

CORRESPONDENCE AND NON-CORRESPONDENCE

Using office accommodation to calculate an organization's propensity for new ideas

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ABSTRACT

Correspondence or non-correspondence is one of the early space syntax concepts, originally proposed by Hillier and Hanson in 1984 in 'The Social Logic of Space'. Describing the overlap between spatial and transpatial solidarities, Hillier and Hanson argued that socio-spatial systems with high degrees of correspondence are systems in which the transpatial category of people (kinship, gender, profession, beliefs, etc.) tightly overlap with their ordering in space, hence similar people occupy proximate spaces. This creates an exclusive system with strong boundaries. The opposite case, a non-correspondence system thrives on openness, is inclusive and brings people together across multiple scales.

We maintain that this essential description of socio-spatial relations has received relatively little scholarly attention over the last decades. Reviewing the literature, we argue that the theory of non-correspondence can unlock why and how organizations are able to innovate and enable the emergence of new ideas.

Thus, in this paper we provide a fresh perspective on correspondence by examining organizations occupying office space. On the basis of an odds ratio, we propose a way to calculate the degree of correspondence or non-correspondence in the socio-spatial system of organisational workplace accommodation using various data sets including the office layout of an organisation, the organization chart, the seating plan, visitor counts, observed space usage and observed interaction data within and across transpatial groupings.

Bringing detailed data on two case studies to bear – a law firm and a research organisation – we highlight different interaction profiles of correspondence or non-correspondence. We use this quantitative analysis in conjunction with qualitative data identifying organisational cultures and operational contexts those organisations were placed in, so that we can judge innovative potential and the propensity for new ideas to emerge in these organisations.

Findings suggest that the law firm operated predominantly as a correspondence system and the research organisation showed high degrees of non-correspondence, particular towards visitors. In both cases, however, subgroups with the contrasting organising principles of correspondence and non-correspondence were found

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nested inside at the group level. In both organisations correspondence offers the key to understanding how and why innovation emerged or did not emerge.

Therefore, we provide a new way of understanding organisational innovations arising from spatial and social conditioning. Rather than treating spatial and social factors in separation, we bring them together. Embedding spatial thinking in management theory and management thinking in spatial theory allows us to make a truly novel and interdisciplinary contribution, which is valuable for further theory development, but also to practitioners in both domains. By developing a rigorous and repeatable method for quantifying the degree of correspondence or non-correspondence in the socio-spatial system of an organization's workplace accommodation, we can highlight the contribution an office layout makes to the emergence of new ideas in organizations.

KEYWORDS

Socio-spatial systems, Office buildings, Correspondence, Interaction, Innovation

1. INTRODUCTION: ON THE IMPORTANCE OF (NON-) CORRESPONDENCE

In ‘The Social Logic of Space’ Hillier and Hanson (1984) built a case for understanding the interplay between social and spatial structures. One commonly cited theory aiming to explain social behaviours as directly related to space – the theory of territoriality – was critiqued by the authors as deterministic, limited and troublesome. Territoriality, they argued, assumed that all human groupings would claim and defend a territory against outsiders, therefore in effect stating that there was always an overlap between socially identified groups and spatial domains.

In contrast, Hillier and Hanson offered a different reading of how social groupings and spatial domains might relate to one another, challenging the tight match put forward by territoriality. Arguing for ‘differential solidarities’, the authors proposed two fundamental rationales for relationships between human beings to form: firstly, all humans belong to a local, i.e. spatial group through their bodily presence, and secondly, humans belong to a number of socially defined categories, i.e. transpatial groups. A prominent example Hillier and Hanson use is the case of academics, who belong to a particular university, which is spatially grounded, but also a discipline, which is socially and culturally defined and unites scholars worldwide. In its most basic form, transpatial solidarities are shaped by family and kinship, membership of the same clan, ethnicity or citizenship. Transpatial categories go much further, however, and may include professional identities and disciplines, but also interests and hobbies, religious beliefs, gender identities, membership of organisations, affiliations, or associations with teams and work departments.

In the words of Hillier and Hanson “*all human social formations appear to exhibit this duality of spatial and transpatial, of local group and category*” (Hillier & Hanson, 1984, p. 42).

The most fundamental novelty of Hillier and Hanson’s theory of differential solidarities is then to propose that spatial and transpatial grouping do not necessarily need to overlap. When they overlap, a correspondence system is born: similar people occupy proximate spaces and encounters deriving from this spatial closeness reinforce group memberships at the expense of relations to outsiders. Therefore, the socio-spatial system becomes locally strong, exclusive, and maintains strong boundaries. In contrast, non-correspondence systems scatter similar people across different spaces, so that transpatial category and spatial grouping do not match. In this case of a non-corresponding socio-spatial system transpatial solidarities allow overcoming spatial boundaries and spatial proximities work to mix and match different kinds of people in a system, which thrives on global strength, openness, inclusivity, weak boundaries and a lack of hierarchy.

The importance of non-correspondence is described vividly by Peponis:

“It is proposed, based on anthropological and sociological literature, that non-correspondence works like a social insurance policy, whereby the strengths deriving from affiliation to social groups are complemented by the strengths derived from affiliation to spatial groups.” (Peponis, 2001, pp. xxiii-xxiv)

If non-correspondence indeed acts as social insurance policy and allows bringing people together, either uniting disparate groups of people through spatial closeness, or uniting people distributed in space through categorical commonalities, this theory is of vital interest to our understanding of a whole variety of issues around social cohesion, exclusion and inclusion, and polarized institutions and societies.

In this paper, we are concerned with offices and a micro perspective on non-correspondence by focussing on life within organisations, specifically their propensity to generate new ideas, or in others words their innovative potential.

Innovation, or how new ideas emerge in an organisational context is indeed another area to which space syntax theory has contributed in the past. In ‘Visible Colleges’ Hillier and Penn (1991) described buildings as capable of acting in generative or conservative ways. Through their spatial structure and the way control, interfaces and encounters between groups of people were designed into the building, an organisation might benefit from morphogenesis and the creation of new ideas, new relationships and new products or knowledge to emerge. Generative buildings were contrasted with conservative buildings, which reproduced relationships or knowledge.

The idea of innovation was also related much more closely to non-correspondence by another paper of Penn and Hillier. Citing Thomas Allen’s work on innovation and the ‘flow of technology’ (Allen, 1984), which maintained that R&D teams with more external interaction links were higher performing, Penn and Hillier (1992) spatialized the argument of where good ideas came from. They argued that innovation required interaction with those outside one’s own field, who become available through the “*largescale movement structure [of a workplace which] takes people with knowledge in one field past people with problems to solve in another*” (Penn & Hillier, 1992, p. 41). Hence they proposed that the central circulation system of a building needs to be designed in a way that it leads

past workstations of others and allows the so called process of ‘recruitment’ (Backhouse & Drew, 1992), so that spatially enforced boundaries between people working on different problems can be broken down via movement.

In their papers Serrato and Wineman (1999; 1997) applied these ideas to the comparative study of two different research laboratories in the US. They found that the lab organised around localized clusters corresponding to knowledge areas (Lab A) was much less interactive than the one where clusters mixed scientists from different research groups (Lab B). Also, researchers in Lab A were less easily available to their colleagues due to occupying a building with a more segregating spatial layout. The theory of correspondence was used to explain how the latter research lab (B) created a more collaborative interface and through its non-correspondence established conditions for the production of new knowledge.

Similar ideas have been proposed from a different angle: that of management. Aiming to break down what is often called ‘organisational silos’ management scholar Tom Peters suggested to mix and match seating arrangements and co-locate staff from different departments in a single space:

“Physical location – in particular, jamming people from disparate functions together in the same room or workspace or cubby hole – is the number one culture change tool that I’ve discovered! Move the accountants to the manufacturing floor: within six weeks the accountants will appreciate the manufacturers, the manufacturers will appreciate the accountants (...), something close to a miracle will invariably occur.” (Peters, 1990, pp. 23-24)

Following Peters’ footsteps, a practical approach to the physical co-location of staff in order to increase collaboration has been attempted much more recently and on a larger scale. The Francis Crick Institute, the largest biomedical laboratory in Europe opened in 2016, locating 1200 scientists under one roof with the aim of accelerating science, allowing scientists to collaborate creatively and enabling ‘discoveries without boundaries’³. Lab leaders in the Crick were not organised in departments or divisions. Instead, the Crick allocated lab benches and write up spaces based on the core resources that scientists required and organised groupings bottom-up according to research interests (Callaway, 2015).

Whether evoking movement such as Hillier and Penn, praising the benefits of co-location of disparate functions like Peters, or doing away with organisational divisions and using space and research interests as ordering mechanisms as in the Crick Institute, it seems there is virtue associated with bringing people of different fields together and that space has a role to play in this process.

However, there are fundamental issues with the above-mentioned discussions and applications of correspondence theory.

Firstly, most accounts draw a black and white picture. A system is described as either correspondent or non-correspondent and accordingly, certain fixed characteristics are assumed. The work of Wineman and Serrato falls into this category, but also some of the work by Hillier and Penn, where one setting is described as correspondent and another as non-correspondent. Clearly this kind of structuralist dualism has been a useful device in early theorising and as such has been anchored very deeply in space syntax thinking. From our standpoint today, this is problematic, since it fails to describe the real-life structuring of many systems, which rarely sit at the extreme ends of the spectrum.

Secondly, different concepts tend to be used interchangeably and thereby become conflated. In ‘Visible Colleges’ for instance, long and short models are discussed as the rule systems underlying interfaces that are strongly or weakly programmed and hence result in conservative or generative buildings. The non-correspondence system found in a lab by Wineman and Serrato was conflated with generativity, arguing it automatically allowed for the production of new knowledge. We argue here that more conceptual clarity will be useful in articulating those theories further, particularly in the case of correspondence, which in our view is a powerful concept which has not been exploited more fully.

Thirdly, another type of conflation is observable in the literature, whereby spatial configuration gets credited for generativity, and other transpatial mixing mechanisms move to the background of the discourse. For instance, in Penn and Hillier’s account of the ‘Social Potential of Buildings’ spatial structures (such as circulation spaces) were highlighted as crucial contributors to innovation. This might be understandable, coming from the perspective of architectural research, however it runs the risk of spatial fetishism (Soja, 1980). It downplays the importance

³ Source: <https://www.crick.ac.uk/about-us/our-vision>

of both spatial and transpatial mechanisms for creating meaningful social relations and therefore ignores the powerful role correspondence has to play in bringing both aspects to bear in a balanced manner.

Last but not least, as a forth issue the practical applications of bringing people together as suggested by Peters or realised in the Francis-Crick Institute seemed not fully aware of the mechanisms at play. What is maybe most problematic is that only a single label is assigned to someone's working relationships, which are in reality much more multi-faceted. The concept of 'cross-cutting social circles' dates back to the sociological thinking of Georg Simmel in the late 19th century (Simmel, 1890) and was discussed more fully by Blau and Schwartz (1984), maintaining that humans are socially differentiated by numerous lines – not just age, gender, class and ethnicity – but also religious beliefs, political positions, industrial sectors, places of employment, formal education and many more. This means we need a way of discussing multiple levels of correspondence or non-correspondence, all at interplay within a single system.

It has become clear so far that correspondence theory is a central contribution by space syntax. Yet in our view correspondence theory has received too little attention to date. It has been overpowered by a focus on spatial aspects, thereby losing the balance of correspondence as a socio-spatial theory and ignoring transpatial mechanisms. At the same time, unlike other central concepts in space syntax, correspondence has not been articulated much further to the best of our knowledge. We maintain that the theory of correspondence can give key insights into an understanding and critical reading of organisations as complex systems of multiple social relations.

Therefore, in this paper we want to trace the theory of correspondence back to its origins to highlight its potential for understanding organisational innovation. In chapter one we have already illustrated how the theory has been received in the scholarly debate to date and have argued that it deserves more prominence. In chapter two we will bring correspondence back into the discourse by going to its roots as established by Hillier and Hanson. We will articulate the theory by focussing on the grey areas in-between correspondence and non-correspondence. Based on in-depth case studies of two different organisations, introduced in chapter three, we will develop a process and model by which we can calculate the actual degree of non-correspondence an organisation has built into its structures. This will be based on floor plans as well as seating arrangements and visitor counts, all of which are relatively easily available data sets. In chapter four we will present the two organisations according to their degrees of correspondence. We will then make a case for how correspondence enabled or hindered those two organisations in their innovative endeavours. Chapter five will offer discussions and implications for the quest to understand organisations equally as spatial and social structures. To conclude we will reflect in chapter six on further research opportunities to study the phenomenon of innovation through correspondence.

2. ARTICULATING CORRESPONDENCE: DEVELOPING THE SPACE IN-BETWEEN

Hillier and Hanson argued in 'The Social Logic of Space' that "*different forms of social solidarity are themselves built on the foundations of a society as both a spatial and a transpatial system*" (Hillier & Hanson, 1984, p. 142). In order to clarify their argument, they drew on examples of different indigenous societies as described in anthropological literature and outlined the 'arrangemental principles' of those societies and which spatial and social mechanisms were used to realise those principles.

The society of the Tallensi of Northern Ghana was categorised by Hillier and Hanson as a correspondence system: sons set up their compounds close to their fathers, hence kinship related to spatial proximity. Clusters of compounds were dispersed in the wider landscape and little interaction was encouraged between them. Most interactions took place locally and followed strict hierarchical rules. Rituals were carried out in the wider landscape, bonding males together, whereas females remained isolated in their compounds. Thus, the Tallensi society was characterised by strict boundaries which reproduced practices, rituals, statuses and identities of its members.

In contrast, the Native American society of the Hopi was identified as an example of a non-correspondence system: a typical settlement consisted of several households, drawn from different clans. With clans dispersed across settlements, encounter incentives were created between settlements, for instance for families to have meals together, which were held by open doorways and allowed passers-by to join in. Rituals were held in public spaces and again created opportunities for people to get together. Therefore, the Hopi society thrived on openness and a relative equality between the sexes.

But rather than just categorising societies as correspondent or non-correspondent, Hillier and Hanson themselves agreed that subtle nuances between different solidarities were crucial to highlight, hence they included not just the example of the Tallensi and Hopi as almost archetypical cases of correspondence and non-correspondence, but also discussed the society of the Ndembu as an in-between case, which resembled the Hopi in some respects, but the Tallensi in others.

The Ndembu of Northern Zambia were described as living in villages with a high degree of mobility between villages. Maternal descent resulted in initial village residence, however women once married moved to their husbands. Divorce was common, resulting in women and their children moving back to the villages of their brothers. Ties were strongest between mothers and children, but also maternal siblings, often spread across different villages. The relationship between the sexes resembled that of the Hopi with relative equality, yet the sexes dominated different spheres: Ndembu women were strongly connected globally (in contrast to the Hopi, where women controlled the local space), but had to obey strict rules in their local villages. Therefore, the society of the Ndembu displayed characteristics of both a non-correspondence system with strong transpatial mixing mechanisms in action across spatial domains, but also that of a more controlled local system with stricter rules and boundaries as is typical for correspondence systems.

What is so interesting about these descriptions is the nuance and detail with which Hillier and Hanson explained the spatial and social operating mechanisms of these societies. The authors refrained from labelling the Ndembu as correspondent or non-correspondent (unlike the Hopi and Tallensi, which were categorised clearly) and instead used discursive techniques to demarcate the subtle differences between the Ndembu and the other two societies.

Exploring and articulating the space in-between the extremes of correspondence and non-correspondence seems an important step for the theory to become more widely recognised and more applicable to real-life situations. With varying degrees of correspondence, it could be asked what a system needs to reproduce itself and to flourish. Hillier and Hanson have already provided a sketch of what a non-correspondence system requires, i.e. to maximise encounters across spatial domains, thus it depends on openness and the presence of various mixing mechanisms. In contrast, a correspondence system is eager to control its boundaries as well as the rules by which people come together, so that it can reproduce itself. But what would a society like the Ndembu need to thrive and how could we describe its degree of correspondence or non-correspondence?

This means we need some way of judging a system and placing it on a continuous scale from correspondence to non-correspondence. We also need a way to appreciate multiple transpatial relations as suggested by Simmel's cross-cutting social circles.

Based on Hillier and Hanson's interpretation of societies as 'encounter probabilities', we now investigate *work organisations* as encounter probabilities, where workplace layouts can be analysed as spatial systems and organisational structures and divisions as transpatial system. The next chapter will detail the methods chosen for this endeavour.

3. DATASETS AND METHODS

In this paper we will discuss two different work organisations, both of which were studied in depth by the authors.

The first organisation is a UK based second tier law firm, called 'Law' in the following. The head office of 'Law', which accommodated 151 staff across three floors of an office building with a total area of 2,250 sqm was studied in 2015. The ground floor was mostly partitioned, hosting a reception and atrium, as well as a series of client-facing meeting rooms. Staircases and elevators led to an open-plan office on the first floor. A boardroom was located on the second floor. Therefore, the majority of staff were located on a single floor. 'Law' was structured into four specialist legal departments (Corporate, Litigation, Real Estate, Private Clients) with a total of 124 staff, supported by 27 staff in administrative roles. The departments varied in size from 18 to 48.

The second studied organisation is a research institute⁴ in Germany, called 'Institute'. Located in Eastern Germany as part of one of the major publicly funded German research societies, 'Institute' hosted researchers in theoretical physics. The purpose-built three-storey building accommodated 182 members of staff at the time of the study in 2006 across a total area of 6,162 sqm. The ground floor hosted shared facilities, such as the library, seminar rooms, a canteen and an outdoor seating area. On the upper two floors, scientists were allocated single or double cellular offices. Adjacent to the main building, 'Institute' had three guest houses to accommodate visiting scientists and

⁴ This case study has been discussed and published previously, see for example Sailer (2010, 2014)

guests. Two apartments in one of the guest houses had been refurbished into office spaces for a small handful of scientists, often those on more temporary contracts. ‘Institute’ had three main departments (ranging from 27-47 staff), six additional research groups (ranging from 1-17 staff), as well as some independent visiting researchers. A 24-staff strong administrative team supported the organisation.

In our analysis we brought the following data sources to bear: firstly, we analysed the floor plans of the workplaces using space syntax methods, particularly relying on isovist paths and visibility graph analysis (VGA) (Turner, Doxa, O’Sullivan, & Penn, 2001). This was conducted in depthmapX (depthmapX_development_team, 2017). Further quantitative analysis and processing was done in R. Secondly, we investigated the structure of the organisations through organisational charts, thus noting which staff belonged to which department or group. Thirdly, we obtained seating plans on group level, mapping exactly which groups occupied which desks or offices. We also mapped locations of meeting rooms, tea points and other relevant attractors. Fourthly, we gathered data on numbers and type of visitors to the organisation. Finally, through further in-depth investigations including observations of face-to-face encounters and movement paths, ethnographic observations of behaviours and space usage and interviews with selected staff members we were able to draw a rich and nuanced picture of organisational life to supplement our quantitative analysis.

These data sources were used to devise a method for calculating the degree of correspondence in our organisations, but also used to contextualise the discussion and add an account of interaction profiles and innovative potential to the evaluation.

To develop a measure for socio-spatial correspondence we created a method determining the degree of overlap of social closeness between people and their spatial closeness. We bring those two dimensions together by using the measure of Yule’s Q, which describes the association between two sets of variables, indicating the relative strength of the relationship (Vann, 2011). Derived from an odds ratio, Yule’s Q takes dichotomous variables (close, not close) and calculates the odds of association of one set of variables (spatially close / not close) to another (transpatially close / not close). It is expressed as a single metric, falling between -1 and +1 and is derived from four input data points a, b, c and d (see table 1) through the following formula:

$$\text{Yule's Q} = (a \times d - b \times c) / (a \times d + b \times c)$$

		SPATIALLY	
		Close	Not close
TRANSPATIALLY	Close	a	b
	Not close	c	d

Table 1: Association of spatial and transpatial closeness in Yule’s Q

A Yule’s Q value of +1 denotes perfect positive association, i.e. all people who are spatially close are also transpatially close. A value of -1 means perfect negative association, i.e. those who are spatially close are transpatially not close. Both are cases of correspondence. A value of zero shows non-correspondence or randomness with equal odds of a person being spatial close to either be transpatially close or not close.

Our method for determining spatial closeness builds on the importance of movement as highlighted by Penn and Hillier (1992) and leans on the work of Kabo et al. (2015) and their interpretation of proximity as path overlap. Rather than relying just on desk or office location as a means to establish proximity, the authors plotted typical everyday paths of staff members and calculated the degree to which paths of pairs of people overlapped. We used a slight variation of this idea and constructed everyday paths for each single member of staff (from their desk or office leading to the entrance, places for eating, meeting rooms, kitchens, toilets, seminar rooms, break out spaces, printers, etc.). We constructed the shortest visible paths (manually in ‘Law’, using depthmapX and R for ‘Institute’) and counted the numbers of desks or offices of colleagues each staff member would pass by and therefore potentially encounter. Those were counted as spatially close. All other colleagues were counted as spatially separated.

Transpatial closeness was determined in different ways. Firstly, we looked at the relations between different groupings inside the organisation. The numbers of people in someone’s own department or group were counted as transpatially close; those in other groupings were counted as transpatially separate. This was obtained for every single member of staff and then averaged. Secondly, we took the numbers of visitors into account and analysed the exposure of the organisation to visitors. Therefore, two groups – inhabitants of the organisation and visitors –

were created. For each member of staff, we estimated how many visitors⁵ they would encounter on a typical working day, given their movement profiles and the locations visitors would normally frequent on the premises.

With these types of closeness variables, the following two Yule's Q measures were calculated: Yule's $Q_{(intra/inter)}$ will identify the correspondence of the internal organisation and its socio-spatial structure as realised through the seating plan, the building layouts and typical movement paths taken by members of staff. Yule's $Q_{(inhabitant/visitor)}$ will highlight the openness of the organisation towards visitors taking locations of visitors as well as visitor numbers into consideration. Table 2 summarises the method of counting both.

	INTRA / INTER		INHABITANT / VISITOR	
	Spatially close	Spatially separated	Spatially close	Spatially separated
Transpatially close	# of people in my group that I'm close to	# of people in my group that I'm not close to	# of people in my organisation that I'm close to	# of people in my organisation that I'm not close to
Transpatially separated	# of people in another group that I'm close to	# of people in another group that I'm not close to	# of visitors that I'm close to	# of visitors that I'm not close to

Table 2: Count criteria for spatial and transpatial closeness or separation for both Yule's Q metrics

The different results for Yule's Q will now be presented to understand the interfaces between different groups of people and therefore identify the degree of correspondence of both case study organisations.

4. RESULTS

In this section, we will discuss the socio-spatial systems of 'Law' and 'Institute'. Each section will start with a description of the type of work processes typical for that organisation, then it will illustrate seating plans and a sample of everyday paths, followed by the presentation of quantitative Yule's Q results. Finally, a qualitative account of the innovative endeavours of the organisations will be given to contextualise the relationship between non-correspondence and innovation.

4.1 THE SOCIO-SPATIAL SYSTEM OF 'LAW'

'Law' was structured into four departments each representing a major area of law. Lawyers had different titles depending on legal experience and seniority. Each department had a cross section of legal seniority in the team and also included some dedicated secretarial support. The firm was run by a small management team, each of which also practiced law.

All legal departments were located on the first floor of the building. This floor was largely open-plan with desk clusters consisting of four to eight desks each (see figure 1). The firm-wide support staff were mostly located in a single open-plan office on the ground floor.

The work of the firm primarily involved developing specialist legal advice and opinion for clients of the firm involving reading, writing, meeting and discussing within the specialist departments. Short discussions within each department took place at the desk clusters but other facilities were available for lengthier discussions or meetings. These included a break-out area, meeting room and training room on the first floor, while more formal planned internal meetings might use the boardroom on the second floor. On the ground floor was a staff restaurant in an atrium with seating facilities that could be used throughout the day. In addition, three small kitchen areas were available to staff. Meetings with clients took place in one of eleven meeting rooms located near the main entrance to the building that were designed specifically for the purpose. Clients all entered through the main entrance at the front of the building, however, staff entered from a separate entrance to the rear.

⁵ In the case of 'Institute' we were able to distinguish between different types of visitors. Exact details of those differences will be presented in the results section.



Figure 1. Seating plan of 'Law' with all department locations marked.

Typical paths in 'Law' were identified through five months of field observation. For staff these paths led from the rear entrance to desks via the rear stairs and from there to meeting rooms, kitchens and toilets. Stairs at the front of the building tended to be used to access the client meeting rooms. For clients a typical path led from the main entrance to a client meeting room via a reception desk. On average, 'Law' received 18 visitors each day most of whom were clients.

This means two different Yule's Q calculations will be presented for 'Law': $Q_{(intra/inter)}$ and $Q_{(inhabitant/visitor)}$.

Regarding the overlap of spatial and transpatial solidarities inside 'Law', the analysis showed that every staff member on average had the potential to meet 25 colleagues in their own department daily. Just five colleagues of their own department were not typically encountered on a daily basis. In addition, 33 colleagues from other departments were encountered on daily movements but 88 were not.

	INTRA / INTER		INHABITANT / VISITOR	
	Spatially close	Spatially separated	Spatially close	Spatially separated
Transpatially close	a = 25	b = 5	a = 58	b = 93
Transpatially separated	c = 33	d = 88	c = 0.25	d = 17.75

Table 3: Yule's Q calculation data for 'Law'

Following the formula above, this results in a Yule's $Q_{(intra/inter)} = 0.86$. This value is tending towards 1, meaning that 'Law' showed correspondence in how relations between groupings were realised. This correspondence means that staff have far more opportunity to interact within their own groups than they do with others. This was verified by the interaction data gathered that showed 72% of all interactions in 'Law' were intra-team.

Substantial differences were revealed between groups when Yule's $Q_{(intra/inter)}$ is calculated separately for each of the legal departments and for the firmwide support staff. The highest Yule's $Q_{(intra/inter)} = 0.97$ was found for department GH. This represents a highly correspondent system meaning that it was far more likely that group members would interact within their own department and not with other departments. GH was based entirely on one side of the office (figure 1) with most of the desk clusters positioned against a wall. Typical movement paths did not take many inhabitants past these desks and the movement paths of GH excluded the other side of the office entirely. Similarly, EF were also located entirely on one side of the office, but their desk clusters were positioned in one of the most frequently used movement paths to the break-out space. This resulted in a Yule's $Q_{(intra/inter)} = 0.84$ for EF.

By contrast, department CD had a Yule's $Q_{(intra/inter)} = 0.46$ representing a system tending towards non-correspondence meaning that CD staff enjoyed the highest likelihood to encounter and interact with members of other departments. It was spread over both sides of the office so had to move across both in order to interact with colleagues in their own department. In addition, the position of all the desks in CD were clustered around the rear stairs used by virtually all staff to reach the ground floor and exit the building. Department KL had a Yule's $Q_{(intra/inter)} = 0.74$. They were also spread across both sides of the office but were clustered around the front stairs that were rarely used in the typical movement paths of staff. Support staff (marked as AB in figure 1) had a Yule's $Q_{(intra/inter)} = 0.82$.

The $Q=0.46$ for department CD was particularly significant because it represented a more non-correspondent system nested inside an organisation with a structure that was heavily correspondent (0.86) overall.

The Yule's $Q_{(inhabitant/visitor)}$ was calculated from the unplanned interface between inhabitants and visitors to the system. The typical movement path for visitors took them from the main reception a short distance to a client meeting rooms. These rooms were self-sufficient in terms of catering, so visitors rarely needed to leave them, and bathroom facilities were immediately adjacent. The movement paths of inhabitants did not take them past the client meeting rooms. This resulted in visitors rarely encountering inhabitants they had not planned to and this was reflected in the $Q_{(inhabitant/visitor)}=0.96$.

So far, this review of 'Law' has discussed the tendency of the socio-spatial system towards correspondence but has noted some substantial differences amongst the departments within the firm. We now want to place this analysis in the context of a more qualitative assessment of 'Law's' propensity to innovate.

'Law' was subject to a management buyout two years prior to the period of study. The new management team were ambitious with the intention of growing the firm rapidly through a combination of organic growth and acquisition. The organic growth was driven from within the firm by legal staff through a firm-wide initiative to cross-sell across legal specialisms to existing clients. To encourage this, 'Law' had redesigned their offices 18 months before the period of study and moved from cellular offices for each of the lawyers to the open-plan offices analysed in this paper. The operations director stated that the office redesign had aimed to "*change the culture from one of a firm of sole practitioners to a team culture where success was manifestly based on merit and relationships across teams became more open and less political*". These objectives, he suggested, could only be accomplished if "*the lawyers talk and work together more*".

Organic growth was targeted at 10% per year and reported monthly in a 'utilisation' figure that measured hours actually charged by each department versus the increased target (thus 90% utilisation equalled 10% growth). In the year prior to this study the utilisation achieved by each department ranged from 85.7% to 92.3% (table 4). This meant that two departments, CD and KL, were meeting or beating the targeted organic growth figure. These two teams also showed the lowest Yule's Q's of the four departments. There are a number of factors that might affect the organic growth rates of different departments such as different market conditions for each specialist area of law or the number of new recruits taken on during the year, but it is noteworthy that the department enjoying the greatest success on this key metric within the firm was the only group that experienced a non-correspondent system. In addition, the two teams that were not meeting budgeted targets had the most correspondent systems.

	Growth versus Correspondence	
	Utilisation %	Yule's Q
CD	92.3	0.46
EF	88.0	0.84
GH	85.7	0.97
KL	90.8	0.74

Table 4: A comparison of the utilisation figure and Yule's Q for each department in 'Law'

The success of the firmwide organic growth initiatives had been a source of disappointment to the CEO who commented "*it is so hard and expensive to win new clients so the logic of selling our existing clients a broader range of legal advice seems compelling to me, but we really seem to be making very little progress*". The operations director, who had led the change to open-plan offices reflected on how this disappointing result had been impacted by interaction in the firm, he said "*each of our teams are working much closer together, by sharing desks it is so easy to tackle problems as soon as they arise. But the teams still don't mix very much, and I am a bit disappointed by this*". It was also evident from our analysis that any chance of lawyers from one department

bumping into clients of another department had been virtually eliminated by the socio-spatial arrangements that separated the movement paths of inhabitants and visitors.

To summarise, as a system in correspondence the socio-spatial structuring of ‘Law’ does appear to explain the lack of inter-team interaction articulated by the operations director. The change to open-plan had created well integrated offices for inhabitants that appears to have increased the frequency of interaction. However, the socio-spatial correspondence of the system meant that the inter-team interaction that had been hoped for was not evident and that chance visitor interaction had been virtually eliminated. This profile of interaction might have contributed to the perceived failure of firmwide growth initiatives. At a more micro level substantial differences were found in the degree of correspondence for each of the departments, with one team showing non-correspondence. It is possible that these differences explain the relative growth performance of each department.

4.2 THE SOCIO-SPATIAL SYSTEM OF ‘INSTITUTE’

‘Institute’, like many research organisations or universities, was rather loosely structured with high degrees of freedom and autonomy for the scientists. As an institute hosting theoretical physicists, no experiments, machinery, equipment or laboratories were involved; therefore, research took place in the shape of reading, writing, thinking, calculating, simulating and discussing. Typical paths in ‘Institute’ led from offices to entrances / exits via the various staircases, to seminar and meeting rooms, printers, break out spaces, kitchens and coffee bars, toilets, outside seating areas including smoking spaces, the cafeteria, the library, a reading room as well as to administrators’ offices, the reception area and pigeonholes. A total of 62 attractors were identified. In this case study, accurate usage patterns of those facilities were available from interview data for around two thirds of staff, which allowed a representative estimate to be made for remaining staff. Shortest paths were then constructed for all staff leading to relevant attractors. Figure 2 shows the exemplary path pattern for a selected member of staff on their floor.



Figure 2: Paths from the office of one particular scientist on the second floor; all attractors are plotted (in yellow) as well as colleagues seen (filled dots) and not seen (circles); red colleagues are from the same group as the root scientist, whereas blue colleagues are from another research group.

For most staff office allocations in ‘Institute’ were made based on the availability of a free space at the time they started their contract. The three directors each occupied a central office near the main staircase in one of the wings (1A, 1B and 2B) and long-standing members of staff were loosely grouped around them, sometimes moving offices after a few years as and when a space closer to their main collaborators became available. On the whole, however, staff were relatively randomly distributed (see figure 3) due to an overall lack of space and the popularity of ‘Institute’.

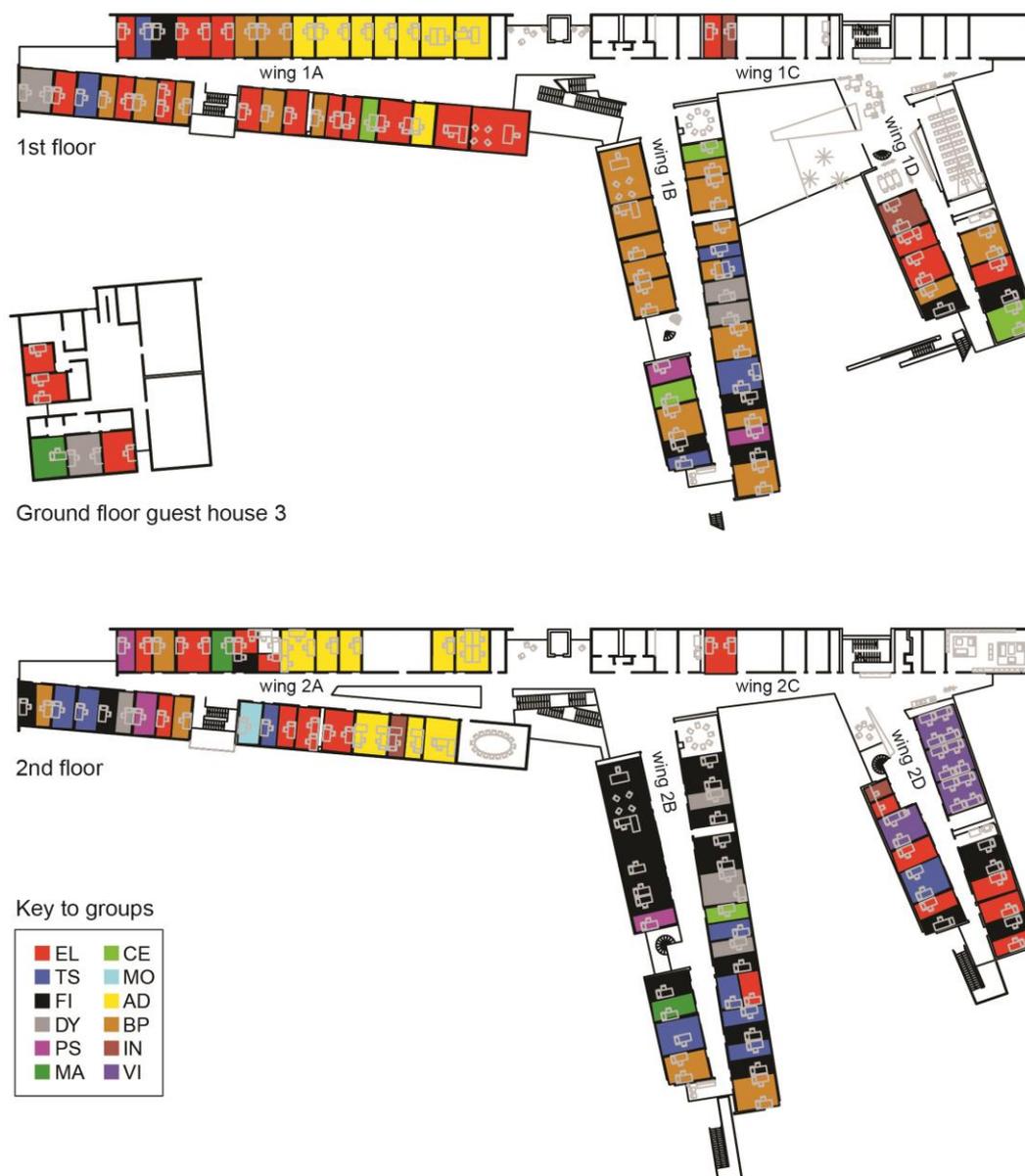


Figure 3: Seating plan of 'Institute' with all group locations marked; group VI are medium-term visitors; IN independent scientists; group AD are the administrators.

'Institute' held a special place in the international scientific community due to its large visitor's programme. Very few scientists held permanent contracts. At any point in time, 70-80 scientists were hosted as long-term visitors (of up to a year); they were treated like any other member of staff. Therefore, all of these scientists were counted as staff in the following calculation. In addition, 'Institute' ran a successful international workshop and seminar programme, hosting 8-10 events every year which lasted between 1-2 weeks for workshops and up to six weeks for seminars. Those events could be organised by 'Institute' staff, but also involved external organisers, who were offered a desk in a shared office for the duration of their stay. In an average year, 50-60 external organisers of scientific events and 1200-1500 short-term visitors frequented 'Institute'. In the following, event organisers are treated as a separate category of visitors (medium-term), while external workshop or seminar participants are counted as short-term visitors.

This means three different Yule's Q calculations will be presented now: $Q_{(intra/inter)}$, $Q_{(inhabitant/medium-term\ visitors)}$ and $Q_{(inhabitant/short-term\ visitors)}$ (see table 4 for details).

Regarding the overlap of spatial and transpatial solidarities inside ‘Institute’, the analysis showed that every staff member on average had the potential to meet 9.4 colleagues of their own group daily. 19.5 colleagues of their own groups were not encountered on every-day paths. An additional 35.7 colleagues from other groups were potentially seen on daily movements, whereas the offices of 116.4 staff from other groups were not passed by on average. Following the formula above, this results in a Yule’s $Q_{(intra/inter)} = 0.22$. This value is near the zero point, meaning that ‘Institute’ showed a non-correspondence in how relations between groupings were fostered. The positive sign means that ‘Institute’ still tended to favour within-group encounters rather than outside-group encounters. This can also be seen in the seating plan (figure 3), where certain clusters of groups are evident, for instance group FI had a stronghold in wing 2B, whereas administrators (AD) were clearly clustered in wing 1A, resulting in higher probabilities of people passing offices of their group colleagues on their journeys through the building.

	INTRA / INTER		INHABITANT / VISITOR MEDIUM		INHABITANT / VISITOR SHORT	
	Spatially close	Spatially separated	Spatially close	Spatially separated	Spatially close	Spatially separated
Transpatially close	a = 9.4	b = 19.5	a = 44.3	b = 136.7	a = 44.3	b = 136.7
Transpatially separated	c = 35.7	d = 116.4	c = 8.8	d = 17.2	c = 8.2	d = 24.5

Table 4: Yule’s Q calculation data for ‘Institute’

Interesting differences emerge between the groups, when Yule’s $Q_{(intra/inter)}$ is calculated separately for each of the research groups and the administrative team. The highest Yule’s $Q=0.66$ is achieved by the administrators, who were clustered most to ease their internal collaboration. Therefore, a correspondence system was nested inside an organisation with an overarching non-correspondent structure. The three departments BP, FI and EL also showed a positive sign for Yule’s Q (0.39, 0.24 and 0.16 respectively). BP was most correspondent of those three, possibly due to the fact that it was the last department added to the organisation structure, which could have meant a higher need for internal cohesion and a stronger sense of identity by favouring intra-group interactions slightly more. The smaller and independent research groups CE, PS, TS and DY could be considered largely non-correspondent with Yule’s Q values of 0.12, 0.08, 0.06 and -0.05 respectively. Only one group shows negative correspondence ($Q=-0.59$) and that is group MA with only three members of staff and most recently founded at the time of study. Their group members were most widely spread, resulting in significantly higher odds to run into members of other groups than their own.

Following the same logic (see table 4 again), Yule’s $Q_{(inhabitant/medium-term\ visitor)}$ is calculated from the interface of inhabitants and medium-term visitors. Medium-term visitors were offered desks in central offices in wing 2D. Their proximity to popular attractors such as the coffee bar, reading room and a breakout space meant that many staff passed by these offices regularly. This resulted in 44.3 staff meeting other staff every day versus 136.7 colleagues not seen. 8.8 visitors were seen on average by the inhabitants and 17.2 visitors were not seen. The Yule’s $Q_{(inhabitant/medium-term\ visitor)} = -0.23$ again is close to the zero mark and as such denotes a system with relative non-correspondence. This time the sign is negative, showing the strong openness towards visitors, which was built into the structures of ‘Institute’ as the odds of bumping into a medium-term visitor was higher for staff than bumping into another staff member.

Finally, short-term visitors attending seminars and workshops at ‘Institute’ would predominantly remain on the ground floor, where all relevant facilities such as seminar rooms, break out spaces, the cafeteria, registration and reception were found. Poster sessions were sometimes held in the corridors of wing 2C next to the central staircase, so on the whole short-term visitors remained in relatively central spaces. The interface to ‘Institute’ staff was estimated by the average number of visitors per day (32.6) and the likelihood of a staff member being interested in the event and attending parts of it (25%). This resulted in an average of 8.2 visitors encountered by a staff member every day. With the remaining figures of the odds of staff encountering other each (44.3) or not (136.7), Yule’s $Q_{(inhabitant/short-term\ visitor)} = -0.01$. This almost perfect non-correspondence system regarding the interplay between inhabitants and short-term visitors is yet another testament to the ethos of ‘Institute’ to provide a service to the research community and maximise chances of intermingling for scientists worldwide working in the field of theoretical physics.

So far, we have discussed the tendency towards non-correspondence structures in ‘Institute’ and its particular openness towards visitors. We now want to elaborate on how this socio-spatial structuring of ‘Institute’ might have influenced its propensity to innovate.

Innovation in science may come in two forms: firstly, in the way science is organised, and secondly, in enabling the generation of new insights, new knowledge and accelerating scientific break-throughs. Both issues are interconnected.

The innovative organisational structure of ‘Institute’ is noteworthy. Considerable efforts at ‘Institute’ were put into maintaining and running their large visitor’s programme. This shaped the place significantly, not just in its ethos and mission, expressed by the Founding Director who stated that “*the institute is its guests*”⁶, but also in the perception of scientists, both internally and externally. A member of group EL commented that “*if you are staying [...] for one year, you can be sure of the numbers of smart, great scientists to come, like Nobel prize winners*”. Scientists working at ‘Institute’ pay back through using this as their affiliation and publishing papers. In the year of the study and the two consecutive years, an average of 313 journal papers were published by ‘Institute’ affiliated scientists annually, which is an average of 2-3 papers per active scientist⁷. Among these outputs were high profile journals, such as five Nature papers.

It seems that scientists at ‘Institute’ enjoyed high levels of productivity, as witnessed by a member of group EL: “*When I came here, I asked my director, in the first days ‘what shall I do?’ [...]. He told me, that you are free, you can do whatever you like. It was great for me, because I had ideas in my mind, [...] so I sat in the chair, behind my computer and did whatever I liked. [...] (When) I went to the director again, and showed him three manuscripts, he was surprised, how did you do all of that in just three months? It was great, [...] I was able to do something very new.*”

The way in which the architecture and socio-spatial structuring of ‘Institute’ was related to its propensity to innovate, was reflected by staff members as well, who commented “*I love the generosity of the spaces. Every morning when I enter the building, I think ‘wow’. The staircase, the big windows, all is very bright. It makes you communicate with the people in the wide spaces.*” The importance of attractors was also recognised: “*A lot more discussions arise now through the new coffee machines, because you simply bump into each other there.*” (leader of group MA)

At the same time a plethora of transpatial mixing mechanisms was in place at ‘Institute’, both on a global level (such as scientific events open to all, but also social gatherings such as summer barbecues, table tennis tournaments, etc.) and on the local level of the group (where each group had their own ways of bringing staff together including joint lunches, excursions and fun trips, tea session in the afternoon or weekly group gatherings).

This level of social contact to others can be directly linked to innovation, as argued here by the leader of group DY: “*You need the social contact and the exchange of knowledge, to know what other people are doing and what can be learnt from them to not reinvent the wheel. In this sense research can be accelerated. Gaining insights is quicker in a group of people or when systems mutually influence each other.*” In a similar fashion, the founding director of ‘Institute’ maintained: “*I think the success of our organisation lies mainly in the creation of the right climate, where new ideas and developments have best chances to prosper.*”

To summarise, the non-correspondence system of ‘Institute’ fostered and perpetuated a climate of openness and generosity. Staff members found it easy to meet others in the building, both within but also across groups. This led to a productive atmosphere, characterised by high-level scientific outputs and an ‘acceleration of research’. At the same time, correspondence systems were in operation, too, for instance by clustering administrators together and enabling ease and speed of working together for this particular subgroup.

5. DISCUSSION: IMPLICATIONS FOR UNDERSTANDING ORGANISATIONS

The previous section has presented two very different organisations: on the one hand the predominantly correspondent system of ‘Law’ (Q=0.86) with its tightly defined boundaries towards visitors (Q=0.96), which almost entirely sealed off inhabitants and visitors from encountering each other, but also with its pockets of non-

⁶ All quotations in the following are taken from interviews led during the study.

⁷ This excludes PhD students.

correspondence, since department CD enjoyed more opportunities to engage with colleagues of different departments ($Q=0.46$).

On the other hand we have discussed the case of 'Institute', an overarching non-correspondent system ($Q=0.22$) with extreme openness towards medium term ($Q=-0.23$) and short-term visitors ($Q=-0.01$), yet with certain subgroups nested inside this organisation as systems of stronger correspondence, as evident in the case of the administrative team ($Q=0.66$).

Discussing organisations as multiple layers of agents relating to each other in different ways – members of one group or department encountering those of others, organisation members encountering different kinds of visitors – allowed for a nuanced analysis, inspired by the idea of cross-cutting social circles (Simmel, 1890), whereby people are acknowledged for building relationships to different kinds of people based on various organizing principles.

Breaking the analysis down to the level of subunits rather than just reporting on the organisation as a whole enabled us to appreciate the inner workings and cultures of clusters of people, which differed from one another. Handy maintained in his account of organisational cultures that different subcultures can exist within a single organisation and the way in which relationships are formed is a crucial aspect of any culture (Handy, 1999). Therefore, it is plausible to find different patterns of relationships within different subgroups of an organisation, as found in both of our case studies. Department CD in 'Law' was an example of a non-correspondent and more open system within a correspondent context, while the administrative team in 'Institute' operated as correspondent system with more controlled boundaries towards other groups than the rest of the organisation. The special role of these two units seemed to come with advantages: CD was highly successful in its utilisation performance and the administrative team of 'Institute' was able to collaborate well internally and manage a complex visitor's programme smoothly and efficiently, thanks to its correspondent structuring.

This means competitive advantage is not just related to non-correspondence as previously maintained. Systems of non-correspondence may seem more naturally inclined towards innovation due to their openness towards the outside world, however, innovation comes in many shapes and forms. The detailed analysis of both cases reveals an interesting story.

In the same way that Burt (2004) found that being connected across groups led to positive performance evaluations, promotions and good ideas, our analysis seems to confirm that teams that experience non-correspondence perform better, even in an overall system that is in correspondence.

At the same time, correspondent teams nested inside a non-correspondent system can improve the overall performance of the organisation due to efficiency gains, as reported in many accounts of social networks, where tightly knit groups maintaining strong ties among themselves were seen as high performing due to the ease with they can share information (Cummings & Cross, 2003), their strong internal cohesion and affective power including the building of trust (Krackhardt, 1992), and their problem solving capacities (de Montjoye, Stopczynski, Shmueli, Pentland, & Lehmann, 2014).

What we were able to show therefore is that a classification scheme that considers an organisation as either correspondent or non-correspondent misses much needed nuance to fully appreciate how an organisation operates on many different levels, across different sets of actors, across different scales from the organisation as a whole down to the level of departments, but also across different transpatial groupings.

A more recently developed analysis method in the related field of social network analysis, that of considering multiplexity, i.e. the degree to which pairs of actors are linked by multiple relations (Tichy, Tushman, & Fombrun, 1979) is very promising and links directly to the research approach presented here. Affiliation to different transpatial groupings and identities within a common subset of actors is exactly what multiplexity investigates. Among other factors, multiplexity has been argued to contribute to the innovative capacity of an organisation by building stable and reliable networks among actors (Dhanaraj & Parkhe, 2006). While we have not fully explored multiplex relations among actors here, investigating subgroups as clusters within an organisation, which can show correspondence nested inside non-correspondent systems, or vice versa begins to make a similar argument of balancing stability with innovation.

6. CONCLUSIONS

In this paper we have presented evidence of two different organisations sitting at different ends of the spectrum of socio-spatial structuring: the case of 'Law', which was found to be overwhelmingly correspondent in the way that spatial proximity supported relations between those working together anyway, and the case of 'Institute', which was highlighted as non-correspondent with a particularly pronounced interface between visitors and inhabitants, where spatial closeness mixed up different kinds of people.

More importantly, we were able to show that socio-spatial systems of great variety were nested inside these overarching structures. Linking this to innovation and the propensity to generate new ideas, we argued that it is not just non-correspondence that can be associated with innovative outcomes and organisational success, but also an intelligent interplay between correspondence and non-correspondence on different levels.

Limitations of this research necessarily include the limited number of case studies. With just one example in each industry, it is impossible to draw wider ranging conclusions beyond the validity of the specific cases presented here. Also, we acknowledge that innovation is a complex phenomenon with many different factors interfering. We also understand that innovation means something very different in a law firm than in a scientific institute and comparisons between the two cases are therefore hard to draw.

Still we maintain that this difference between the cases also contributes to the strength of the ideas developed here. Being able to study as different organisations as we have done with the same unifying method, and finding similar underlying structures of varying strength of correspondence as well as nesting of substructures within the organisations is a key contribution and points to the wide applicability of the research presented here. This opens up a plethora of exciting avenues for further research, of which we will sketch a few.

Firstly, it would be worthwhile to compare more cases and systematically map commonalities or differences across industries. Secondly, we can envisage fine-tuning the model by taking path popularity and attractiveness of attractors into account when plotting the movement paths through offices as systems of closeness and encounter. Thirdly, it would be interesting to explore multiplexity alongside correspondence and model differential solidarities between staff by additional attributes such as length of service, seniority, gender or common background rather than just primary work relation. Another idea here would be to consider matrix-organisations with dual department / project affiliations and map the multiple correspondences of complex organisations. Finally, it would be fascinating to simulate correspondence by varying seating plans and locations of attractors for a given layout, or in fact simulate changes in correspondence if the same seating arrangements and attractor placement principles were applied to different layouts.

Our main contribution in this paper is to articulate a theory central to space syntax and provide an easily applicable model to calculate the degree of correspondence in any given office structure in order to be able to make assumptions about the propensity of the organisation to innovate. We have challenged the idea of classifying an organisation as either / or in terms of correspondence or non-correspondence and have developed a nuanced and rigorous method to fully appreciate organisational realities of complexity and multiplexity. By straddling different domains – architecture and management – we have introduced a tangible and practical way of architectural thinking into management and a management thinking into architecture.

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