A note on social networks and physical space

Invited Paper 1

Christofer Edling
Jacobs University Bremen
c.edling@jacobs-university.de

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Sociologists would almost unanimously claim that an office certainly has spatial properties, but to understand what is going on at the office we need primarily to study its social and not its spatial organisation. With "going on" I mean all human activity that takes place in the office. For a very long time, a crucial distinction in the study of what is going on at the office is the one between formal and informal organisation. Although, the concept organisation has wide ranging application in sociology (Ahrne 1994) formal organisation is mostly used synonymously to the every-day meaning of an organisation, for instance a business organisation. Formal organisation implies, among other things, well-defined borders and a set of rules that set out to regulate internal hierarchy, work contracts, and detailed specifications of positions, tasks, the division of labour, etc. In other words, formal organisation is defined as a particular type of social organisation. The study of physical reality and work organisations is almost exclusively reduced to the analysis of unequal distribution of unpleasant and dangerous working environments and its effect on individual health and wellbeing.

Formal organisation is contrasted by informal organisation. This is the non-regulated, spontaneous organisation of human activity that is not set out in the rules of the formal organisation and was famously "discovered" in the so-called Hawthorne experiments in the late 1920's and early 1930's (but see Jones 1992, who claim that re-analysis of the data "show slender or no evidence of a Hawthorne effect").

The most fertile ground for sociological analysis lie perhaps at the intersection of formal and informal organisation, and from a management perspective it is of outmost importance to understand the informal organisation of the office. To understand informal organisation however, it is not enough to tease out the rules by talking to management or by contemplating organisational charts and bookkeeping. For this we need theories and tools that can detect and map the structures of social interaction. I would argue that social network analysis is that tool.

This brief paper proceeds with a presentation of network analysis, followed by a look at two well-established sociological examples that illustrate the potential interaction between the spatial and the social. I then speculate that an interesting distinction to make in future research is that between a first- and second order influence of physical space on social organisation, and finish with a concluding remark that is even more speculative.

Social network analysis: Structures from relations

Social network analysis is a methodological approach for the study of social relations. A core assumption is that a focus on the ties that connect actors will tell us more about social life than studying only the characteristics of actors themselves. Surely we will learn something about an organisation by e.g., studying every employee of a firm by him- or herself. But network analysts would claim that we gain the fundamental insights only by studying the ties that connect employees. Those ties can have different contents. They can be formal ties, defined by contracts and hierarchical structures, or ties formed in project oriented work processes. But we would also

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be interested in informal ties between employees, such as friendship and gossiping. Mapping such relevant ties among all employees, we would get a network capturing a social structure of the firm that would possibly differ dramatically from what could be inferred from the isolated employees or organisational charts. Such is the claim that I will make in a short while, although one should keep in mind Han's (1996) claim that there is sometimes a strong relation between informal networks and formal networks. When analyzing such a structure, we need to put an equal emphasis on ties that are and ties that are not. Further on, we wish to at least take into account the direction of a tie, i.e., A receiving a piece of gossip from B does not imply that B also receives gossip from A, and the weight of a tie, i.e., does A have strong feelings about B, or could B easily be replaced by someone else?

Social networks are analyzed from two different perspectives. One alternative is to account for the whole network and study structural properties and change dynamics of a complete network. Returning to the example of the firm, we could ask for instance what consequence a high turnover rate has for the robustness of the social network. Or we could ask what difference the density of the network would make for overall job satisfaction. Density is the measure of actual ties over possible ties, where in a network where everybody is connected to everybody else the density is 1.

Another alternative is to account for the positions within the network. For instance, we could ask if an employee with many (incoming and/or outgoing) ties have a higher learning potential than an employee with few ties. This simple metric is known as degree centrality. We could ask if high level managers are also the connectors in the form, or if the actual bridging and brokerage is to be found somewhere else. A bridge, loosely defined, is a tie that connects two otherwise unconnected parts of the network, thus a bridge actually involve two positions. A broker, A, has ties to two otherwise unconnected positions in the network, B and C, and can utilize this role by playing off B against C in various ways.

Both approaches to network analysis face the problem of boundary specification; however it is more crucial for the total network approach. The case of the firm provides a natural boundary with regards to the nodes of the network, the number of nodes equals the number of employees. But certainly, employees are connected indirectly through ties that reach out of and into the firm that we will not be accounting for if we draw this boundary. This problem is non trivial, and so far there are no clear work around solutions.

Broadly speaking, network analysis is concerned with describing and explaining 1) how social ties come about, are sustained, and dissolved, and 2) what constraints and opportunities are mediated through social tries that affects individual behaviour. Because social reality is a dynamic complex system, the two objectives are often intertwined.

The role of space in social network analysis

It is enough to quickly browse through a textbook or a research journal on social network analysis to conclude that physical space does not play a significant role in this field. Although it is not intentionally, a recent state of the art review also makes this point very clear (Borgatti et al. 2009). Indeed, some of the defining and pioneering studies in social network analysis indicate that spatial constraints are not a concern, and if anything, the objective is rather to demonstrate that there are other, more significant structures than spatial location that explains social behaviour (e.g., Moreno's work). It is not without a reason that sociologists developed and work with the conception of social space. Indeed, many sociologists would be inclined to argue that the distribution of human activity within and across physical space is in fact determined by individual's positions in multidimensional social space, rather than the other way around. Having said that, there is convincing evidence that physical space does, if not determine so at least interact with social space in affecting human social behaviour. The socalled broken window hypothesis is one of the better-known findings, highlighting the surprisingly clear influence that worn-down urban spaces have on increasing the frequency of anti-social and "deviant" behaviours (for a recent demonstration see Keizer et al. 2008).

Physical space might not be a central concern in social network analysis but it has played a prominent supporting role in few key studies, and it seems clear that at least at some level most social networks are spatially constrained. We do tend to interact more frequently and to be closer to friends who are also, relatively speaking, within closer physical distance (see Fisher 1982). However, the reason for this is primarily because they are cheaper to maintain, as overcoming distance traditionally is associated with some cost (ibid.). Indeed, with online communication and virtual communities these costs are dramatically reduced and spatial proximity becomes a less salient factor, both in tie formation and maintenance (e.g., Wellman 2001). Even though we have all experienced or heard of close ties being established online, most of these social relations develop into repeated personal interaction in physical space, and some more intimate ones even terminate in physical space. But more importantly, our most significant social foci (Feld 1981), such as school, work, and family remain organized around interaction that is fairly concentrated in physical space, and they will most likely remain so for the foreseeable future. School and work are moreover examples of important foci where both formal and informal organisation is oriented towards what Steen (2009) calls "programmed" activities.

Just after the Second World War Leon Festinger and his associates conducted a study of a new housing project that had been erected to house married veteran students at MIT, Westgate. The topic of the study was informal groups, and among many other things they were interested in the "spatial ecology of group formation" (chapter 3 in Festinger et al. 1950). What is particularly interesting to note is that in order to answer the question what effect spatial organisation had for the formation of friendships they applied sociometry, a quantitative method for studying social relationships and a precursor to modern social network analysis. They found striking evidence for a spatial effect both within and between buildings. Even within very limited areas, spatial proximity was a strong predictor for sociometric choice, i.e., the closer you are in physical space, the higher the likelihood that friendship will evolve.

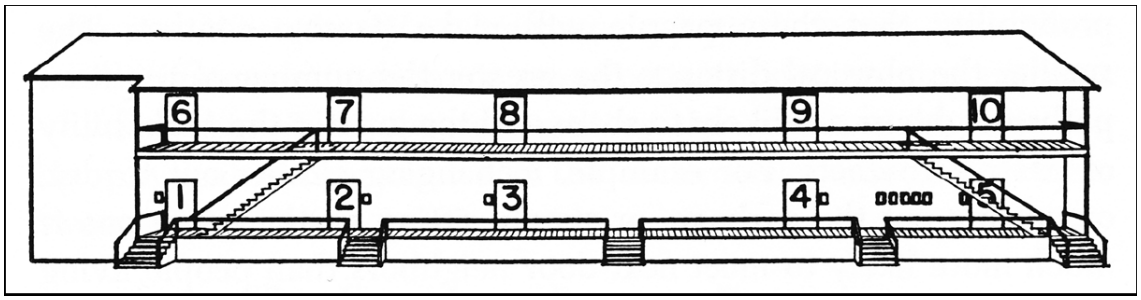

Figure 1
Schematic diagram of Westgate West. Sociometric choice (friendship) is most likely between next door neighbours on the same floor. Between floor choice are determined by closeness to staircase (Festinger et al. 1950:36).

One should keep in mind (as the researchers also did, see Festinger at al. 1950:Ch 2), that the people who lived in Westgate was a highly homogenous group in terms of age, class, education, etc, which was also somewhat distinct from other MIT students. Again, a sociologist would argue that this "socio-economic boundary" is what triggers the spatial effect: Because all individuals are more or less the same in Westgate, what is left for people to distinguish upon is spatial proximity. And reversely, if the Westgate population would have been heterogeneous across the same socio-economic dimensions, spatial proximity would have been completely overshadowed by proximity in social space and the tendency for social homophily (see McPherson et al. 2001).

But let us return to the idea of programmed interaction (Steen 2009), i.e., the idea that social activity is structured around the tasks and roles set out by the formal organisation, which was not was Festinger et.al. were focusing upon. And let us once more return to the experiments at Western Electric Company's Hawthorne plant.

The Hawthorne effect, controversial as it might be, is the idea that "behaviour during the course of an experiment can be altered by a subject's awareness of participating in the experiment (Jones 1992:451)." The formulation of this effect has emerged as a conclusion from various experiments in the so-called Relay Assembly Test Room, conducted over 270 weeks to test effects on productivity. However, it is another perhaps less well-know part of the Hawthorne experiments that has caught the attention of social network analysts, the experiment conducted in the so-called Bank Wiring Room (see Homans 1950:Ch 3, for an authoritative analysis of these data). In this room 9 wiremen attached wires to terminal panels that were soldered by 3 soldermen. The room also had 2 inspectors and an observer (and occasionally a trucker would pick up assembled terminals and bring new supplies). The men where observed for about 6 months in order to study social organisation under "normal" working conditions and the study contain a host of interesting materials and findings relating to small group work dynamics. For the purpose of this paper, I wish to highlight one of the several social networks (of friendship, antagonism, help, etc) that where constructed from the observational data.

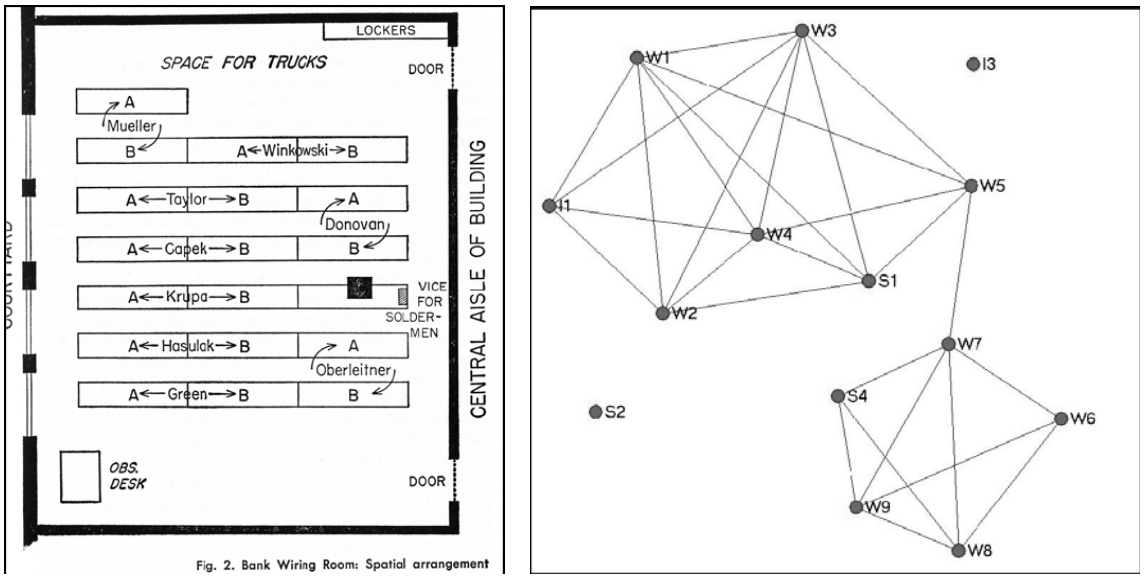

Figure 2

Spatial layout and social network of game-playing in the Bank Wiring Room. Spatial layout (left) gives positions for wiremen. In the network (right), W1-W9 are wiremen (for spatial positions se, S1, S2, S4 are soldermen, I1, I3 are inspectors (left image originally published in Roethlisberger and Dickson Management and the Worker [1939], right image produced in NetDraw from data shipped with UCINET 6).

Figure 2 depicts the spatial layout of the Bank Wiring Room. To carry out their work task, the wiremen alternated between two positions at the same or adjacent table. The network depicts who were involved in playing games with whom. These were frequent but minor betting games about almost everything that formed an important part of social life in the room. It should be fairly clear from these two pictures that there is a significant overlap between the social network and the spatial layout of the room. The same pattern is found for other social relationships as well, in particularly friendship. Other accounts from these data, such as conflicts over windows and the fact that tables in the front of the room had higher status than tables in the back leave a lasting impression that space does work its way into social life. This status in turn served to further constrain social relations to spatial dimensions.

Certainly, there are contemporary findings pointing in the same direction as the studies of Westgate and Hawthorne. A recent analysis of intra-organisational emailing for instance, found that 87 percent of emails are sent within same office floor (Adamic & Adar 2005), and Steen and his associates found very much the same in the analysis of the head office of the Swedish mail company, Posten (Bohman 2007, Steen 2009). From a normative perspective, these findings might be problematic,

because we know from experience and research that walking around in the same circles might bring a sense of security, but it does not provide new information or boost creativity (Granovetter 1973, Uzzi & Spiro 2005). And as Allen (e.g., Allen & Sloan 1970) repeatedly reports, it is the offices and laboratories that allow for chance meetings that tend to produce more innovation.

First and second order influence of physical space

The examples from Westgate housing and the Hawthorne plant might seem old and tired, but to some extent I do not think their implications have been fully appreciated by sociologists. They clearly demonstrate the fact that spatial design does structure social behaviour; not only as anticipated by functional and rational anticipation but also in a way that was unanticipated. I would like to underscore this distinction between such first- and second-order influences of physical space on social life with one last example.

Although it might not have been his intention, Schelling's (1978) book on the problem of micro motives and macro behaviour opens with a nice illustration of the role that physical space may play in structuring social behaviour. The author recaptures a lecture he was delivering in which at first it seemed as if the lecture hall was still empty when the lecture was about to begin; he good see that the first 12 rows where indeed empty. However, as he stepped up to the rostrum and was able to take in the whole auditorium, there were some 800 people in the audience. The first 12 rows where as empty as ever, but otherwise the hall was crowded with almost every seat occupied from row 13 and back to the last row. How come, asks Schelling, that seating dynamics in the lecture hall follow this pattern? Schelling is interested to explain in which way individual action creates macro dynamics, and proposes a range of preference based explanations for this particularly seating dynamic (Schelling 1978:11-17).

Schelling does not make the point that the organisation of physical space structures social life. And in this example, making that point might seem a bit superfluous. After all, the lecture hall is designed in such a way that the speaker, and her supporting material, is positioned at the centre of attention of an audience. But if we shift our attention away from this "first order" structuring of social behaviour that was apparently intended by the designer, and look at the "second order" structuring, it becomes more interesting. It is obvious that nobody intended the lecture hall to be filled from row 13 and back, not even the architect. If anything, I believe the designer would assume that the hall would be filled starting with the (visually and acoustically) best seat, then following the second best, and so forth, which is indeed the mechanism used to put a price on and to sell tickets to a theatre or concert hall. But as Schelling's example and many teachers' experiences indicate, when there is no market for seating, as in public or academic lectures, other mechanisms seem to be at work. And similarly, also spaces for programmed activities have "holes" or "niches" in which the second order influences of physical space are played out.

Concluding remark

Social network analysts usually acquire data through (structured) interviews or files, seldom through observations. To do a six months observational study as they did at the Hawthorne plant would be impossible today. This implies that the lion part of empirical work at the micro-level (for instance of interacting individuals in an office) have to rely on reported perceptions of social reality and social relationships and subjectively reported rather than observed behaviour. This might not be a disadvantage, and anyway we need to tinker with established tools in order to pick up second order influences of physical space. I say so because my sense is that these second order influences are much more strongly connected to the social construction of meaning that the first order influences. Indeed, I would think that what goes on in the "holes of programmed activities" is closely related to what Gieryn (2000) refers to as the construction of "place". Place does include unique physical space only as so far as it is intertwined with meanings and values of those actors who relate to the "place". Interestingly enough, Gieryn suggests that a highly significant property of "place" is its visual key. A suggestion that provides both a methodological challenge to social network data collection, in an otherwise visually accustomed research tradition (Freeman 2004), and an opportunity for further exchange between sociology and spatial analysis, e.g., Space syntax.

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