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Spatial and social patterns of an urban interior:

The Architecture of SANAA

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Abstract

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 and often characterized by multiple layers of transparent materials, establishing a continuous relationship between interior and exterior. The present study seeks to understand whether there is an underlying configurational logic behind SANAA's architecture that is shared across their buildings. The results of this exploration are presented in this paper in two sections. The first section analyses a selection of buildings from diverse functional and formal typologies in order to explore whether in spite of differences they share spatial similarities. The analysis takes into account two different properties: permeability, as the spatial network created by accessible spaces, and visibility, as the set of visually interconnected spaces, either directly or through transparent materials, but not necessarily accessible. Drawing on the conclusions of the first part of the analysis, the second section of the study focuses on what can be considered the first in-depth study of SANAA's Rolex Learning Centre looking at both spatial properties and social practices. The particular geometry of the building entails methodological challenges derived from a fluid and continuous undulated interior. Thus, syntax tools are customized to address the floor and ceiling's undulations; a systematic framework for analysing the intricate relations between permeability and visibility in the building is created; finally, the indeterminate condition of space is explored through a comparison between spatial properties and spatial practices in the building. According to the results of the first section of the study, where a strong foreground structure is identified in the buildings analysed, and after analysing the Rolex Learning Centre by making use of the 'nearly invariant' properties proposed by Hillier to describe organic cities (Hillier, 1996), it is argued that the architecture of SANAA resembles urban systems in its topology, and in certain cases its geometry. Moreover, the spatial arrangement is qualified by the control in the use of transparent and opaque materials, which originates a set of areas in the layout with different levels of privacy. Finally, a closer look to spatial practices in the building reveals that the places likely to be used in a more informal way are those hosting a disjunction between levels of visibility and permeability. This is considered an incisive finding that, added to existing research on permeability and visibility relationships, provides a new way to explore the relationship between architectural complexity and functional uncertainty in buildings.

Keywords

SANAA, uncertainty, flexibility, visibility, permeability.

1. Introduction

The Japanese practice SANAA, led by Kazuyo Sejima and Ryue Nishizawa, have constituted in the last two decades one of the most influential international architectural offices. Their moderate and personal style, characterized 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 constrictions and physical boundaries. It seems that the architecture of SANAA is conceived so as to be spatially and programmatically ‘uncertain’ through characteristics 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 be clear representations of 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 have a more solid and opaque appearance than other SANAA projects. But perhaps the most characteristic building in 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).

The present study seeks to understand whether there are underlying configurational properties behind SANAA’s architecture that are shared across their buildings creating conditions for programmatic uncertainty. To do so, we undertake analysis of ten projects illustrated in Figure 1.

The buildings selected for the analysis come from diverse functional and formal typologies in order to explore whether in spite of differences they share spatial similarities. 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 sense that through life and use the buildings can accommodate spatial practices that were not planned in the beginning? Which spatial conditions are necessary in order to produce this kind of non-definition of use and functional freedom?

Due to the use of open spaces and transparent materials in most of the buildings selected, it seems necessary to address the study of the spatial organization taking into account two different properties: permeability, as the spatial network created by accessible spaces, and visibility, as the set of visually connected spaces, either directly or through transparent materials, but not necessarily accessible. Thus, visibility graph analysis (VGA) and axial analyses are undertaken for each building¹. The buildings’ layouts are divided in 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 interpretation of axial analysis, the ‘four-pointed star model’ method recently proposed by Hillier et al to compare normalized values of integration and choice in urban research, has been applied in order to compare patterns of axial permeability and visibility across all buildings (Hillier et al, 2012)³.

¹ Making 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 Varoudis T., “DepthmapX Multi-Platform Spatial Network Analysis Software: Version 0.30 OpenSource, UCL, 2012. <http://varoudis.github.io/depthmapX/>.

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

Permeability value / maximum value of permeability = normalized permeability value

Visibility value / maximum value of visibility = normalized 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.

³ Hillier argues that cities are normally composed by few long integrated lines, represented by the maximum normalized 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 (Hillier, 2012). This



Figure 1: Building selections. Location and typologies.

The second part of the research comprises a detailed analysis of the Rolex Learning Centre (RLC). Drawing on the results obtained in the first part of the study, the RLC is studied not only in terms of configurational properties, but also in the empirical dimensions of social practices observed in the building. This will allow us to define to which extent this apparently fluid spatial strategy used by SANAA as a design tool affects the generation of social activities and group interaction. Finally, a global interpretation about the urban condition of SANAA's architecture and the properties of non-definition in its architecture is outlined.

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.

2. Experiential, geometrical and configurational uncertainty

When observing designs like the RCL, the continuous perforation of the building mass by open spaces and the 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 this notion as something to be used productively: experiential uncertainty, associated to the traditional conception of space in Japan; 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; 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 facade 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). 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, 2004). The second one concerns diversity – equivalent to what this paper refers to as uncertainty - which 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 (Nitschke, 1966), 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. 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).

Geometrical Uncertainty

During the 1990s, non-hierarchical architecture was theorized 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 Post-modernism⁴, 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).

Among the emergence of spatial uncertainty during the 1990s, Stan Allen's definition of 'Field Condition' provides a rather clearer explanation of how space might be seen as a set of infinite parts conforming 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, 1992). Thus, although 'non-hierarchical compositions cannot guarantee an open society or equality in politics', 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.

⁴ See 'Folding in Architecture' (Lynn, 1993)

Configurational Uncertainty

According to Hillier, “buildings as a combinatorial system take the form of one combinatorial explosion within another with neither being usefully countable”. He suggests that, what it seems to be crucial in order to achieve an analytical theory of architectural form, are the laws that restrict the possibilities for a space to be architectural. Thus, ‘It is the systematic nature of these effects by which local physical moves lead to global spatial effects that are the key to how combinatorial possibility in architecture is restricted to the architecturally probable” (Hillier, 1995, 222). This perception of the architecturally possible combinations leads to the definition of generic function. For Hillier, every building or built environment shares a set of spatial properties independent on their function. These properties define the particular paths taken through the combinatorial field that make certain patterns of occupation, movement, integration and intelligibility possible. The theory would act as a filter that selects possible and usable architectural arrangements provided by the cloud of combinations available. In this paper we are interested in how Hillier's notion of uncertainty relates to the geometrical and the experiential version of the concept. We will begin with analysis that allows us to define the configurational aspect of uncertainty to later explore the connections of this to the other two notions.

3. Comparative study. Visibility versus permeability

Drawing on Hillier's concept of generic function, this section compares permeability and visibility values obtained in each of the buildings analysed. Figures 2 and 3 illustrate the results of the comparative syntactic analyses.

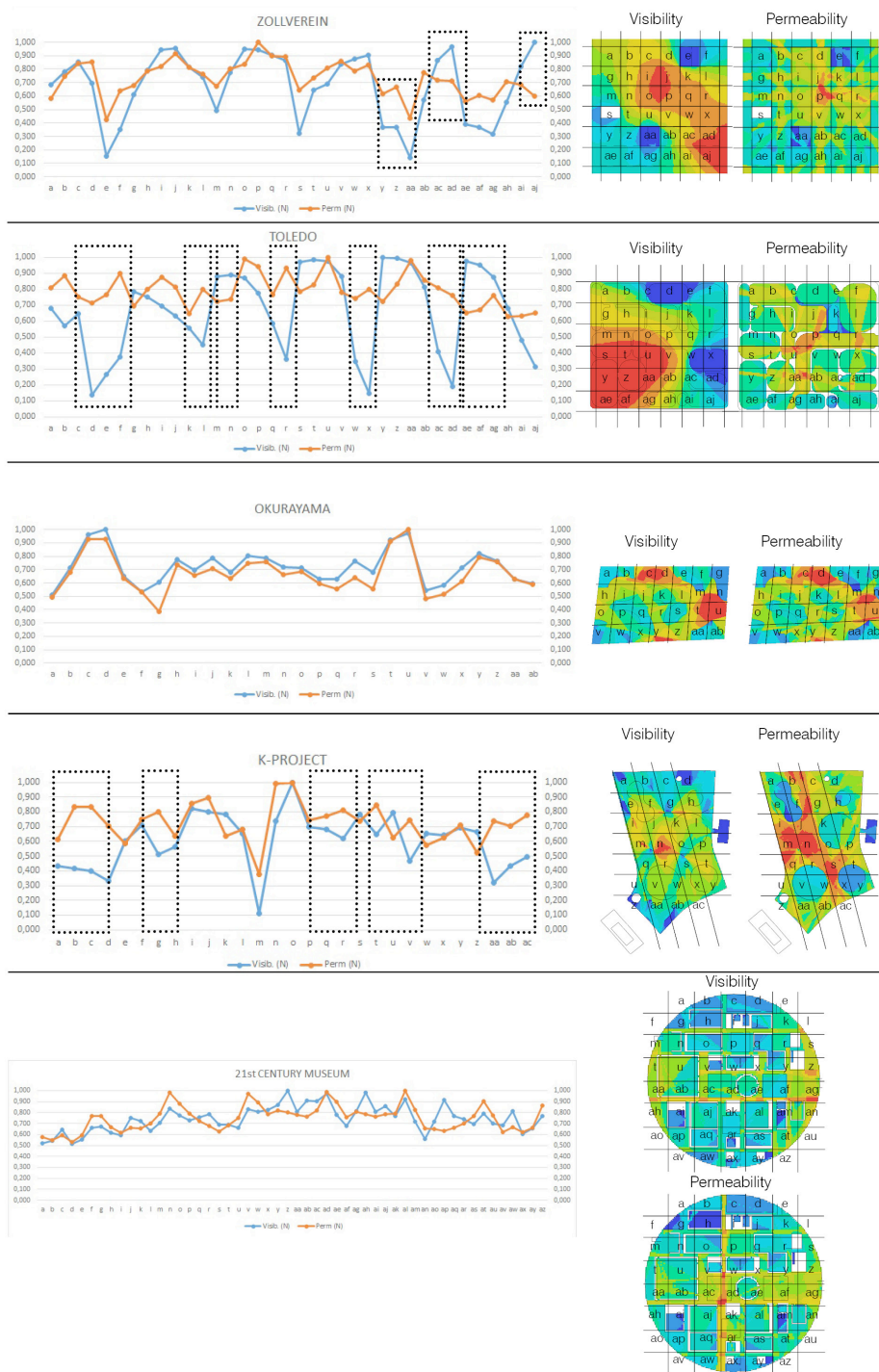


Figure 1: VGA analysis. Comparison between values of visibility and permeability.

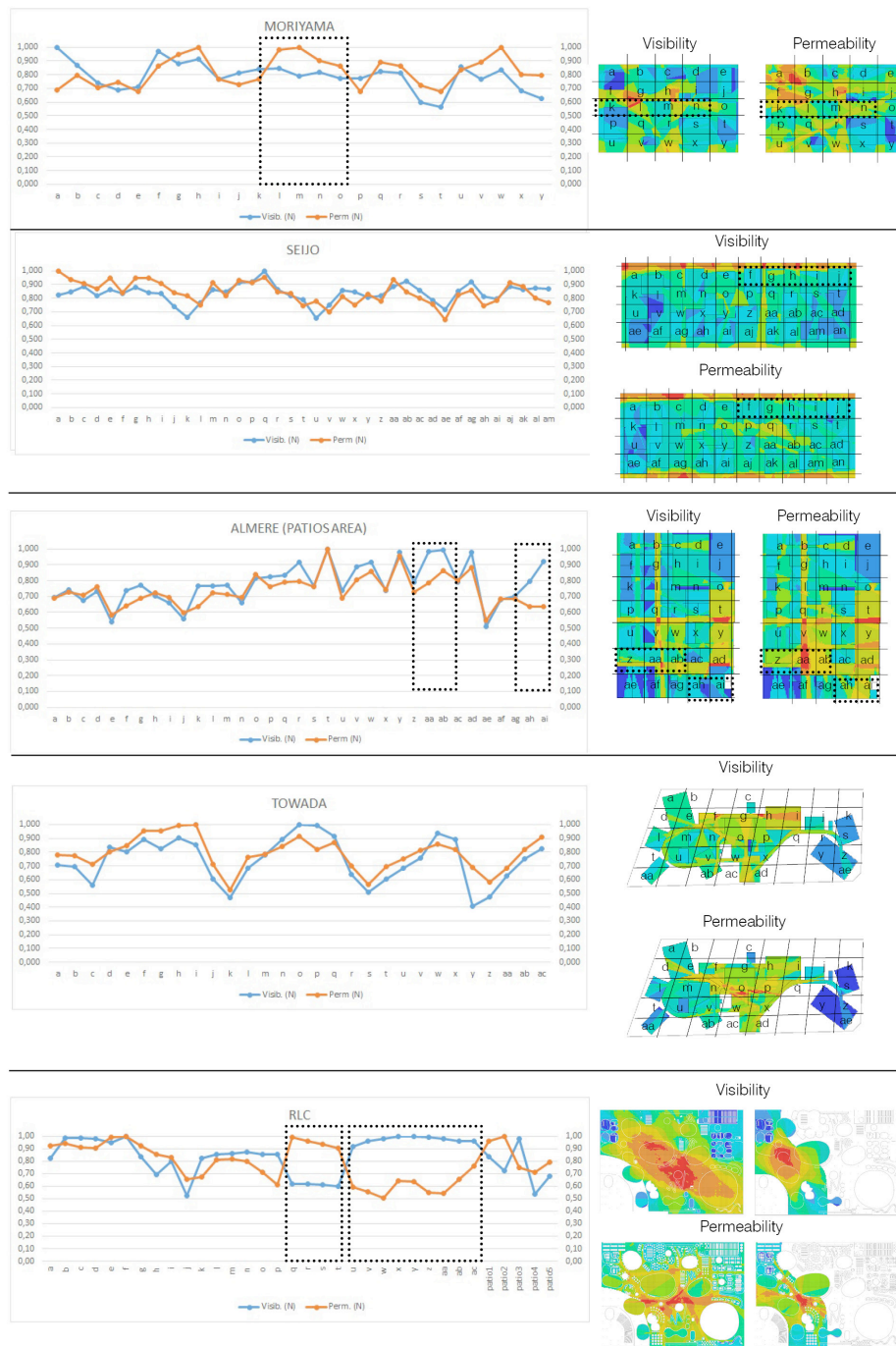


Figure 2: VGA analysis. Comparison between values of visibility and permeability.

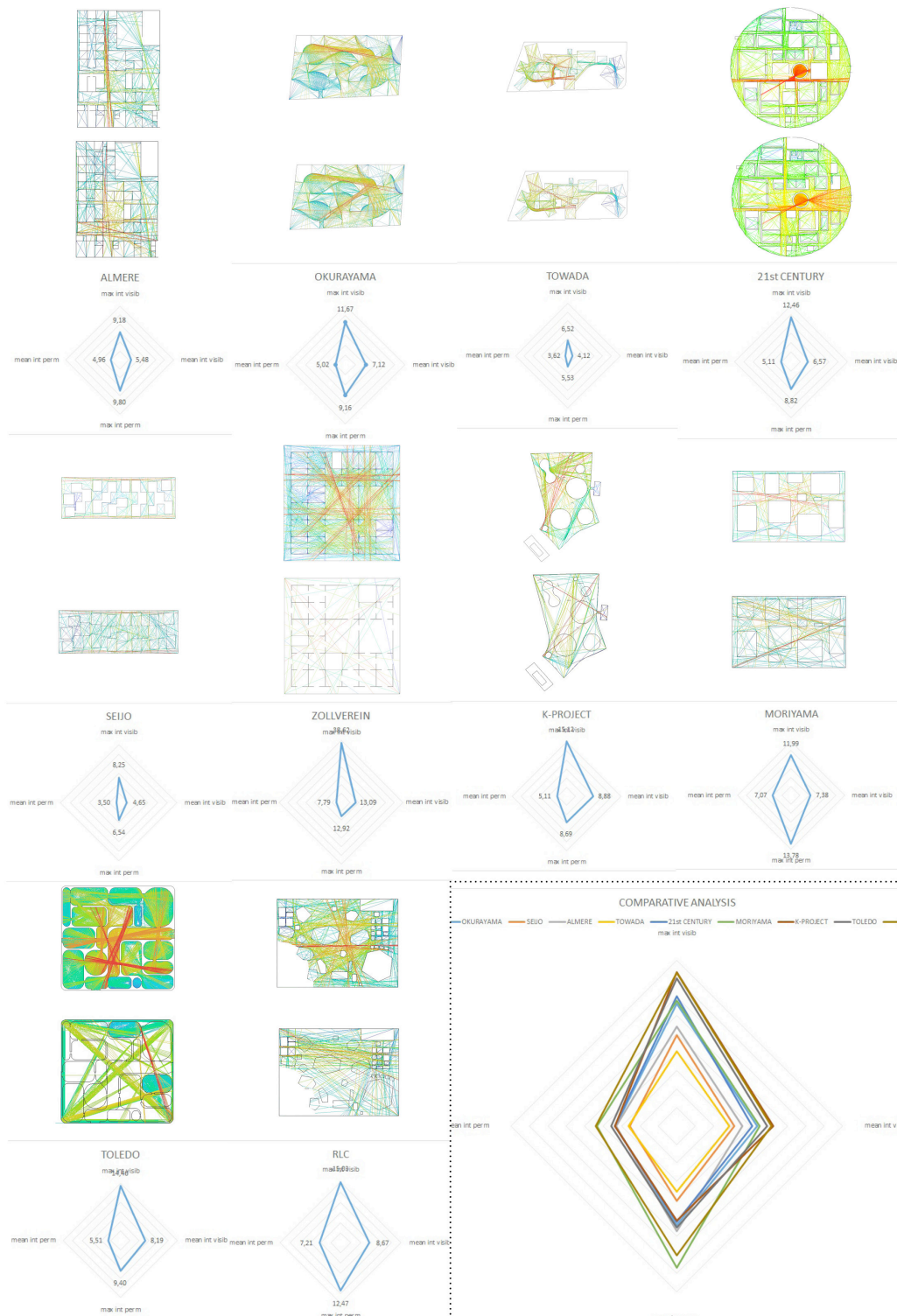


Figure 3: Axial Analysis. Comparison between mean and maximum values for visibility and permeability.

Regarding VGA Analyses, the graphs reveal certain topological rules from which three configurational categories can be outlined and are marked in Figure 2:

- i. In some cases, the values corresponding to permeability and visibility are very similar in all sectors of the buildings, like in Seijo and Okurayama. Both are housing projects, mainly constituted by opaque elements where the linear graphs of distribution of visibility and permeability values almost coincide. Can the weighted methodologies be used to add the impact of an entire city outside a region without being modelled spatially?
- ii. In other cases, like in Toledo and K-Project, 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 correspond to the network of permeable spaces.
- iii. There is a third pattern shown in projects like Almere and, most clearly, in the Rolex Learning Centre, where the disjunction between values of visibility and permeability can only be found in few areas, which moreover correspond to places located near to the outer boundaries. This last case will be explored in the second section of the study to identify whether this disjunction might coincide with particular social practices in the buildings.

As for axial analyses, certain similarities arise among the projects analysed. The four pointed stars have a slender form 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 organization, the layouts have a leading structure that steps out as a foreground network⁵. The similarity in the shapes of the pointed-stars indicate 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. Moreover, the geometrical organisation of the buildings suggests strategies of aggregation resembling in some cases urban systems. The analysis of the axial networks created by these strategies shows that, like certain urban systems (Hillier, 2012), there is a prioritisation of some linear elements over others, showing a conscious employment of geometrical and topological rules in the generative process. These observations will be discussed in detail in the analysis of the RLC. Therefore, one might say that although each layout is different and open to experimentation in terms of sectorial visibility and permeability relationships for each typology, an underlying generic structure exists with regards to the relationship between these two networks for the buildings as wholes. However, in terms of function, when looking at the values obtained for maximum and minimum integration and standard deviation 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.

PROJECT	FUNCTION	FORM	AUTHOR	ST DEV	max int visib	mean int visib	max int perm	mean int perm
OKURAYAMA	housing	organic	S	0,049	11,67	7,12	9,16	5,02
SEIJO	housing	orthogonal	S	0,07	8,25	4,65	6,54	3,50
ALMERE	research	orthogonal	S + N	0,076	9,18	5,48	9,80	4,96
TOWADA	museum	organic	N	0,087	6,52	4,12	5,53	3,62
21st CENTURY	museum	orthogonal	S + N	0,096	12,46	6,57	8,82	5,11
MORIYAMA	housing	orthogonal	N	0,116	11,99	7,38	13,78	7,07
ZOLLVEREIN	education	orthogonal	S + N	0,17	38,62	13,09	12,92	7,79
K-PROJECT	museum	organic	N	0,178	15,12	8,88	8,69	5,11
TOLEDO	museum	orthogonal	S + N	0,275	14,46	8,19	9,40	5,51
RLC	education	organic	S + N	0,245	15,03	8,67	12,47	7,21

Table 1: Relation of buildings analysed. Function, form, author, standard deviation and maximum and mean values for permeability and visibility.

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 transparent materials in museums and educational buildings, and the absence of such disjunction in housing projects, the

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.

analyses do not bring clear results that indicate shared rules of generic function for different building types. This non-correspondence between configuration and function talks about a design method which is not attached to a cause-effect way of solving an architectural programme, but it has more to do with a creative, almost 'artisanal' process in which the spatial arrangement seems to be the result of an experimental approach to design. It is the identification of a leading, urban-like structure of few and long integrated lines and a large number of shorter lines in the spatial system what seems to be shared among most buildings. In this sense, the pointed stars are generally slender, which represent the importance of the maximum values – and therefore the existence of a main foreground structure – in the spatial configuration (See comparative diagram in Figure 3).

The next section is devoted to the analysis of the RLC addressing syntactic analysis, and the study of social practices in the building⁶. Moreover, the urban-like character of SANAA's architecture will be explored in-depth by looking at the spatial properties of the RLC in relation with the social practices observed and the urban rules set by Hillier as commonly found in organic cities (Hillier, 1996).

4. The Rolex Learning Centre

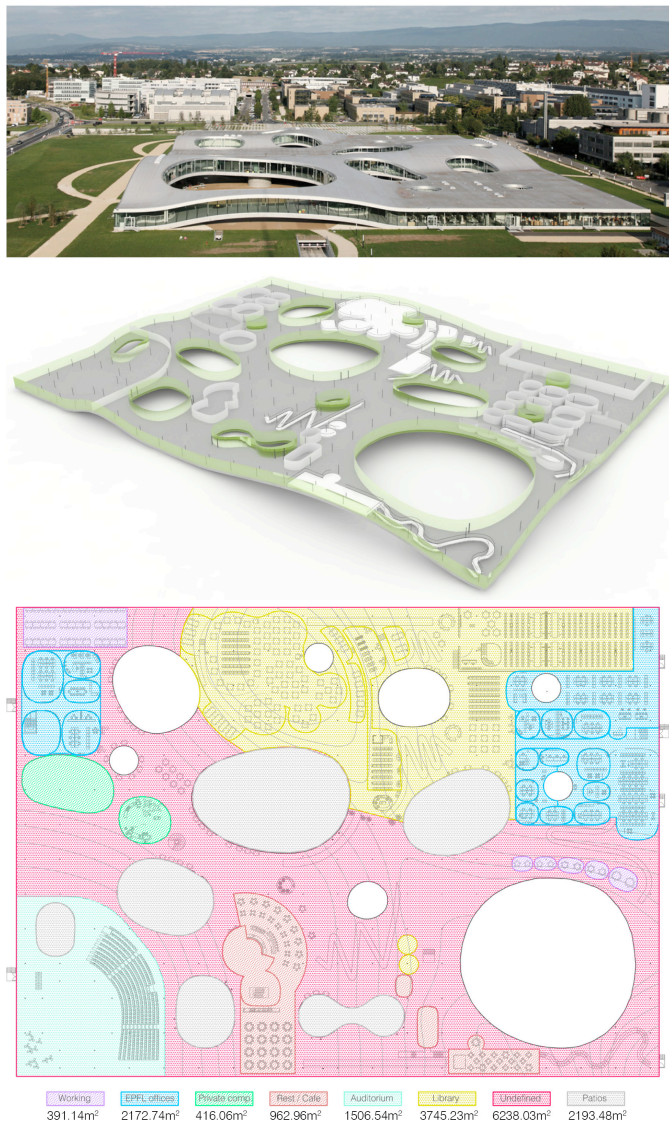


Figure 4: Relation of buildings analysed. Function, form, author, standard deviation and maximum and mean values for permeability and visibility.

⁶ Such practices were studied by observation techniques during field work between the 21st and the 25th of June, 2014

Finished in 2010, The RLC is a building consisting on two undulating slabs that are perforated by round atria and courts that construct multiple points of entry (Figure 4a). The building is today the main multi-purpose facility of the École Polytechnic Fédérale de Laussane (EPFL) in Switzerland. A building that consists of different heights but does not define separate floors or rooms in the interior raises two significant questions: first, the role of the third dimension in its configuration; second, the use of boundaries to demarcate spaces, distribute the programme and articulate socio-spatial relationships. At the same time, the relationship between internal and external spaces and the uninterrupted visibility through its courtyards seem to contribute to a potential for the generation of interactions and social encounters. Finally, its fluid interior space and the smooth waving form of its floor and ceiling suggest that it is a functionally flexible system likely to be used in many different ways. It was the intention of both the architects and the institution to construct a building that not only mediates the relationship between the various disciplines in the EPFL campus, but also generates unforeseen connections among students from different departments. The RLC is described by the architects as based on the 'intent to create a place where activities are gently separated but at the same time naturally blending into one another to create a unified space' (SANAA, 2008).

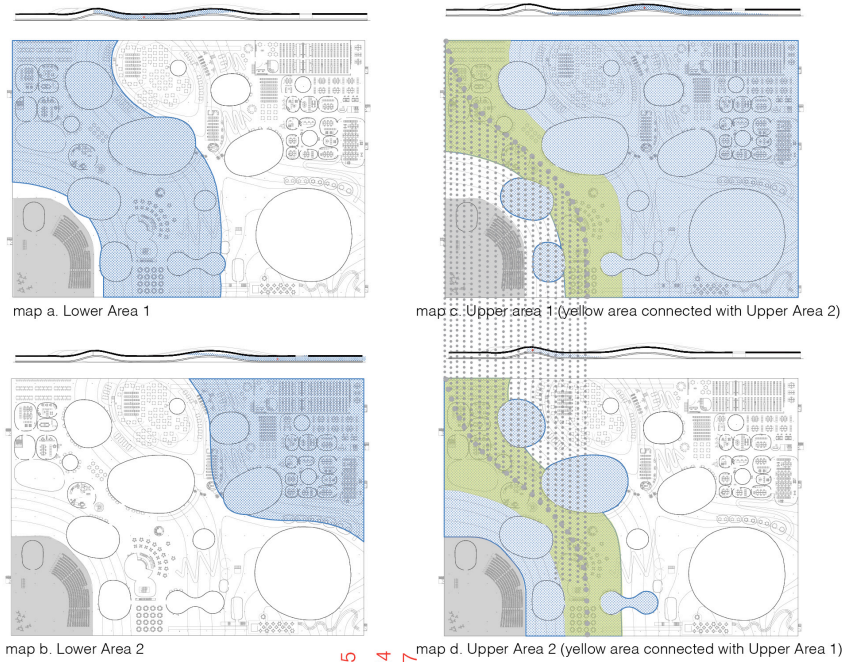
Spatial Analysis

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 two 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 program, 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 sense of non-programmatic definition in the entire layout. From a total interior surface of 17620 m², over 6200 m² has no defined program, which represents more than 35% of the building surface (Figure 3c). In order to include the three-dimensional variable in the analysis, two different sectorizations have been made inside the building:

- i. 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.
- ii. 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)

With these two divisions, the impact of the third dimension is included as a parameter to be considered in the analysis and so 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.

VISUAL SECTORS



HEIGHT SECTORS

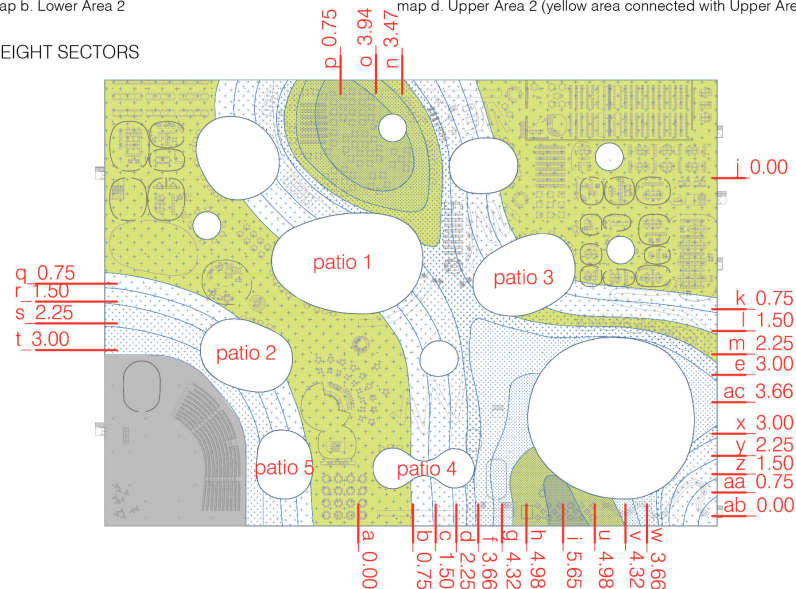


Figure 5: Distribution of Visual Sectors (above). Distribution of height sectors and areas in m² (below). Flat sectors are hatched in yellow.

Additionally, in order to understand the role of three-dimensionality in the characterization 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'). Convex analysis, axial analysis and Visibility Graph Analysis (VGA) are undertaken. Thus, the following maps are represented in Figure 5:

- i. 'Real RLC'
 - Lower area 1 + Lower area 2
 - Upper area 1. Connected with
 - Upper area 2
- ii. 'Flat RLC'



Figure 6: Distribution of visual sectors / Convex analysis / Axial Analysis / Permeability Analysis / Visibility Analysis.

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 around the patios (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 graphs. However, the convex analysis of the Upper Area 1 in the 'Real RLC' picks the south-east corner as an additional area scoring as the most segregated places in the building. The relevance of this result will be highlighted in the study of spatial practices in the building, where precisely this area is spotted as being one of the quietest places chosen by students to relax. Thus, although both analyses have some similarities, it seems that the analysis performed in the 'Real RLC' obtains more detailed and defined results in the distribution of integration values. This means that the third dimensional articulation of the building has an effect on spatial configuration.

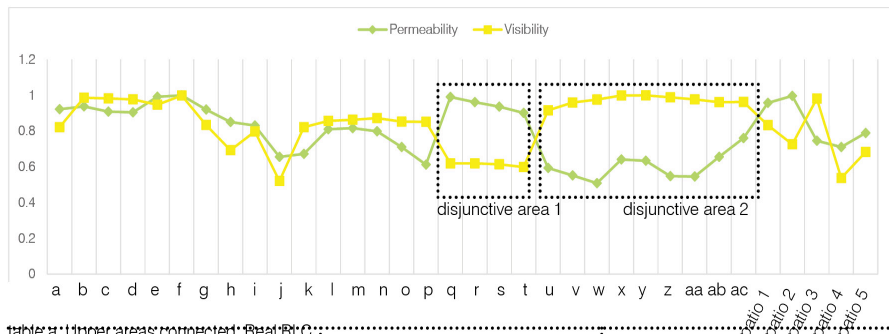


table a. Upper areas connected: Rear RLC.

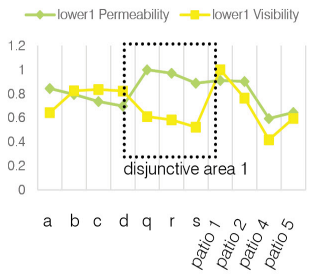


table b. Lower 1.

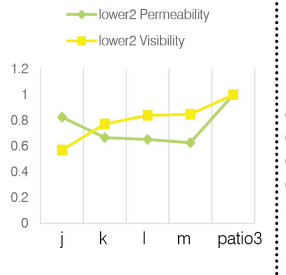


table c. Lower 2

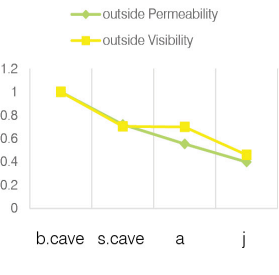


table d. Exterior Space.



table e. Flat RLC.

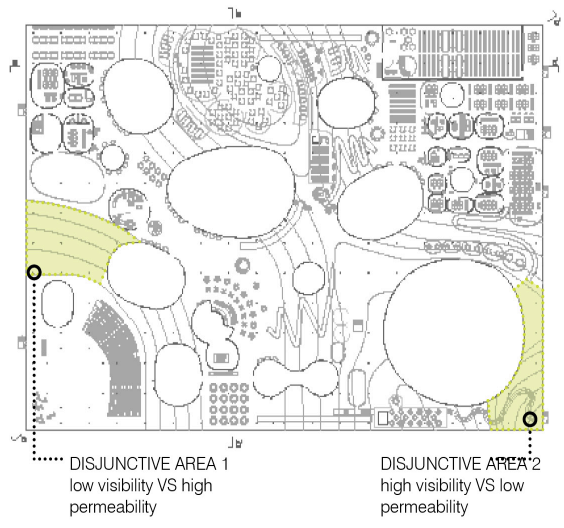


Figure 7: Comparison of integration values between permeability and visibility analysis. Normalized values.

Comparing the axial analysis for the 'Upper Areas connected' 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 points of accessing 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 normalized 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). In the description of spatial practices observed in the building it will be highlighted that it is precisely in these sectors where the majority of informal uses and transgression of programmes take place. 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 for these areas to be used in a more generative or uncertain way. Thus, it seems that spaces which are visibly reachable but hardly accessible and areas with easy access but high values of visual privacy are likely to hold leisure practices, acting as a sort of 'place to escape' from the rest of uses in the building.

Spatial practice

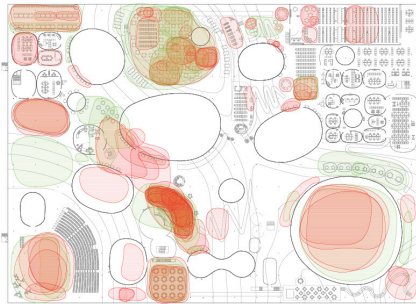
The observation of spatial practices focuses on the central area of the building, where the library entrance, the café and, most importantly, a great amount of undefined space are located. The rest of the areas such as library and offices were excluded from this study as they mostly have demarcated boundaries and fixed programmes. The study of gates, snapshots, traces and the conduction of questionnaires will show how the undefined area is used by students and how these practices relate to configurational properties of the building (Figure 8).

The study of movement flows reveals that in areas with similar levels of integration, a higher influx of people is perceived in those areas which hosts defined programs, like the library entrance. This result is also observed in the study of traces. If we classify the number of traces per height sector as shown in Figure 8, we see that traces 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 in two areas with similar levels of integration – the main entrance and the library entrance – a higher influx of people is perceived in the library, where people go with a specific purpose. One could argue that the specification of program is related in this case with the purpose of people who visit the building – according to the results, the majority of people visit the RLC to use the library.

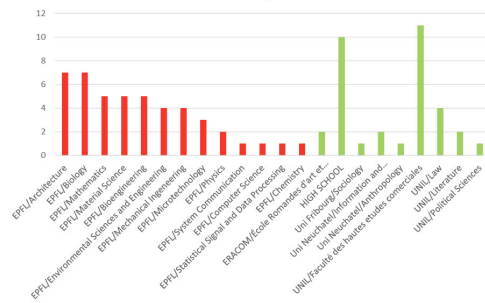
The snapshots observation shows that students tend to use the undefined area to study. In fact, this area is seen as a working environment without restrictions, that is, a place where people can work, but also talk and eat without being reprimanded, as it would happen inside the library. Areas with lower levels of movement coincide with those that have disjointed levels of visibility and permeability. 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 no longer belongs exclusively 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%). As observed, there is a mix of students from different academic origins all over the building. However, as the library is the place that has the highest amount of use, where there are specific restrictions to talk, this fact does not guarantee real interaction between students.

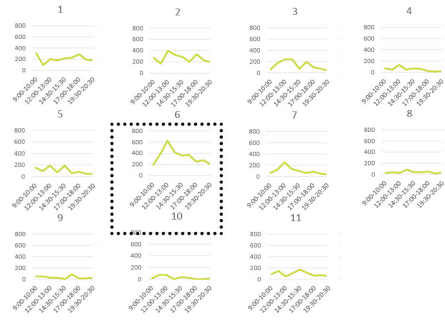
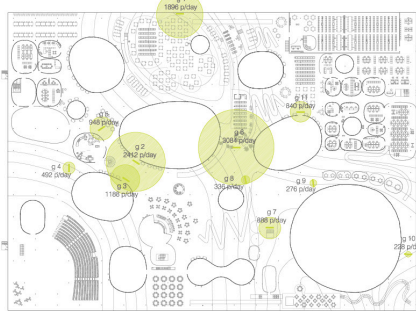
QUESTIONNAIRES



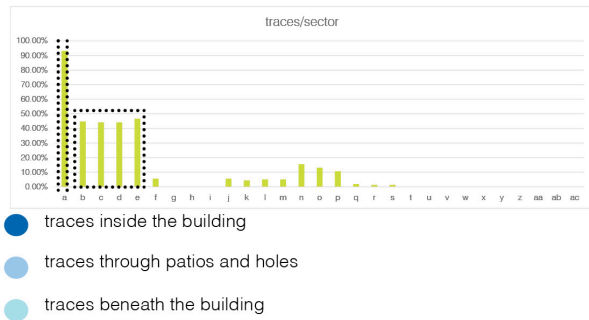
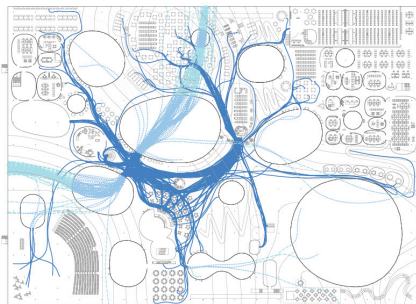
Students / Department



GATE COUNTS



TRACES



- traces inside the building
- traces through patios and holes
- traces beneath the building

SNAPSHOTS

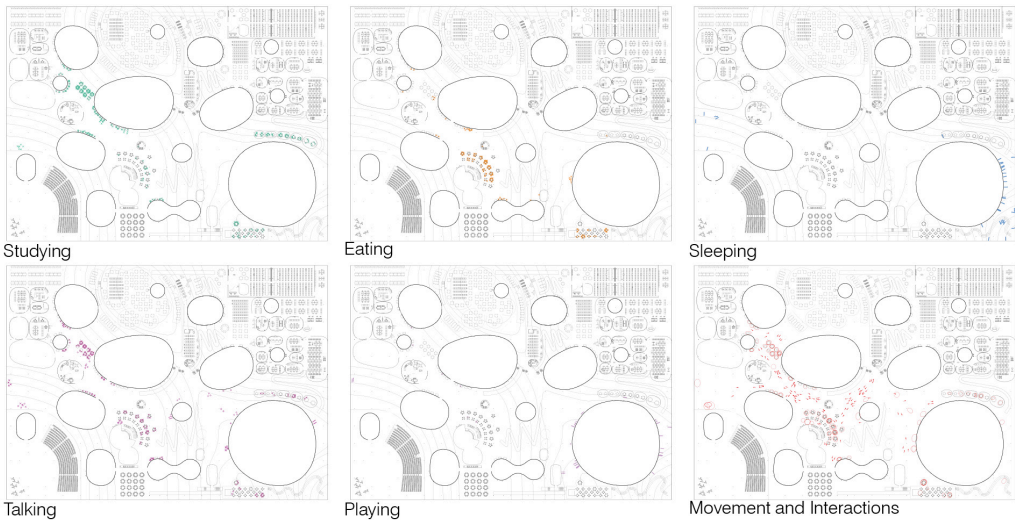


Figure 8: Observation analysis.

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 seems 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. This means that the cognitive organisation of the building varies depending on which height one is situated. However, what seems to be a more determinant factor in the characterization 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, where the majority of informal uses are produced. In this case, the disjunction between permeability and visibility values seems to create a sense of freedom, spontaneity and informality in the use of space. A continuously open interior might be programmatically subject to flexible use but in 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 free space inside the building is essential for the defined programs to function. The non-defined space acts as a kind of substitute to walls, which in normal buildings separate spaces from one another. However, we have seen that the RLC also has areas with specific programs and places that, although undefined, are mostly used for activities such as working and eating. Therefore one could say that the RLC hosts different ‘spatial areas’ in its configuration, places characterized 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).




GEOMETRY	VISIBILITY	PERMEABILITY	PROGRAM	ACTIVITY FOUND	DESCRIPTION	LOCATION
Flat	High	High	Defined	Bank Stationery Café Library / working areas	Assigned program areas 'BUILDINGS' 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 uses.	
Flat	High	Low	Defined	NOT FOUND		
Flat	Low	High	Defined	NOT FOUND		
Flat	Low	Low	Defined	Offices Restaurant	Emergent program areas 'PUBLIC SPACE' 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.	
Flat	High	High	Undefined	Main entrance area Patios		
Flat	High	Low	Undefined	NOT FOUND		
Flat	Low	High	Undefined	NOT FOUND		
Flat	Low	Low	Undefined	NOT FOUND		
Slope	High	High	Defined	NOT FOUND		
Slope	High	Low	Defined	NOT FOUND		
Slope	Low	High	Defined	NOT FOUND		
Slope	Low	Low	Defined	NOT FOUND		
Slope	High	High	Undefined	Circulations in library Area around café and library entrance	'Private-in-public' program areas 'PERSONAL SPACE' Transgression of uses is found in these areas. Commonly used for activities not related with learning and studying. Private practices in public	
Slope	High	Low	Undefined	Disjunctive Area Not easily accessible areas with visual control		
Slope	Low	High	Undefined	Disjunctive Area Easily accessible and visually protected		
Slope	Low	Low	Undefined	NOT FOUND		

Figure 9: Spatial Typologies contained in the RLC.

5. SANAA's architecture as an urban system

Taking account of the variety of spatial situations and uses observed, the morphology of the undefined areas and the social vibrancy, it could be said that the RLC is closer to behave as an organic urban system. This would support the hypothesis drawn on the first section of the study where a sort of 'urban structure' was identified among the analysed buildings. In this sense, it seems that the spatial configuration in SANAA's buildings could be considered similar to what is defined by Hillier as *city of production*⁷. Contrary to the *city of reproduction*, where space is organized by top-down regulations and patterns of behaviour, the city of production neither respond to hierarchical nor to geometrical rules, and so it is created to generate exchange and social interaction (Hillier, 2014).

According to Hillier, cities organize 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, 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' properties⁸. The question now would be whether any of these 'nearly invariant' properties are to be found in the architecture of SANAA. Taking the RLC as example, 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, 167).

In order to check if any of the nearly invariant properties are present in the RLC configuration, and analogous as to what Hillier does to explain them (Hillier, 1996, 167), an all-line map analysis⁹ 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, 281). Moreover, it seems that the 'nearly invariant' properties apply in its configuration when observing Figure 10a, in which we can see: a leading foreground structure of long integrated lines; a configuration based on objects placed next to and opposite each other; a set of interconnected lines of sights and an independence of the outer boundary with regard to the interior spatial rules. Moreover, when performing the same experiment in the rest of buildings as shown in Figure 10b¹⁰ we realize how, in general terms, they tend to follow the nearly invariant properties as well, although in some examples like Zollverein, Seijo and Toledo, not all properties can be identified. A further possible step of the present research would be that of translating Hillier's nearly invariant properties in quantitative values, so that they can be more accurately associated to a particular spatial organisation.

⁷ In the case of housing buildings, the urban spatial arrangement according to laws of cities of production is applicable to the placing of housing units in the general layout. However, since housing programmes are places of cultures mainly conditioned by patterns of control and privacy, the extent to which the laws of production also affects interior arrangements would need further analysis beyond the scope of the present research.

⁸ According to Hillier, the following 'nearly invariant' properties are commonly found in organic cities: 1) Buildings are placed next to and opposite each other to form spaces which stress linearity rather than, for example, enclosure. 2) Lines of sight and access through the spaces formed by buildings tend to become extended into other spaces. 3) Some of the linear spaces are prioritized to form larger scale linear continuities in the urban grids. 4) There is a well formed local area structure of some kind coexisting with a strong global structure. 5) Cities, as they grow, tend to fill out in all directions to form more or less compact shapes. (Hillier, 1996, 263).

⁹ Integration analysis to the set of lines made up of all lines drawn tangent to the objects conforming the layout (Hillier, 1996, 271).

¹⁰ Invariant 5 has not been performed for the rest of buildings to focus on the interior spatial properties and simplify the diagrams.

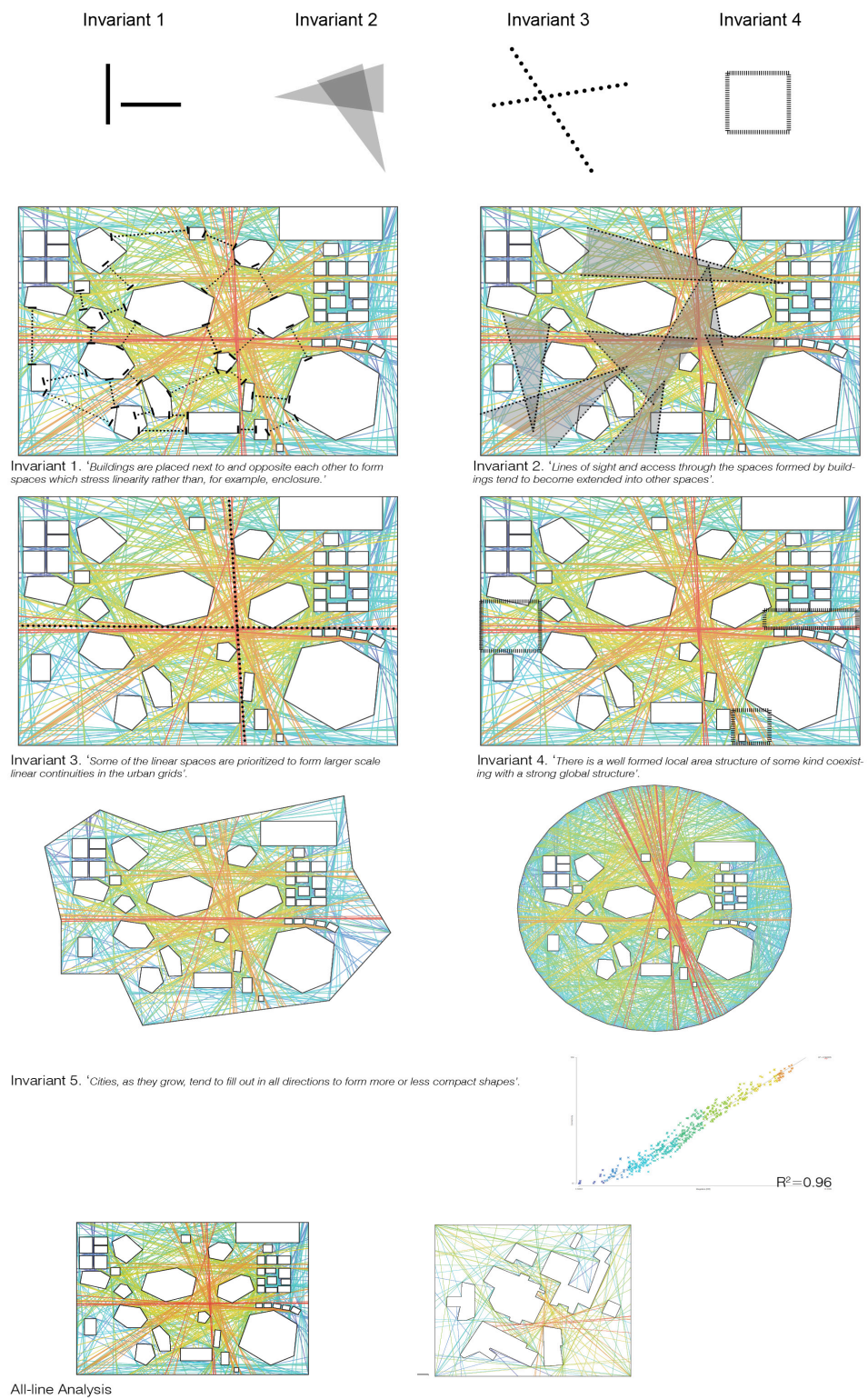


Figure 10a: Nearly Invariant Properties in the RLC / All-line analysis comparison with a French hamlet.

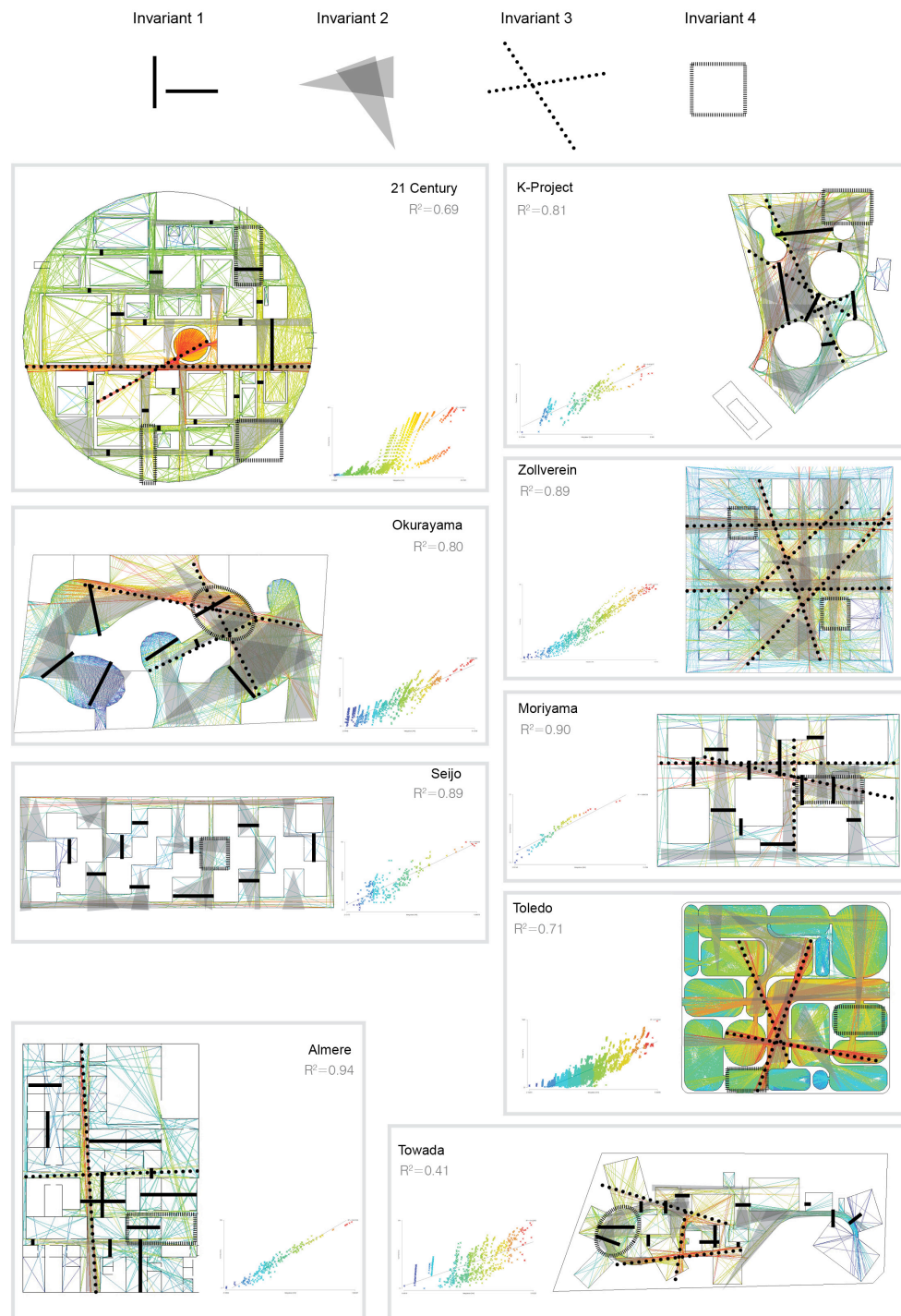


Figure 10b: Nearly Invariant Properties in the rest of buildings analysed.

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 organizations 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, 222, 281). 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, 269).

6. Conclusion

According to the results of the first section of the study, where a leading foreground structure has been identified among the buildings analysed, and after observing how the nearly invariant properties defined by Hillier for organic cities could be associated to them, one could say that the architecture of SANAA resembles urban systems in its topology and in certain cases in its geometry. However, while urban topology develops through the human mind's intuitive laws of space shaped by bottom-up evolution (Hillier 2014) and top-down functioning by the way in which space is read by people so as to facilitate large-scale movement, SANAA's buildings are shaped by top-down spatial configurations - since it is the human mind that shapes space at once – but in a way which resembles the topology of an evolutionary urban system. The particular spatial arrangement of each building is further modulated by transparent and opaque materials, which originates a set of areas in the layout characterized by different levels of privacy. Thus, public areas provide multiple possibilities for visual interaction through their layers of transparency, whereas more private spaces, although being also organized from the conception of a continuous space which contains objects inside, restrict and control the visual network and the capacity of surveillance. Finally, what seems to be also important to understand is that the disjunctive relation discovered between permeable and visible patterns acts as generator of personal and improvised practices in space. This point should be considered an incisive finding that, added to past research, provides a new layer of complexity in the study of the built environment.

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