Data in the Garden: A Framework For Exploring Provocative Prototypes as Part of Research In The Wild

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ABSTRACT

Research in the Wild (RITW) typically involves the deployment of technology in a setting, using the methodology of 'probing' contexts, to change behaviour or enhance community practice. This way of conducting HCI research is becoming an increasingly popular approach. To help in this endeavour, Rogers and Marshall [28] present an overarching framework that considers the different aspects involved. As part of the framework, they stress the importance of the design of the technology to be deployed. However, they do not detail *how* researchers should go about this. Here, we propose how to fill this gap: by providing a more explicit and principled rationale as part of RITW, presenting a method for accomplishing this, and reporting a case study about community gardening that uses a provocative prototype.

CCS CONCEPTS

• **Human-centered computing → Field studies**; *Interaction design process and methods*; Mixed / augmented reality; Collaborative interaction;

KEYWORDS

Research In The Wild, Provocative Prototypes, Community Gardening

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1 INTRODUCTION

With the increasing embedding of technology into everyday life and the encroachment of interactive systems into shared spaces, many researchers in HCI are adopting Research in The Wild (RITW) as a methodological approach [28]. Specifically, RITW seeks to explore current practice and future behaviour by disrupting existing practice with the introduction of novel technology [26]. However, the exact nature and design of the technology to be deployed can be difficult to specify despite being a central concern for RITW. Here, we are concerned with how to explicate this aspect in a principled way that explores underlying thinking about the design rationale.

Any research project involves a diversity of decisions, from big 'headline' choices, such as method and theoretical framing, down to the minutiae of operational detail. Within RITW, there are arguably even more decisions to make with many uncertainties needing to be resolved as the project progresses [28]. As researchers, however, we often neglect to document and reflect on these decisions and their impact on our research and thinking [6]; this is true even of the 'hardest' of sciences [22]. One way of improving our research accountability is to make more explicit the rationale behind the many decisions that are made when conducting research by engaging in what Braun and Clarke call *"an ongoing reflexive dialogue on the part of the researcher or researchers"* [6]. In this paper, we propose an approach for helping making this process more explicit when conducting RITW. Namely, we focus on how to be principled when understanding the rationale for considering the selection and design of technologies as part of a RITW project.

To this end, we describe a framework for exploring which technologies to deploy in the wild, comprising a set of questions and decisions. In particular, these are intended to be used to structure a rationale for technology design in RITW and to address the tensions that can arise between 'community-led' concerns and 'designer-led' aspirations. To illustrate its value for conducting RITW we show how it helped us in the design, selection and deployment of a particular provocative prototype for supporting community gardeners in their planning and decision-making activities. Specifically, we show how it informed the choice, design and use of sensing and data visualisation technology that could provide real time data transformed into contextual visualisations of the environment. A key question was how to provide additional digital information about environmental conditions when deciding on how and where to plant that would augment the gardening activity while not getting in the way or taking the joy out of being there in nature.

2 BACKGROUND

2.1 Research in The Wild

HCI researchers are increasingly interested in what Rogers [26] calls the *everydayness* of life; *everyday* activities situated in real, messy spaces with multiple inhabitants and visitors (*ibid*). But how do they conduct research in such spaces? Whilst ethnographic and ethnomethodological approaches, imported into HCI in the 80s and 90s, are insightful for analysing and describing *current* situations, they lack the ability to *"proffer suggestions of a possible future"* [4, 13]. Alternatively, approaches such as probes and breaching experiments have been used that go beyond current practice and enable possible future explorations [7]. Cultural Probes, for example, were introduced by Gaver et al. [9] in 1999, with the goal of exploring potential gaps for technology interventions in unfamiliar communities without wanting to superimpose their own designs but at the same time not wanting the communities to constrain their creative designs by focussing too much on their particular needs.

By disrupting practice and examining behaviour change, using conceptual, design or technical probes, it is hoped that research ideas and future designs can be explored in context. In particular, *provocation* or *disruption* are techniques that allow the researcher to observe behavioural change [26]. An outcome can be wild theories *"emerging from the cross-fertilisation of alternative theory, findings from in-the-wild studies and contemporary social concerns"*. However, the exact nature of the provocation at the heart of the in-the-wild study and how to develop it is not specified.

RITW is also viewed as being broad in scope and *"agnostic about the methods, technologies or theories it uses"* [28]. This makes RITW highly adaptable to different research contexts, but also leads to a myriad of decisions to make and parameters to tweak, the approach to which will vary wildly depending on the context and motivations of the research. One constant, however, is that RITW involves not only observation but also active disruption through the introduction of technology.

Whether custom-designed or off-the shelf, the design and selection of the intervention in RITW is a vital part of the approach. However, researchers often gloss over this part of their reasoning when reporting on their research making it difficult to understand the choices made. Unlike the scientific paradigm, where there is a protocol in place to describe the procedure behind an experiment and the thinking underlying hypothesis generation, it is less clear what the research thinking is when researchers decide on how to *create* a technological intervention.

2.2 Which technology?

So how do researchers decide given that there is a huge array of technologies and interfaces they can choose from? Preece, Sharp, and Rogers [24] catalogue 20 of the more prevalent types of interface that have been developed and used over the last 10-30 years, and this is by no means an exhaustive list. It is possible and affordable to choose almost anything from this 'buffet' of technologies, from the more mundane techs such as web and mobile [13], to the more 'exotic' ones, such as tangibles [10,15] and robots [30,21]. Do researchers tend towards what tech is the 'flavour of the month' (e.g. VR) or which is easiest to program (e.g. an app)? Or is there a principled process involved? If so, how?

One rationale has been to consider sustainability and practical aspects. Balestrini et al. [2], for example, deliberately chose to use a collection of 'off-the-shelf' technologies - mobile phones, YouTube, QR codes and Google maps because of their availability and accessibility. These 'locally available everyday technologies' were used in a community history project to maintain engagement and sustainability, and to encourage uptake through familiarity and ownership. The project also reported practical advantages of using existing technologies, arguing that they support sustainability of the project, as the ongoing maintenance of the technology deployed does not require researcher intervention. Other researchers have been more concerned with how to deploy new technologies in settings, such as ambient displays and sensor-technologies, so as to embed them into the environment in ways that are fitting and yet also stand out to be noticed in order to change behavior [27].

2.3 What Motivation?

There are usually various motivations for a research project and its grounding that need to be taken into account. One such focus is the empowerment and engagement of the community. These framings suggest constraints, such as cost, user acceptance, usability, potential impact on behaviour and level of user involvement. For example, a design can be constructed purely based on the social commentary, making use of design guidelines and frameworks to support a principled approach. However, in order to contextualise the design, it is important to know more about the target area. In some cases, the context could be driven by a community request (as in [10]).

Whilst such community-driven initiatives often capture contemporary matters of concern, by their nature, it is also possible for such contemporary social issues to take centre stage. For instance, [20] used mock sensors to investigate 'activating spaces', driven entirely by political concerns. This use of mocked-up sensors (colourful cardboard boxes) demonstrates that the technology in question does not have to be *functional* to be useful as a probe. The selection of 'low tech' materials can also be driven by community concerns; Koeman et al. [19], for example, used chalk graffiti for representing voting data, to avoid screen aversion in public displays and to make it widely accessible to the general public. The voting data was collected with physical voting boxes, highlighting that deployments do not necessarily consist of a single type of technology or interface.

2.4 Which Kind of Prototype?

A prototype can also be used instead of a fully functioning technology, introducing it to everyday contexts where it doesn't yet exist. For example, Kuznetsov et al. [21] introduced wall crawling robots to public spaces, in essence, to see what would happen. Alternatively, the prototype can be more heavily driven by a *specific* technology or product; by introducing a novel technology into its intended context (such as in [32]), or an existing technology to novel or unintended contexts. Another kind of prototype that has become popular is the *technology probe* [16] which are viewed as *"...not a prototype, but a tool to help determine which kinds of technologies would be interesting to design in the future"*. Heyer and Brereton [12] argue that the broader body of techniques that grew out of technology probes may be better described now as *exploratory prototypes*, since many do not have the 'required' features of probes (such as being longitudinal) or of technology probes specifically (such as self monitoring). They argue that *continuously usable prototypes* are the ideal as the goal is to evaluate the use, misuse and non-use and also to rapidly update in response to the observed activity. However, these continuous use prototypes are most viable for scenarios where existing technologies are used and usage is explicit and intense. It is also possible to argue that this focus on single continuously usable, updated prototype places emphasises the more context-appropriate elements of the design; it is well suited to improving mature technology or established practices, but lacks the *provocative* nature that cultural probes were seeking [9], and that Boehner et al. [4] argue is the element that is often lost in 'probes' in HCI. This balance between contextual appropriateness and provocation is discussed by Auger [1] in the context of 'speculative' design in design fiction; they argue that provocation is vital as *'If a design proposal is too familiar it is easily assimilated into the normative progression of products and would pass unnoticed'*, but also that going *too* far can lead to *'revulsion or outright shock'*.

A central concern in RITW is to decide upon the role such prototypes will serve at different stages of the project. Is it to engage communities, to elicit feedback on an evolving design, to provoke responses or something else? And how can we design to best serve these roles? Below, we suggest the idea of a using a provocative prototype to encourage researchers to reflect on their design decisions. Underlying this debate is the importance of clarifying what kind of probe one is using as it can help towards choosing which kind of technology and functionality making more explicit the rationale.

The aim of our research is to provide a conceptual framework by which to explore the *provocativeness* of prototypes when choosing potential technologies. There are many different ways of conceptualising provocativeness. For instance, [25] discuss using three axes of provocation from critical design: functional, aesthetic and conceptual provocation, which can be used to structure an approach. [5] also offer some practical guidelines; 'Balance between inconspicuousness and intrusion' and 'Maintain some mystery, but explain eventually.'

Regardless of how it is operationalized, we argue that thinking about the 'provocativeness' of different dimensions of a prototype can help a researcher to structure their approach to RITW, particularly in tackling tradeoffs between community goals and contextual appropriateness, and researchers' theory driven goals: where should your prototype be on the scale of continuously usable to extremely provocative?

3 METHODOLOGY

Here, we present our approach to structuring the rationale behind the choice of technologies for deployment as part of a RITW process. The framework proposes a reflective approach, comprising two core questions for the researcher to ask themselves, the answers to which are intended to inform four further decisions for (i) Selection of technology, (ii) Modality and representation, (iii) Spatial and temporal scope, and (iv) Fidelity of prototypes. The questions are based on the process of understanding what the researcher is intending to do with a provocative prototype. The process of making these scaffolded and reflected decisions, with further exploring the details, are intended to feed back into the initial questions, changing the scope and intent of the research.

Most RITW processes realistically involve more than just the final deployment - these questions and decisions can also be applied to each research activity throughout a RITW process. Indeed, it could be argued that one way to constrain the design space is to explicitly approach RITW, not as a single deployment, but as an iterative research process that includes this kind of 'grand deployment'. Next we describe how we extended the RITW framework to accommodate provocativeness.

4 EXTENDING THE RITW FRAMEWORK

Rogers and Marshall [28] present a framework for understanding RITW projects, consisting of four inter-related 'cores': Theory, In-Situ, Design and Technology (see Fig. 1). These cores allow the 'scoping and operationalisation' of the project. This is useful for characterising projects from a 'top down' perspective, such as at the end of a project or during planning. However, although the inherent interconnectedness of the model represents the interdependent nature of influences in RITW, the lack of an ordering or natural endpoints does make it difficult to know where to *start*. It is possible to extend frameworks at this conceptual, broadly scoped level – for example, [11] added an 'understanding' phase to the traditional User-Centred Design model. However, rather than add another core, we elaborate on the methods that can be adopted within the framework at a more granular level. One way to do this is to consider that, although the four cores can be looked at from a 'project' level, during the research the perspective of the researcher moves around the structure, and the nature of the influence of the cores changes.

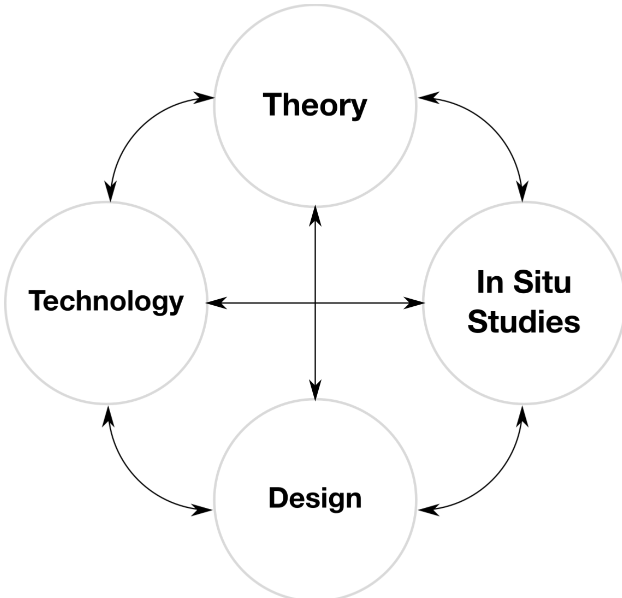

Figure 1: RITW framework from Rogers and Marshall (2017)

As such, we can see that when we are 'standing on' the Design core, we can imagine a shift in perspective (see Fig. 2). The refocus on the design node of the graph, and the edges connecting it: Technology, Theory and In-Situ (marked A, B and C in Fig. 2).

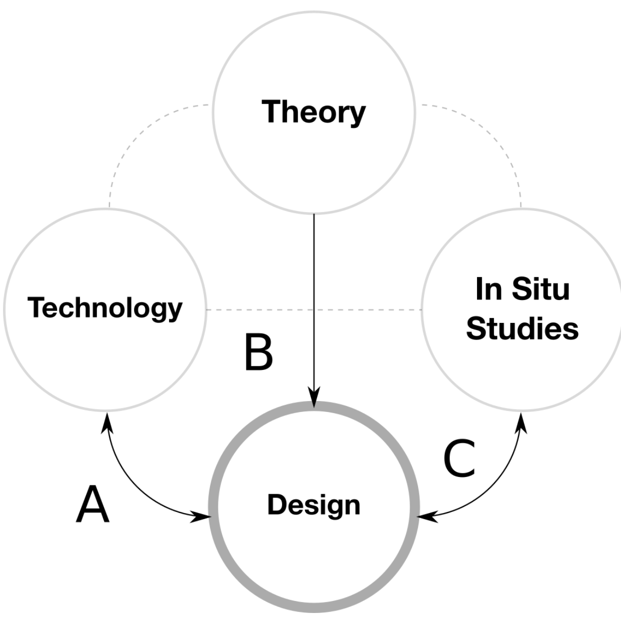

Figure 2: The adapted RITW framework

Edge A: *Technology, not primarily in the sense that it restricts what you can do, but in the sense that it affects the community; e.g., updateability, sustainability, level of engagement, importance of appropriation.*
Edge B: *Theory, in part as it shapes the goals and in part as it applies to the intervention; doesn't have to be the same theory.*
Edge C: *The In-Situ inputs here are contextual information from previous studies, and what is known about the community. The In-Situ core is broader than studies alone, covering 'context' more generally.*
These three edges let us consider 3 motivations:

A. Fixing something in the world (In Situ focus)
B. Using something in the world to explore theory (Theory focus)
C. Introduce novel tech to see what happens (Technology) focus

The motivations are not necessarily orthogonal. However, there are trade-offs; for example, 'community-led' concerns and 'designer-led' aspirations, and the tension between augmenting current practice and finding out something new.

4.1 Core Questions

In addition, we suggest asking a set of core questions at this stage, namely:

(i) What do you want to understand and achieve? Are you solving a community problem, or finding something out? What mix of the three motivations are most important?

(ii) How provocative should the prototype be?

A distinction should be drawn here between intermediary and final deployments; the goal of *this specific deployment* isn't necessarily the end goal.

The important thing is to consider each aspect of the design in terms of how it will provoke, and how this provocation will help answer the understanding/achievement question, and to reflect on it while making design decisions. Different aspects of the system can have different trade-offs, especially for systems that are distributed across a space; different levels of provocation may be appropriate for different elements.

4.2 Core Decisions

Following this, we suggest explicating the following four decisions:

1. Selection of technology - By this we mean, which broad paradigm or paradigms? What things to use and how? For instance, a technology might have high familiarity, but may not be context appropriate; or it might have high appropriateness, but not provoke interesting behavioural changes and responses.

2. Modality and representation - How is the deployed system represented to people? This applies from high-level choice of modality, all the way to specific interface details. For instance, tangibles might be minimally invasive and good for gently augmenting a particular community practice, but not help a researcher understand how access to a completely novel data source would impact the community.

3. Spatial and temporal scope - How long should the deployment be for? And where should all the parts go? Is it important to remain embedded in the community after the research? [5] talk about provocation *on encounter*, *on use* and *on reflection*; the temporal scope will affect the choice of level of provocation at each point, and equally the decision to focus on a particular type of provocation could inform the temporal scope.

4. Fidelity of Prototypes - Which parts of the prototype really need to work, with what kind of depth, and how should it look and feel? A central question is whether a professionally designed prototype is needed or is it better to use a low tech one? Should it look like a real product, but be non-functional?

5 USER STUDY

The *context* of applying our framework was to help a community carry out decision-making tasks in situ – in this case using environmental data when making planting decisions in community gardening. In particular, we were interested in exploring aspects of sensing an environment and activities to augment in an outdoor garden setting rather than designing a solution for a specific community garden.

The initial motivation was that sensing technologies have demonstrated benefits in commercial settings [31, 8], but have not been used in a community context. However, previous research has also shown that food growing communities are resistant to technological augmentation of their practice [23]. Although some have argued that this concern makes technological augmentation in this domain inherently unsuitable [10, 14], it can also be argued that it is the specific design of such technologies that is problematic rather than 'technology', *per se* [3]. The tension between being appropriate to the garden context and seeing how novel technology can be designed for that context makes this a challenging environment for designing a RITW intervention and hence one where a framework could be helpful in the initial stages of decision-making.

To begin, we conducted a series of contextual interviews at various community gardens to understand better the current practices, goals and technology use of these groups. This was followed by a co-design workshop with community gardeners to explore their values in relation to placing environmental sensors in the garden. Based on the outcomes of these studies, a provocative prototype was then designed and deployed in a community garden in order to elicit responses to different types of situated data in the wild.

The reflection that took place when considering which provocative prototype to develop and which technologies to use explored the value of providing *situated* and *overview* representations of environmental data in a community garden. These two perspectives were considered as possible ways of providing additional data to gardeners at the point of decision-making and problem-solving while planning what to plant in a community garden. The idea was to provide a level of digital augmentation that would not be perceived as tech getting in the way of being at one in the garden but which could enhance what can be complex decisions to make. We selected 'emplaced' sensors to enable us to probe the spatial aspects of where to collect and which data to use. For the prototype display itself, we selected Augmented Reality (AR) and map representations. Specifically, the provocative prototype was chosen to explore how the use of an augmented reality app could overlay light level data on (map) representations and whether this might provide contextual information that could help community gardeners in situ. We built the sensors and made the prototype applications specifically for this study, so that we would have as much control as possible over the design of the artifacts.

When considering which technology to use we looked first to 'precision agriculture' where there seem to be two main types of sensing: remote sensing and environmental sensors. Multispectral sensors that can 'see' photosynthesis can be adapted from digital cameras, and mounted on drones, kites, or head mounted displays, but we found their usage to be largely interpretation focused. Specifically, when piloted during the design workshop, multispectral sensors were perceived to be overwhelming and the interpretation unclear as to provoke interesting responses. Environmental sensors are enough within existing understanding not to need substantial scaffolding – the multispectral imagery went beyond everyday provocation.

5.1 Motivation

During the initial phases of the research (see [17,18]), it emerged that community gardening practices were largely 'ad-hoc' and situated, although we observed both situated and overview data artifacts in gardens. Following this, we asked ourselves the core questions from the framework:

What do we want to understand and achieve?

A main concern was how to probe the different effects of situated and overview data on community practice – without getting in the way of current practice and compromising the community member's values about technology. We wanted to find out whether there might be a sweet spot of new real-time information we could provide in different settings to aid their planning and decision-making. Might these be different – depending on whether a gardener is in the garden or a potting shed? How might they bring these together? Furthermore, would light levels be of most interest to the community, since they are visible and understood by community members, but change over time and in a more granular way than is generally understood. For example, in the UK shadows are cast North more than South due to the latitude, so areas to the North of shadow casters will get less sun than areas to the South. We assumed that this kind of information is not easy to remember or apply and that if it could be provided in the moment might be assimilated when thinking about what, where and when to plant.

How provocative should we be?

When answering this question, we considered whether using sensor technology to obtain the data should have a low provocation level, and be running in the background. Also, at a practical level, we considered the extent to which the presence of sensors in a garden might become a theft risk. We also considered whether the data representations arising from the sensors needed to be towards the higher end of 'everyday' provocativeness. Did they need to elicit feedback in a short session rather than continuously over time?

5.2 Sensor Deployment

We deployed a set of four light sensors (Fig. 3) in the garden, identifying areas that were of interest but had different light readings (Fig. 4). Two of the sensors were placed at the north and south of a raised bed. The other two were placed in two adjoining beds to the north, at the foot of trees in each bed. The sensors were set up to capture light measurements every 15 minutes for three months. To protect the sensors, small food containers were used; this 'found materials' aesthetic is common in the target community and judged to be of low provocation.

Figure 3: A light sensor placed in the community garden to measure light levels

5.3 Prototypes

Two types of provocative prototype were developed: Situated and Overview. The rationale for using these was the potential for offering gardeners additional information otherwise not available to them while in situ. The objective was to help them to make planning decisions about what to plant and where – depending on being provided with extra information about the way the light and shade changed through the day. These were viewed using a tablet while walking around the garden.

The Situated prototype was designed using an Augmented Reality (AR) overlay to show real data collected over time, where the sensor data was rendered from the device camera in such a way that it aligned with the real-world location of the sensors (Fig. 5). The Overview prototype provided a schematic map view on which the same sensor data was depicted (Fig. 6). Both prototypes bind the data to its location; the Situated prototype does this in a three dimensional, first person reference frame whereas the Overview prototype uses a two-dimensional frame of reference. As a result, the Situated prototype only displays data which is in its field of view, whereas the Overview prototype always shows all the data. This difference in degree of physical abstraction is the main difference between the two prototypes. The data in both prototypes was presented using a simple line graph (Fig. 7) with mean light levels shown for each of the 24 hours in a day.

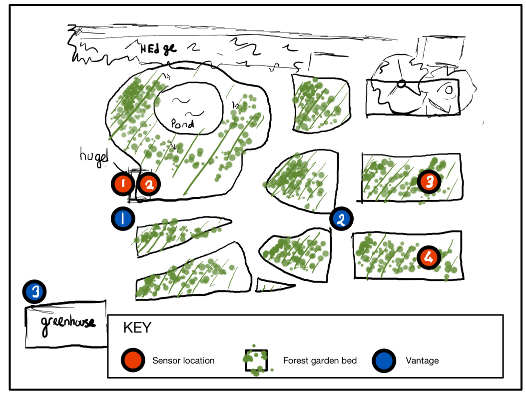

Figure 4: Sensor placements in the garden (the map also shows where the prototypes were planned to be used)

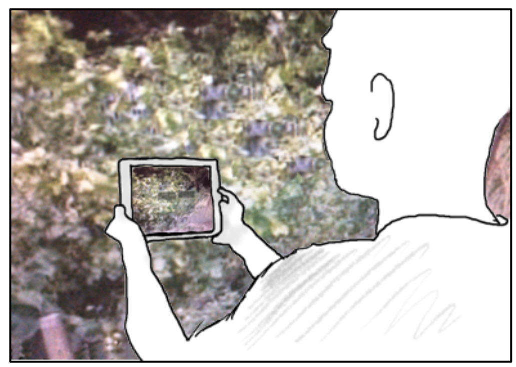

Figure 5: A participant looking through the situated prototype

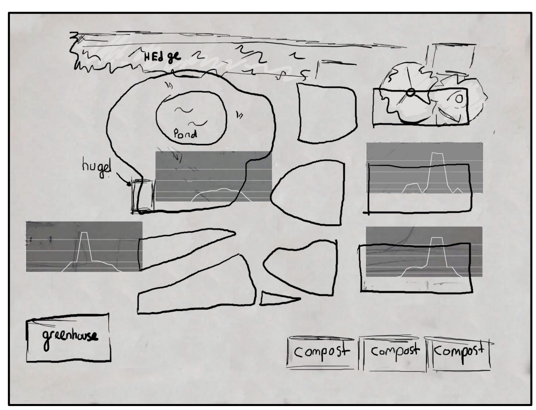

Figure 6: The overview prototype

Augmented Reality was chosen to present the light level data as it can overlay the place where the decision-making needed to take place. This kind of representation, however, was novel to the participants. The representations chosen were deliberately simple line graphs. This followed an initial trialing of a number of complex and novel representations. These however, proved difficult to understand in situ – even though some of them might have appeared as 'better' designs. A tablet was used to present the augmented light levels in the AR form, with the further aim of provoking speculation about the technology and what it could be used for.

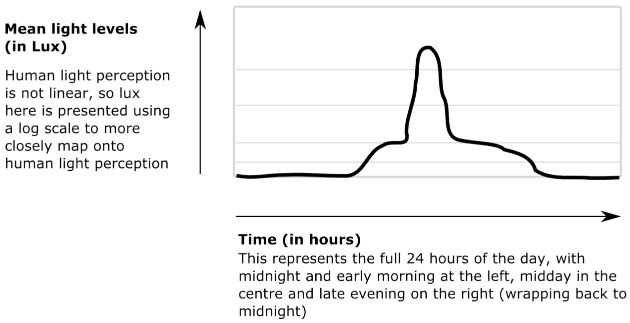

Figure 7: Line graph of mean light levels per hour, that was used in both overview and situated prototypes

5.4 Participants

Six participants (five female and one male) were recruited from a community garden, through a combination of opportunity sampling and snowball sampling. All were experienced volunteer gardeners, with at least 2 years of experience of both gardening and volunteering in different types of gardens.

5.4 Setting

A community 'forest' garden in London was chosen as the site for exploring the two prototypes. Forest gardens attempt to emulate a forest edge ecosystem, by focusing on sustainability, biodiversity and utility. The aim is to create complete ecosystems; the selection of appropriate plants and design of the ecosystem is a complex problem where additional data inputs could be especially valuable, making this a particularly interesting type of community to investigate.

The site was roughly 25m by 75m, of which around 25m by 20m was actively managed by the community. It was a rectangle broadly aligned North-South, with the long 75m edge of the rectangle being North-South and the short 25m edge being aligned East-West. A square edible showcase bed was located near the entrance to the site to the South, and a number of forest garden beds were planted to the North, shading a number of mature trees.

5.5 User study

Participants were informed that the study was about using data collected from light level sensors placed in the garden. They were shown one of the sensors, and told that there were three others in the garden, all measuring the light levels in the different locations. During this initial phase, the researcher asked questions about their current practice, especially relating to planting.

The participants saw their day-to-day activities as being primarily about maintaining the garden. They also saw making large changes to the garden as being a *design* activity. For example, p2 said: *"with something like a forest garden, most of the effort is... is in the establishing of it, and the setting it up ... and then after that, you kind of ... letting the natural ... processes kick in and you know, the ... so it needs less management anyway"*. Participants reported that most planting decisions were done collaboratively in the garden. For example, p1 described the following as a joint action: *"umm … I think [community champion name] said oh we could do with some ground cover and I said oh we've got some strawberries…"*.

The researcher then presented the participants with the *situated* prototype. The participants were asked to look through it at the raised bed, and view at the same time, two of the superimposed sensor graphs. The researcher gave minimal prompting to the participants as to what to do; using open prompts to facilitate discussion, such as *"tell me about this* [while indicating tablet]'" or *"what is this telling you?* [while indicating tablet]". After the initial exploration, the researcher gave the following instructions: *"1. Imagine you have some [plant that prefers sun\shade] that you want to plant. Show me which of these areas would you plant it in.*

2. Imagine you want to plant something in this area [indicate an area]; Tell me what would you plant there."

The researcher then guided them to nearby pre-set vantage points with a known location. These vantages were chosen to allow probing of particular aspects; for instance, position 2 allowed the participant to see the Northern sensors and rotate around to see the Southern sensors, and position 3 allowed the participant to see all of the data from the four sensors at the same time. The *overview* prototype was then introduced. This was also presented via the tablet and similar activities were carried out. The session ended with a 10-minute discussion and debriefing.

5.6 Findings

The audio recordings from each participant were transcribed and coded, and analysed using thematic analysis [6]. Overall, it was found that there was a preference for using the Overview map prototype compared with the Situated one. The reason for this preference seemed to be that they could envision how it might help them more readily when designing the beds and deciding what to plant where.

Situated Prototype

The line graphs were understood by all participants, with all of them identifying that the x-axis represented 24 hours and the y axis represented the light level. P2, for example, said "*uh that's probably the peak 24 hours so that is the night and that's midday and this is the one behind so it takes less sun because its all covered* *by ... the plants."* Two of the participants initially struggled to grasp the concept of the Situated prototype. Despite understanding that the data was related to the garden area they were seeing, these participants appeared to find the idea that the data was spatially bound to the sensors challenging; both P1 and P5 asked why two graphs were visible on the raised bed. When pressed, both suggested the second graph might be moisture, indicating that it wasn't clear to these participants that there was one graph for each light sensor. Later, P1 asked: "*why could I see the plants through the screen? Was it ... to make me feel more comfortable?',* suggesting that these issues with understanding may extend beyond initial use.

Two other participants started discussing how they could use the information for making decisions, for example, P3 said: *"like if I uh, if I'm planting I dunno sunflowers that needs full sunlight or a hydrangea that needs shade I would know..."*

The participants also appeared to combine the information available in the graphs in the situated prototype with their existing knowledge of the garden and light conditions rather than seeing it as completely new information; for example, P1 said *"... I'll know from the direction... it might help ... on a more micro-scale... cos obviously the hügelbed is gonna cause some amount of shade that the other side and maybe ... maybe people wouldn't have thought of that".* P3 on looking at the sensors on either side of the bed, then proceeded to work through explaining why there was a spike in the graph on the left (the Southernmost side shows a large spike at midday but the Northernmost does not). After a few minutes of talking through why this should be, P3 then exclaimed *"but of course it's all obvious".* Later, she reiterated that the Situated view wasn't useful because it was obvious that the light would be different.

The participants also suggested that something other than light might be more useful for conveying as a graphical overlay. These included moisture levels, frost, wind, and photosynthesis.

Overview Map prototype

The participants struggled to localise the positions of the sensors on the Overview map. However, despite this, all participants stated a preference for the Overview map prototype. Three of the participants mentioned that the Overview prototype would be useful in designing gardens, and discussed the desirability of having parts of the prototype map view combined with parts of the physical maps. One participant also specifically wanted *"those graphs on this map"* and another wanted to be able to *"click on the map and get… all the information".*

Discussion

The two prototypes were able to provoke a range of responses but at times the visualisations proved difficult to understand in situ. Two main uses for them were suggested: one which emerges in the day-to-day maintenance context and the other in a garden design setting. Despite the participants' conceptualisation of the day-to-day context as maintenance, much of what gets done during this phase also leads to changes to the garden. This suggests that much of the shaping of the garden occurs during the emergent maintenance phase and where additional augmented information may be quite useful.

Moreover, it appears that when data is presented as an overview, it can lead to the generation of new insights in the maintenance tasks. However, most participants didn't recognise this; they indicated that it was obvious, or stated that the prototype would be more useful for a different kind of environmental sensing, such as moisture levels. Possibly, the new knowledge provided from the augmentation, was internalised through the process of thinking about it with the data from the graphs – that it then seemed obvious. For the participants who seemed to be understanding something new, the data appeared to be a trigger to applying domain knowledge; specifically, the surprise on discovering that one sensor should have such a drastic spike which the others did not have. It is even possible that the data itself is not the most important factor, but the reframing of the task at hand - simply presenting ambiguous data or an information-free reframing device could lead to similar reflections.

The local reframing of planting and maintenance tasks when provided with situated data could lead to more optimal decision-making emerging in the garden in a non-intrusive manner. The fact that the participants did not realize they had altered their understanding suggests it was readily assimilated. The finding that the overview prototype was considered more useful might be due to the nature of the data as being perceived as being more useful for design tasks. It being more abstract might also have led to the participants perceiving it as being less disruptive to the garden.

6 HOW USEFUL IS THE FRAMEWORK?

From the case study, it can be seen how the expanded RITW framework helped us to think more about what kind of prototypes to design, what kinds of information to present, how these might be used in situ and when it might not be suitable to use a given type of interface. This suggests, it might also help other researchers frame the potential pros and cons of a selected prototype. In particular, our case study has shown how exposing the intent and rationale behind the design of a prototype during this part of a RITW process, allows the researcher to critique their thought processes and assumptions.

It also helped us to explore the notion of provocativeness in terms of what *kinds* of prototypes to build rather than focusing on usability or design guidelines. By thinking about how provocative each element should be, we were able to help overcome tensions between research and design. For example, by considering that the graph representations were not supposed to be provocative in themselves, we were able to select a simple representation that was easy to understand when used in situ – but which was not as aesthetically pleasing or informative compared with other ones we had considered using.

In some ways, the 'how provocative?' focus allows the overcoming of biases towards polished or novel interfaces when they are not needed; [25] argue that within HCI we often design things that are 'beautiful' or at least 'best-practice' without making an explicit choice or reflecting on how this representation will affect responses to the design. Similarly, having a focus on provocation can also help to overcome a desire to make something *useful.* RITW projects often involve a long-running relationship with a community, and it can be difficult not to slip into building a system to 'help them now' rather than a system to 'find things out'. Assessing each element for provocativeness helps to focus on the wider aims of the research, rather than the immediate 'design task' which may call for gently augmenting current practice.

The case study reported here was driven mainly by theory and previous in-situ results. Would this focus on provocativeness be as applicable to a RITW project with a stronger technology or design motivation? What about in the case where a professional designer is hired (such as in [10]), or for larger multidisciplinary teams common in RITW projects? We explored one kind of potentially helpful technology, i.e. augmented reality. In doing so, we were able to explore many ways of considering what to emphasize or push in a prototype. Furthermore, we argue that our extended RITW framework has much potential for providing a more principled approach to help frame research questions, explore trade-offs and understand the underlying rationale, which may otherwise remain implicit.

7 CONCLUSIONS

RITW is a broad umbrella term [28] encompassing many different motivations and contexts and giving rise to a wildly diverse range of possible interventions. The designs of these interventions can have a huge impact on outcomes. Here, we have shown how a RITW project can benefit from exploring, in a principled way, the rationale behind the technology selection, design and deployment of a prototype in-situ. Embracing a more focused process, and making our design decisions explicit and reflexive, allows for a better understanding and to better inform our thinking as researchers and designers.

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