Introduction and research outline

The architecture of the Japanese practice SANAA, led by Kazuyo Sejima and Ryue Nishizawa, seems to be conceived so as to be spatially and programmatically ‘uncertain’, with configurations that tend to be freed from constrictions. Characterised by multiple layers of transparent materials, their buildings establish a continuous relationship between interior and exterior. This study focuses on the analysis of one of the buildings designed by SANAA, the Rolex Learning Centre (RLC). The study provides an in-depth analysis – the first of its kind using space syntax methodology – of this building looking at both spatial properties and the social practices of users. The particular geometry of the building entails methodological challenges and the customisation of syntax tools derived from a fluid and continuous undulated interior. New methods of syntactical analysis are tested in order to overcome the particular morphology of the building. In particular, this is done by the development of a series of methodological experiments concerned with the comparison of visibility and permeability values and the role of the third dimension in space syntax theory and applied software. The study will first analyse selected buildings from diverse functional and formal typologies to provide a background analysis of the architecture of SANAA, to then later address the RLC.

The first section of the study identifies a strong foreground structure in the buildings analysed, but almost no correlation between function and configuration. The analysis of the RLC shows how the spatial arrangement is determined by the use of transparent and opaque materials, which constructs different levels of privacy, and how this is reflected in a diverse combination of levels of visibility and permeability in different areas of the building. Finally, a closer look to the spatial practices of users in the RLC reveals that the places that are used in a more informal way are those characterised by a disjunction between levels of visibility and permeability. This is considered an incisive conclusion that, added to the methodological experimentation performed in the study, can provide an alternative way to understand the relationship between spatial complexity and functional uncertainty in buildings.

Keywords: visibility, permeability, uncertainty, Japanese architecture

The Japanese practice SANAA, led by Kazuyo Sejima and Ryue Nishizawa, has constituted in the last two decades one of the most influential international architectural offices. Their moderate and personal style, characterised by clear geometrical forms – sometimes rectilinear, sometimes curved – is the signature of their projects. Their work is also distinguished by the use of multiple layers of transparent materials, establishing a continuous relationship between interior and exterior. This characteristic creates spatial conditions where space and use seem unlimited by programmatic restrictions and physical boundaries. It seems that the architecture
The study makes use of the computer software DepthmapX originally developed by Alastair Turner at University College London for the analysis of spatial networks and the application of space syntax theory, and subsequently extended by Tasos Varoudis (Valuedis T. “DepthmapX Multi-Platform Spatial Network Analysis Software: Version OpenSource, UCL, 2012.”).

Each group of values (permeability values per sector and visibility values per sector) have been divided by the highest value of each group:

\[
\text{Permeability value} / \text{maximum value of permeability} = \text{normalised permeability value} \\
\text{Visibility value} / \text{maximum value of visibility} = \text{normalised visibility value}.
\]

This way, all the values except the maximum are below 1, enabling a comparison between pairs of values, as shown in Figure 2.

Hillier argues that cities are normally composed by few long integrated lines, represented by the maximum normalised values (NACH) and constituting the foreground, and a large number of shorter lines represented by the mean values (NEIN) which conform the background of the urban grid. NACH and NEIN values represent structure and order respectively (Hillier, 2001). Thus, similar values for foreground and background are to be found in non-hierarchical spatial systems, where opportunities are equally distributed of SANAA is conceived so as to be spatially and programmatically ‘uncertain’ through certain attributes yet to be rigorously described. Buildings like the 21st Century Museum in Kanazawa and the Toledo Museum of Contemporary Arts for instance (Figure 1) seem to clearly represent the above description. Other projects, like the Zollverein School of Management and Design and the Moriyama apartments (Figure 1) share this sense of fluidity and open-endedness even though they use more solid and opaque materials than other SANAA projects. But perhaps the most characteristic building of SANAA’s architecture is the Rolex Learning Centre (RLC), serving as the main educational facility for the École Polytechnique Fédérale de Lausanne in Switzerland (EPFL) (Figure 1).

This study focuses on the analysis of the RLC as a building that, due to its particular geometry based on undulated floors and ceilings, challenges space syntax methodology with respect to its three-dimensional application. The building seems to support the hypothesis of being a functionally uncertain architecture. As Sejima and Nishizawa themselves point out, the intention with this design was “to create a place where activities are gently separated but at the same time naturally blending into one another to create a unified space” (El Croquis, 2008, p.174). As a background study, the paper starts by analysing permeability and visibility values of a set of buildings designed by SANAA, before moving to the study of the RLC. This is done in order to understand whether there are underlying configurational properties behind SANAA’s architecture that are shared across their buildings, creating conditions for programmatic uncertainty derived from the encountered patterns of permeability and visibility. Also, this preliminary study offers the opportunity to test the alternative methodology created to measure visibility and permeability values that this research proposes. The buildings selected for the analysis come from diverse functional and formal typologies in order to explore whether, in spite of programmatic differences, they share spatial similarities. Figure 1 displays the selection of analysed buildings.

Thus, the research addresses the following questions: if SANAA’s buildings share a sense of fluidity and non-functional definition in space, can they all be understood as sharing a common abstract spatial typology not based on functions but on configurational properties? Can this typology help define functional uncertainty in the case of the RLC, in the sense that through life and use the buildings can accommodate spatial practices that were not planned in the beginning? Which spatial characteristics are necessary in order to produce this kind of non-definition of use and functional freedom in the RLC?

Due to the use of open spaces and transparent materials in most of the buildings selected, it seems necessary to address their spatial organisation taking into account two different properties: permeability, understood as the spatial network created by accessible spaces, and visibility, i.e. the set of visually inter-connected spaces – either directly or through transparent materials – but not necessarily accessible. Integration values are analysed in visibility graph analysis (VGA) and axial analyses, both analyses undertaken for each of the building selected1. The buildings’ layouts are divided in spatial sectors in order to be able to compare pairs of values (visibility – permeability) in different areas. Moreover, due to the much higher values of visibility in relation to those of permeability, a normalisation process is used in order to plot both analyses in the same graph2. As for the representation of axial analysis, this research draws upon the ‘four-pointed star model’ method – proposed by Hillier et al to compare normalised values of integration and choice in urban research – in order to contrast patterns of axial permeability and visibility across all buildings (Hillier et al, 2012)3. The methodological experimentation undertaken to study visibility

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2 Each group of values (permeability values per sector and visibility values per sector) have been divided by the highest value of each group:

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Figure 1. Buildings, locations and typologies.

(Hillier et al., 2012). This criteria is considered in the present study to analyse the ‘perceptual’ structure and order in the buildings’ layout by comparing mean and maximum values of permeability and visibility.
and permeability values aims to develop a more accurate comparison of pairs of values based on spatial sectors, allowing a thorough exploration of the disjunctions between the two properties. With this purpose in mind, the first part of the research is used to test this methodology and reflect upon an alternative understanding in the relationship between visibility and permeability by also drawing upon past and current works on the topic at hand. Especially interesting is the study performed by Koch into morphological identity and syntactic contrasts between visibility and permeability. Based on previous studies of Hanson (1998), Hillier (2003) and Zamani and Peponis (2007), Koch argues that the differences in values of permeability and visibility can be interpreted with cultural meanings. Thus, high levels of visibility with restricted access can produce certain kinds of community feeling, but he also points out the risk that these effects “can conversely be seen as a way to produce control and surveillance” (Koch, 2012, p.4). Later works developed by Koch, especially the exploration of Adolf Loos’s House for Josephine Baker, further discuss the extent to which the differences between visibility and permeability patterns contribute to the creation of spatial narratives in the building (Koch, 2013).

Additionally, due to the singular geometry of the RLC characterised by its undulated floor and ceiling, the study of this building raises important methodological issues regarding the use of space syntax theories and applied software in a building with a non-flat continuous surface. This contribution intends to draw upon current discussions originated in later works with respect to the development of syntactic tools like in research by Varoudis and Penn (2015) – which performs incisive improvements in Visibility Graph Analysis – and the ongoing work on three-dimensional analysis conducted by Varoudis and Psarra (2014). They all share a concern for the exploration of visual relationships in buildings and envisage future research developments on the topic. Finally, the RLC is studied not only in terms of configurational properties, but also in the empirical dimensions of spatial practices observed in the building. This will allow us to define the extent to which this apparently fluid spatial strategy used by SANAA as a design tool affects social activities and group interaction. Thus, although this paper is based on the study of a particular practice in order to understand issues regarding the correspondence between configuration and function, the research also contributes to methodologically dealing with spatial properties that have been rather problematic when analysed with space syntax techniques. This has been the case in the analysis of buildings like the RLC where boundaries between rooms are not clearly defined and are thus hard to classify using standard syntax concepts; the presence of glass walls and transparencies – challenging the otherwise usual correspondence between visibility and permeability patterns in buildings – and the analysis of a non-flat building layout, pointing out at the problem of how to take into account the third dimension when using space syntax tools.

**Experiential, geometrical and configurational uncertainty**

The continuous perforation of the RLC by open spaces and its fluid spatial form suggests that some functional areas are not clearly demarcated and remain susceptible to improvised future activities (Figure 1). At this point, we identify three theoretical definitions of uncertainty that could help understand the ways in which this notion has been defined by other authors: experiential uncertainty, associated to the traditional conception of space in Japan and in certain western practices during the post-war period; geometrical uncertainty, as a current emerging in the 1990s where continuously variable organic shapes are supposed to be capable to adapt to internal and external forces; and configurational uncertainty, as derived from Bill Hillier’s notions of
‘generic function’ (Hillier, 1996), in which space is understood as a form-free entity defined by patterns of movement and occupation.

**Experiential uncertainty**

In an interview with Sejima and Nishizawa conducted by Alejandro Zaera-Polo in their early days, the architects refer to the apparent non-hierarchy between structure, partitions and façade in their architecture. Further, they discuss how in projects such as ‘Almere’ (Figure 1), they “try to generate something like flexibility of system or method by the repetition of units in space” (Zaera-Polo, 2000, p.15). In another interview they acknowledged two elements in their architecture that could be directly related to Japanese spatiality and tradition. The first one is structure, in as much as “all the relations between the parts of the structure are in sight. Nothing is hidden, it is all very clear” (Cortés, 2008, p 11). The second one concerns diversity – which seems to be equivalent to what this paper refers to as uncertainty – a condition that is not produced by the use of movable elements, but with the enabling of multiple relationships between spaces and uses, non-controllable a priori but potentially present due to the materiality and the configuration of their buildings. In this line of thought, the Japanese concept ‘ma’, which is the traditional term that refers to space as an entity that is indivisible from time, can be seen as an intrinsic characteristic of spaces which do not seem to follow a logical hierarchy, but are distributed so as to preserve the sequencing of experiences in time created between built objects (Nitschke, 1966). The anthropologist Mitsuo Inoue refers to the traditional arrangements of Japanese palaces, like the Hommaru Palace, as being an exemplary application of the “irregular” and the “indeterminate” (Inoue, 1985, p.143).

The advocacy for an uncertain architecture based on experience and movement also played an important role in western practices, especially in those emerging during the sixties and seventies. As architectural historian Reyner Banham postulated, the evolution of technology forced the architect of the post-war period to rethink his role for society, “including the professional garments by which he is recognized as an architect” (Banham, 1960, p.330). This loss of certainty towards the problems to solve in architecture contributed to the emergence of a series of radical positions. Among them, Archigram’s Plug-in City, with an imaginary borrowed from the incipient pop culture aesthetics, the adaptive urban planning of Yona Friedman’s Spatial City, and the call by the Situationist to transform the city into a place with infinite experiences to discover “in order to make life exciting” (Violeau, 2000, p.239), promoted an indeterminate and unpredictable conception of the built environment. Especially interesting for the present research is the work of Cedric Price, an architect whose most paradigmatic project, the Fun Palace, developed during the Sixties as a leisure and learning facility for working class people in London, was conceived from the possibility of the existence of an active inhabitant who could decide by himself in a flexible space designed to generate new possibilities of use. Price’s intention was not only that of anticipating to future problems, but also to “extend the possibilities of choice and delight” to users (Lobsinger, 2000, p.126). In this sense, it seems that some SANAA’s projects like the Rolex Learning Centre share with Price’s philosophy this concern for how buildings should be created to provide social and spatial interaction between users by the generation of what Price calls free-space (Price, 1984).

**Geometrical Uncertainty**

During the 1990s, uncertain architecture was theorised as a compound of geometrical properties that were possible due to the advancements in computer software for modelling and parametric design. Borrowing some Deleuzian concepts, such
as ‘fold’ and ‘smooth space’, architects like Gregg Lynn and Jeffrey Kipnis promoted a new current that distanced itself from the more historicist tendencies of Postmodernism⁴, referring as well to the social consequences of this new emergent spatiality, where “heterogeneous spaces that do not support established categorical hierarchies are sought, a respect for diversity and difference is encouraged” (Kipnis in Lynn, 1993, p.57).

Among articles that emphasised the resurge of spatial uncertainty during the 1990s, Stan Allen’s notion of “field condition” provides an explanation of how space might be seen as a set of infinite parts coming together to construct an indeterminate whole. Field conditions are, according to Allen, non-figural configurations that function as the breeding ground from which a particular physical organization can grow, mutate and expand, and where “independent elements are combined additively to form an indeterminate whole” (Allen, 1999, p.94). Thus, although “non-hierarchical compositions cannot guarantee an open society or equality in politics” (p.102), Allen advocates for a “loose fit” – especially in museum typologies and educational institutions – between activities and forms in order to provide a field condition where users can create unforeseen practices.

**Comparative study: Visibility vs Permeability**

This section compares permeability and visibility values of integration obtained in the buildings selected using VGA and axial analysis. Figures 2 and 3 illustrate the results of the comparative syntactic analyses.

Regarding VGA analyses, the graphs reveal certain topological rules from which three configurational categories can be derived:

- In some cases, the values corresponding to permeability and visibility are very similar in all sectors of the buildings, like in Okurayama and Seijo (Map C and Map G in Figure 2). Both are housing projects, mainly constituted by opaque elements in which the linear graphs of distribution of visibility and permeability values almost coincide.
- In other cases, like in Toledo and K-Project (Map B and Map D in Figure 2) there seems to be no correspondence between visibility and permeability values, as in many areas visibility raises whereas permeability drops and vice-versa. In these buildings, where the use of glass is predominant, transparencies generate visual relationships among areas which do not

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⁴ See ‘Folding in Architecture’ (Lynn, 1993).
Figure 2. VGA Analysis. Comparison between integration values of visibility and permeability.
Figure 2.
VGA Analysis. Comparison between integration values of visibility and permeability.
Figure 3. Axial Analysis. Comparison between mean and maximum integration values for visibility and permeability.
correspond to the network of relations among permeable spaces.

There is a third pattern shown in projects like Almere (Map H in Figure 2) and, most clearly, in the Rolex Learning Centre (Map J in Figure 2), where the disjunction between values of visibility and permeability are concentrated in few areas, which moreover correspond to places located near to the outer boundaries. As this disjunction occurs in specific areas, the difference between the two kinds of properties might be more prominent and likely to be noticed by users than in buildings in which the disjunction is observed in the entire layout. This unique characteristic most notably grasped in RLC will be one of the key elements to analyse in the second part of this paper.

As for axial analyses, certain similarities arise among the projects analysed. The four pointed stars have a slender form (Figure 3) due to the higher values of maximum visibility and permeability compared to the mean values of these measures, which means that, despite the apparent non-hierarchical spatial organisation, the layouts have a leading structure that steps out as a foreground network\(^5\). The similarity in the shapes of the pointed stars indicates that the buildings are configurationally similar in terms of the distribution of values to axial elements. Combined with the high maximum values, the low mean values indicate buildings with a strong difference between a powerful foreground system and a weak background one. This means that a few elements are strongly differentiated from the background homogeneous structure. As argued by Peponis, these configurational features are certainly common among a great range of buildings regardless their particular function, historical period and formal composition. This is associated with the existence of purview in buildings, which defines the intelligibility of the spatial interior. Peponis argues with this regard that “to have purview over space means to be able to judge space as a potential field of access, movement, search, encounter, and co-presence” (Peponis, 2012, p.15). This directly relates with the property of intelligibility. As explained by Hillier, intelligibility is “the correlation between connectivity and integration” (Hillier et al, 1987, p.237). This correlation defines “the degree to which what can be seen and experienced locally in the system allows the large-scale system to be learnt without conscious effort” (Hillier, 1996, p.171). Therefore, the presence of a leading foreground network among a weak background network in the buildings analysed can be interpreted as a condition defining the high levels of intelligibility of the selected buildings, a condition however common in interior spatial arrangements.

However, in terms of function, when looking at the values obtained for maximum and minimum integration in relation with the building typologies and their geometrical character (Table 1), there seems to be no apparent correspondence between data, and therefore no underlying spatial strategy which correlates functional types with spatial properties. This might suggest the existence of configurational properties that are shared among diverse functions. This fact could respond, as argued by Koch, to an intention by the architects to create a similar “configurational aesthetics” across different functional typologies by the architects (Koch, 2012, p.16), and seems to go in line to what other critics on SANAA have speculated when analysing their architecture. In particular, this is related to the notion of disappearance of their architecture, which seems to be achieved not only through the use of transparent materials but also by the particular way of configuring space so that partitions and limits are not clearly grasped by the users when navigating the building. This notion is particularly present in the RLC, which articulating space seems to be “an undefined zone where it is hard to distinguish beginnings from endings” (Devabhaktuni, 2009, p.76).

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\(^5\) Zollverein has higher values than the rest of buildings analysed and they have not been displayed in the comparative analysis as they would considerably distort the chart scale. However, as it can be seen in the individual chart, the values represent, and in the other examples, a slender shape.
Thus, although in some cases certain design decisions might provide a sort of functional identity, like the disjunction between visibility and permeability based on the use of transparent materials in programmes such as museums and educational buildings, and the absence of such disjunction in housing projects, the analyses do not bring clear results that indicate shared rules of generic function for different building types. This non-correspondence between configuration and function characterises a design method which is not deterministic and does not attach a consistent topological pattern to an architectural programme, but has more to do with a creative, almost ‘artisanal’ process in which each spatial arrangement seems to be the result of an experimental approach to design.

The next section is devoted to the analysis of the RLC addressing syntactic analysis, and the study of spatial practices in the building6. Moreover, the urban-like character that is to be grasped in the RLC is discussed in relation with the spatial practices observed and the urban rules set by Hillier as commonly found in organic cities (Hillier, 1996).

### Table 1.

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>FUNCTION</th>
<th>FORM</th>
<th>AUTHOR</th>
<th>max integration visibility</th>
<th>mean integration visibility</th>
<th>max integration permeability</th>
<th>mean integration permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>OKURAYAMA</td>
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<td>organic</td>
<td>S</td>
<td>11.67</td>
<td>7.12</td>
<td>9.16</td>
<td>5.02</td>
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<td>orthogonal</td>
<td>S</td>
<td>8.25</td>
<td>4.65</td>
<td>6.54</td>
<td>3.50</td>
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<tr>
<td>ALMERE</td>
<td>research</td>
<td>orthogonal</td>
<td>S + N</td>
<td>9.18</td>
<td>5.48</td>
<td>9.80</td>
<td>4.96</td>
</tr>
<tr>
<td>TOWADA</td>
<td>museum</td>
<td>organic</td>
<td>N</td>
<td>6.52</td>
<td>4.12</td>
<td>5.53</td>
<td>3.62</td>
</tr>
<tr>
<td>21st CENTURY</td>
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<td>orthogonal</td>
<td>S + N</td>
<td>12.46</td>
<td>6.57</td>
<td>8.82</td>
<td>5.11</td>
</tr>
<tr>
<td>MORIYAMA</td>
<td>housing</td>
<td>orthogonal</td>
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<td>11.99</td>
<td>7.38</td>
<td>13.78</td>
<td>7.07</td>
</tr>
<tr>
<td>ZOLLVEREIN</td>
<td>education</td>
<td>orthogonal</td>
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<td>38.62</td>
<td>13.09</td>
<td>12.92</td>
<td>7.79</td>
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<tr>
<td>K-PROJECT</td>
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<td>N</td>
<td>15.12</td>
<td>8.88</td>
<td>8.69</td>
<td>5.11</td>
</tr>
<tr>
<td>TOLEDO</td>
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<td>orthogonal</td>
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<td>8.19</td>
<td>9.40</td>
<td>5.51</td>
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<tr>
<td>RLC</td>
<td>education</td>
<td>organic</td>
<td>S + N</td>
<td>15.03</td>
<td>8.67</td>
<td>12.47</td>
<td>7.21</td>
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</tbody>
</table>

6 Such practices were studied by observation techniques during field work between the 21st and the 25th of June, 2014.
likely to be used in many different ways. The final question raised in this section therefore, concerns whether these characteristics and intentions are actually realised.

Spatial Analysis

The geometry of the RLC can be defined by two major morphological moves. First, the surface is bended in all its extension to create two main hills and to main valleys. Second, a total of fourteen round perforations with different sizes break this undulated surface. The valleys and hills define places where the building touches the ground and is lifted off the ground respectively. These movements produce an external open space beneath the floor of the building. The undulated and perforated surface is complemented by other elements such as flat surfaces, ramps and enclosures which transform this shape into a habitable space (Figure 4b). In terms of the distribution of programmes, the building has some areas defined by specific uses, but it is the vast area dedicated to circulation and general use which seems to produce the absence of programmatic definition in the entire layout. From a total interior area of 17620 m², over 6200 m² has no defined programme, which represents more than 35% of the building area (Figure 4c).

In order to include the three-dimensional variable in the analysis, two different sectorisations (Figure 5) have been made inside the building:

- Visual sectors, delimited by the areas in which the interior can be divided according to the visual barriers caused by the hills. This division originates four visual sectors - Lower Area 1, Lower Area 2, Upper Area 1 and Upper Area 2 (Figure 5 above).

- Height sectors, defined according to the divisions produced on the floor by the topographic curves. Sectors hatched in yellow can be considered flat. Sectors ‘A’ and ‘J’ correspond to the two main valleys in the building. Sectors ‘P’ and ‘I’ are the peaks of the two main hills. (Figure 5 below).

With these two divisions, the impact of the third dimension on visibility and permeability connections is included as a parameter to be considered in the analysis. The results will refer to the different altitudes in order to elucidate to which extent the third dimension is a relevant issue with respect to the configuration generated and the spatial practices observed.

Additionally, in order to understand the role of three-dimensionality in the characterisation of the spatial configuration, two types of analyses are conducted: first, as if the building floor were flat (‘Flat RLC’); second, taking into account its three-dimensional morphology (‘Real RLC’). This will allow a comparison between the flat morphology as seen in plans and the real curved topography of the scheme. The research uses convex analysis, axial analysis and Visibility Graph Analysis (VGA) shown in Figure 5. With this division, we obtain the following plans:

- ‘Real RLC’
  - Lower area 1 + Lower area 2 (map a and b)
  - Upper area 1 (map c). Connected with
    - Upper area 2 (map d).

- ‘Flat RLC’

The convex division of the ‘Real RLC’ follows the height sectors to define convex subdivisions inside the building. At first sight, it seems that every sector has its highest levels of integration located around the patios (as displayed in the VGA Permeability and Visibility graphs in Figure 6). Regarding segregated areas, there is a slight but important discordance between the ‘Real RLC’ and the ‘Flat RLC’. If we compare the analyses of the Upper Area 1 in the ‘Real RLC’ and the ‘Flat RLC’ we can see that office-related programmes are segregated in both cases. However, the convex analysis of the Upper Area 1 in the ‘Real RLC’ picks the south-east
Figure 4.  
a) The RLC. Bird’s eye view. b) Three-dimensional model. c) Programme distribution.
Figure 5.
Distribution of Visual Sectors (above). Distribution of height sectors and areas in m² (below). Flat sectors are hatched in yellow.
<table>
<thead>
<tr>
<th>REAL RLC</th>
<th>EXIT RLC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Map a. Lower 1 + Lower 2</strong></td>
<td><strong>Map b. Upper Area 1</strong></td>
</tr>
<tr>
<td><strong>Map c. Upper Area 2</strong></td>
<td><strong>Map d. Flat configuration</strong></td>
</tr>
</tbody>
</table>

**Figure 6.**
Distribution of visual sectors / Convex analysis / Axial Analysis / Permeability Analysis / Visibility Analysis.
corner as an additional area scoring as the most segregated place in the building. The relevance of this result will be highlighted in the study of spatial practices, where this area is identified as being one of the quietest places chosen by students to relax.

Comparing the axial analysis for the ‘Upper Areas connected’ in the ‘Real RLC’ and the ‘Flat RLC’ one can see very similar levels of integration and segregation, because the stretch of vision from the Upper Area 1 reaches almost the whole surface of the building. However, as Lower Area 1 and Lower Area 2 function independently, they have their own integration cores. In both lower areas, the most integrated lines meet close to patios’ entrances. This result seems to suggest that the configurational structure is accessible to people immediately on entering from the multiple access points to the building.

The VGA analysis shows that the integrated parts also coincide with the entrances situated in the lower areas. Additionally, as it was pointed out in the previous section and was also observed in other buildings analysed in this paper (Toledo, K-Project), the normalised values of permeability and visibility represented in the graphs show certain sectors with high levels of visibility and low levels of permeability and vice-versa (Figure 7). This analysis brings the question on how different values of visibility and permeability might influence certain areas in the building by the production of particular conditions subject to their visibility and permeability values that will be further explored in relation with the spatial practices observed in the building.

Thus, the spatial analysis of the RLC shows that the ‘Real RLC’ has first more integrated spaces at the centre of the layout than the ‘Flat RLC’ and sharper differentiations between integrated areas and segregated areas. In the flat version of the building the transition between integration and segregation is smoother. This shows that the three dimensional rise and fall of the curved surfaces of the building regulate the distribution and transition of spatial relations as though they were traditional boundaries in action that impact on spatial structure whereas in reality the space is continuous and has no divisions.

Spatial Practice

The observation of spatial practices focuses on the central area of the building, where the library entrance, the café and, most importantly, a great amount of undefined space are located. The rest of the areas such as library and offices were excluded from this study as they mostly have demarcated boundaries and fixed programmes. The study measured movement flows at gates, mapped activities through snapshot studies, traces of people’s paths and conducted questionnaires to explore how this functionally fluid area is used by students and how these practices relate to the configurational properties of the building (Figure 8).

The study of movement flows reveals that in areas with similar integration values and defined programs, like the library entrance, the café and, most importantly, a great amount of undefined space are located. The rest of the areas such as library and offices were excluded from this study as they mostly have demarcated boundaries and fixed programmes. The study measured movement flows at gates, mapped activities through snapshot studies, traces of people’s paths and conducted questionnaires to explore how this functionally fluid area is used by students and how these practices relate to the configurational properties of the building (Figure 8).

The study of movement flows reveals that in areas with similar integration values and defined programs, like the library entrance, there are higher use levels by people. This is also the case in terms of movement traces. If we classify the number of movement traces per height sector as shown in Figure 8, we see that they concentrate mainly in Sector ‘A’, but also in sectors ‘B’, ‘C’, ‘D’ and ‘E’, which define the shortest route to go to the library. Therefore, it can be said that comparing the two areas with similar levels of integration – the main entrance and the library entrance – we see that a higher influx of people occurs in the library, where people go with a specific purpose.

The snapshots show that students tend to use programmatically undefined areas to study (Figure 8 below). In fact, this area is seen as a working environment without restrictions, that is, a place where people can work, but also talk and eat without being reprimanded, as it would happen inside the library. Areas with lower levels of movement rates coincide with those that have disjointed levels of...
Figure 7. Comparison of integration values between permeability and visibility analysis. Normalised values.
visibility and permeability, which also have lower levels of integration (although they are not the most segregated areas in the building). It is here that more informal activities were observed taking place, such as sleeping and playing games. In addition, informal uses are also generated in a third area close to the café, where people sit and lay on the ramps and the floor while having their lunch break.

Finally, among the students recorded in questionnaires, 42% belong to other universities in the region, which informally turns the RLC in an academic building that is not exclusively attached to the EPFL, but to a much wider academic population. The map showing the distribution of students in the building illustrates that the most crowded places are located in the hill inside the library (22.71%) and in the café (19.56%). Furthermore, there is a mix of students from different academic origins all over the building. However, as the library is the place with not only the highest amount of use but also the greatest restrictions on talking, real interaction is not guaranteed among students.

Thus, attending to the practices observed, there seems to be a distinction between flat areas, which are occupied by people, and areas in slope, which seem to serve as connectors between uses and as places for informal activities such as laying, sleeping, playing, chatting, kissing, etc. In addition, the configurational effects of the undulated surface in the RLC seem to add a new layer of perceptual complexity. A certain space can have high levels of integration when the building is explored from a lower area and it can be perceived as a segregated space when observed from an upper area, like lower areas in the library and the offices (see VGA analysis in Figure 7). This means that the cognitive organisation of the building varies depending on which height one is situated. However, what seems to be a more incisive factor in the characterisation of the spatial configuration is the non-correspondence between permeability and visibility in certain areas. The study of the spatial practices performed demonstrates how these areas – with high levels of visibility and low levels of permeability and vice versa – are, in fact, those where the majority of informal uses take place. In this case, either the low levels of integration or the disjunction between permeability and visibility values or both seem to create a sense of freedom, spontaneity and informality in the use of space. A continuously open interior might be intended for flexible use but in fact it is also a layout of continuous surveillance by others. When sectors are easily accessible but visually segregated or vice versa, they offer an opportunity to ‘escape’ from work or from the continuous presence of people. The disjunction between visibility and permeability therefore seems to enable a more malleable relationship between space, the self and others.

Another fact observed in the RLC is that the amount of space free of programmatic definition inside the building is essential for the defined programs to function. Non-defined spaces act as a substitute to walls, which in normal buildings separate spaces from one another. However, we have seen that the RLC also has areas with specific programmes and places that, although undefined, are mostly used for activities such as working and eating. Therefore one could say that the RLC hosts different ‘Programme Areas’ in its configuration, places characterised by geometrical, configurational and programmatic parameters that can be compiled into three final categories of areas – ‘Assigned’, ‘Emergent’ and ‘Private-in-public’ Programme Areas (Figure 9).

The Rolex Learning Centre interpreted as an urban system

Taking into account the variety of spatial situations and uses observed, together with the morphology of the undefined areas and social vibrancy, it could be argued that the RLC tends to behave as an organic system, resembling urban patterns to a certain extent. In this sense, it seems that the spatial configu-
Figure 8. Observation Analysis.

**QUESTIONNAIRES**

**GATE COUTS**

**TRACES**

**SNAPSHOTS**

- **Studying**
- **Eating**
- **Sleeping**
- **Talking**
- **Playing**
- **Movement and Interactions**
According to Hillier, cities organise their shape following two kinds of laws: laws of spatial emergence, where global configuration properties grow as consequences of local ones, and laws of generic function, which guarantee a balance in the creation of occupation spaces and movement between spaces (Hillier, 1996, p.262). The fulfilment of these laws is produced by a set of configurational strategies found to be common in organic cities. Despite the singular properties by which every urban environment can be defined, organic cities share certain “nearly invariant” properties. The question now would be whether any of these “nearly invariant” properties are to be found in the RLC. If we generate a plan in which we include the elements creating enclosure, the resulting pattern could at first sight look like a small village. In fact, the spatial configuration is very close to one of the French hamlets that Hillier and Hanson used to explain the foundations of the space syntax theory (Hillier and Hanson, 1984, 59; Hillier, 1996, p.167).

In order to check if any of the nearly invariant properties are present in the RLC configuration, and analogous to Hillier’s explanations (Hillier, 1996, p.167), an all-line map analysis is performed. As it can be seen, the RLC has, as has the village, a “beady ring” shape – “irregular ring streets with occasional larger spaces like beads on a string” (Hillier, 1996, p.281). Moreover, it seems that the “nearly invariant” properties apply in its configuration when observing Figure 10a, in which we can see: a dominant foreground structure of long integrated lines; a configuration based on objects placed next to and opposite each other; a set of interconnected lines of sight and an independence of the outer boundary with regard to the interior spatial rules. A further possible step of the present research would be that of translating Hillier’s nearly invariant properties in quantifiable values, so that they can be more accurately associated to a particular spatial organisation.
<table>
<thead>
<tr>
<th>GEOMETRY</th>
<th>VISIBILITY</th>
<th>PERMEABILITY</th>
<th>PROGRAM</th>
<th>ACTIVITY FOUND</th>
<th>DESCRIPTION</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat</td>
<td>High</td>
<td>High</td>
<td>Defined</td>
<td>Bank</td>
<td><strong>'BUILDINGS'</strong>&lt;br&gt;Practices in this area correspond with programs 'top-down' defined. Areas easily found in other academic buildings. Reproduction of practices, with not so much interaction between users.</td>
<td></td>
</tr>
<tr>
<td>Flat</td>
<td>High</td>
<td>Low</td>
<td>Defined</td>
<td>Stationery</td>
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<td></td>
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<tr>
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<td>Low</td>
<td>High</td>
<td>Defined</td>
<td>Café</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat</td>
<td>Low</td>
<td>Low</td>
<td>Defined</td>
<td>Library / working areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat</td>
<td>High</td>
<td>High</td>
<td>Undefined</td>
<td>Main entrance area</td>
<td><strong>'PUBLIC SPACE'</strong>&lt;br&gt;Areas with no defined uses where space is generator of encounter and relationships between students. Located in highly accessible places in the building, with a strong relation with the patios.</td>
<td></td>
</tr>
<tr>
<td>Flat</td>
<td>High</td>
<td>Low</td>
<td>Undefined</td>
<td>NOT FOUND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat</td>
<td>Low</td>
<td>High</td>
<td>Undefined</td>
<td>NOT FOUND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat</td>
<td>Low</td>
<td>Low</td>
<td>Undefined</td>
<td>NOT FOUND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat</td>
<td>High</td>
<td>High</td>
<td>Undefined</td>
<td>Circulations in library</td>
<td><strong>'PRIVATE-IN-PUBLIC' program areas</strong>&lt;br&gt;Transgression of use is found in these areas. Commonly used for activities not related with learning and studying. Private practices in public.</td>
<td></td>
</tr>
<tr>
<td>Flat</td>
<td>High</td>
<td>Low</td>
<td>Undefined</td>
<td>Dejunctive Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat</td>
<td>Low</td>
<td>High</td>
<td>Undefined</td>
<td>Dejunctive Area</td>
<td></td>
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<tr>
<td>Flat</td>
<td>Low</td>
<td>Low</td>
<td>Undefined</td>
<td>NOT FOUND</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 9. Spatial Typologies contained in the RLC.**
Figure 10. Nearly Invariant Properties in the RLC / All-line analysis comparison with a French hamlet.

Invariant 1: Buildings are placed next to and opposite each other to form spaces which stress harmony rather than, for example, enclosure.

Invariant 2: Lines of sight and access through the spaces formed by buildings tend to become extended into other spaces.

Invariant 3: Some of the linear spaces are orientated to form larger scale linear continuities in the urban grid.

Invariant 4: There is a well formed local area structure of some kind consisting with a strong global structure.

Invariant 5: Cities, as they grow, tend to fit out in all directions to form more or less compact.

All-line Analysis
The urban rules set by Hillier stem from a conception of space that, as Stan Allen also argues in Field Conditions, is based on an infinite number of possibilities from which spatial organisations can emerge. However, whereas for Allen the local rules are not considered as parts of an overarching global logic, for Hillier local rules create global effects that define the architecturally possible combinations of space (Hillier, 1996). As Hillier suggests, “In its raw state, space already contains all spatial structures that could ever exist in that space (…). When we intervene in a space by the placing of physical objects we do not create spatial structure, but eliminate it.” (Hillier, 1996, p.269).

Conclusion

One could argue that the spatial arrangement of the RLC resembles an urban system not only in its topology but also in the way functions are not precisely associated to defined spaces. However, while urban topology develops through the human mind’s intuitive laws of space shaped by bottom-up evolution and top-down functioning by the way in which space is read by people so as to facilitate large-scale movement (Hillier, 2014), the RLC is consciously designed in such a way that resembles the topology of an evolutionary urban system. Its particular spatial arrangement originate a set of areas in the layout characterised by different levels of privacy. Thus, public areas provide multiple possibilities for visual interaction through their layers of transparency and their levels of integration, whereas more private spaces, although being also organised from the conception of a continuous space which contains objects inside, restrict and control the visual network and the capacity of surveillance. Additionally, what is also important to understand is that the disjunctive relation discovered between permeable and visible patterns seems to act as a catalyst for the generation of personal and improvised practices in space as observed in the study of the social practices in the RLC. This point would need further research in order to continue with the development of the proposed methodology for the exploration of visibility and permeability values. Last but not least, the seemingly urban properties identified in the spatial organisation of the RLC brings the question of whether it is possible to directly imply functional degrees of freedoms in a building by the application of properties that usually belong to organic cities. This research has only provided an initial hint to understand this phenomenon by the empirical application of Hillier’s nearly invariant properties in the analysis of the RLC, and so it aims to open up the discussion for further analytical and quantitative methodological explorations following this line of thought.

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