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(IN)ACCESSIBLE CAMPUS:
Space syntax for universal design

084

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Abstract

This paper has an exploratory perspective and intends to discuss the configurational variables, investigated by means of the Theory of the Social Logic of Space, in studies about universal design and accessibility. It aims at analysing the social and spatial dimensions of the experience of disability individuals and accessibility taking into account the development of a mapping profile and the premises for an indicator to evaluate the Level of Effort (LoE). Applied in a Portuguese case study (Campus Alameda, at the Technical Institute of Lisbon), the research explores procedures to synchronize different reading and representing tools (Space Syntax strategies, walkthroughs, interviews and space-use observations), in order to produce subsidies for the planning and design of inclusive leaning environments.

Key words: *universal design, accessibility, built space, inclusive space, Space Syntax*

Theme: *Spatial cognition and Behaviours*

INTRODUCTION

The experiences of people with differing physical abilities serve as a graphic example of the impact of built environment in mediating human behaviour, and in reflecting and replicating social relations (Curtis and Jones, 1998). People with disabilities are not only marginalised by social and political structures, but these same structures are also reflected in the built environment, in the form of inaccessible spaces and places.

Based on the assumption that an accessible environment is a precondition for disabled people to take part in education, this paper is centred on the social and spatial dimensions of the experience of disability and accessibility in educational environments. It is based on a study developed within the framework of IN_LEARNING research project (Nascimento, 2012), using the IST campus in Lisbon as a case study. This university campus was built in late 1930s and not designed with accessibility to all in mind. It presents challenges in providing easy and independent access to people with disabilities. Existing architectural barriers make the built environment inconvenient, uncomfortable and unsafe and prevent this particular group of users to fully participate in the academic life. These features serve to reinforce the physical and psychosocial isolation associated with disability.

Building on theoretical discussions on universal design, as well as on spatial analysis and qualitative data techniques, the goal of this paper is to analyse the social and spatial dimensions of the experience of disability and accessibility within the IST campus.

The research also pursues the objective of investigating, within a project-oriented research, the ways the built environment reflects and impacts attitudes about disability and in particular what accessibility means from the perspective of students and staff identified as having a permanent or temporary disability, such as mobility/motor or sensory (e.g. sight or hearing).The significance of this study lies in making progress towards linking architectural design and universal design research by understanding the relationship of spatial features in the environment on the one hand and disabled people's strategies and path choice preferences on the other.

This study was developed by means of a **mapping profile** using both high- and low-tech spatial description techniques, namely Space Syntax (Hillier and Hanson, 1984; Turner, 2004) synchronized with conventional measured survey involving direct data capture and *map interviews*, i.e. an inquiry procedure combining walkthrough (Sanoff, 1991) with semi structured interviews, documentary analysis and space-use observations. It operated by combining a macro analysis of the campus with a microanalysis of accessibility conditions and architectural barriers.

The discussion is organized in three parts. The first one a) explores universal design and accessibility concepts, justifying the adoption of Space Syntax techniques and b) presents the case study based on a brief narrative of its design and occupation processes. The second one refers the methodological procedures applied into the description and evaluation of accessibility conditions. The third part is focused on the diagnosis of campus accessibility: a particular emphasis is given to the definition of an accessibility indicator - Level of Effort (LoE) - built by Nascimento (2012) to inform about overload physical efforts and time consuming required to disabled people.

1. UNIVERSAL DESIGN, ACCESSIBILITY AND THE CASE STUDY CAMPUS (IST)

1.1. Some Paradigms: a Built Space Perspective

According to Universal Design paradigm, accessibility in the built environment indicates the degree to which any space to be used by people is reachable by someone with a permanent or temporary impairment. A disadvantage (handicap) is not just a characteristic of people with disabilities. Rather it can occur with anyone whenever the demands of the environment exceed their capabilities. The options are between raising people's capabilities or reducing the demands of the built environment. Intervention at the level of people's capabilities is possible and necessary. However, without intervening at the level of the built environment, there will always be people whose capabilities fall short of the demands made upon them. The idea is that through a deliberate design process that focuses on the needs of all users, especially including persons with all kinds of disabilities, most of the built environment can be improved for all users, and also greatly expand the range of users.

A failure of accessibility would become a barrier that effectively isolates many groups of people, preventing them from going to meet others and holding them back from participation in social, educational and work activities. This could mean changes in level, insufficient space, a rail, or the cumulative difficulty of many people with limited walking abilities, from the wheelchair-user, to the blind or people with extreme physical proportions. When looking at a given route from the perspective of people with disabilities it is critical to assess all barriers to movement along the way to get an idea of how hard it will be for them to use this route, and whether they will prefer another.

There are a growing body of literature on accessibility as well as a considerable number of building codes and regulations, barrier-free standards and generic design guidance governing accessibility to the built environment. These documents provide a good source of information in terms of checking for consistency and best practices but cannot be considered suitable instruments for supporting a "universal" design process. They are in general limited in scope and complaint-based rather than proactive. They exist as a disembodied data set of definitions, prescriptions, rules, and tables, evolved through a process, which has a strong internal logic, but ignore the "geography of accessibility" and the consequences of territorial and mobility-related needs of disabled people, in particular regarding the demand for overload physical efforts and time consuming.

Mobility and accessibility patterns from the perspective of disabled people have received relatively little attention from the Space Syntax Community. Nevertheless, Space Syntax has the distinct feature of providing tools to capture the properties of both *accessible routes* i.e. continuous, unobstructed paths between accessible elements and *obstacles sequences* rather than only looking at the suitability of single obstacles as usually done by accessibility studies. Therefore it appears relevant to explore configurational variables, investigated by means of the Theory of the Social Logic of Space, in studies about universal design and accessibility as well as research procedures to synchronize different reading and representing tools, in order to produce subsidies for the planning and design of accessible leaning environments.

1.2. IST Campus: a Scenario of Growth

The IST Campus, concluded in 1937, was the first university campus to be built in Portugal (Simões, 2010). It was typically planned as mono-functional zone with a focus on academic activities related to engineer education at the university level (Figure 1).

The campus was located on a sloping site of about 10,4 ha within the inner city area, which defines an entire urban block. It was designed as an isolated complex of pavilion typology composed of six building clusters of modernist language including a canteen, a sports hall and a covered swimming pool. The central building has a multifunction purpose. It serves for administrative, teaching and social activities. The other clusters were organized according to a departmental organizational structure, accommodating teaching and research activities.

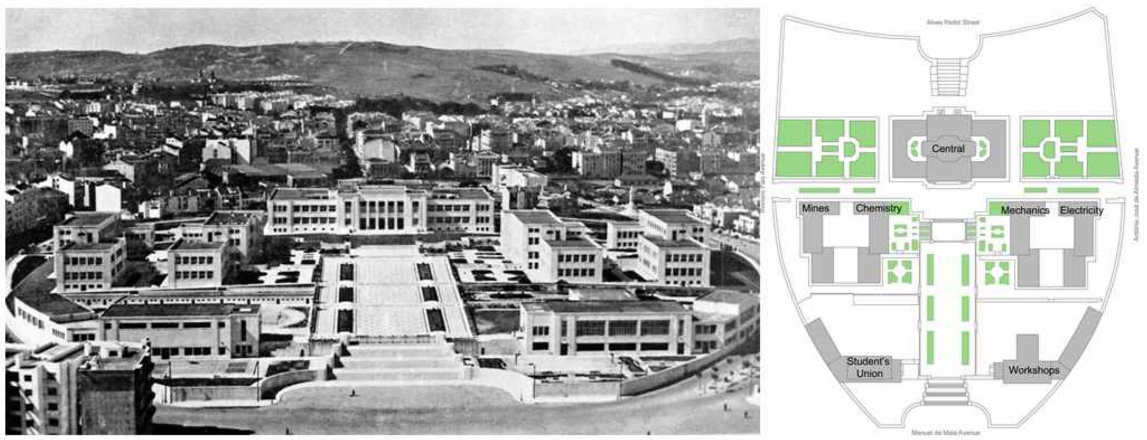

Figure 1: 1940: view of Instituto Superior Técnico (left) and Campus plan and functional program (right). Source: AMS (1940-1950).

The campus concept, focused on distinctiveness, is based on an enclosed territory surrounded by walls, which take the form of a semi-opaque boundary. Its layout follows a symmetrical spatial organization defined by a central axis coincident with a central boulevard – a ceremonial path - linking the main entrance to the front of the main building. This central boulevard is accessed by large and impressive staircases and provides indirect access to different building clusters. There is no focus between the buildings except the central boulevard.

The campus prominent location on the hilltop combined with its strong architectural projection and image, which was used at the time as a tacit structural element key to shaping a new expansion area, performed as a highly visible local landmark and simultaneously proclaimed the importance of the engineering education. The external staircases and the non-permeable boundaries embody the isolated and closed character of this university setting, or at least emblematizing the separation from the public realm.

From the late 1969s up to now (Figure 2), some of the existing buildings were extended and new ones were built, keeping the original campus area. Currently IST campus comprises a built area of 34 386 m^2 organized according to a faculty / related departmental structure, and serves a population of about 12 000 users, (about 10 500 students, 1000 faculty and researchers and 500 administrative – NEP, 2012). People with disabilities face multiple physical barriers to access the site and to move within it (Ferreira and Duarte, 2009).

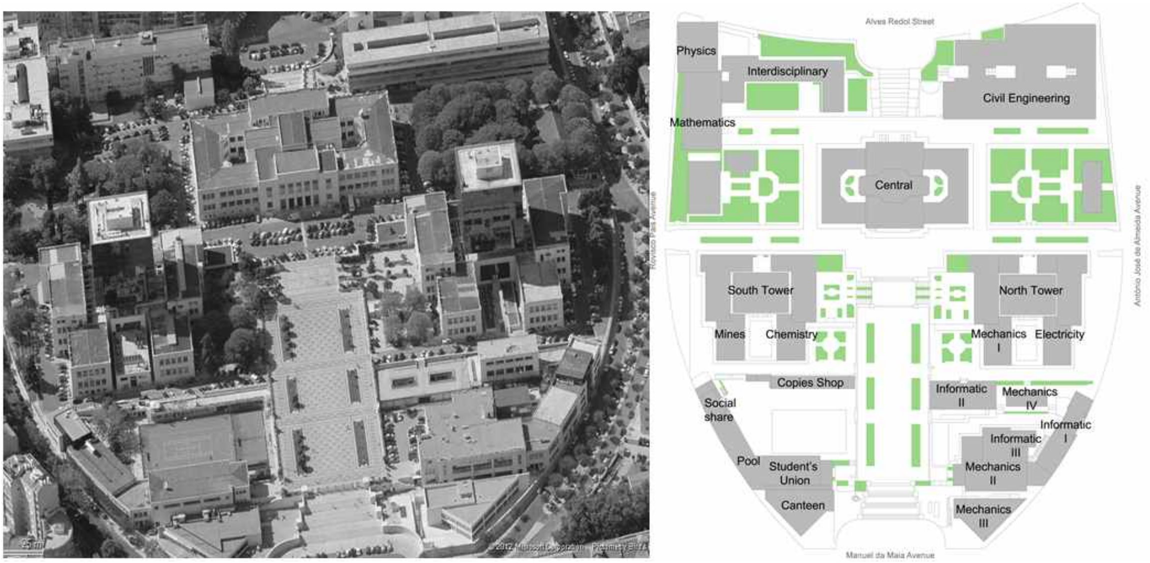

Figure 2: 2013: view of Instituto Superior Técnico (left) and Campus plan and functional program (right). Source: Bing (2012) View.

2. METHODOLOGICAL PROCEDURES

The first methodological procedure for this research considered the design a mapping profile prototype, to record and structure information and to provide a spatial framework within which accessibility conditions could be quantitatively compared and monitored, as well as a simple way for project participants and other key stakeholders to communicate, explore accessibility improvements and prioritize areas of intervention. Aerial photographs and Geographical Information System (GIS) based maps were used as base material to develop the mapping profile.

The spatial description of IST campus was carried out in two stages. The first one was focused on the syntactic description of the campus by means of visibility/isovists and axiallity/convexity techniques (Depthmap® software) regarding the external circulation network and the second one on research-based fieldwork.

The axial description considered two alternative maps: one regarding the overall circulation system, including stairs and ramps, which were defined as single axis on the axial map, and the other one excluding stairs as well as all the areas that are only accessible through stairs, i.e. without architectural barriers. This second axial map corresponds to the experience of those travelling in a wheelchair. Besides revealing the importance of access ramps it shows the extent of very hard-to-reach areas within the campus.

The visibility description also considered two alternative maps: one including car parking areas and the other one excluding them in order to understand how far undisciplined car parking using pathways areas break the links within the Campus.

The fieldwork integrated: 1) the survey of all architectural barriers - 60 stairs, 61 ramps, 113 pathways and sidewalks; 2) exploratory interviews with users and accessibility experts including therapists and analysts to accomplish the assessment of architectural barriers and explore different perspectives related to the campus overall accessibility; and 3) space-use observations.

A total of ten participants were recruited for interviews and walkthrough experiments on voluntary participation. All of them were familiar with the campus: three female and five male students in their early-twenties and two staff members in their fifties one with blindness and other with a temporary disability (broken foot) moving with canes. Three recruited students didn't have any disability. Accessibility experts assessed the campus conditions and identified failures of accessibility and barriers responsible to create architectural conflicts.

All the participants were invited for a walkthrough experiment within the campus, beginning from outside their own department building (main entrance) and ending at the Canteen building, a place daily visited by the academic community, especially by the students. Navigation performance was measured with the following variables: (1) time to complete the task; (2) stops; (3) distance covered; (4) average speed.

The walked route for each participant was described and analysed individually, being object of comparison with the walked routes performed by the three participants without disability. This approach was intended to determine the effect of barriers on user behaviour.

Before the walkthroughs, participants were interviewed about their experiences with accessibility on the campus. Interviews were carried out to obtain information on typical routes used for daily travel within the campus, locations where barriers exist — these may be physical/architectural (e.g. stairs), social (restricted access), or attitudinal (due to negative perceptions or feelings) and locations that represent positive areas (these could result from the presence of friendly people, accessible building design, or useful resources). Architectural barriers were classified according to the overload physical effort required to overcome them (low, medium or heavy). The interviews also covered questions about past experiences, perceptions and social attitudes about disability, and expectations for the future with regard to accessibility within the campus. Walkthrough tests were recorded in video and timed.

Finally, in order to consolidate the mapping profile, the exploration of an indicator considering the Level of Effort (LoE) completed the survey of accessibility conditions. LoE expresses the proportion of overload physical efforts and time consuming required to disabled people in face of a barrier such as: stairs, ramps, pathways and sidewalks.

3. DIAGNOSIS

3.1. IST Campus: an Accessibility Description

IST campus is accessed by a total of five entrances. Two of them are exclusively for pedestrian access but as they are reliant on large and high staircases without handrails, they became inaccessible for people with disabilities, in particular for wheelchairs. Three lateral entrances make the access by car. Nevertheless cars do not directly access all the building entrances. Parking provision is concentrated around the central building and the borders of the campus.

The Canteen, the students Union, the Central Pavilion and Civil Eng. Pavilion show the highest rates of use. The Central Pavilion embodies the public face of the campus. It accommodates the faculty board, the administrative and students support services, the main library and other teaching spaces (lecture halls and classrooms). Three entrances with staircases serve it.

The Civil Eng. Pavilion is located close to one of the campus pedestrian entrances. It contains formal teaching and learning areas and a 24hour study area, which are used by all the departments. It also houses working spaces for academic staff and lectures, research staff and research students based on the civil engineering and architecture department.

The Canteen and the Students Union are open to all the IST community and offer a variety of services from catering, sports and students support services.

Within the campus there isn't a continuous accessible route. The central boulevard slope and pavement is not suitable for handicapped people. Because parking provision is scarce and not suitable for purpose, it becomes inconvenient for pedestrians. Moreover accessible routes through the campus linking the different building clusters are not clear identified.

Up to now the efforts to improve accessibility have been localized (e.g. installation of lifts or platform lifts and ramps to overcome building entrances stairs). Despite of that, these changes are often developed in order to facilitate the distribution of goods, so they are not sufficient to ensure complete accessibility to the campus on a universal design perspective.

3.2. Space Syntax Analysis

The campus syntactic model shows that the highest integrated value corresponds to the central boulevard (main pedestrian access) and the integration core (average: 0.62) defines a ring surrounding the main building and is linked to both the main pedestrian and car entrances. Moreover, the most globally segregated lines show a high degree of local integration (HH R3), allowing that no area is left without a potential flow of people according to the natural movement perspective. Within the campus, the most frequent paths surround the central building, making it the building recognizable to users (Figure 3).

The configurational analysis also shows a direct relation between visibility conditions (Figure 4) and integration values. Within the external circulation system the most visible spaces are also the more integrated spaces, that usually appear as main circulation routes and can be designated as the primary circulation system. Constituted lines, i.e., lines which provide direct access to the buildings form the secondary circulation system. These lines show less integrated values and low visibility.

Figure 3: Axial map of IST Campus (Integration HH).

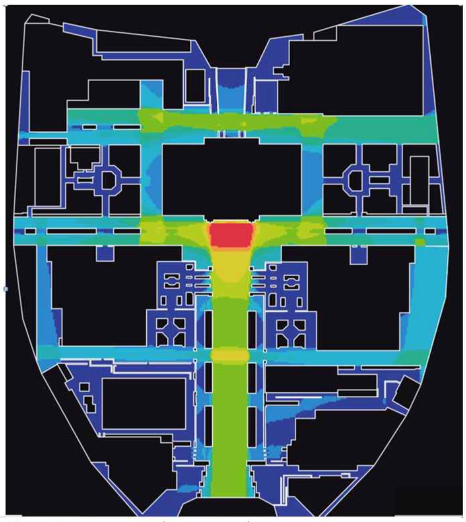

Figure 4: IST Campus without car parking (VGA Connectivity).

These findings support the participants' individual experiences, as well as reflect the implications of an enclosed campus model surrounded by walls, which produces a clear break in the physical and visual continuity of many paths. Among the secondary circulation spaces, stairs appear as relatively segregated spaces. At the same time they are not highly visible within the configurational structure. It can be suggested that the visual relations between primary and secondary circulation spaces are rather limited and it is this characteristic that results in difficulties to move within the campus, in particular for those with disabilities.

It is important to mention that in this analysis, stairs and ramps (including skates) were considered as single and independent lines in terms of movement, once this approach seemed to be more refined concerning the main purpose of the research.

The second level of analysis was based in the exclusion of the stairs and the Campus zones which were exclusively accessible by them. It was assumed this linear representation and corresponding axial map would represent a proper perspective of those travelling in a wheelchair or unable to surpass such kind of barrier. The map reveals the importance of the access ramp and shows spaces which are hard-to-reach, producing a distinguished appropriation of the Campus (Figure 5).

Figure 5: Axial map of IST Campus, excluding stairs (Integration HH).

The visibility graphs in both scenarios (parking zone disregarded – Figure 4 – or as a barrier – Figure 6) allow to realize how the car parking breaks the links within the Campus. Findings reveal the contrast of the more connected zone, the Campus Alameda - which has no car parking - and the rest of the precinct, which has very low values of connectivity.

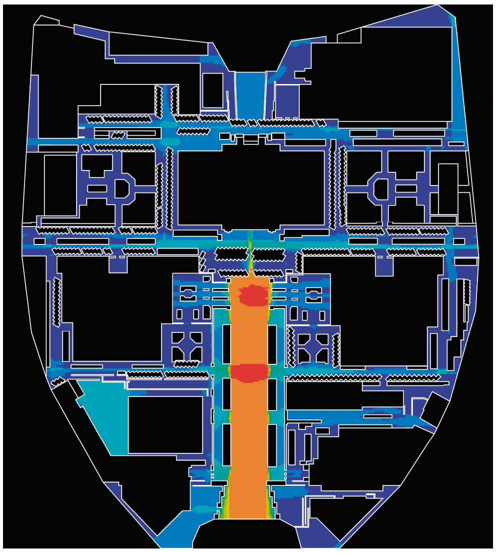

Figure 6: IST Campus with car parking as barriers (VGA Connectivity).

On the other hand, by means of the connectivity analysis in Figures 4 and 6, it's possible to verify how this spatial system is more cohesive and homogenous when represented without car parking zones. Yellow/orange tones are highlighted and spread all over the zones. Opposingly, when the car parking is included, low values of connectivity, if compared to the previous scenarios, are predominant.

Through axial maps, the Campus network of pathways can be seen from the perspective of those travelling in a wheelchair, revealing the importance of the access ramp. Visibility Graph Analysis proved that the car parking harms pedestrian traffic and eliminates the natural property of spaces to allow movement or conviviality.

3.3. Survey of Accessibility Conditions

The Survey of Accessibility Conditions implied the collecting of user's opinion by interviews and walkthroughs, complemented by the expert's opinion. The conducted interviews with a group of users (including students, teachers and employees with temporary or permanent disability) intended to identify and characterize each participant and also contain generic questions about accessibility and specifically about their experience in IST. There were also free-form interviews with a group of experts, in order to collect different meanings, perspectives and experiences about accessibility.

A metric survey of spatial elements was also developed, intending to list and evaluate stairs, ramps, pathways and sidewalks, complemented by photographic records, measurements and observations.

The walkthroughs with users were recorded on video and were useful to identify conflicts through a qualitative assessment, in which the user classified the barriers depending on the effort to overcome them: low, medium or intense. The courses were held between the Pavilion of each user and the Canteen, which are the most used by the participants (Figure 7). The best approach to select the courses was widely discussed in advance, since it was a sensible point of the research methodology with direct impact over the results. The selected routes should, in all cases, reflect the daily experience of the campus. Firstly, was tried to find a common course for all users. This would allow direct comparisons and simplify the analysis. But sooner this option revealed to be impossible since the users report very different routines. Choosing a familiar path for each participant seemed more "natural" and adequate to the study aims. The variety of the paths shows the advantage of allowing the exploration of the campus accessibility in a wider way. The initial problem related with the comparison of the different traveling experiences was overcome by its analysis through the metric navigation variables (referred in section 2) and also by LoE accessibility indicator as explained in the next sections.

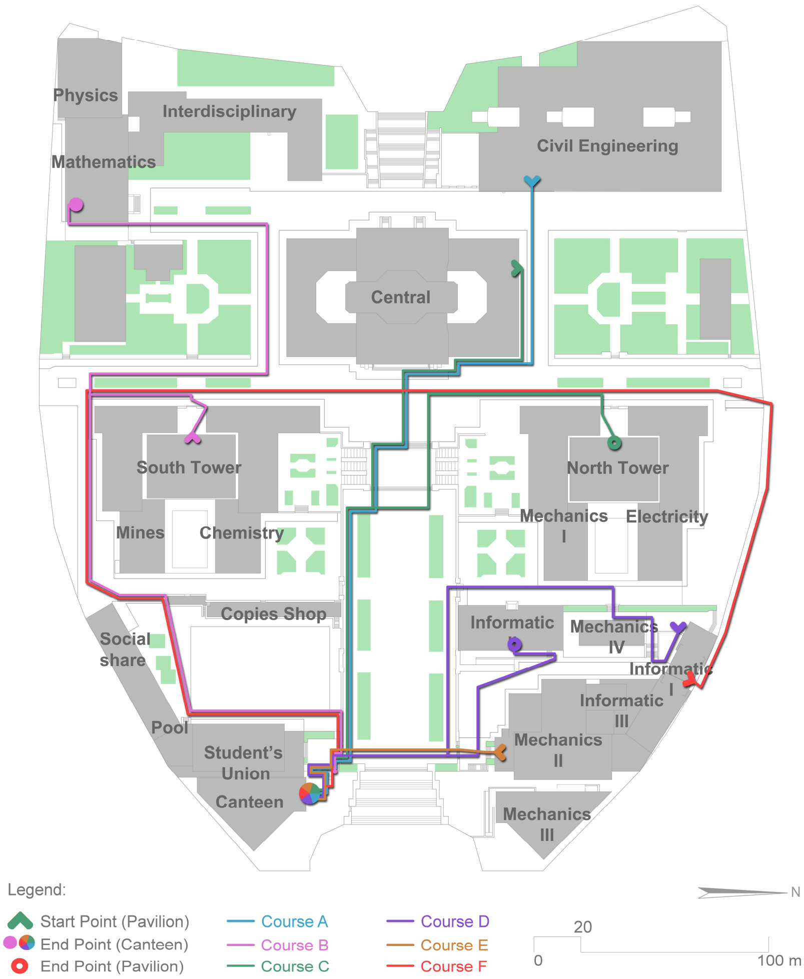

Figure 7: Courses performed by participants in walkthroughs at IST Campus

3.3.1. Walkthrough Results

A visually impaired participant held Walkthrough A. It began in front of the Civil Engineering department. The participant had to be re-aimed seven times because, not only, he didn't know well the path but, also, faced several obstacles such as the car parking.

A disabled person in wheelchair performed the walkthrough B. It began in front of the Chemistry department. The participant had to choose a longer path consisting of ramps to overcome the gaps. The canteen is inaccessible to a person in a wheelchair, because it has 2 main obstacles: the user had to be helped climbing 2 steps and to go down on the last gap; the vertical platform elevator did not work properly.

A motor handicapped performed Walkthrough C. It started in front of the main building going up to the canteen and ending in North Tower. This participant took the longest time (37min 30s) to go back and forth from the canteen, despite being the third shortest route (628 m).

Walkthrough D was carried out by a visually impaired person who revealed that it becomes easier for him to move outside of the Campus, having the wall as reference. The walked tour started in front of the Computer science department.

A teacher, with temporary disability, performed Walkthrough E. She identified as the major barriers the bad floor conditions and the fact that the exterior ladders do not have handrails.

A participant who moved in a wheelchair performed Walkthrough F. It started in front of the Computer science department toward the canteen, having to ride on the outside of the IST.

Based on the video recording of each walkthrough, the walked route for each participant was hand-drawn into printed plans of the campus. This was used to determine distances of routes as well as the position and the duration of stops. In addition behavioural data was related with the syntactic analysis of the campus, based on the external circulation network. The circulation network was segmented, as well as the different routes used by each participant. Results have shown that users with disabilities find multiple barriers when crossing the Campus: it is not a continuous accessible route.

3.4. Level of Effort (LoE)

Based on information obtained in the metric survey were evaluated each stair, ramp or path of the case study, by requirements of the law and inputs of interviews and walkthroughs. The determination of the evaluation criteria and their weighting in the final value of LoE demanded holding four simulations and a final proposal, obtained by calculations in Excel© and representation in Depthmap© (Nascimento, 2012). It was used a table of the survey data which was completed with the evaluation for parameters that define LoE (element by element). This evaluation consisted in assigning points to each item, i.e., according to their geometric characteristics and materials.

The values were then imported to Depthmap© (Turner, 2004), which allowed the creation of a visual image of LoE in the Campus (as an axial map – Figure 6), were each line was assigned with the final LoE value, taking into account the colour grading.

Regarding the items, LoE was evaluated by intensity, type of floor, the existence of muzzle, existence of railing, extension, texture floor, pitch, dimensional irregularity and presence of obstacles (Table 1). An example of the definition and procedures for intensity can be verified in Table 2 (more detailed information is available at Nascimento, 2012).

Table 1: Evaluation parameters for LoE

	Ponderation on LoE [%]	Min. scale	Max. scale	Increment	Number of categories
Intensity	35	1	9	2	5
Floor	8	1	2	1	3
Muzzle	6	1	1.5	0.5	2
Handrail	8	1	2	1	2
Extension	10	1	3	1	3
Tactile	8	1	2	1	2
Pitch	21	1	6	1	6
Dimensiona	6	1	1.5	0.5	2
Obstacles	10	1	2	1	3
Scale of LE	-	**0**	**15**	-	-

Table 2: "Intensity" item for LoE

<table>
<tr><td>INTENSITY</td><td>As for intensity, the weight in the final score in the LoE was 35%, with 5 levels corresponding to a scale 1-9 incremental values of 2, as presented in the tables Intensity stairs and ramps.</td></tr>
<tr><td>Ramps intensity</td><td>The variable is measured by its slope: the first interval was defined having as basis national legislation for the case of ramps, which established a limit of 6% of slope. The remaining intervals increase about 5 and above 20% slope is considered extremely intense, so it is assigned the level 9 (maximum).
<table>
<tr><td colspan="5">RAMPS INTENSITY [%]</td></tr>
<tr><td>]0;6]</td><td>]6; 10]</td><td>]10; 15]</td><td>]15; 20]</td><td>>20</td></tr>
<tr><td>1</td><td>3</td><td>5</td><td>7</td><td>9</td></tr>
</table></td></tr>
<tr><td>Stairs intensity</td><td>It was based on the Law of Blondel: 63 <2 * riser + tread <64. By applying this law, even the most comfortable stairs, had highest score, so the rule is demanding in some aspects and not clearly differentiated stairs well or badly proportioned. Furthermore stairs with risers or treads too small / large are put in parallel with stairs with acceptable dimensions. As such, it was necessary adapt this rule, allowing a wider range of relationships and the step size also being limited.
Were surveyed rules related to the design of stairs, allowing you to find an adaptation of Blondel Law more flexible.
Thus, the scale measuring intensity of stairs is: 61 <2 * riser + tread <64 (Neufert 1965 p.120), constituting the first interval. The others intervals for a total of 5 categories were defined on an increase of 2 points for every 0.5 that exceed the range given by the rule. The stairs that have riser outside the range [14, 18] cm, or tread less than 28 cm, score one more value to a maximum penalty of 9.
<table>
<tr><td colspan="5">Stairs intensity
"=2*riser+tread"</td></tr>
<tr><td>]63; 64[</td><td>]62.5; 63] U [64; 64.5[</td><td>]62; 62.5] U [64.5 ;65[</td><td>]61.5; 62] U [65; 65.5[</td><td>]62; 62.5] U [64.5; 65[</td></tr>
<tr><td>1</td><td>3</td><td>5</td><td>7</td><td>9</td></tr>
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The scores sum of each LE parameter was ranged between 9 and 26 values, and when subtracted 9, it is obtained a scale ranging from 0 to 15 with an increment of 0.5. After five simulations, adjusting, adding and removing parameters there was a strong approach to the perception of the LoE user about the analysed space (Nascimento, 2012).

As can be seen from Figure 8, there is no element involving a null LoE but then also there is no worse value of LoE (the maximum). Another relevant situation is that even on the stairs or ramps mode (5 or 6 respectively) was less than half the maximum of the scale (15). Since the campus is quite large, many elements dilute most of serious situations.

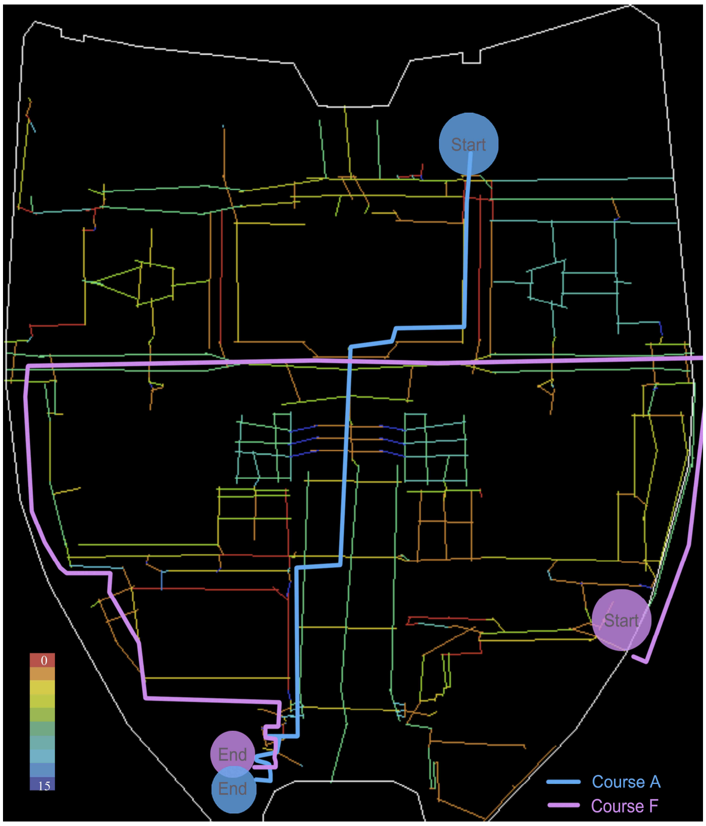

Figure 8: LoE in Depthmap®, showing walkthroughs "A" and "F".

The method of LoE is clearer by viewing the map than by direct observation values. The analysis of values in the Table 3 suggests most of the campus requires very little effort to the user (mode = 2) when following courses. However when analysing the axial map (Figure 1) it is realized that the main routes integrate elements that impose more difficulties, with values between 10 and 13 of LoE (blue tones).

Table 3: LoE values summary.

	Number of elements	Mean	Mode	Maximum	Minimum
Campus	151	5	2	13	1
Stairs	43	7	5	13	2
Ramps	54	6	6	12	2
Paths	54	2	2	4	1

By equating the qualitative assessment of the users with a quantitative evaluation of the LoE, it follows that there is a correlation between the LoE and the average number of barriers flagged by users. The fact that the correlation is stronger may have been influenced by: (a) the level of habituation to the route; (b) the existence of different paths for each user; (c) the different types of impairment for each user; (d) the perception of effort is relative for each user (depending on age and habituation or not to exercise) and (e) the sample being small to test a correlation.

These variants lead us to a continuation of the study, creating user groups with approximate profile, carrying out the same route.

3.5. Discussion

The Space Syntax analysis showed several "black points" on Campus as the parking lot, the discontinuity of sidewalks and walkways, and the limitation of paths for wheelchair users. Through formal interviews and walkthroughs these situations were reinforced and pointed to others. It was decided to make the analysis of the Campus by courses, having elaborated a synthesis by each participant/course presented in a series of fact sheets. There is a synthesis feature for each step with the barriers identified by the user, this time in comparison with the average time of users without disabilities, the distances and the LoE.

The main "black points" of Campus are the car parking on sidewalks; the stairs too extensive and without handrail, and issues of management and maintenance of the space as handling platforms, state of the cladding and vegetation. The existing routes have multiple barriers and, it can't be forgotten that the mere existence of one barrier in the continuity of a route can restrain the movement of a pedestrian, including disable people.

The analysis to the Pavilions was focused in entrance areas, with the exception of the Canteen, Student Association and Pool in which was made a critical reflection to other internal spaces. Due to the fact that internal analysis of buildings isn't the center of this study, it was posted to synthesis attachments that verify the connection with the outside world, reception, access to adjacent spaces and sanitary facilities. The main barriers identified by users with disabilities are the space limitations for which they have access to and the complexity of the pathways. In the case of visually impaired users, the absence of tactile references is harmful to their orientation, although it is easier in interior spaces than exteriors due to the fact that is a smaller dimension.

It was also analyzed the correlation between the Level of Effort and barriers identified by participants in the walkthroughs. The total value of barriers (for each step) was calculated by assigning 1, 2 and 3 points respectively to the barriers that require low, medium or intense effort:

Total value of Barriers = low effort x 1 + medium effort x 2 + intense effort x 3

The steps that have lower LoE were a road parallel to the "Pav. Central", a road behind the "Pav. INF. II", and the access road to "Pav. INF. II", showing great proximity to the barriers identified by users (0 or 1).The main differences were in the steps of the Torre Norte interior ramp and stairs behind the "Pav. Mecânica IV", which had, respectively, 8 and 9 values for the LoE, which are only covered by one user.

The steps that have a higher LoE were the stairs to the Canteen and the stairs near the playground, respectively with 11 and 11.5 LoE values and in accordance with the barriers that have obtained the highest score, 16 and 9 points respectively.

The linear association between the variables can be quantified through the Linear Correlation Coefficient of Pearson, resulting in a value of r = 0.5, that means the correlation is Moderate positive. The average correlation between the LoE and the number of barriers identified by users, may have been influenced by habituation or not to the course, there were different routes for each user, according to the different types of disability or impairment and the fact that the effort is relative to each user (depending on age and whether they make effort regularly or not).

Finally, Space Syntax Analysis combined with the other methods referred, allow concluding that the Campus spaces were not connected and that the Campus itself, was not effective in terms of orientation and location for the user. Campus Alameda internal configuration of is very complex, in due to adding buildings or spaces along the time, with many corners between walls, slopes and buildings, that lead to an excessively fragmented space. The interpretation supported on visibility graphs (VGA) showed how much car parking affect pedestrian circulation and eliminates the natural capability of spaces to embrace social interaction, resulting in loss of configurational clarity.

Axial map that exclude from courses network the stairs, made it possible to understand the perspective of who moves in a wheelchair, revealing the importance of ramps and showing how existing ones on Campus are insufficient – there is a vast patch of difficult access, especially in the bottom of the Campus (Student Association, Cafeteria, Informatics Pavilions and Mechanics Pavilions). Axial map that considers only safe paths (such as crosswalks and sidewalks) allowed to realize a very limited and complex network, implying many changes of direction, which makes a course labyrinthine.

CONCLUSION

An inclusive university requires spaces that meet the needs of a wide public, regardless age or ability (Inclusive, 2012). Any user within a Campus must feel that the space allows his immediate understanding, the different routes and places where they want to go, without having the feeling to be limited in their access to any areas.

The syntactic analysis shows that the spaces on Campus are not connected and it is not effective in terms of orientation and location to the user. Supported by VGA, it was proved that the car parking harms pedestrian traffic and eliminates the natural property of spaces to allow movement or conviviality.

The analysis of the courses made in walkthroughs allowed to conclude that although there are sites with good accessibility, accessibility to outdoor spaces is not continuous between the point of origin and the point of arrival of a route, which makes it impossible for the user autonomy. Therefore, we may conclude that the outside spaces of the Campus have a poor accessibility.

The LoE completed some situations that were not evaluated by users and still allow using the survey as a preliminary environmental accessibility condition of a space, without dispensing the later observation *in loco* and the perspective of the user. The map which represents the LoE revealed strong accessibility problems on Campus, which are featured on the main routes with high values of LoE.

It is worth to mention that the techniques proved useful for several reasons. Syntactic analysis provided methods for visualization and pattern identification and helped communicate findings. Thinking about the geography of accessibility made an important learning tool that involves building a more systemic view of the campus layout and in particular of its global structure of accessibility and social relations pattern. These techniques also proved to be an effective method for engaging students in accessibility research and stimulating productive discussions on the multiple social dynamics of accessibility on campus.

As future developments it is intended to develop the indicator LoE, through its application in other areas with different morphologies and uses. It is interesting to correlate LoE with other configurational measures, to understand the physical accessibility. The main syntactic variables related to this indicator will allow the understanding of how the space configuration influences accessibility.

The use of configurational tools for accessibility evaluation, articulated with other methodological procedures, was relevant to insert a new analysis technique for the investigation of accessibility problems, with the potential to evolve.

The modelling of the space according syntax was designed to match distinct categories of barriers and permeability's associated not only related to visibility, but also allows the search for synchronizing the varying degrees of users abilities with impairment. The apparent indiscipline in relation to establishing the theoretical body of space Syntax reveals a field, whose preliminary results are promising.

The use of the tools such as space syntax and LoE for accessibility evaluation allowed technical analysis of accessibility problems, with the potential to evolve by introducing a relationship between various media (observation, user's opinion and regulatory requirements) allowing to represent, analyse and simulate how the variation of the characteristics of spatial elements influence the accessibility of a space.

The results of the evaluation to the outdoor spaces Campus is able to provide accessibility requirements for future maintenance, construction or adaptation, in terms of accessibility conditions. The design must try to answer to the needs of all people, because in addition to law enforcement, it is a moral basis for architectural design. Accessibility must enhance the building or public space and not be a discordant element of overall design and aesthetic quality and functionality. The absence of recognition about the real benefits of inclusive architecture, by the agents that affect the built environment, originated the forgetfulness of civil rights of disabilities.

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