, c.1, 2.066115703
Mark Wesley, c.2.1, 3.884297521
Mark Wesley, c.2.10, 3.884297521
Mark Wesley, c.2.7, 3.884297521
Mark Wesley, c.2.9, 3.884297521
Mark Wesley, c.3.1, 2.066115703
Mark Wesley, c.4.1, 2.066115703
Mark Wesley, c.4.2, 2.066115703
Mark Wesley, c.4.3, 2.066115703
Mark Wesley, c.4.4, 2.066115703
Mark Wesley, c.5.1, 2.066115703
Mark Wesley, d.1.1, 1.704545454
Mark Wesley, d.1.2, 1.704545454
Mark Wesley, d.2, 1.704545454
Mark Wesley, d.3, 1.704545454
Mark Wesley, d.4.1, 1.704545454
Mark Wesley, d.5.2, 1.704545454
Mark Wesley, d.5.3, 1.704545454
Mark Wesley, d.6, 1.704545454
Mark Wesley, g.4.3, 7.272727272
Mark Wesley, i.3.3, 7.272727272
Martin Payne, a.1, 1.428571429
Martin Payne, a.2, 1.428571429
Martin Payne, a.3.1, 1.428571429
Martin Payne, a.3.2, 1.428571429
Martin Payne, a.3.3, 1.428571429
Martin Payne, a.3.4, 1.428571429
Martin Payne, a.3.6, 1.428571429
Martin Payne, c.1, 5.454545455
Martin Payne, c.2.1, 5.454545455
Martin Payne, c.2.10, 5.454545455
Martin Payne, c.2.7, 5.454545455
Martin Payne, c.2.9, 5.454545455
Martin Payne, c.3.1, 5.454545455
Martin Payne, c.4.1, 5.454545455
Martin Payne, c.4.2, 5.454545455
Martin Payne, c.4.3, 5.454545455
Martin Payne, c.4.4, 5.454545455
Martin Payne, c.5.1, 5.454545455
Martin Payne, d.1.1, 2.5
Martin Payne, d.1.2, 2.5
Martin Payne, d.2, 12.5
Martin Payne, d.3, 2.5
Martin Payne, d.4.1, 2.5
Martin Payne, d.5.2, 2.5
Martin Payne, d.5.3, 2.5
Martin Payne, d.6, 2.5
Mat Reed, b.1.4, 20
Mat Reed, f.2.1, 40
Mat Reed, g.2.2, 40
Mick Carin, a.1, 9.377289379
Mick Carin, a.2, 3.223443224
Mick Carin, a.3.1, 4.659340659
Mick Carin, a.3.2, 4.659340659
Mick Carin, a.3.3, 4.659340659
Mick Carin, a.3.4, 4.659340659
Mick Carin, a.3.6, 3.633699634
Mick Carin, c.1, 1.165501166
Mick Carin, c.2.1, 1.165501166
Mick Carin, c.2.10, 1.165501166
Mick Carin, c.2.7, 1.165501166
Mick Carin, c.2.9, 1.165501166
Mick Carin, c.3.1, 6.293706292
Mick Carin, c.4.1, 1.165501166
Mick Carin, c.4.2, 1.165501166
Mick Carin, c.4.3, 1.165501166
Mick Carin, c.4.4, 2.191142191
Mick Carin, c.5.1, 6.293706292
Mick Carin, d.1.1, 3.333333333
Mick Carin, d.1.2, 3.333333333
Mick Carin, d.2, 1.282051282
Mick Carin, d.3, 1.282051282
Mick Carin, d.4.1, 1.282051282
Mick Carin, d.5.2, 2.564102564
Mick Carin, d.5.3, 2.564102564
Mick Carin, d.6, 1.282051282
Mick Carin, f.6.2, 12.82051282
Mick Carin, g.1, 2.051282051
Mick Carin, g.2.1, 1.709401709
Mick Carin, g.2.2, 0.683760684
Mick Carin, g.2.3, 1.709401709
Mick Carin, g.3.2, 2.051282051
Mick Carin, h.2.1, 1.025641026
Mick Carin, h.2.3, 1.025641026
Mick Carin, h.3, 1.025641026
Mike Dawson, a.3.1, 5
Mike Dawson, a.3.2, 5
Mike Dawson, a.3.3, 5
Mike Dawson, a.3.4, 5
Mike Dawson, a.3.6, 5
Mike Dawson, b.3.1, 5
Mike Dawson, b.7, 5
Mike Dawson, d.1.1, 25
Mike Dawson, d.5.3, 15
Mike Dawson, g.3.2, 20
Mike Dawson, h.1, 0.714285714
Mike Dawson, h.2.1, 0.714285714
Mike Dawson, h.2.3, 0.714285714
Mike Dawson, h.2.4, 0.714285714
Mike Dawson, h.3, 0.714285714
Mike Dawson, h.4, 0.714285714
Mike Dawson, h.5, 0.714285714
Neil Roper, a.3.1, 5.957446809
Neil Roper, a.3.2, 24.04255319
Neil Roper, a.3.3, 2.765957447
Neil Roper, a.3.4, 2.765957447
Neil Roper, a.3.6, 2.765957447
Neil Roper, b.1.1, 1.063829787
Neil Roper, b.1.4, 3.191489362
Neil Roper, b.1.6, 1.063829787
Neil Roper, b.4, 21.27659574
Neil Roper, b.5, 1.063829787
Neil Roper, c.4.1, 2.659574468
Neil Roper, c.4.2, 2.659574468
Neil Roper, c.4.3, 5.85106383
Neil Roper, c.4.4, 16.4893617
Neil Roper, h.2.3, 6.382978723
Nicolas Curry, a.1, 20
Nicolas Curry, c.3.1, 20
Nicolas Curry, c.4.1, 2.5
Nicolas Curry, c.4.2, 2.5
Nicolas Curry, c.4.3, 2.5
Nicolas Curry, c.4.4, 2.5
Nicolas Curry, h.5, 50
Niyi Akers, c.1, 4.545454545
Niyi Akers, c.2.1, 4.545454545
Niyi Akers, c.2.10, 4.545454545
Niyi Akers, c.2.7, 4.545454545
Niyi Akers, c.2.9, 4.545454545
Niyi Akers, c.3.1, 4.545454545
Niyi Akers, c.4.1, 9.545454545
Niyi Akers, c.4.2, 9.545454545
Niyi Akers, c.4.3, 9.545454545
Niyi Akers, c.4.4, 9.545454545
Niyi Akers, c.5.1, 4.545454545
Niyi Akers, d.1.1, 10
Niyi Akers, g.1, 10
Niyi Akers, g.2.3, 10
Noshir Holmes, a.1, 2.142857143
Noshir Holmes, a.2, 2.142857143
Noshir Holmes, a.3.1, 2.142857143
Noshir Holmes, a.3.2, 2.142857143
Noshir Holmes, a.3.3, 2.142857143
Noshir Holmes, a.3.4, 2.142857143
Noshir Holmes, a.3.6, 2.142857143
Noshir Holmes, b.4, 10
Noshir Holmes, c.1, 2.727272727
Noshir Holmes, c.2.1, 2.727272727
Noshir Holmes, c.2.10, 2.727272727
Noshir Holmes, c.2.7, 2.727272727
Noshir Holmes, c.2.9, 2.727272727
Noshir Holmes, c.3.1, 2.727272727
Noshir Holmes, c.4.1, 2.727272727
Noshir Holmes, c.4.2, 2.727272727
Noshir Holmes, c.4.3, 2.727272727
Noshir Holmes, c.4.4, 2.727272727
Noshir Holmes, c.5.1, 2.727272727
Noshir Holmes, d.1.1, 1.875
Noshir Holmes, d.1.2, 1.875
Noshir Holmes, d.2, 1.875
Noshir Holmes, d.3, 11.875
Noshir Holmes, d.4.1, 1.875
Noshir Holmes, d.5.2, 1.875
Noshir Holmes, d.5.3, 1.875
Noshir Holmes, d.6, 1.875
Noshir Holmes, f.4.1, 20
Oliver Cullen, a.1, 11.42857143
Oliver Cullen, a.2, 11.42857143
Oliver Cullen, a.3.1, 1.428571429
Oliver Cullen, a.3.2, 1.428571429
Oliver Cullen, a.3.3, 1.428571429
Oliver Cullen, a.3.4, 1.428571429
Oliver Cullen, a.3.6, 1.428571429
Oliver Cullen, c.3.1, 20
Oliver Cullen, c.4.1, 5
Oliver Cullen, c.4.2, 5
Oliver Cullen, c.4.3, 5
Oliver Cullen, c.4.4, 5
Oliver Cullen, c.5.1, 5
Oliver Cullen, d.5.2, 5
Oliver Cullen, d.5.3, 5
Oliver Cullen, g.1, 15
Paul Ayers, a.1, 5
Paul Ayers, a.2, 5
Paul Ayers, a.3.1, 2
Paul Ayers, a.3.2, 12
Paul Ayers, a.3.3, 2
Paul Ayers, a.3.4, 2
Paul Ayers, a.3.6, 2
Paul Ayers, c.4.1, 2.5
Paul Ayers, c.4.2, 12.5
Paul Ayers, c.4.3, 2.5
Paul Ayers, c.4.4, 7.5
Paul Ayers, d.1.1, 10
Paul Ayers, d.1.2, 5
Paul Ayers, d.5.2, 5
Paul Ayers, d.5.3, 5
Paul Ayers, g.1, 10
Paul Ayers, g.2.1, 5
Paul Ayers, g.2.3, 5
Rachna Kaplan, a.1, 30
Rachna Kaplan, a.3.1, 4
Rachna Kaplan, a.3.2, 4
Rachna Kaplan, a.3.3, 4
Rachna Kaplan, a.3.4, 4
Rachna Kaplan, a.3.6, 4
Rachna Kaplan, c.3.1, 20
Rachna Kaplan, d.5.2, 5
Rachna Kaplan, d.5.3, 5
Rachna Kaplan, g.1, 10
Rachna Kaplan, g.3.2, 10
Ray Hardy, a.1, 4.166666667
Ray Hardy, a.2, 8.333333333
Ray Hardy, a.3.1, 4.583333333
Ray Hardy, a.3.2, 6.25
Ray Hardy, a.3.3, 3.75
Ray Hardy, a.3.4, 3.75
Ray Hardy, a.3.6, 2.5
Ray Hardy, c.3.1, 12.5
Ray Hardy, c.4.1, 3.541666667
Ray Hardy, c.4.2, 2.708333333
Ray Hardy, c.4.3, 1.041666667
Ray Hardy, c.4.4, 3.125
Ray Hardy, c.5.1, 12.5
Ray Hardy, d.1.1, 10
Ray Hardy, d.5.2, 2.083333333
Ray Hardy, d.5.3, 2.083333333
Ray Hardy, g.1, 5
Ray Hardy, g.3.2, 10
Ray Hardy, h.3, 2.083333333
Richard Fuller, a.3.1, 6
Richard Fuller, a.3.2, 6
Richard Fuller, a.3.3, 6
Richard Fuller, a.3.4, 6
Richard Fuller, a.3.6, 6
Richard Fuller, b.3.1, 5
Richard Fuller, b.7, 5
Richard Fuller, c.1, 0.909090909
Richard Fuller, c.2.1, 0.909090909
Richard Fuller, c.2.10, 0.909090909
Richard Fuller, c.2.7, 0.909090909
Richard Fuller, c.2.9, 0.909090909
Richard Fuller, c.3.1, 0.909090909
Richard Fuller, c.4.1, 0.909090909
Richard Fuller, c.4.2, 0.909090909
Richard Fuller, c.4.3, 0.909090909
Richard Fuller, c.4.4, 0.909090909
Richard Fuller, c.5.1, 0.909090909
Richard Fuller, d.5.3, 15
Richard Fuller, g.3.2, 20
Richard Fuller, h.1, 2.142857143
Richard Fuller, h.2.1, 2.142857143
Richard Fuller, h.2.3, 2.142857143
Richard Fuller, h.2.4, 2.142857143
Richard Fuller, h.3, 2.142857143
Richard Fuller, h.4, 2.142857143
Richard Fuller, h.5, 2.142857143
Richard Marsh, a.1, 10
Richard Marsh, c.5.1, 25
Richard Marsh, d.1.1, 6.25
Richard Marsh, d.1.2, 16.25
Richard Marsh, d.2, 6.25
Richard Marsh, d.3, 6.25
Richard Marsh, d.4.1, 6.25
Richard Marsh, d.5.2, 6.25
Richard Marsh, d.5.3, 6.25
Richard Marsh, d.6, 6.25
Richard Marsh, g.2.1, 1.666666667
Richard Marsh, g.2.2, 1.666666667
Richard Marsh, g.2.3, 1.666666667
Robert Clarke, i.3.3, 15
Robert Clarke, i.3.4, 15
Robert Clarke, j.2.1, 10
Robert Clarke, j.3.4, 30
Robert Clarke, j.5.5, 30
Roger All, a.3.1, 18
Roger All, a.3.2, 18
Roger All, a.3.3, 18
Roger All, a.3.4, 18
Roger All, a.3.6, 18
Roger All, c.5.1, 10
Ruth Simon, a.3.1, 20
Ruth Simon, a.3.2, 20
Ruth Simon, c.3.1, 10
Ruth Simon, c.4.1, 2.5
Ruth Simon, c.4.2, 2.5
Ruth Simon, c.4.3, 2.5
Ruth Simon, c.4.4, 2.5
Ruth Simon, c.5.1, 10
Ruth Simon, d.5.2, 5
Ruth Simon, d.5.3, 5
Ruth Simon, g.1, 20
Samuel Mackey, a.3.1, 20
Samuel Mackey, a.3.2, 20
Samuel Mackey, a.3.3, 20
Samuel Mackey, a.3.4, 20
Samuel Mackey, a.3.6, 20
Sarah Brante, a.1, 10
Sarah Brante, a.3.1, 3
Sarah Brante, a.3.2, 3
Sarah Brante, a.3.3, 3
Sarah Brante, a.3.4, 3
Sarah Brante, a.3.6, 3
Sarah Brante, c.3.1, 15
Sarah Brante, c.4.1, 3.75
Sarah Brante, c.4.2, 3.75
Sarah Brante, c.4.3, 3.75
Sarah Brante, c.4.4, 3.75
Sarah Brante, c.5.1, 15
Sarah Brante, d.1.1, 1.875
Sarah Brante, d.1.2, 1.875
Sarah Brante, d.2, 1.875
Sarah Brante, d.3, 1.875
Sarah Brante, d.4.1, 1.875
Sarah Brante, d.5.2, 9.375
Sarah Brante, d.5.3, 9.375
Sarah Brante, d.6, 1.875
Sean Wall, a.1, 0.902255639
Sean Wall, a.2, 0.902255639
Sean Wall, a.3.1, 0.902255639
Sean Wall, a.3.2, 0.902255639
Sean Wall, a.3.3, 0.902255639
Sean Wall, a.3.4, 0.902255639
Sean Wall, a.3.6, 0.902255639
Sean Wall, c.1, 0.669856459
Sean Wall, c.2.1, 0.669856459
Sean Wall, c.2.10, 0.669856459
Sean Wall, c.2.7, 0.669856459
Sean Wall, c.2.9, 0.669856459
Sean Wall, c.3.1, 0.669856459
Sean Wall, c.4.1, 0.669856459
Sean Wall, c.4.2, 0.669856459
Sean Wall, c.4.3, 0.669856459
Sean Wall, c.4.4, 0.669856459
Sean Wall, c.5.1, 0.669856459
Sean Wall, d.1.1, 0.657894737
Sean Wall, d.1.2, 0.657894737
Sean Wall, d.2, 0.657894737
Sean Wall, d.3, 0.657894737
Sean Wall, d.4.1, 0.657894737
Sean Wall, d.5.2, 0.657894737
Sean Wall, d.5.3, 0.657894737
Sean Wall, d.6, 0.657894737

Sean Wall, e.1.2, 2.631578947
Sean Wall, e.2, 2.631578947
Sean Wall, g.4.5, 26.31578947
Sean Wall, g.5, 26.31578947
Sean Wall, h.1, 0.30075188
Sean Wall, h.2.1, 0.30075188
Sean Wall, h.2.3, 0.30075188
Sean Wall, h.2.4, 0.30075188
Sean Wall, h.3, 0.30075188
Sean Wall, h.4, 0.30075188
Sean Wall, h.5, 0.30075188
Sean Wall, j.1.1, 13.15789474
Sean Wall, j.5.1, 2.631578947
Sean Wall, j.5.4, 2.631578947
Sean Wall, j.5.5, 2.631578947
Simon Farmer, a.1, 5
Simon Farmer, d.1.1, 10
Simon Farmer, f.4.1, 20
Simon Farmer, g.1, 15
Simon Farmer, g.4.4, 15
Simon Farmer, j.2.3, 5
Simon Farmer, j.6.2, 15
Simon Farmer, j.6.3, 15
Simon Mann, a.1, 10
Simon Mann, a.3.1, 10
Simon Mann, c.3.1, 10
Simon Mann, c.4.1, 3.75
Simon Mann, c.4.2, 3.75
Simon Mann, c.4.3, 3.75
Simon Mann, c.4.4, 8.75
Simon Mann, c.5.1, 15
Simon Mann, d.5.2, 5
Simon Mann, d.5.3, 5
Simon Mann, g.1, 15
Simon Mann, g.2.3, 5
Simon Mann, h.3, 5
Steve Curry, c.2.1, 100
Tamsin Pitts, a.3.1, 4
Tamsin Pitts, a.3.2, 4
Tamsin Pitts, a.3.3, 4
Tamsin Pitts, a.3.4, 4
Tamsin Pitts, a.3.6, 4
Tamsin Pitts, c.3.1, 20
Tamsin Pitts, c.4.1, 5
Tamsin Pitts, c.4.2, 5
Tamsin Pitts, c.4.3, 5
Tamsin Pitts, c.4.4, 5
Tamsin Pitts, c.5.1, 20
Tamsin Pitts, d.5.2, 10
Tamsin Pitts, d.5.3, 10
Tariq Haines, g.4.4, 15.78947368
Tariq Haines, i.3.6, 5.263157895
Tariq Haines, j.5.1, 10.52631579
Tariq Haines, j.6.3, 31.57894737
Tariq Haines, j.7.1, 21.05263158
Tariq Haines, j.7.2, 15.78947368
Tim Pugh, c.1, 1.818181818
Tim Pugh, c.2.1, 1.818181818
Tim Pugh, c.2.10, 1.818181818
Tim Pugh, c.2.7, 1.818181818
Tim Pugh, c.2.9, 1.818181818
Tim Pugh, c.3.1, 1.818181818
Tim Pugh, c.4.1, 1.818181818
Tim Pugh, c.4.2, 1.818181818
Tim Pugh, c.4.3, 1.818181818
Tim Pugh, c.4.4, 1.818181818
Tim Pugh, c.5.1, 1.818181818
Tim Pugh, d.1.1, 3.75
Tim Pugh, d.1.2, 3.75
Tim Pugh, d.2, 3.75
Tim Pugh, d.3, 3.75
Tim Pugh, d.4.1, 3.75
Tim Pugh, d.5.2, 3.75
Tim Pugh, d.5.3, 3.75
Tim Pugh, d.6, 53.75
Tony Boston, b.3.4, 20
Tony Boston, c.2.7, 10
Tony Boston, c.4.1, 1.25
Tony Boston, c.4.2, 1.25
Tony Boston, c.4.3, 1.25
Tony Boston, c.4.4, 1.25
Tony Boston, g.4.4, 15
Tony Boston, h.1, 0.714285714
Tony Boston, h.2.1, 0.714285714
Tony Boston, h.2.3, 0.714285714
Tony Boston, h.2.4, 0.714285714
Tony Boston, h.3, 0.714285714
Tony Boston, h.4, 0.714285714
Tony Boston, h.5, 0.714285714
Tony Boston, j.1.1, 30
Tony Boston, j.3.3, 5
Tony Boston, j.6.3, 10
Wendy Richey, a.1, 7.453416149
Wendy Richey, a.2, 7.453416149
Wendy Richey, a.3.1, 7.888198757
Wendy Richey, a.3.2, 7.888198757
Wendy Richey, a.3.3, 5.714285714
Wendy Richey, a.3.4, 7.888198757
Wendy Richey, a.3.6, 5.714285714
Wendy Richey, c.1, 0.395256917
Wendy Richey, c.2.1, 0.395256917
Wendy Richey, c.2.10, 0.395256917
Wendy Richey, c.2.7, 0.395256917
Wendy Richey, c.2.9, 0.395256917
Wendy Richey, c.3.1, 0.395256917
Wendy Richey, c.4.1, 1.482213439
Wendy Richey, c.4.2, 1.482213439
Wendy Richey, c.4.3, 1.482213439
Wendy Richey, c.4.4, 3.656126483
Wendy Richey, c.5.1, 0.395256917
Wendy Richey, d.1.1, 2.173913044
Wendy Richey, d.1.2, 10.86956522
Wendy Richey, d.2, 2.173913044
Wendy Richey, d.3, 2.173913044
Wendy Richey, d.4.1, 2.173913044
Wendy Richey, d.5.2, 2.173913044
Wendy Richey, d.5.3, 2.173913044
Wendy Richey, d.6, 2.173913044
Wendy Richey, g.3.2, 8.695652175
Wendy Richey, h.2.3, 2.173913044
Wendy Richey, h.3, 2.173913044
Will Miles, a.1, 1.428571429
Will Miles, a.2, 1.428571429
Will Miles, a.3.1, 1.428571429
Will Miles, a.3.2, 1.428571429
Will Miles, a.3.3, 1.428571429
Will Miles, a.3.4, 1.428571429
Will Miles, a.3.6, 1.428571429
Will Miles, c.1, 1.818181818
Will Miles, c.2.1, 1.818181818
Will Miles, c.2.10, 1.818181818
Will Miles, c.2.7, 1.818181818
Will Miles, c.2.9, 1.818181818
Will Miles, c.3.1, 1.818181818
Will Miles, c.4.1, 1.818181818
Will Miles, c.4.2, 1.818181818
Will Miles, c.4.3, 1.818181818
Will Miles, c.4.4, 1.818181818
Will Miles, c.5.1, 1.818181818
Will Miles, d.1.1, 1.25
Will Miles, d.1.2, 1.25
Will Miles, d.2, 1.25
Will Miles, d.3, 1.25
Will Miles, d.4.1, 1.25
Will Miles, d.5.2, 1.25
Will Miles, d.5.3, 1.25
Will Miles, d.6, 1.25
Will Miles, e.1.2, 7.5
Will Miles, e.2, 7.5
Will Miles, f.1, 2
Will Miles, f.2.1, 2
Will Miles, f.4.1, 2
Will Miles, f.6.1, 2
Will Miles, f.6.2, 2
Will Miles, g.1, 15
Will Miles, j.6.3, 20
Yogesh Katz, a.3.1, 35
Yogesh Katz, a.3.2, 10
Yogesh Katz, a.3.3, 35
Yogesh Katz, a.3.4, 10
Yogesh Katz, a.3.6, 10

Appendix G Alternative RateP Questionnaire

Requirement	Rating
1. Better user experience	
1.1 Access cards that are easier to use with more accurate scanning	
1.2 For library entrance, remove the need to put card in exact location for barcode scanning	
1.3 All in one card	
1.3.1 ID card and session card	
1.3.2 Library card	
1.3.3 Bloomsbury fitness	
1.3.4 Club and societies	
1.3.5 Cashless vending	
1.3.6 Time and attendance	
1.3.7 Computer Logon	
1.3.8 Santander Bank Card	
2. Improve processes (reduce manual data entry and improve efficiency for access control and library processes)	
2.1 Library barcode generated together with card (less 1 library queue)	
2.2 Import photos from registry for advance card production (save queuing time for students)	
2.3 Centralised management of access and identification information	
2.4 Card issue available anywhere within the UCL campus	
2.5 Digitally storing, printing and exporting photographs to other systems	
2.5.1 Staff photograph	
2.5.2 Student photograph	
3. Improved security	
3.1 Enable security/reception staff to check that the appearance of the card user matches the digitally stored photo	
3.2 More locations to be controlled by smart card access readers	
3.3 Enable the reliable removal/suspension of access rights and library borrowing privileges	
3.4 Enable the gathering and retrieval of the time which individuals enter and leave buildings	
3.4.1 Library	
3.4.2 Other buildings	
to minimise impact on Portico	
QoS: Software application needs to be able to switch to standby system in the event of hardware failure	
Rule: Entire live system must perform network backup to off-site backup server	
Rule: Access to administer the system needs to be strictly controlled (limited to certain ip addresses and/or users via vpn)	

Requirement	Rating
Rule: system is situated in central machine room(s) with redundant and backup power supplies and adequate air con.	
The UCL shop provides a service as to where students & staff can purchase a replacement ID card.	
UCL branding according to visual identity guidelines Design approved by DCCO	
colour coded for type of user	
Alumni version for library access inc online journals - in combination with alumni network card.	
Maybe - use instead of event badges so should have large clear name & job title & method of wearing.	
Maybe use as cashless purchase card (like oyster) to buy merchandise at events.	
Not easily copied	
Allow late access to buildings for events staff	
Use to book out equipment. Eg laptops, AV equipment OR files from central records office.	
Monitor alumni use, eg library use, shop, fitness etc - helps to understand alumni engagement.	
Use at public events to create attendance events. Help to monitor staff, student, alumni & public attendance	
Mobile readers for use at events not restrict entry though	
Credit a student's card instead of setting them up on payroll for ad-hoc assistance at events/during calling appeals.	
RALIC is not defined well enough. Very few people know what it is.	
RALIC system is not documented at all well. Nobody seems to understand how it works.	
RALIC data is backed up and can be restored if a disaster - recovery situation arises.	
RALIC services are resilient. The RALIC servers in Wolfson House must have counterparts in Foster Court so that RALIC continues to work during a power failure.	
Only security staff and a limited number of IS staff have access to the RALIC servers, i.e., the servers that control buildings access.	
RALIC data must be made available to other systems, naturally HR (Resource-Link), Registry (SITS), Library (Aleph).	
The system should have an efficient way of exporting the photos or library barcodes to external systems	
The system should not have the ability to import photos from Registry	
The system should be easy to maintain and support	
The system must be compatible with other UCL systems eg. HR, UPI, Portico	
The system should be written according to Management Systems standards	
The system should meet our security standards	
accurate feedback from RALIC of services provided to end-users (ID cards, library access)	
not require excessive modifications to UPI	
Resilient enough to not to break other UPI processes.	
ID management via UPI to goven access based on associations (staff/student/visitor)	
ID card status: Ability to check if a user has collected an ID card	
Recognisable cards e.g. for buildings without cardax access, security guards should be able to easily recognise a UCL ID card	
facilitate future online enrolment of students to reduce queuing	

Appendix H RankP Classification Questionnaire

The RALIC Project

Requirements Classification Survey

Please complete the following information about yourself.

Name:____

Instructions

The stakeholders of the RALIC project have provided a list of requirements.

Please match the requirements to their corresponding categories.

Below is the list of categories.

A. **One card**: Multiple functions in a card, e.g., ID, access control, library borrowing
B. **Card design**: A UCL branded ID card
C. **Security**: Increase security and access control to buildings
D. **Process**: Produce, issue, and monitor cards efficiently
E. **Library**: Provide and suspend library access and borrowing rights automatically
F. **Cost**: Save costs
G. **Other systems**: Integrate with other systems, e.g., student, staff/HR, visitor
H. **Data**: Improve quality, availability, and accuracy of card holder data
I. **Future**: Allow future functionality, e.g., time and attendance, cashless vending
J. **Development and support**: Constraints, standards, and technology
K. **Others** (please explain why or suggest new categories)

Student 1

ID	Requirement	Category
1	The card can be extended for future requirements, such as a digital certificate	
2	To have a card which would satisfy NHS requirements so that students could have 1 card that would be	
3	Interoperability with existing administrative systems	
4	Conformance with UCL technical architecture standards	
5	Potential for future extension of use for other authentication and authorisation purposes.	
6	System is maintainable and supported by suppliers for a minimum of 5 years	
7	System is able to continue operation of up-to-date hardware and server operating systems.	
8	Server software can be concurrently maintained on 2 server instances in different data centres, with seamless & unattended failover between them	
9	Server software is able to run in a virtual machine environment and this mode of use is supported by the suppliers.	
10	is the only id needed throughout UCL	
11	can be renewed/changed without card being present	
12	photo id	
13	readers can be easily installed in new locations.	
14	reliable operation even a few mm from sensor.	
15	system allows temporary cards for visitors.	
16	To improve the quality of the access systems database	
17	To reduce the effort needed to maintain the access systems database.	
18	To have clear business rules for eligibility for access cards, for staff, students and visitors	
19	To update the access systems database within five minutes of a change in card eligibility being made in the feeder systems	
20	To export photos to the student system, nightly	
21	To export access card changes to the library system, nightly	
22	To report leavers - people whose eligibility for a card has stopped - to the library	
23	To make the software interface easy to maintain	
24	To make the software interface reliable	
25	The system should be easy to maintain and support	

Student 2

ID	Requirement	Category
1	The system must be compatible with other UCL systems eg. HR, UPI, Portico	
2	The system should be written according to Management Systems standards	
3	The system should meet our security standards	
4	Photograph of user	
5	Control access to buildings	
6	have multiple uses (one card for many things)	
7	expiry date	
8	name of user	
9	student status	
10	name of department	
11	name of university	
12	To identify member of bloomsbury fitness through the bf's MRM database system	
13	To gather participation & attendance data	
14	To identify subscription type and expiry date	
15	To allow/deny access to BF via the security gates	
16	To allow/deny access to keys, equipment for the club officers	
17	To provide a means by which locker keys can be made available (i.e., a deposit in return for the locker key)	
18	Save money on purchase of smart cards from MRM	
19	Card should show name of cardholders & photo ID so that members do not transfer their cards to non-members 2 card mix ups are less likely to occur when locker keys are returned	
20	Save time in processing memberships and renewals, increase accuracy of transfer of information as some of the members details are on the card	
21	The card should be of a quality that lasts 5 or more years and be easily read by our card readers	
22	The card should not be designed in such a way that multiple individuals could make use of it	
23	It should not have so many features that would make members reluctant to have it as a locker key deposit	
24	entry to buildings	
25	clocking in and out	

Student 3

ID	Requirement	Category
1	borrowing books	
2	all these on one card	
3	One multi-purpose card, with photo.	
4	A card that is valid for more than one year, but can be centrally activated or de-activated, depending on student status	
5	Cards not really helpful for attendance monitoring in large groups.	
6	all software including packages and all oracle objects	
7	business rules documents	
8	requirements document	
9	design document	
10	To identify users when collecting computer registration details from user services	
11	To allow entry to the Kathleen Lonsdale building where the user services office resides	
12	To allow checking of the roles a person has in their department (e.g., DA, UG tutor etc)	
13	The UPI must be displayed in the card	
14	The persons photo should be displayed in the card	
15	Simple queries should be possible from any computer	
16	QoS: Software application needs to be able to switch to standby system in the event of hardware failure.	
17	Rule: Entire live system must perform network backup to off-site backup server	
18	Rule: Access to administer the system needs to be strictly controlled (limited to certain ip addresses and/or users via vpn)	
19	Rule: system is situated in central machine room(s) with redundant and backup power supplies and adequate air con.	
20	All students to have one ID card, with validity based on their enrolment status	
21	Should contain student number	
22	No longer needing to produce session cards	
23	To control who has access to departmental offices, so unauthorised people are not able to gain access to office equipment.	
24	To be able to gain access to different buildings, so that I can attend meetings and visit clients, so correct level access given.	
25	Access to UCL library on same card.	

Student 4

ID	Requirement	Category
1	Support all physical access requirements. - success criteria - all legacy cards & keys replaced by new system	
2	Support all "transactional" requirements where keyboard not possible or desirable - no other forms or "tokens" of ID need to be carried - eg.cashcard library cards	
3	form the basis of a computer security keycard authorisation scheme	
4	Should be remotely updatable\wipeable. Should carry a role ID which allows granular access\authorisation	
5	High levels of security but read at "further" proximity	
6	Hard to forge/duplicate/decrypt	
7	be cheap x 10p item	
8	Should be upgradeable (software revisions)	
9	Should allow automate attendance tracking	
10	The UCL shop provides a service as to where students & staff can purchase a replacement ID card.	
11	A single card providing for multiple use (access to multiple services)	
12	A card where access can be controlled (a) time (b) "basket" of services	
13	A sturdy/robust card	
14	Attractive card	
15	A card with an image/picture of the user	
16	A card with the details of the user	
17	A paper/cardboard card	
18	Data must be stored securely by Access Systems.	
19	Security Systems are aware how they store info & who can access.	
20	To reduce time spent queuing for access cards	
21	To carry less cards/ access items	
22	To have a ucl id	
23	To access university buildings & borrow library books	
24	As a credit/debit bank card or cashcard	
25	To ensure the right access to the right students at the right time	

Student 5

ID	Requirement	Category
1	To utilise recording to monitor attendance at teaching and assessment events	
2	To identify the student when required.	
3	To use for "purchasing" in terms of transcripts, payment of ceremony tickets etc.	
4	To deliver the cards in an easy way to avoid student queuing/delays	
5	To produce a cheap but secure option	
6	To enable suitable entry to students who require partial access e.g. exam resit students.	
7	To place card access on all buildings.	
8	To take into account disability issues/users	
9	RALIC data is backed up and can be restored if a disaster - recovery situation arises.	
10	RALIC services are resilient. The RALIC servers in Wolfson House must have counterparts in Foster Court so that RALIC continues to work during a power failure.	
11	Only security staff and a limited number of IS staff have access to the RALIC servers, i.e., the servers that control buildings access.	
12	RALIC data must be made available to other systems, naturally HR (Resource-Link), Registry (SITS), Library (Aleph).	
13	Access and data information for users of facilities, specifically Bloomsbury Fitness	
14	Access to buildings (25 Gordon St)	
15	Proof of student membership (to join clubs & socs, gain entry to bars etc)	
16	Library	
17	Student discount	
18	everyone should carry an ID card to have access to building	
19	visitors should be provided with cards saying they are visitors.	
20	those coming for lectures from outside (not from UCL) should also have special cards. It is not enough to just say they have lecture.	
21	In long run, using thumb reader. Some students lost their card, other people can use it.	
22	Use one card to gain access to all buildings for which I have permission	
23	Fast and easy to use	
24	Use the same card as my library card	
25	Card should not be easily breakable	

Student 6

ID	Requirement	Category
1	Allow management to track my movements	
2	To allow easy access to Bloomsbury Fitness using a single entry system	
3	To control access to Bloomsbury Fitness	
4	Within 12 months use a single entry system	
5	Staff should be able to view members entering the gym and log all visitors	
6	The system must be compatible with the Gladstone Membership Management System	
7	The system should have a lifecycle of 5 years.	
8	Must not involve significant new expenditure.	
9	Must not take more than 12 months for implementation	
10	To have a homogeneous solution for access related functions such as building access and library card.	
11	To enable smooth/efficient building access control whether via turnstile, or visual inspection.	
12	To be able to audit staff movement from a HR, estates management, security perspective.	
13	Individuals must not have access when contracts are terminated where this is the required behaviours	
14	Access to buildings and other services should be capable of being extended beyond date of eligibility where this is required and has been approved.	
15	Provide "all access" and "all areas" style cards to important people	
16	Provide cards to any eligible party. Staff, student, visitor, honorary prof….	
17	Ensure suitable information security - e.g. back-end data	
18	Ensure system failure does not result in restricted access	
19	All library members to be able to use a RALIC card for all "library business" (a) enter libraries through turnstiles (b) borrow books from staffed desks (c) borrow books from self service units (d) key in authentication details to use self-service online functions	
20	Card must interact with library member's borrowers record so banned/expired members cannot use libraries.	
21	RALIC data (e.g. unique ID) must be regularly and frequently transferred into library system to update e.g., expiry date of UCL student/staff send barcode data for new student/staff	
22	(1a) enter libraries through turnstiles so either libraries have proximity readers or card must have barcode printed on it	
23	(1b) borrow books from staffed desks (library staff computer must have proximity reader or card must have barcode) and card must have photo of owner	
24	(1c) borrow books from self service (ss unit must have proximity reader or card must have barcode) and card must have PIN	
25	(1d) online self service card must have barcode and PIN	

Student 7

ID	Requirement	Category
1	Any UCL site where there is a library must also have a RALIC - issuing office (in library or separate) to allow external people to join library	
2	Card must have unique ID	
3	Card should be usable as a payment mechanism for e.g. photocopying, refectory etc	
4	to provide/produce id smart cards to ucl members in a quick and efficient manner.	
5	to change access rights on cards and change times of access. Also using and creating access reports. All this should be quick and easy to do in the RALIC software.	
6	to provide a clear looking identification card that provides efficient access to buildings and easily readable bar codes for library use.	
7	to report on how often cards are used for access, identification purposes and library access which will tell us how important the card and the ralic software has become.	
8	to ensure cards are not programmed incorrectly for use on access to buildings not required by the user. to ensure that the cardholder does not let his friends/colleagues use their card for improper use.	
9	the system must be fully maintained by the programmers to ensure that the various software systems that connect to ralic in ucl are up-to-date and communicating effectively.	
10	to encourage ucl members that the new ralic id smart card is now an integral part of life whilst on ucl premises.	
11	Enable colleagues to enter the building easily	
12	Insure that equipment is secure by preventing access to rooms. currently a key is required a room by room system will be better	
13	Be able to inactivate lost or stolen cards	
14	Be able to view real time data about access (how many people are in the building at any given time)	
15	Reduce queuing	
16	Control access	
17	Security officer ID student	
18	System compatibility	
19	Cost saving on cards	
20	Easy to use	
21	Combining - clubs & societies member, gym membership etc. on to one card	
22	Clear specifications - hardware & software for installing Cardax	
23	The system must be compatible with existing ADS supported systems	
24	The system must have full vendor support for the cardax software	
25	Single card for all users	

Student 8

ID	Requirement	Category
1	Issued only to eligible students & cancelled when they become inelligible	
2	easy to read	
3	durable	
4	Clearly articulated business processes relating to whole lifecycle of ID and access card.	
5	clear policy statements	
6	set of rules regarding access rights - allowed + restricted	
7	documented processes of dependent systems e.g. HR joiner + leaver and student joiner + leaver	
8	technical documentation of UPI system	
9	don't want significant changes to processes or dependent processes happening in parallel.	
10	long lead time to go live to allow for pilot + revisions to interfaces.	
11	don't want multiple technology stacks.	
12	don't want changes to technology approach such as development languages e.g. oracle to microsoft	
13	easy to use system	
14	"one stop shop" - ie. All access levels for one members of staff set once, not for every activity/building separately	
15	ability to manage access to, for example, buildings without having to go through a central authorization process	
16	automatic reminders of access end dates for staff so that access can be reviewed + extended	
17	having to go through different central divisions to authorize or arrange access levels	
18	to be able to gain easy entry to the helpdesk front desk in the dms science library for all ucl staff, students, visitors etc.	
19	to be able to find out who has gained entry to cluster rooms/ IT rooms (this would help us identify people in cases where we are investigating abuse of services).	
20	card readers must be easily accessible	
21	smart card function could be used to pay for services such as photocopying or print charging	
22	cards must easily be replaceable if reported lost or stolen	
23	any data must be secure	
24	Clear description (from business stakeholders) of existing process	
25	Evidence of existing process performance (or under performance)	

Student 9

ID	Requirement	Category
1	Access to business stakeholders & their ideas for business improvement	
2	Tools to model new process & estimate changed performance	
3	Chance to review proposed changes to business process with stakeholders	
4	Chance to confirm with stakeholders business process requirements as identified to achieve desired change to business operations	
5	the system should be compatible with other ucl systems	
6	the system should allow for future additional functionality and/or integration with other central systems.	
7	it should be possible to incorporate additional information on the photocard/id card if requested by IS	
8	it should be possible to extend the system to manage access to the pc cluster rooms (e.g. to allow access to particular groups of students during specific hours).	
9	there should be an online system that allows approved staff in depts to allocate revise and revoke access (to rooms etc) in as close to real time as possible.	
10	there is a need for the dept to hold a batch of cards which can be issued quickly to contractors (to avoid delay)	
11	card to give access to special facilities (eg our computer cluster) for disabled students	
12	card readers should be easy to see	
13	card readers should be easy to reach (ie height accessible to wheelchair users).	
14	it should be straightforward to have cards activated / permissions changed / cancelled etc.	
15	to identify cardholders and indicate their associated rights to access IT services	
16	full security on all perimeter doors of all ucl buildings	
17	one system to cover all access rather than several independent systems	
18	clear reporting line to control centre that reports any potential faults	
19	easier use of system for input of personal data	
20	ID + access all in one	
21	UCL name not to be on card in case card is lost	
22	Provide a single card solution as per the pid.	
23	To impact minimally on Portico	
24	To allow me as a member of staff access to required buildings	
25	Provide a combined card to give cardholders all functions on one card. ID + access control card + library card.	

Student 10

ID	Requirement	Category
1	To populate access control system with personal data for central databases. Enable validity to be controlled by this data (expire when HR or Registry record expires)	
2	Provide a card that can be produced in one process of printing + encoding smart card chip with data	
3	Provide the automated granting of base level of access based on person type	
4	Produce visually appealing + difficult to tamper of fake card.	
5	Provide a system capable of producing cards fast enough to deliver at the beginning of the academic year.	
6	Ensure a platform for further expansion/use of smart card chip.	
7	UCL branding according to visual identity guidelines Design approved by DCCO	
8	colour coded for type of user	
9	Alumni version for library access inc online journals - in combination with alumni network card.	
10	Maybe - use instead of event badges so should have large clear name & job title & method of wearing.	
11	Maybe use as cashless purchase card (like Oyster) to buy merchandise at events.	
12	Not easily copied	
13	Allow late access to buildings for events staff	
14	Use to book out equipment, eg laptops, AV equipment OR files from central records office.	
15	Monitor alumni use, eg library use, shop, fitness etc - helps to understand alumni engagement.	
16	Use at public events to create attendance events. Help to monitor staff, student, alumni & public attendance	
17	Mobile readers for use at events	
18	Not restrict entry though	
19	Credit a student's card instead of setting them up on payroll for ad-hoc assistance at events/during calling appeals.	
20	Contactless and fast	
21	either - use cards with contact (x) - replace mifare classic with desfire - diversify the keys = upgrade all readers + software	
22	selectively allow guards to see pictures of people passing the gate	
23	Access control for ucl staff to ucl buildings	
24	Access via swipe or proximity	
25	Identity card that stores information on the holder	

Student 11

ID	Requirement	Category
1	Access must stop at the end of the last day of service	
2	Access control card must not stop working prior to end of last day of service	
3	The card must not cause staff to come to HR about access issues or card issuing	
4	ID management via UPI to govern access based on associations (staff/student/visitor)	
5	ID card status: Ability to check if a user has collected an ID card	
6	Recognisable cards e.g. for buildings without cardax access, security guards should be able to easily recognise a UCL ID card	
7	to be able to control the access to all buildings at ucl	
8	to make data retrieval easier for investigation purposes	
9	to turn all cards unto i.d. cards which is better for checking purposes	
10	to help the officer positioned by turnstiles be able to check the i.d + cctv image with a split screen access on their desk	
11	the cards should have a photo and name on the front/cover	
12	to give appropriate access to each individual	
13	to ensure a "one-card-fits-all" policy is completed	
14	cards should be reusable so they can be re-cycled	
15	no ucl logo should appear on the card in case they are found in the street. A 'secret' Return Address should be placed in the back	
16	Gain information about levels of use of the library and by which category of user	
17	To produce 1 card which controls access to all library sites and facilitates borrowing	
18	To bar entrance to all libraries by unauthorised users	
19	To achieve compatibility between the library's access system and other UCL systems	
20	To enhance the user experience of UCL's libraries by providing streamlined access with ONE card	
21	To reduce time queuing for cards in Access Systems	
22	To save money	
23	To provide digitial photos for security guards	
24	A single card that allows data exchange easily between HR/student/security and library system.	
25	A secure system that enables staff or student to access buildings or resouces	

Student 12

ID	Requirement	Category
1	Identification system which is unified between management systems, IS systems and HR systems i.e. photo, department, name and a standard id number accessible to all systems.	
2	Should achieve substantial savings in cutting down costs in maintaining paper trails, queing time, waiting time for staff and less time when different systems need to exchange data	
3	Have stable backup system to use in the event of an outage	
4	Allow a quick cancellation of services in the event a card is reported as missing/stolen or lost	
5	To control access to university buildings	
6	To have one standardized system fall access	
7	The system must be compatible with other UCL systems	
8	Security guards should be available to view cardholders photos	
9	To reduce the time a student spends queuing for access cards	
10	Enable additional access control	
11	Control access and egress from premises	
12	Put in place control measures in line with health and safety legislation	
13	assess a reviewing process to establish if the system fits with the needs of the stakeholders.	
14	Flexibility in the system is a must - this has to be incorporated in the review process to ensure that the system works for all	
15	Robust system which has the ability to distingush between stakeholders and non-stakeholders	
16	Single issue unified card system	
17	Unique card for staff which may also be students	
18	Enable users to verify access priviledges online	
19	for students - easy access to all buildings they require to be in	
20	no access to private offices via ralic	
21	To have one single ID card for access to all UCL buildings	
22	To use one ID card for library access	
23	A card that can be rapidly + easily produced for new staff on arrival at UCL	
24	Links to the Rlink System so that staff leaving UCL automatically have access denied	
25	Simple system for replacing lost cards (same as 1 above)	

Student 13

ID	Requirement	Category
1	Good quality/visibility/size of visual image on card to allow easy identification. Match + avoid abuse and sharing of cards.	
2	System that can track staff movements if necessary ie investigation of fraud or disciplinary matters - data easily accessed from system	
3	Cost effective system that produces robust cards not easily broken	
4	User friendly system which does not require a complex training programme	
5	Arrangements for carrying the cards that are convenient and likely to be adopted by staff.	
6	System that doesn't interface with Rlink	
7	The system must be secure with clear procedures for dealing with ID fraud/loss of data/loss of card etc.	
8	Clear policies must be in place for use of data, monitoring, etc.	
9	System must be cost-effective, i.e., a measurable improvement over a fixed period	
10	System must be safe (e.g. in case of power failure) and stable	
11	System must be extensible (given the above)	
12	The system should map user identity to the UPI, including group memberships and roles	
13	The card should permit extra data to be written to it in the future - for example, small cash amounts for payment.	
14	The cards and readers should permit reuse for tracking presense (e.g., student attendance at lectures, staff location tracking)	
15	The technology used should conform to ISD standards	
16	The system chosen should be open and extensible.	
17	The ongoing cost of the solution should be predictable	
18	The solution should be reusable as a smart card for use with desktop login software in cluster rooms.	
19	The rules for permitting access to buildings should be easy to view and easy to amend on a per-person basis.	
20	The system should have a demonstrated ability to continue working without interruption for hundreds of days (with the right infrastructure)	
21	ease of control of access of staff and students to different areas within our buildings and for different times	
22	ease of obtaining access cards for staff, students + visitors	
23	ease of granting additional access rights or removing access rights for cardholders	
24	ability to prevent sharing of cards with unauthorised personnel	
25	ability to view user access rights for our areas	
26	from above - ability to send requests/corrections online	

Student 14

ID	Requirement	Category
1	cabling infrastructure -> for physical connection to server fibre connection / copper connection utp	
2	landswitch which server connects to -> connects to gateway / router which provides internet connection	
3	security policy - who is allowed to access the server - antivirus -> make sure server is protected against viruses	
4	any information on the server is backed up regularly	
5	ensure that the service is resillient (backup physically in different location)	
6	explicit firewall rules that allow access to the RALIC server.	
7	maintenance aspect of networking: to upgrade both the hardware & software	
8	accurate feedback from RALIC of services provided to end-users (ID cards, library access)	
9	Not require excessive modifications to UPI	
10	Resilient enough to not to break other UPI processes.	
11	To be able to monitor access against competance/training requirements	
12	To control access to high hazard areas both in the main campus and in the satelite and "shared" facilities	
13	The system must have finite time-limitations and must have strict authorisation protocols.	
14	The system must not rely on a single security feature for access eg. Like a pin code in a bank card	
15	The system design should not be constrained by a card solution	
16	The system must be compatible with future proposed and planned strategies as when as being future proofed for a period to allow payback for the investment	
17	The system must fail - safe in event of power/IT loss.	
18	The back up system must be defined such that safety and security are not compromised.	
19	Distance arragenements for preparation of card for easy supply to part-time, modular flexible students.	
20	Appointment system for students as above.	
21	Arragements for one-off students?	
22	It must be of a compatible technology to the systems we presently use in UCL, and allow integration with other systems	
23	Any commercial constraints must fall within UCL policy and provide support and confidence in longer-term supply	
24	The cost must represent value for money i.e. the return must equal or be better than the lost after NPV	
25	Support and growth of the system must be ensured, both in terms of improvements from the supplier and internal support	
26	The system, as it governs access, must be compliant with fire regulations - i.e. it must fail 'open' rather than 'closed'.	

Student 15

ID	Requirement	Category
1	The data in the system should either be a single-point of truth - or subscribe to another single point of truth data set - there should not be two.	
2	The hardware must be replicated as a failover configuration and the software & data be backed up	
3	The project must ensure change management - communications / training and enforced usage where necessary - there must be high-level business sponsors - user uptake must be very high	
4	The project must ensure quality management - i.e. the system must meet with users' expectations of functionality & efficiency	
5	Compatibility of system with current MRM software	
6	Access allowance with smart card technology	
7	Speed of access	
8	Different entry methods, barcode, smart card etc on one card, confusing for students	
9	One technology for all systems	
10	To control access to buildings	
11	To access the libraries	
12	To display on card full names of user & photo	
13	to display on card status (student or staff) and expiry date	
14	card could be used as photocopy card - able to top it up with bank card	
15	ucl logo	
16	a card could be disactivated for banned users or for other reasons	
17	To control access to university	
18	To easy identification	
19	To easy book issuing	
20	Access to the library	
21	Access to work building	
22	Easier reading of the barcode by the scanner	
23	System Goal - A reliable integrated system that does not restrict the access process or delay it.	
24	Identification of an individual must be UPI, 1 person 1 UPI.	
25	Extraction of UPI must be automated, hence minimal/no human interaction apart from initiation & maintenance.	
26	Technical interface with UPI must be such that should the RALIC system fail, there will be no adverse affect on UPI	

Student 16

ID	Requirement	Category
1	Any change in use of UPI data must be informed to UPI team, e.g. public exposure of UPI data.	
2	The interface needs to be designed so that the maintenance of the interface should fall into the responsibility of RALIC team.	
3	Produce and create UCL IDs clearly, that work, produce barcode for Library.	
4	Applied Access - Reliable so people can open doors.	
5	Change Records	
6	Reports	
7	Provide a safe and secure environment for staff, students, and visitors.	
8	While providing security, enable staff and students to access building and facilities easily	
9	To enable efficient issue of cards without queuing, delay, or requiring staff or students to attend more than once	
10	To minimise the cost of security and access control to UCL.	
11	To interface with other system so that data is entered and maintained in one place.	
12	To be robust in operation and provide good value for money or in the planned life cycle.	
13	that it be compatible with the current network infrastructure and protocols.	
14	that it be secure at all its end points to ensure the network was secure.	
15	that the database version and type meets the ISD standards for platforming.	
16	that there is a full service & DR/BCP plan and that IS is included in the plans.	
17	that the card printers are secured as client devices	
18	that there is an agreed support contract for the card printers.	
19	that there is an agreed support contract for the card readers.	
20	that there is an agreed incident management process for handling RALIC incidents.	
21	that there is a clear budget for the project which includes all IS needed equipment and staff time.	
22	to control access to secure facilities based on levels of access.	
23	should be able to confirm identification within secure areas.	
24	should be able to provide accurate logs of use.	
25	control access to certain floors in the department - staff + students	
26	do not need to view photos of the card holder	