Can Mobility Flow Analysis Improve Informal Learning Processes in Traditional Educational establishments?

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Abstract
The aim of this paper is to explore the potential of mobility flow analysis (MFA) for improving and strengthening the role of informal learning in educational establishments. Visualization data acquired by current technologies was correlated with the spatial structure of the learning environment of a university building in the IST Campus in Lisbon, to contribute for the development of a space-use analysis model (SUA). This paper analyses mobility graphics i.e. simplified two-dimensional representations of spatial movements, and compares patterns of spatial configuration and of user mobility obtained in the university campus. Correlations between space and mobility are established and in the end the potential of the proposed method for the development of a space-use analysis model is discussed.

1. Introduction

How far will it be possible to stimulate secondary and higher education institutions, including universities, to promote and foster informal learning environments and experiences to their students? We refer to new approaches to learning and teaching beyond the typical structure of fixed duration classes with breaks in between, in a way to facilitate student-centred and collaborative learning, as a decentralized process that takes place anytime, anywhere (Fisher, K. 2005). This implies reconfiguration of educational facilities to support changes in the societal context of education and we argue that enhancing student learning and facilitating continuous experiences and "learning events" requires, per se, the adequate application of space-use methodologies and analysis.

It is well known that the impact of student-centred learning methods, such as problem-solving learning, evidence-based learning, reflective study and group work, implies learning activities that are more socially responsible and reflexive, where learners and practitioners collaborate on a problem in a specific, localised context. This resulted in a growing need for more flexible learning spaces, such as laboratories or studios based on interactive exchange of knowledge (Schon, 1985).

But learners and teachers spend a large amount of their time outside classes, laboratories or studios and the time spent in socially peer-to-peer oriented settings discussing academic work or other related topics complements the learning process (Lomas and Oblinger, 2006, p.6). It happens through flexible and informal processes and in casual community settings, such as lobbies, and common rooms, where there is a greater tolerance of noise and activity.

Research by Scott-Webber (2004) examines the social or informal learning environment and the reduction of formal timetabled learning activities. The author emphasizes the importance of learning "hubs" - informal and formal learning precincts and student socializing areas - as well as "third learning" spaces were people go for collaboration and share information in a social and casual two-way process (face-to-face or by media interface).

Chism (2006, p.4) explores the "third learning" space concept, as a forum for discussion and information sharing, where informal contacts occurs, and endorses its contribution to improve learning: "Environments that provide experience, stimulate the senses, encourage the exchange of information, and offer opportunities for rehearsal, feedback, application and transfer are most likely to support learning".

This paper reports to a major research project on learning environments developed in the framework of secondary and higher education. The main research question is on how the configurative properties of learning settings influence the users' experience of space, generate interaction and facilitate their capacity to acquire and share knowledge. It is argued that spatial configuration has the potential to influence the space use of learners and teachers and regulate the ways in which knowledge is shared and learning takes place. The type of rules space imposes on users constitutes the key condition on how the socio-informational function may arise. The answer to this question requires the development of a space-use analysis model (SUA) capable of a systematic, objective and non-arbitrary description.

This paper is focused on temporary "learning events", i.e. informal knowledge-sharing scenarios that took place in the IST campus in Lisbon in the scope of the "third learning" space concept, aiming at evaluating the capacity of space to support, promote and enhance social and informational interface. The potential of current video technology to describe mobility flow, namely interaction and navigation patterns, and the correlation of that data with spatial structure analysis is explored in order to contribute for the development of a space-use analysis model - Mobility flow analysis (MFA). This model is based on the exploration of available edition software for images in motion. Video data is crossed over with "Space Syntax" models combining spatial description with motion graphics, from which emerging spatial patterns of informal knowledge-sharing are identified.

The paper is divided into four parts. The first one describes the methodological procedures applied to develop MFA. The second refers the main tasks carried out. In the third part, the motion graphics are analysed, patterns of spatial configuration and patterns of user mobility are compared, and correlations between space and mobility are established. Finally the potential of the proposed method for the development of a Space-Use Analysis (SUA) model is discussed.

2. Methodological Procedures

MFA was applied in the context of four learning events held during 2008's Spring Term in the central atrium of a university building shared by the Civil Engineering and Architecture faculties (CE+Arch_b) at the IST Campus, in Lisbon. E1 An event organised by the IST Student Union aiming at fostering links between enterprises and students (May 2008); E2 An exhibition organized by architecture students aimed at presenting their work and debating architectural themes (May 2008); E3 An installation - White Cube - produced in the scope of 2nd year architectural design studio to support the projection and viewing of videos. (May 2008); E4 A retrospective of 2nd year architectural design students' final works (June 2008).

E1, E2 and E3 were realised during the teaching term period. E4 ran for two weeks, during the examination period. E1 and E2 last for three consecutive days. E3 took place during the design studio time from 9:00 a.m. to 13:00 a.m., with an attendance peak at around 11:30 a.m.

All the layouts were characterised by an extensive occupation of the central atrium, with the exception of E3. The White Cube was installed close to the north top of the rectangular central atrium.

E1 layout adopts a compartmentalised configuration made of a set of cubicles defined by opaque partitions approximately 2.80m high. From the point of view of physical and visual restrictions, it was the most intrusive one. On the contrary, E2 was the most permeable layout, considering the extension of space occupied and the type of exhibits: a set of 30 real-scale human figures made of cardboard were randomly spread all over the atrium.

The analysis was carried out in two phases (Figure 1). These two phases were carried out separately and their outputs subsequently compared.

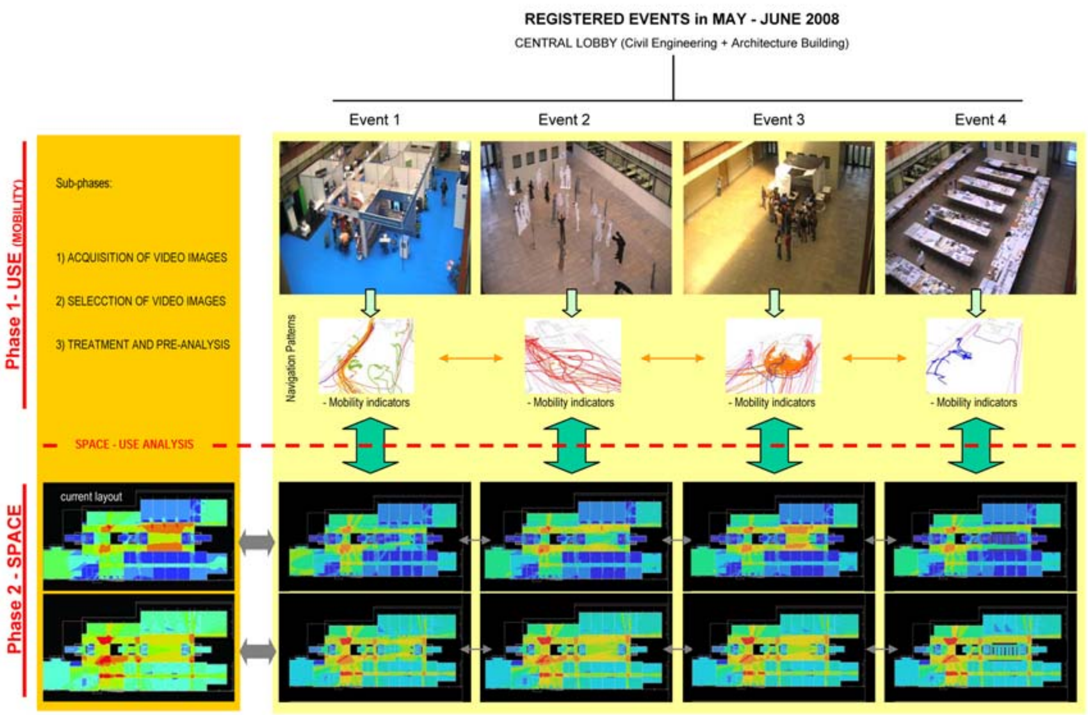

Figure 1
Methodological scheme

Phase 1 concentrated on the general description of the learning events. The following sub-phases were considered: 1) acquisition of video images; 2) selection of the recorded images; and 3) the editing and pre-analysis of the recordings. Phase 1 produced as output models or mobility graphics, i.e. simplified descriptions of the observed users' spatial movements resulting from the post-processing of the video recordings, and that identify the navigation and interaction patterns for each event observed. These patterns were described objectively and, as much as possible, quantified in accordance with mobility indicators i.e. parameters that allow characterizing the mobility flow patterns.

Phase 2 focused on the spatial description of both the atrium and the layouts adopted in the four different events. The spatial description was firstly concentrated on the syntactic analysis of the overall spatial system where the central atrium is embedded. The permeability condition was described locally in terms of connectivity and globally in terms of integration. The same procedure was applied to each of the events layouts.

The configurational patterns of the four events were compared with each other as well as with the configurational pattern of the atrium in order to identify the changes to the overall spatial system's permeability imposed by each event. The configurational patterns of each event were, in turn, compared to users' navigation and interaction patterns in order to analyse the space-use implications, i.e. the capacity of each event layout to attract and keep users interacting in the atrium. The time spent by users in the atrium was considered a basic condition for the effectiveness of informal knowledge-sharing, i.e. to stimulate encounters and the exchange of information.

3. Development

3.1 Acquisition and selection of video images - equipment and procedures

The images were captured using a HDD digital video camera. In operational terms, the most relevant technical features were: 30 GB hard disk and the MPEG-2 video recording format. As for the lenses, the most relevant features were the focal distance f=2.3 mm to 78.2 mm and the diaphragm aperture F 2.0 to 4.7.

The images captured were mainly wide shots. A normal recording mode (720 x 576 pixels) was used, allowing 640 minutes of video recording. The camera, equipped with a rechargeable lithium ion battery, allowed uninterrupted recording for 90 minutes.

The methodology applied to capture the video images was based on recognition of the central atrium through the camera. This procedure was aimed at understanding the visual field area covered by the camera and identifying the most appropriate positions for the image pick-up as well as the most favourable angles for capturing images in accordance with the spatial characteristics of the atrium and the layout of each event.

The central atrium height corresponds to three floors. It is surrounded by two galleries at the level of the 1st and 2nd floors, providing a privileged view of the ground-floor level. The images were recorded from the 2nd floor gallery (from a height of approx. 6 m). The corners of the atrium were chosen as the image pick-up positions, as they enabled viewing along the diagonals and deeper and more comprehensive vision fields of the space.

The video images were systematically recorded at different times of the day. Recordings were made from each of the atrium's four corners. The resulting clips lasted in general between 3 and 7 minutes. E3 was the exception. Given the concentrated nature of the event in terms of space and time, longer recordings (14 minutes) were made from the two corners facing the area in which the installation was set up.

For editing and analysis purposes, the clips were selected taking into account the explicitness of the recordings, i.e. considering the number and diversity of paths. This paper presents the results of four clips (one for each event). The E1, E2 and E3 clips were recorded around mid-day, between 11:00 a.m. and 1:00 p.m. The E4 clip was recorded at 6:00 p.m.

3.2 Editing and pre-analysis of the video recordings

The recorded clips were edited using video available edition software for images in motion - After Effects - aiming at producing mobility graphics. These representations allow the identification of mobility patterns for the observed events and serve as support elements for the events analysis.

Mobility graphs were produced through the application of analyzers. Analysers were defined as basic geometric elements (points or lines). These allow a graphic representation, in an abstract and simplified form, of users' movement in space. The purpose of this simplification is to identify the underlying configuration of the movement, contributing to the construction of a mobility flow taxonomy i.e. a systematic classification of spatial movements by types.

Accordingly, three types of analysers were defined:

a) Continuous lines (defining the user's path);
b) Discontinuous lines (defining the user's path and adding the speed of movement factor);
c) Points (identifying the spatial distribution of the users in each moment, making it possible to work out the space occupation density per time unit).

The discontinuous lines are made up of points of varying proximity to one another. This enables immediate, intuitive reading of the movement speed and the pauses of the user: the further apart points signify faster movement; the closer together points signify a slowing down; points on top of each other making up segments of continuous lines signify stoppage. The point analyser makes it possible to visualise the space occupation density determined (number of users per area unit) and, thus, identify zones of greater and less occupation. The analyser definition was aimed at testing various forms of translation and schematic visualisation of the user mobility flows.

The analysers were applied as follows: each user captured on film was identified with a line or a point on one of their feet. The line drew users' spatial paths, following their movements continually. The point followed the user "stuck" to his/her foot. The lines remained on the image even when the user left the scene, as opposed to the points, which disappeared with the users. Each line or point was associated with an identifier in the form of a number. This number is attributed by order of entry into the scene by the users, thus making it possible to identify them and at same time to count them (Figure 2).

a) Continuous lines   b) Discontinuous lines   c) Points

ANALYZERS (event 1)

	Event 1	Event 2	Event 3	Event 4
Date	16-05-08	21-05-08	28-05-08	24-06-08
Hour				
Duration (clip)*	03:13:23	04:58:14	14:24:00	04:46:02
Mobility Indicators:				
Number of users	54	32	53	9
Frequency index** (users by minute)	18.00	7.75	3.78	2.25
Interaction percentage	pDC= 44.44% PIC= 37.03 % pNC= 18.51% pC=81.47%	pDC= 6.25% PIC= 59.37 % pNC= 34.37% pC= 65.62%	pDC=16.98% pIC=9.43% pNC=69.81% pC=26.41%	pDC=22.22% pIC=11.11% pNC=66.66% pC=33.33%

Event 1

Users` type	17	1	1	19	12	4	54
Types of interaction with events pDC	1		1	9	12	1	24
pIC	9	1		10			31
pNC	7					3	10

Event 2

Users` type	28	1	2	-	-	1	32
Types of interaction with events pDC	2						2
pIC	19						19
pNC	7	1	2			1	11

Event 3

Users` type	47	1	4	-	-	1	53
Types of interaction with events pDC	10	1					11
pIC	5						5
pNC	32		4			1	37

Event 4

Users` type	6	2	1	-	-	-	9
Types of interaction with events pDC		2					2
pIC			1				1
pNC	6						6

Types of paths		Event 1				Event 2				Event 3				Event 4			
pL_C	pDC	9	pDC	-	-	9	pDC	-	-	22	pDC	-	-	6	pDC	-	-
	pIC		pIC	-	-		pIC	-	-		pIC	-	-		pIC	-	-
	pNC		pNC	9	6 3		pNC	9	6 1 2		pNC	22	18 3 1		pNC	3	3
pL_D	pDC	3	pDC	1	1	1	pDC	-	-	11	pDC	-	-	-	pDC	-	-
	pIC		pIC	2	1 1		pIC	-	-		pIC	-	-		pIC	-	-
	pNC		pNC	-	-		pNC	1	1		pNC	11	11		pNC	-	-
pNL_C	pDC	21	pDC	2	1 1	12	pDC	-	-	1	pDC	-		1	pDC	-	-
	pIC		pIC	18	8 1 9		pIC	12	12		pIC	-			pIC	1	1
	pNC		pNC	1	1		pNC	-	-		pNC	1	1		pNC		-
pNL_D	pDC	16	pDC	16	8 8	10	pDC	2	2	19	pDC	11	10 1	2	pDC	2	2
	pIC		pIC	-	-		pIC	7	7		pIC	5	5		pIC	-	-
	pNC		pNC	-	-		pNC	1	1		pNC	3	3		pNC	-	-

* minutes:seconds:number of frames
** minutes / number of users

pDC – paths Directly Connoted with event
pIC – paths Indirectly Connoted with event
pNC – paths Not Connoted with event

pL_C – Continuous Linear paths
pL_D – Descontinuous Linear paths
pNL_C – Continuous Non-Linear paths
pNL_D – Descontinous Non-Linear paths

Students
Teachers
Staff
Others
Stands
Undefined

MOBILITY INDICATORS

Figure 2
Analyzers and mobility indicators.
Event 1 (background: clip of event).

Each line or point was coloured according to a predefined code with the aim of qualifying the users' paths (Figure 2). The colours were attributed on the basis of two criteria: a) the type of user; and b) the type of user interaction with the event. For the user types, the colours were attributed as follows: student - red; teacher -blue; staff - purple; others - yellow; stands - green; undefined - grey. The "undefined" category was created because it was not always possible to identify the user in the clips. Other categories were created to characterise special user groups. The "others" and "stands" categories were created for E1: the former identifies a group that crosses it en bloc; the latter identifies the exhibitors.

The users' paths were characterised according to three types of interaction with the event:

a) paths directly connected with the event (pDC) - those in which there was interaction with the event (example: E1 - visitors who stopped to observe something or request information);
b) paths indirectly connected with the event (pIC) - those that went around the event on their way to another destination (example: E1 - the users that passed through it on the way to the canteen);
c) paths not connected with the event (pNC) - those that would occur even in the absence of the event (example: E1 - users who passed along the side corridors of the event without stopping).

The pDC are paths that "interact" with the events; the pIC are paths that "touch" the events without actually interacting; the pNC are paths "indifferent" to the events. In line with the type of interaction with the event, the colour code included variations of the shade of colour attributed to each user type.

The definition of mobility indicators enabled a more systematised analysis of the navigation and interaction patterns. The following indicators were defined: a) number of users; b) types of users; c) types of interaction with the event; d) types of paths; e) dominant directions; f) speed of movement; g) occupation density.

The paths types defined were organised into two categories: a) basic – which considers an essential definition of the paths in accordance with their linearity and continuity; and b) secondary – resulting from the combination of the former. The types of paths defined were the following:

Basic categories: Linear paths (with a well-defined direction or one without inflection) Non-linear paths (with changes of direction or inflection) Continuous paths (without pauses) Discontinuous paths (with pauses) Secondary categories: Continuous linear paths (pL_C) Discontinuous linear paths (pL_D) Continuous non-linear paths (pNL_C) Discontinuous non-linear paths (pNL_D)

Visualisation procedures were also included in the editing of the video images. Different backgrounds for patterns of lines and points visualisation were tested, namely; a) the clip of the event; b) an image of the atrium without users (a frame from the clip); c) a schematic plan of the central atrium with the event layout; and d) a schematic plan of the central atrium. This was justified by the need to identify the most effective visualisation mode in terms of analysis of the user/user and user/space interactions. The backgrounds were defined to contextualise the movement in the space, going from the most realistic representation (a) to a more abstract one (d).

The video image editing phase worked as pre-analysis. As the images were edited by non-automatic resources, i.e. manually (although with the use of software), the operator made a set of options in relation to the colour codification of the analysers that were decisive for the analysis phase (type of user and type of interaction with the event).

The outputs in this phase consisted of the following file types: ".avi" or ".mpeg"; ".jpeg"; ".psd"; and ".aep" (After Effects files).

4. Analysis of the Results

The analysers made it possible to identify the mobility patterns for each event: continuous lines patterns (Figure 3); discontinuous lines patterns (Figure 4); and points patterns (Figure 5).

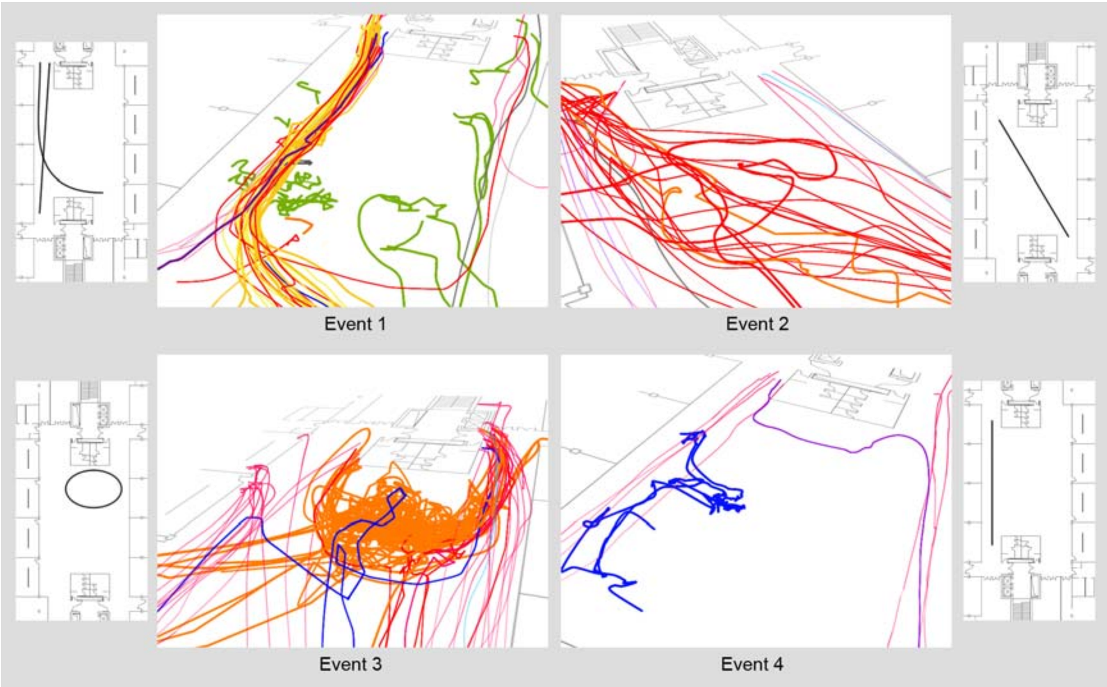

Figure 3

Mobility patterns of events. Continuous lines
(images backgrounds: central lobby plan).
Dominant directions / zones of movement – lateral schemes.

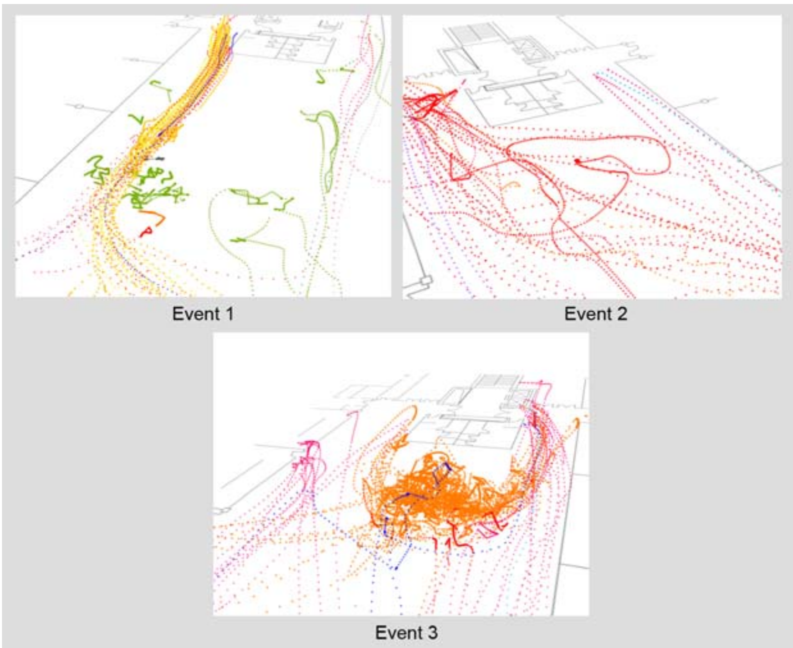

Figure 4

Mobility patterns of events. Discontinuous lines (images backgrounds: central lobby plan)

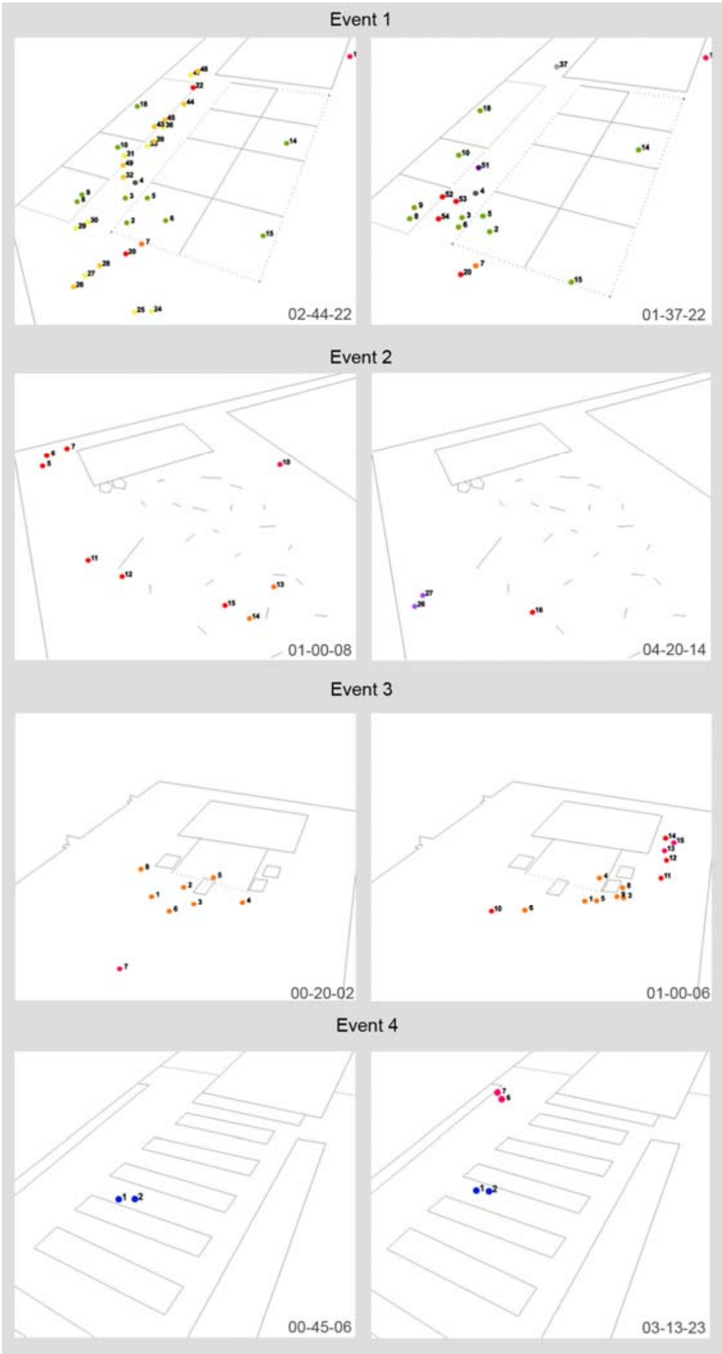

Figure 5

Mobility patterns of events. Points (images backgrounds: central lobby plan plus layouts of the events)

Comparing the mobility indicators (Figure 2) enabled us to link quantified values to the patterns and deepen their analysis. The event registering the highest number of users was E1 (54), followed closely by E3 (53). However, whereas the former had the highest atrium frequency rate (18.00 users per minute), the latter had one of the lowest frequency rates (3.78 users per minute). This information contrasts with the spatial distribution detected in the patterns (Figures 3-4). E3 presented the highest concentration of users per unit of area. E4 showed the lowest frequency rate (2.25 users per minute). The frequency rates for the events decreased over time. This fact shows some influence of the transition from the teaching term period (greater user presence) to the examination period (lower user presence) in the obtained results.

E1 showed the most variety in types of users identified. In addition to "students", "teachers" and "staff", two other specific groups were identified: the exhibitors ("stands" - green) and a large group, which, in a given moment, crossed the atrium in the direction of the canteen ("others" - yellow). Some members of the group got information leaflets at one of the stands, followed by the rest of the group. It was not possible to identify if they were students or teachers. The grouping of these users into one single category was a result of the similar spatial behaviour they demonstrated. E1 was also the event with the greatest number of non-identified users, which is understandable considering the interest it always attracts in the academic community, particularly in students.

The "students" type was predominant in all events, with the exception of E1. In the latter case, "others" presented a slightly higher value (19) that "students" (17). However, it is probable that some of the "others" were students not identified as such. The event that registered the highest number of students was E4 (47).

In terms of types of interaction with the event, E1 was the one with the highest percentage of paths connoted with the event (81.47%). Even when one excludes the number of exhibitors (12), the percentage of pDC goes down by half (22.22%) but the total of paths (directly and indirectly) connoted with the event remained the highest (59.25%). E2 also presented a considerable percentage of connoted paths (65.62%), although they were mostly made up of indirectly connoted paths. E3 and E4 presented low percentages of connoted paths. E3 was the one with the lowest percentage of connotation with the event (26.41%), although it was mostly made up of directly connoted paths (16.98%). E3 was also the one that presented the highest percentage of non-connoted paths (69.81%). In both cases these percentages were made up predominantly by "students" users.

As far as the types of paths identified are concerned, from the globality of events it was possible to extract and confirm a number of general findings. The discontinuity and non-linearity of the paths are particularly relevant in terms of analysis of the user-event interaction for the following reason: discontinuity implies that the user at least made a pause in his/her course, the occurrence of which can signify an opportunity to exchange/acquire information; the non-linearity means that there was potentially an exploratory attitude to the event on the part of the user. Thus, pNL_D is the path type that produces the greatest probability of user-event interaction.

However, by comparing the types of paths and types of interaction with the events we were able to conclude the following: a) the pl_C are always pNC with the events but the reverse is not necessarily the case; b) the pNC can assume any type of path; c) the pDC are always discontinuous. While they may be linear or not, they are normally not linear and the reverse is not always the case; d) the pNL_D can represent any type of interaction with the events; e) the association between pNL_D and pDC depends on the spatial location of pauses (inside or outside the event layouts) and the relationship between inflections in the trajectories and geometry of the layouts. But the location of pauses and inflections is, in itself, not probatory. Visualization of the clip is required to adequately interpret the user's spatial behaviour.

All the paths types were recorded for each of the events, with the exception of E4, for which the pL_D type was not registered. E3 had the highest number of discontinuous trajectories - 30. However, as far as association with the type of interaction is concerned, only 11 were pDC (10 students and 1 teacher), 5 were pIC (students) and the rest were pNC (students). In comparison, E1 registered only 19 discontinuous trajectories. However, 17 were pDC (8 others; 8 stands; 1 staff) and 2 were pIC (1 student; 1others). For E1 and E4 all the pNL_D were also pDC. For the other events, the pNL_D were related with all types of interaction. For E1 exceptional situations were identified, such as the case of users with no trajectory, i.e. they were still in the same position during the whole clip.

The dominant directions and zones of greatest movement concentration emerging from the mobility patterns for the events (Figure 3) were: the diagonal route connection between the canteen and the access to the atrium closest to the exit (E1 and E2); the side axis that links the exterior access and the students' room (E1 and E4). The mobility patterns for E2 were characterised by a cluster that was denser at the centre, reflecting the polarisation of the spatial movements of the users around the installation set up at the base of the north tower.

The capacity to fix users in the atrium was illustrated in contrasting extremes by E1 and E3. The latter coupled a low atrium frequency rate and a low percentage of paths connoted with the event. E1 presented a high frequency rate together with a high percentage of paths connoted with the event. The high level of discontinuity registered for E3 is not significant in terms of connotation of the spatial movement with the event. Rather it reflects the occurrence of parallel activities in the atrium. Inversely, for E1 a direct relationship between discontinuity, non-linearity and movement connotation with the event was identified. E1 had the capacity to induce more exploratory and interactive attitudes on the part of the users. This could be explained by the fact that E3 was an event that a limited group of students and teachers were interested in, whereas E1 was of interest to a wider selection of the academic community and therefore attracted not only more but also a greater variety of users.

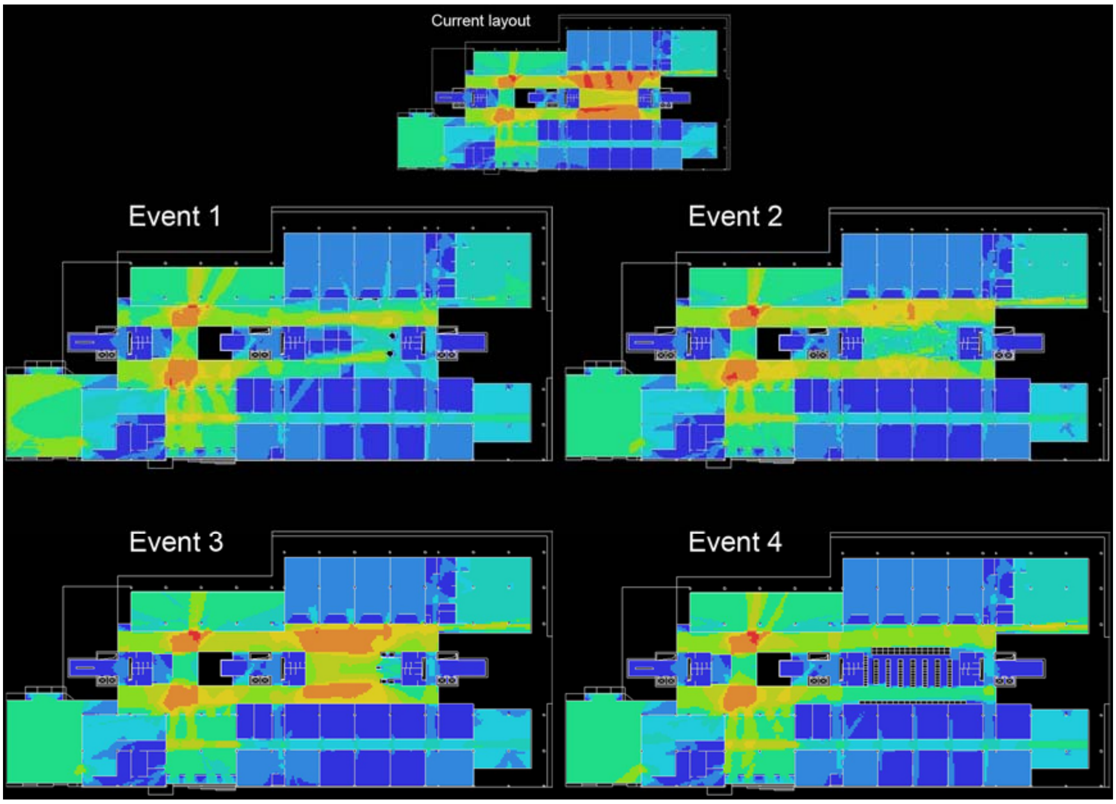

Figure 6
Civil Engineering and Architecture Building / central lobby: syntactic models (ground floor). Connectivity.

The layout of E1 introduced a clear alteration to spatial patterns in the atrium (Figures 6-7). Compared to the current layout, the levels of permeability of the atrium decreased significantly both in terms of connectivity and integration. In the case of E4, the same phenomenon seems to have taken place, but it was only registered in terms of physical accessibility: the tables used in E4 restricted the paths course. As far as visual accessibility was concerned, they had no implication. For E1, both physical and visual accessibility were equally restricted by the stands. Contrary to the other events, the stands for E1 extended the accessibility limitation beyond the central area of the atrium into the side areas. E2 and E3 only occupied the central zone of the atrium, leaving these corridors free, which are normally intensively used by pL_C-type paths. In E4, the tables disposed along one of the corridors were only a very minor physical obstruction and not visually obstructive at all.

There seems to be a direct relationship between lesser layout permeability and the mobility patterns in E1. The layout seems to have had the capacity to stop the users in their movement across the atrium and keep them fixed for different lengths of time. A similar phenomenon seems to have taken place in E3, but on a more localised level. The very concentrated density that is a characteristic of the mobility patterns for E3 was directly related to the reduction of the spatial permeability levels in the north tower base where the installation was set up.

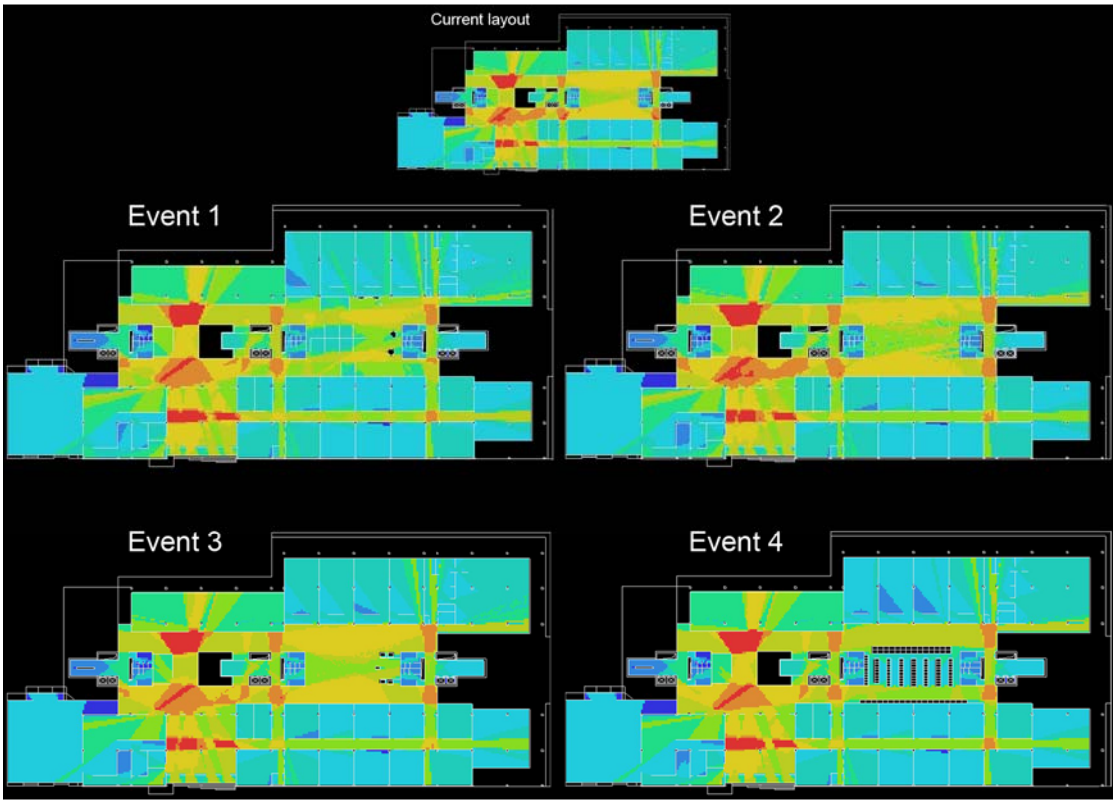

Figure 7
Civil Engineering and Architecture Building / central lobby: syntactic models (ground floor).Integration.

The spatial pattern for E2 led to a more subtle reduction in the atrium's permeability levels. This event's layout, characterised by the random distribution of human figures in the space (limited to the central area) did not have a very evident impact in terms of physical and visual obstruction of the atrium. The mobility patterns were coherent with the spatial patterns, given that the web of flows at this event is the closest to the empirical knowledge of normal use of the atrium. The video recordings made it possible to observe users that navigated through the labyrinth of figures, following corridors created as a result of the free spaces resulting from the event's layout.

E4 showed a more rigid layout both in terms of the type of exhibit elements used (tables) and its spatial organisation. The space was segmented according to well delimited corridors, restricting access to the central part of the atrium. The spatial pattern was characterised by an accentuated drop in permeability in the centre of the atrium, which was physically more inaccessible, and by the contrast between this more impermeable centre and the side zones more defined as corridors.

The mobility patterns were also marked by the rigidity of the layout. One should recall the high number of pL_C observed - the users tend to pass by on the margins of the event. The observations allow to conclude that access to the exhibition area was effectively made by those with interest in doing so, probably due to the rigidity of the layout limits. The layout of E4 did not work in the sense that it wasn't able to attract people to the event.

The main difference in terms of spatial permeability of the atrium is related to the local dimension (connectivity). The event layouts had less of an impact in terms of alteration of the overall permeability of the system (integration). This fact is easily confirmed by the similarity between the spatial patterns of the events and the current spatial pattern (E2 and E3) or by the maximum chromatic integration values expressed in the spatial patterns of the events (E1 and E4).

5. Conclusions and Future Work

The proposed MFA shows potential to evaluate the capacity of space to support and promote social and informational interface. Its potential is based on the possibility of objectively supporting the analysis of users' spatial behaviour, focused on their spatial trajectories.

The crossover of digital video technology and moving image editing software allowed credible registration of the users' mobility patterns. The credibility results from the possibility of reviewing the recorded clips and auditing the whole subsequent video image editing process, including the upstream image acquisition method itself. Defining mobility indicators made it possible to link some quantification to the analysis of the patterns, thus making the model more objective.

The main advantages of applying digital video technology in observing and recording the users' spatial behaviour, is using portable mid-range equipment to report, the effectiveness of the process and the low-cost technical resources. The portability of the cameras, and their autonomy, allowed that even when an observer was surprised by an event, he/she could record it. However, the cameras' operationality does bring technical limitations - the spatial context must have favourable conditions for recording the images (for example, high ceiling heights) - as well as legal restrictions as to the use of this type of recording. The main disadvantage of the proposed method lies in the possible slowness of the video image processing. Depending on the duration of video recording and the complexity of the event (number of users and their spatial concentration), the processing can vary in times of duration. The processing time for a video recording, using the After Effects equivalent software, can be roughly calculated by multiplying the duration of the clip by the number of users captured. Adding to this is the fact that it is a specific program from the field of multimedia and the operator requires specialised knowledge and skills.

The future developments of MFA should include the following aspects:

1. in terms of image acquisition:

   a) Use of large angular lenses to get more comprehensive image pick-up;

   b) Use of tripods or other camera support and fixation equipment to capture more stable images (which facilitate subsequent processing);

2. in terms of the analysis methodology:

   a) Development of mobility indicators, as their allocation to the paths is not always evident. Determining the type of user interaction with the event, for example, the subjectivity in the process can be influenced by the operator;

   b) Definition of mobility sub-indicators that would make it possible to deepen the trajectory configuration analysis and develop a taxonomic classification. For example, in the case of paths types, taking into account the number of pauses, inflections and inflection angles, it will be possible to characterise in greater detail the discontinuous and non-linear paths;

   c) Conversion of the mobility patterns in accordance with orthogonal projections so as to enable direct superimposition with the syntactic models and thus facilitating the analysis.

References

Chism, N. (2006). "Challenging traditional assumptions and rethinking learning" in D. G. Oblinger (Ed.), Learning spaces, Chapter 2. EDUCAUSE e-book

Fisher, K. (2005). The evolution of the hybrid campus. TEFMA Learning Environments Seminar, Queensland University of Technology, March, 2005

Lomas, C. and Oblinger, D.G. (2006) "Student Practices and Their Impact on Learning Spaces" in D. G. Oblinger (Ed.), Learning spaces, Chapter 5 EDUCAUSE e-book

Scott-Webber, L. (2004). In sync: Environment behaviour research and design learning spaces. Michigan: Arbor

Schon, D. (1985) The design studio: An exploration of its traditions and potentials (Architecture and the Higher Learning), RIBA Building Industry Trust, London