Movement in Workplace Environments – Configurational or Programmed?

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Abstract In countless case studies space syntax research has found that the configuration of a spatial system offers a powerful explanation to movement flows. However, this relationship is restricted for complex buildings where movement cannot be assumed as random since there may also be a programme that requires specific actions and interactions. A distinction has to be made here according to the nature of the organisation occupying a building: a strong programme building where the interaction and co-presence of people is highly controlled may not allow movement flows to follow configuration. In contrast, a weak programme building with an all-play-all interface might be expected to experience more randomised movement patterns increasing the significance of configuration as determining factor.
Though being useful, these assumptions lack the power to fully explain real life movement flows in workplace environments for two reasons: firstly, most workplace environments follow neither purely strong nor simply weak programmes, they lie in-between the two poles and comprise aspects of both systems. Secondly, configuration considered as the crucial cause of movement in an office may even be limited for weak programmes due to the effects exerted by everyday attractors such as the coffee machine, the watercooler or the photocopier, toilets or the building entrances.
This paper explores different strategies for explaining observed movement patterns, among them axial and segment analysis. It aims at an in-depth analysis of strong and weak programme aspects in order to find ways of understanding office movement patterns. The data used stems from two case studies representing those 'in-between' settings: a university school and a research organisation hosting theoretical physicists.
The results suggest that movement in these workplaces may be reflected best by a metric analysis, as opposed to urban movement that follows angularity patterns. Distances seem to matter most in small and well known spaces. Moreover, it can be shown that flows of people can only be explained through configuration whenever it is possible to exclude attractor driven movement.
On this basis a new approach is suggested that combines configuration based integration measures with attractor based ones in order to predict actual movement flows in offices.

Keywords: complex buildings; workplace; office; strong and weak programmes; movement; attractors

1. Introduction

To understand the logic and functioning of organisations, it is crucial to make sense of movement patterns within them, as movement gives rise to a number of emerging social phenomena: presence and co-presence of people, sojourn and encounter of people, their interaction patterns, the way they communicate, collaborate, exchange knowledge etc. Whenever people want to intermingle with others, it first of all involves movement. Thus it also involves space and the configuration of space.
The space syntax research community has proven over and over again that configuration is the primary generator of movement in urban systems even if under the influence of other factors like attractors (Hillier et al., 1993). In contrast to cities, movement in the workplace is not that easily explained solely by configuration. On the one hand, a variety of other

factors is involved, like an organisation's mission and vision, its culture and character, its work processes and structures. On the other hand, it also means analysing smaller and easy structured spaces where movement even on an aggregate level of collections of individuals may not be regarded completely random.
This paper aims at answering the question whether observed movement flows in knowledge-intensive organisations can be rather related to and explained by configuration or whether they are implied by any sort of programme.

2. Movement in complex buildings

To understand the influence and power of spatial configuration on movement patterns within complex buildings, Hillier (1996, Chapter 7) introduced the concept of the so called programme of an organisation, which is defined as the spatial dimension of organisation realised through an interface, i.e. a spatial relation between or among categories of persons like inhabitants and visitors. An interface thus incorporates the functional idea of an organisation by allowing levels of control over space and regulating the way in which categories of people may or may not encounter and interact with each other.
Whenever an interface is highly regulated and follows manifold complex rules, for example in a court (Hillier and Penn, 1991), the building is strongly programmed. Its essential characteristic is that movement flows are determined ahead and do not generatively follow the layout and configuration of the building. In contrast, a weakly programmed building hosts an all-play-all interface like on the editorial floor of a newspaper with low levels of rules to follow. This results in hive like activities and randomised movement flows with hardly any control or limitations. Configuration and layout structure act generatively in these organisations and influence movement patterns as was shown in numerous case studies (Grajewski et al., 1992, Hillier and Grajewski, 1990, Penn et al., 1999, Spiliopoulou and Penn, 1999).
However, when analysing those previous studies and their results of configurational influence on movement closely, it appears that though the theory of space syntax has a point to make in complex buildings, it still lacks the explanatory power to consistently and significantly predict movement flows – a power which it has gained in the analysis of urban structures. Correlations between observed movement and spatial integration on the level of the whole building result in every possible value, even negative ones, as table 1 shows.

study	organisation	R^2	measurements
Hillier and Grajewski 1990	airline research org. computer firm	0.375 - 0.593 0.449	INT: integration of axial lines MOV: density of moving people per $100m^2$ (snapshot)
Grajewski et al. 1992	research org.	0.921[1]	INT: mean global integration of each floor MOV: density of movement per $100m^2$ (snapshot) as proportion of all activities
Penn et al. 1999	ad. agency	0.502	INT: all-axial lines MOV: sum of traces
Spiliopoulou and Penn 1999	consultancy	0.094	INT: all-axial lines MOV: sum of traces

table 1: overview of space syntax research on movement in offices

Additionally to the problem of low consistency in results throughout the studies, there are two more issues that complicate matters: On the one hand, the used measurements vary quite significantly which impedes reproducibility and the development of secured insights. On the other hand and even more problematic, the data sets were then reduced in various ways in order to improve the relationship between spatial integration and observed movements. While separating the data into different floors is quite consistently done (and makes correlations rise, e.g. from 0.375 to 0.736 and 0.400 in Hillier and Grajewski, 1990), manifold other ideas and concepts are used, e.g. excluding gates to dead-end spaces (Penn et al., 1999 thus increase the correlation from 0.502 to 0.959), or 'including only the south part (studio) of a floor and omitting gates in deep areas where long lines penetrate' (increase from 0.333 to 0.902 in Spiliopoulou and Penn, 1999). Data reduction strategies seem to be arbitrary and likewise unique to each case study.

While this procedure may make sense for the exploration of the character of a single case study organisation, it is counterproductive for the development of a model with the power to genuinely and correctly predict the flow of movement in workplace environments. Not only are recurring methods and measurements needed, moreover, add-ons to the general theory of space syntax are required. It seems that configuration only accounts for a certain part or percentage of movement flows in the office with other influences disturbing the clear relationship.

This study tries to find a systematic behind the failures to explain movement through pure configuration and thus aims at filling one of the gaps that obviously exist in the space syntax analysis of workplace environments.

3. Methodology

Data from two case studies conducted in 2005 and 2006 as part of the PhD research of the author is presented here. Various methodologies were used to understand the studied organisations as intimately as possible. Firstly, short interviews were led with every member of staff inquiring roles and functions within the organisation, characteristics of their work, and detailled facilities usage[2] patterns. Secondly, the spatial layout of the organisation was analysed using Space Syntax methodologies, including axial line maps and segment maps (Iida, 2006). Finally, patterns of space use (e.g. movement traces, interactions, people standing and sitting, group behaviours, as well as the locations of these) were observed and mapped[3].

4. Case Study One: University School

The first case study organisation is located in central London. It is a university faculty divided into five more or less autonomous organisational entities or 'schools', of which one was studied in depth.

At the time of the study[4], this school had sixty-nine members of staff and comprised a central administration and six different research groups (ranging from one to twenty-one members) that offered twelve Masters-Programmes of study with around 200 students in total. It was spread over two different locations (being 300 metres apart from each other) with four individuals in one location (B) and the rest on three different floors in another building (A).

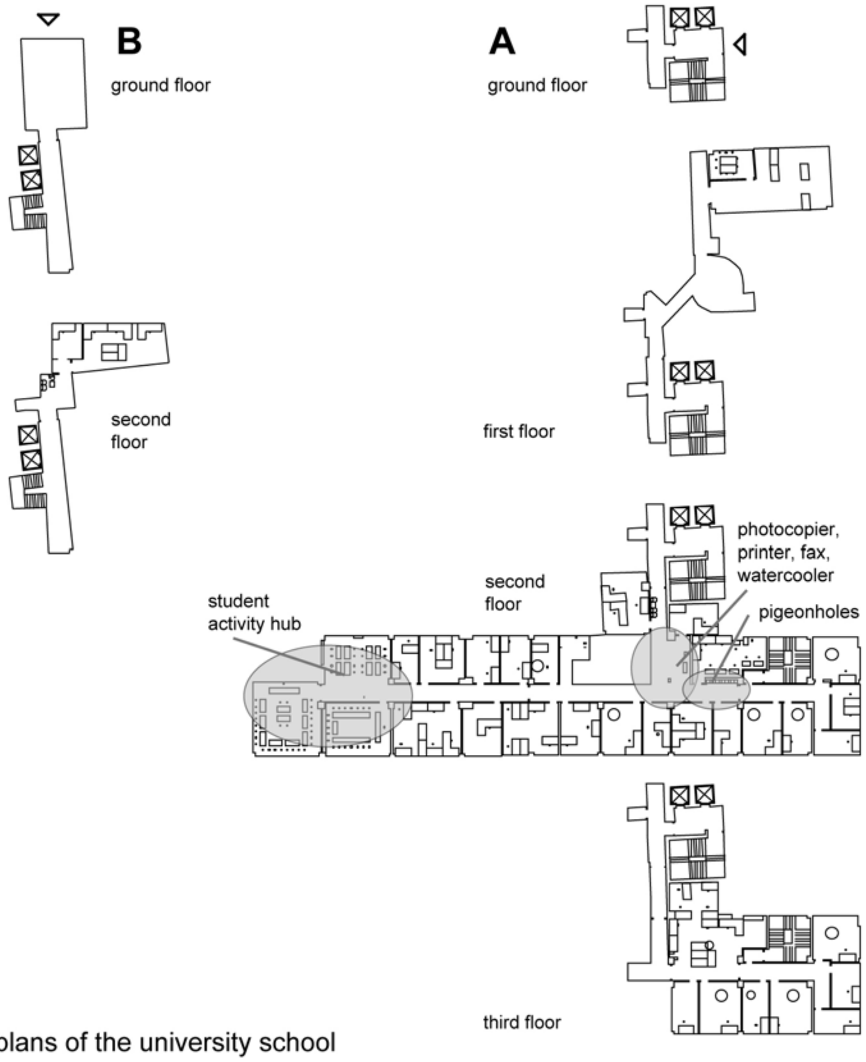

figure 1: floorplans of the university school

4.1 Spaces of the Organisation

The heart of the organisation is located on the 2nd floor of A where it occupies a whole building wing. Half a wing on the floor above and one group office a floor below comprise the school's spaces. The spaces are structured into variously sized and shaped offices, with a majority of single and double cellular offices and some group offices occupied by three to seven people. On the third floor one open space work area is provided. The only more or less public spaces in the building are a small central area at the intersection of the two main corridors with facilities such as the photocopier, printer and water-cooler, the computer cluster at the one end of the 2nd floor with two seminar rooms nearby and the narrow corridors connecting the whole system.

The axial and segment line maps of the building clearly identify the long corridor of the 2nd floor of building A, more specifically the intersection with the entrance corridor as the centre of the spaces. All the main staff activity areas (photocopier, printer, fax, water-cooler as well as the pigeonholes) are strategically well placed in the centre of the integration core. Building B is highly segregated as expected.

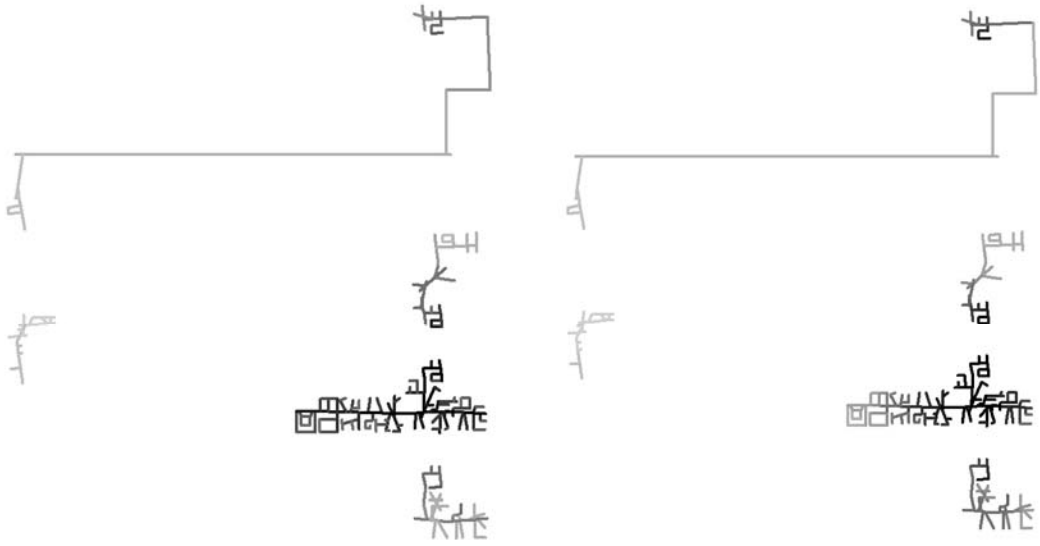

figure 2: integration of axial topology (left) and metric distance (right); darker lines are more integrated

4.2 Character and Programme of the Organisation

The school activities are strongly research-based although during term time teaching forms the everyday business as well, with trails of students moving in and out and bustling activities especially around the two seminar rooms and the computer cluster. Being part of a university, the school tends to be loosely structured with high levels of self-responsibility, freedom to decide and autonomy. If Hillier's definition of the programme and interface of an organisation is followed, the university school could be considered weakly programmed: the interface is an easy short model with nearly no rules to follow, hence movement flows are not controlled and different categories of people like students (visitor status) and staff (inhabitant status) may meet and interact whereever and whenever they wish. Therefore it would be expected to find movement flows that follow the configuration of the building.

4.3 Movement within the Organisation

The traces of movement however, observed separately for staff and students, do not clearly follow the structure of the building. While for members of staff movement at least partly corresponds to configuration, student movements contradict spatial integration. Apart from few exemptions most students head directly to the computer cluster and seminar rooms which form a bustling centre of both static and moving activities.
The inability to explain student movement flows by configuration is set out in the following table showing the results for correlating axial and segment integration[5] with observed movement.

	axial topology	angular	segment topology	metric
all	0.555	0.522	0.441	0.372
staff	0.368	0.307	0.652	0.617
students	0.259	0.316	-0.007	-0.027

table 2: R^2-values for the correlation of segment integration (1/Mean Depth) with observed movement flows

Whereas integration based on segment topology or metric distance can capture staff movement patterns strongly and significantly, it completely fails to do so with student flows. Even if only those spaces that lie along the main trails of students are taken into account, correlation values do not improve but worsen (e.g. for axial topology R^2 decreases from 0.259 to -0.043). This means that the students do not at all follow configurational suggestions when moving through the building, but clearly a programming, defined in time (e.g. schedules for seminars)[6] and space (location of student areas at the very back end of the corridor and thus in rather segregated areas).
At the same time, the power of a purely configurational movement explanation is limited for staff movement as well. If looked at closely, we can see that the observed traces especially in the central area around the photocopier and the pidgeonholes directly lead to these attractors and only coincidentally along integrated paths. This could mean that we mainly receive a strong correlation between movement and integration, because the attractors were placed in a way that mirrors the configurational logic of the system. If the attractors would be placed somewhere else, one would strongly suspect the relationship between movement and integration to break up.
To summarise the lessons learned from this case study, the university school though being considered weakly programmed due to its function and organisational character shows an emerging phenomena rather associated with strong programmes i.e. the clearly targeted movement of students. It seems to be an example of an in-between setting that is constituted neither by a purely weak nor by a completely strong programme. Furthermore, the results suggest that office movement is hardly ever randomised but additionally influenced by movements towards the various attractors connected to people's work tasks. Moving onwards from this first case study, it was aimed to investigate this assumed attractor driven movement more closely with the next case study.

5. Case Study Two: Research Organisation

The second case study organisation is located close to the university campus in Dresden/Germany, three kilometers south of the city centre. It is a research institute being part of one of Germany's major publicly funded research societies and hosts theoretical physicists. This institute had 181 members of staff at the time of the study[7] and comprised a central administration, a guest programme (with short term and long term visitors coming from all over the world to work on their research in this environment), three different departments (with two respectively three subgroups each) as well as three independent research groups led by young scientists. Two of the departments including all subgroups and all independent groups (109 people in total) were studied in depth.

5.1 Spaces of the Organisation

The institute inhabits a purpose-built structure, designed by the architectural firm 'Brenner and Partners' in the mid 1990s and extended in spring 2006 with the newly added wing D. The building is a three storey comb-shaped complex with three small buildings adjacent functioning as guest houses to host the international visitors temporarily working there.

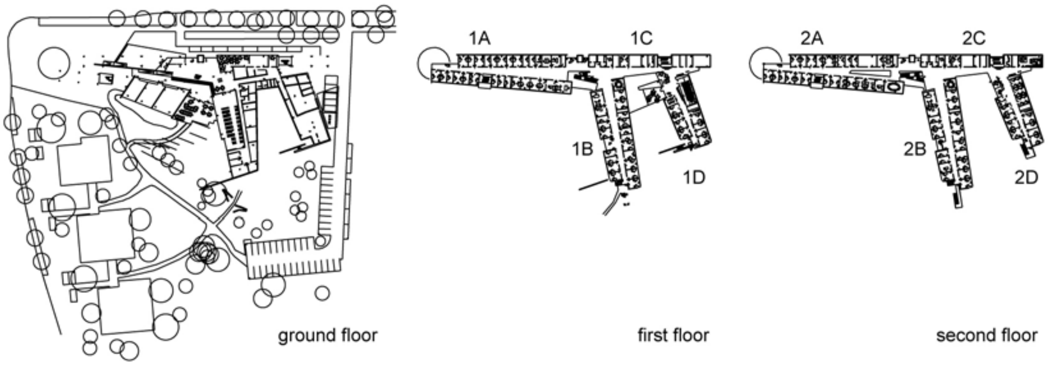

figure 3: floorplans of the research institute

On the ground floor three seminar rooms, the cafeteria and an outside terrace, the reception desk, and the library are grouped around a large lobby with an open central staircase. Additionally, server and storage rooms, and the offices of the facility managing staff are located on the ground floor. The other floors accomodate the majority of staff in single and double (sometimes used as triple) cellular offices. The C and D wings predominantly host facilities of interest to the whole organisation, like kitchens, coffee bars, toilets, seminar rooms, photocopiers, and open work areas (as opposed to the printers and little seating areas that are decentralised and thus widely spread across the institute). The newly added D wings act as main areas for the seminar participants staying for some weeks. Two apartments in guesthouse three had been refurbished to function as working areas as well, hosting around ten members of staff.

The axial and segment line analysis of the spaces shows a very differentiated picture: while the axial topology picks out the central staircase and the corridors leading into the wings 1B, 1C and 1D as particularly integrated, the metric distances integration highlights the central core around the major staircase on all three floors as most integrated spaces. Either way, the people working in the guesthouse are cut off significantly.

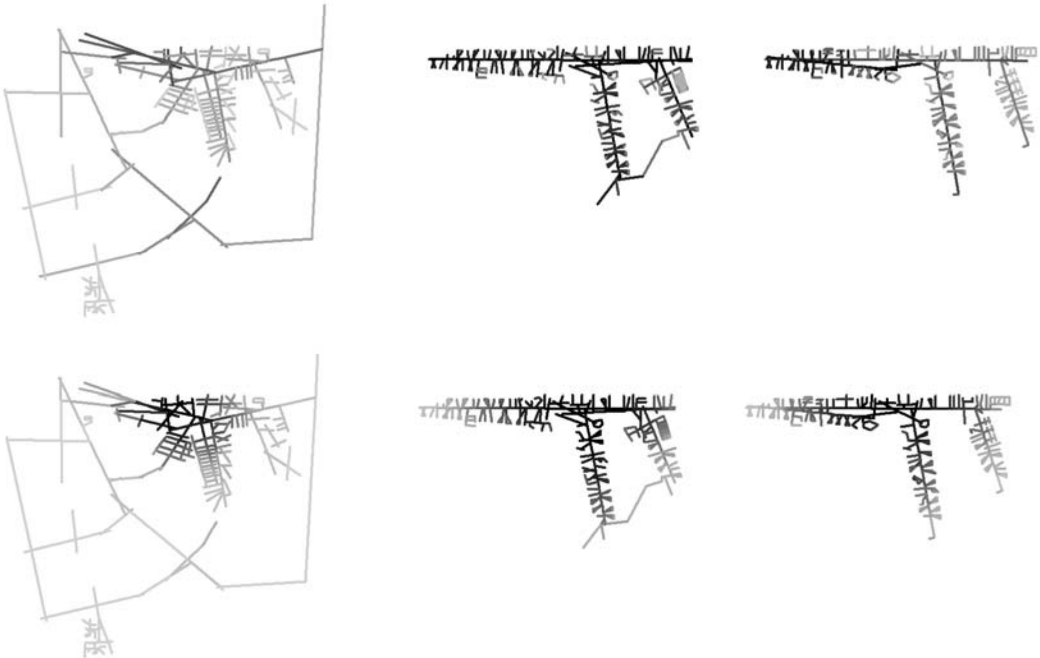

figure 4: integration of axial topology (top) and metric distance (bottom); darker lines are more integrated.

5.2 Character and Programme of the Organisation

The institute works in the area of classical and quantum physics and attracts a variety[8] of theoretical physicists. Their work processes are all office based and involve reading, thinking, calculating, computing, discussing, and writing as main activities with a focus on interactive and collaborative aspects ("Science emerges through discussion", as one member of staff expressed it). The institute hosts around 200 incoming visitors each year[9], staying from four weeks to one year, it also acts as a conference centre with six to ten workshops and seminars being held within its spaces every year, each lasting from one to four weeks. Thus the organisation is extremely dynamic and ever-changing. Nearly everyone working in the institute is on a temporary contract (apart from leading scientists and the administrative staff), thus there is a great feeling of fluidity, temporariness, and a diverse culture to be experienced. Everyone feels as a guest somehow, so that it is not possible to draw a distinction between inhabitants and visitors. Hence there is no interplay between different categories of people to be analysed, however, with its flat hierarchy, very open structure, high levels of autonomy and freedom that allow for everyone to work on their topics of interest and use the institutes infrastructure with only few rules to be followed, it can be clearly seen as a weakly programmed organisation.

5.3 Movement within the Organisation

The flows of observed movement seem to be following the structure of the building at first sight. If the whole building is taken into account, the correlation between movement and integration delivers R^2 values between 0.159 (axial) and 0.424 (metric), which are lower than the ones noted in the previous case study discussed but in the same range of values repeatedly reported by the majority of studies. Figure 5 illustrates a clear difference between the results for axial and metric correlations. Whereas the scattergram for axial integration shows a predominantly random distribution of points with a slight upwards tendency, the metric integration at least limits maximum movement flows quite clearly though the general distribution in the lower half is a little blurry. It is worth noting that again axial integration does not capture movement flows in the workplace environment best, it is outranged by the metric distances analysis. Still the results do not satisfy and movement seems to flow only partially in accordance to the configuration of the building.

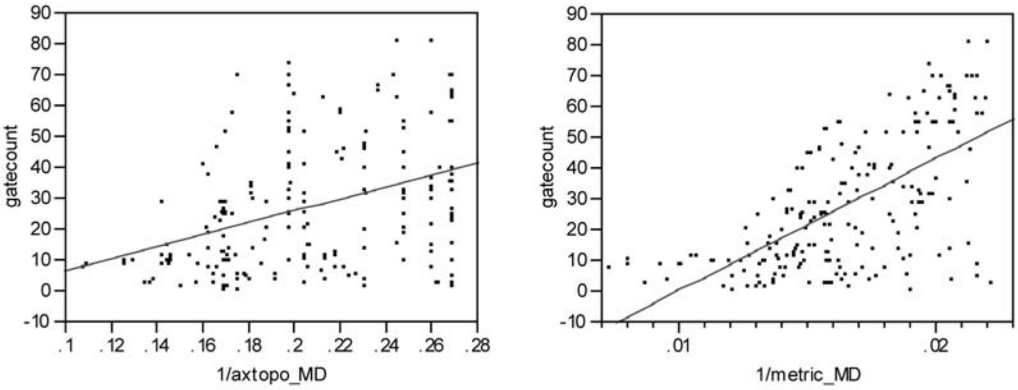

figure 5: observed movement hardly correlates with axial integration (left, R^2=0.159, $p<0.0001$) but more so with metric integration (right, R^2=0.424, $p<0.0001$)

If floors are looked at separately, correlation values do not simply all increase as expected. Whereas an improvement is reached in three cases (first floor: 0.583, wing 1A: 0.908, wing 1BC: 0.605) which may prove the often stated separation of different floors in multi-storeyed buildings (Allen, 1984) where movement flows break off, the correlations get worse for the rest of the sample. Figure 6a shows in a zigzag line how the correlation of movement with integration changes if areas are looked at separately from the first point on the left (whole building) to sometimes higher and sometimes lower values, the lowest being reached for wing 1D (0.128 metric).
If this wing 1D is investigated more closely, we find it dominated by extraordinary functions. Especially the more integrated and central parts of the wing host attractors like a big seminar room, open work places for short and long term visitors, the exit to a wooden terrace with outside tables and seats[10] as well as an open bar with newly installed fancy coffee machines[11].
As observed in the previous case study many of the movement traces directly lead to attractors instead of moving along integrated lines. Due to the size of the building studied here, it was possible to exclude those gates that lead to attractors directly. The whole set of correlations was tested again, resulting in slight to significant improvements as set out in figure 6b. The second floor data set nearly doubled its R^2 values from 0.347 to 0.612 (metric), as did wing 1D (from 0.128 to 0.247 although being still considerably weakly correlated), but the strongest improvement could be reached for wing 2BC which raised its value from 0.280 to 0.879. Since none of the correlation values decreases and six out of nine data sets now deliver results above R^2=0.5 it can be considered quite sure that attractor driven movement does disturb people following the configuration of the building.

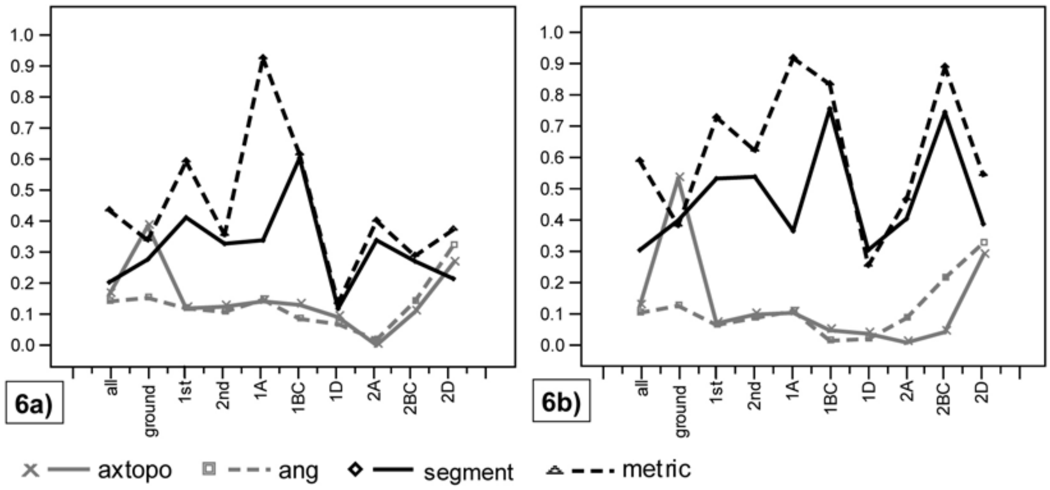

figure 6: R^2 values for the correlation of segment integration (1/Mean Depth) with observed movement flows. 6a (left) represents the whole data set, 6b (right) shows correlations when gates leading directly to attractors are excluded

However, this does not help solving the problem outlined yet: neither could reliable and constant correlations be reached throughout this study as the ground floor and two of the wings are still underperforming with less than 50% of the movement flows being explained. This may be due to the inability to completely extract attractor driven movement out of the data set. Only gates leading directly to an attractor were excluded, but still targeted movement affects the whole path from origin to destination. Nor did the study deliver a tool to influence future design solutions because movement patterns in workplace environments still cannot be predicted. We only know that in areas with high densities of attractors it is most likely that movement flows are distracted from integrated paths.

6. Attractor model

In order to work towards a predictive model of movement in workplace environments, an idea on how to integrate attractor driven movement with configuration based movement has been developed:

All movements leading to and from specific attractors in the workplace were modelled into a set of routes that could be independently analysed and integrated into space syntax configuration measures. For this purpose data on the detailled usage of facilities of all study participants[12] of the research institute was gathered. With the help of Segmen (Iida, 2006), the shortest geodesic path from each segment representing the desk of an individual to each segment representing an attractor used by this person was obtained. For every segment on each of those shortest paths, the frequency of how often it was used daily was accumulated as attractor weight (of a segment), normalised by the formula

$$A = \frac{F}{\sqrt{n_p n_a}}$$

where A is the attractor weight, F is the accumulated daily frequency for each segment, n_p is the number of people and n_a the number of attractors in the whole system.

This method allows for considering purely attractor based movement to become an independent value. It is based on human behaviours, e.g. choosing the shortest way[13] when heading for a facility that offers standard quality such as a printer or photocopier, but accepting longer trips when the target is worth it like the fancy coffee bars. At the same time it takes the configuration of the system into account because the path from one location to another relies on structure and layout of the spaces.

This leads to new questions: First of all, can the attractor weight of a segment be considered as a different kind of integration in itself? And secondly, can the two measurements of metric integration (as purely configurational value) and attractor weight (as locational value, i.e. the result of the decision where to place an attractor, partly taken by the designers in advance, partly taken by an organisation afterwards) be combined to improve predictability of movement? We would assume to find that real life movement flows are informed by both: configuration as a structure distributing randomised movements as well as location of facilities attracting people directly.
Concerning the first question, pure attractor weight correlates quite well and significantly with movement flows already with no figure lower than 0.48 as the grey line in figure 7 shows. For the whole building the correlation found is 0.570 (0.424 metric), even the ground floor performs up to 0.481 (0.328) and most remarkable, wing 1D that proved a considerable weak correlation with any configurational value (0.128) now rises to 0.824. The curve behaviours in figure 7 show the discriminating power of each of the two factors – configuration (black dotted line) and attraction (grey line). For most floors and wings attractor weight correlations are high when metric integration correlations are low and vice versa. Exceptions are the first floor and wing 1A where the difference between attractor weight scores and metric integration ones are considerably low.
Movement within the first floor as well as within wing 1A and 1BC is best explained by configuration, hence they may be considered areas of rather weak programming. In contrast, movement on the ground and second floor, and in wings 1D, 2A, 2BC and 2D significantly follow attractors more than layout, therefore may be regarded as rather strongly programmed areas. Though having nearly identical layouts, interestingly the A and BC wings behave differently. This may be due to the placement of a meeting room in 2A and some heavy smokers occupying offices in 2A and 2BC thus causing extra attractor driven movements. Since attractor weight does not outrange every single value compared to metric integration (dotted line), it may be assumed that attractor weights do not capture movement flows if considered alone.

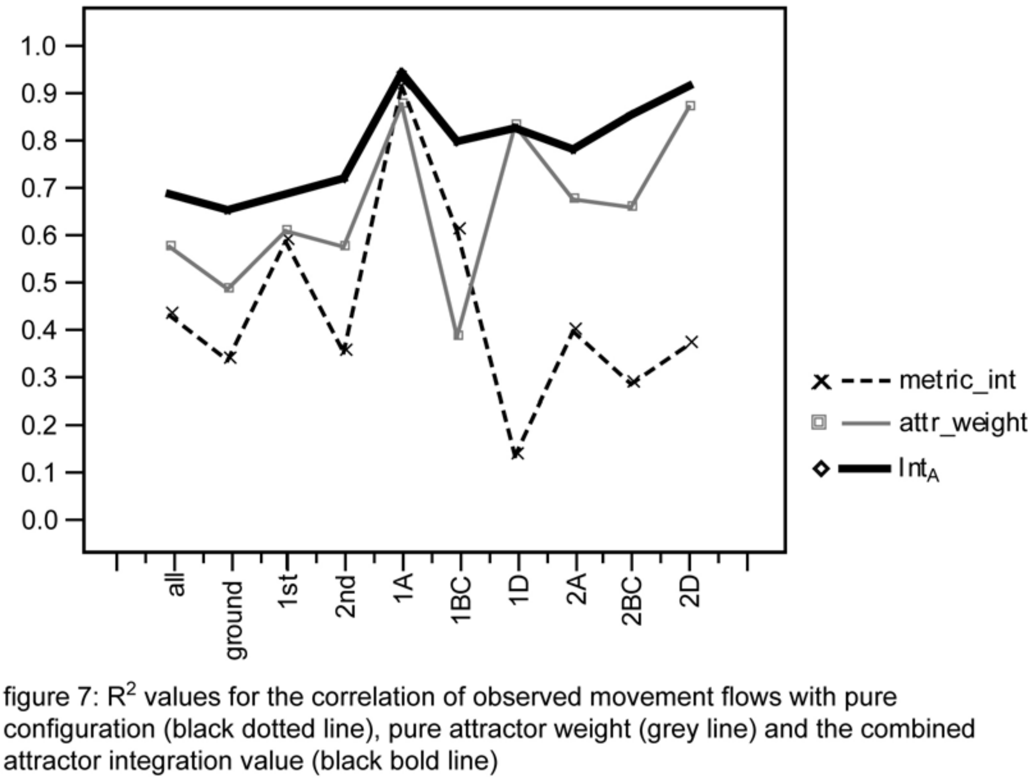

figure 7: R^2 values for the correlation of observed movement flows with pure configuration (black dotted line), pure attractor weight (grey line) and the combined attractor integration value (black bold line)

Concerning the second question on how to combine attractor weight with configuration a simple mixture is tested resulting in a new measurement called attractor integration (Int_A) which is calculated by the formula:

$$Int_A = \alpha \frac{mean(\frac{1}{MD})}{mean(A)} A + (1-\alpha)\frac{1}{MD}$$

where A is the attractor weight, α is the mixing factor between the two measurements (with 0<α<1) and 1/MD is the space syntax integration value derived from mean depth (MD).
Thus attractor integration values can be correlated with movement flows testing a variety of alpha values. On the level of the whole building R^2 rises as high as 0.682 for α=0.3. This means first of all that the combined Int_A allows for better correlation results as either of the two values taken alone (compare the black bold line[14] in figure 7). Secondly it means that attractors account for around 30% of the movement flows with configuration influencing the majority of 70%.
To understand which mixture of factors delivers the best correlation, R^2 values (attractor integration versus movement) are plotted against alpha, resulting in a sample of curves for all separate wings and floors as shown in figure 8. The curves highly resemble each other in that they have a maximum when α ranges between 0.15 and 0.4 with lower values for either end of the curve where α=0 (pure configuration) or α=1 (pure attractor weight). The only exception is wing 1D where the maximum correlation is reached at α=1.

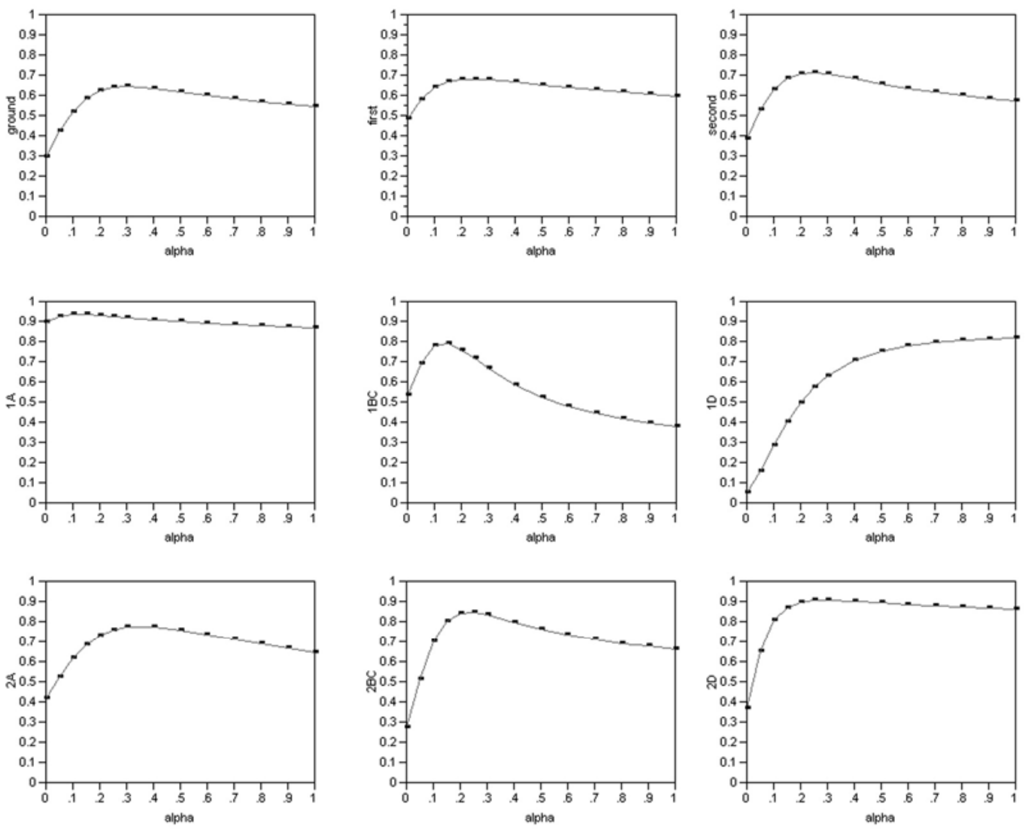

figure 8: curves fitting alpha-values against maximum reached R^2 for all separate floors and wings

What distinguishes one curve from another is the height of the starting and end point (which are the values for how well configuration and attractor weight perform on their own) and the height of the amplitude. The curve for wing 1A for example shows very significant correlation throughout although there is a maximum at α=0.1 (with R^2=0.935). This curve behaviour may be interpreted as a setting in which all possible attractors are distributed according to the logic of the configuration, hence adding attractor values does not change much. Or viewed the other way round: due to the placement of attractors according to the logic of the structure, significant correlations could be achieved already by a solely metric integration analysis. The function and use of wing 1A confirms this interpretation, since it hosts nearly exclusively cellular offices. Apart from a printer and a seating area at the far end of the wing, there is no attraction whatsoever found. All attractor driven movements hence head towards the centre of the building which is more integrated at the same time. The curve for wing 1BC in contrast has a clear rising and falling behaviour with a maximum at α=0.15 (with R^2=0.79). This may be interpreted as a setting where attractor weights and metric integration are mostly independent and decoupled from each other. Both sides can explain the movement traces to a certain extent and each explains different aspects of it but only together do they deliver a full and reliable picture.

7. Conclusions

To summarise the findings of this paper, contributions to the development of space syntax theories and methods in workplace environments could be made on various levels.
Firstly, conceptual differentiation was added to the idea of weak and strong programme organisations and their buildings. It was shown that even if the organisation and its set of roles and relationships suggest a weak programming, we may still find aspects and accordingly behaviours connected to strong programme settings involved.
Secondly, the paper was able to provide evidence that the observed patterns of movement in workplace environments seem to follow metric distances rather than axial topology or angular integration. Hence it may be assumed that in small and well known systems like the office, the costs that clearly determine movements are metric distances as opposed to urban environments where angularity patterns have proven to be the best predictor to movement flows (Hillier and Iida, 2005). This would put the question of metric proximity and distance in accordance with a configuration very high on the agenda of workplace designs as a mean to integrate or segregate. However it should be kept in mind that so far only two case studies have been taken into account and further testing would be necessary to prove the importance of metric distance for small scale environments.
Thirdly, the application of space syntax to workplace environments could be enhanced by proving the influence of attractors as drivers to targeted movement. A new model was developed that was able to improve the overall levels of correlation of movement flow and spatial integration by modelling targeted movement into the classic space syntax approach. First results on testing the model seem rewarding and fascinating, although much more research will be needed in order to fully evaluate its potential and effects. Even though the method still requires much detailled information about the usage of facilities and is hence time consuming and complicated to use, it offers the potential to add to the general theory of space syntax. It may provide a first step towards the development of a more predictive model that would allow for the precise planning of integrated and segregated areas in the office by offering a second set of parameters. Not only could the layout and configuration be designed to result in the wanted levels of integration and segregation, but also the placement of facilities could be used as a means to that.

Acknowledgements

I would like to thank Shinichi Iida for his continuous help and patience in explaining, developing and finally adapting Segmen so that it would run my attractor analysis. It would have been impossible to write this paper without his support. I would also like to thank Christian Sailer who continuously discussed the ideas of the paper with me, greatly helped with the mathematical implications of developing the attractor model, and also wrote tools to aquire, handle and transform the data needed for the analysis.

[1] The study correlates mean global integration of each floor with movement density as proportion of all activities (talking, sitting, standing, moving) within the floor, thus it only has five single points in the scattergram with $p<0.026$

[2] It was asked which facilities, spaces and attractors someone used and how often (per day, week or month) each was frequented. The following were considered: entrance and exit, printer, fax machine, photocopier, library, reading room, coffee or tea area, lunch, meeting and seminar rooms, open seating areas, pigeonholes, administrators, and other spaces or rooms. A standard value of twice daily for men and trice daily for women was assumed for toilets since as it was regarded a too sensitive question to ask. This data is only available for the second case study.

[3] Apart from open observations of individual and group behaviours, movement traces and stationary activities were observed at ten different times throughout regular working days for five minutes at each observation spot.

[4] Which was conducted in October/November 2005.

[5] As there is no standard way yet on how to calculate integration for segment values, 1/Meandepth was taken in this study.

[6] Although this was not observed in-depth with movement traces.

[7] Which was conducted in July/August 2006.

[8] The main areas of the institute are quantum physics of condensed matter, non-linear phenomena and dynamics, and biophysics. I was told that for physicists this is regarded as a very "interdisciplinary" institute (although they have all studied the same subject, the focus, methodologies used etc. vary significantly).

[9] i.e. it has a staff turnover of around 50% within half a year.

[10] Which were highly frequented during the time of the study due to nice and sunny weather

[11] Those coffee machines produced cappuccino, café latte, espresso etc. as opposed to the kitchens in wing C that offered just simply coffee. The ratio of usage of coffee bars to kitchens could be observed as 2:1.

[12] The data for the remaining 72 staff members not participating in the study was estimated based on the average answers (thus taking into account the culture and usage patterns of the place) as well as based on their roles (administrative versus scientific staff versus short term guests).

[13] Multipurpose trips like checking the pigeonholes when coming back from lunch were taken into account wherever possible and thus counted only once.

[14] The results shown here have varying alpha values, for each category the best performing value was chosen

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