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Preface by Chief Editor

Kimmo Lapintie
Aalto University School of Arts, Design and Architecture
Kimmo.lapintie@aalto.fi

This is the first issue of the journal of Architectural Research in Finland. It grew out of the annual symposia organized by the three schools of architecture in Finland, The Department of Architecture in Aalto University, Tampere University of Technology School of Architecture and Oulu School of Architecture. These symposia have turned out to be very important for scholars in architectural research in Finland, as an overview of the work that is done in the three universities, but also as a forum for publishing the results of ongoing projects and doctoral dissertations. A selection of the papers presented at the symposia have been published in proceedings after each event, many of them after a double-blind peer review.

After the 7th symposium, the organizing universities decided to establish a new journal of Architectural Research in Finland (ARF) that will publish research of high quality with systematic editing and peer review. Most of the articles will still come out of the annual symposium, but the journal is also open to other contributions and thematic issues. The articles are mainly published in English, but national languages are also an option.

There are several reasons for this change. It is important to make sure that the papers published as articles in the journal are treated fairly and equally and with academic rigour, in order to provide a respectable forum for publishing new results of architectural research in Finland, as well as critical debate on the contemporary issues relevant to architecture. On the other hand, architectural research is becoming more and more international also in the national context. Very few of the issues discussed in architectural research have a national character, although it makes sense to address the role of local and national variations in architecture. We have invited international scholars as keynote lecturers in the symposia with contribution to the journal, but there are also many scholars working in the Finnish universities from various national backgrounds.

Architectural research as an academic discipline presents specific challenges to common symposia as well as publications. The field covers a variety of scales from technical details to global issues of urban and regional development. It is interdisciplinary by nature, covering technical sciences on construction and digital tools, social sciences on urbanism, environmental sciences on the impacts of

urbanization and on landscape, and humanities on the history and theory of architecture. In addition to this, architecture as an art and design practice is more and more used as a research method on its own, as arts-based research or research by design.

Thus, there is the danger of architectural research becoming a fragmented collection of small research groups with very little communication between them. In a way, this is natural, since different subjects in architectural research need to cooperate with neighbouring disciplines: history of architecture with history of art and archaeology, urban planning with urban studies, building design with art and technical sciences, etc. Architectural research is like an open hand, where the 'palm' as the core of the design and planning of the built environment easily leads to 'fingers', discourses that are farther from the profession of architecture. It is not easy to jump from one fingertip to another, even though they are all connected through the palm. This is why common fora are of such importance, not for integration but recreating connections.

Editorial Introduction

Helena Teräväinen
Aalto University School of Arts, Design and Architecture
helena.teravainen@aalto.fi

The 7th symposium called “ARCHI+TECTONICS Architecture, Communities and Cities under Change” was organized by the Department of Architecture of Aalto University School of Arts, Design and Architecture in Otaniemi, October 22-24 of 2015. The theme’s (ARCHI+TECTONICS) aim was to cover a variety of contemporary discussions in architectural research, from architectural design at different scales, to the context of urban planning and development, among other themes that were discussed in the sessions during the conference.

The symposium offered interesting Keynote lectures, which three of them are published here as (non-reviewed) articles, and marked as “Keynote speeches”.

Ombretta Romice, Senior Lecturer from Urban Design Studies Unit (UDSU) Department of Architecture, Unit University of Strathclyde, Glasgow, presented her research in different areas of urbanism; she explained how they have used this approach in evidence-based masterplanning. The paper “The Road to Masterplanning for Change and the Design of Resilient Places” is touching upon certain milestones, such as: 1) the form of cities, studied across space and time, as complex systems, 2) the impact that cities have on their inhabitants and, 3) the form and design of sustainable and resilient cities. The paper explains which questions have led them to name *‘Masterplanning for Change’*, the normative approach to city design.

Juanjo Galan, Professor in Landscape Architecture at Aalto University School of Arts, Design and Architecture, presented “Landscape planning: from theory to teaching”, starting with definitions of ecosystem services and urban metabolism. In his article he points out positive academic experiences in landscape architecture which are rising from courses working multidisciplinary hand in hand with the new planning context. He is enhancing a holistic perception of the territory, promoting a global understanding of urban, agricultural and natural areas. Specially, he emphasizes the proactive character of the landscape planning tools which can overtake formal description and produce new models and clear spatial or normative determinations which conveniently can be introduced in the planning context.

You are now reading first number of the journal "*Architectural Research in Finland"* (Vol 1, 2017).
This is a new peer-reviewed scientific journal founded by the three Finnish universities offering architectural education in Finland:
Aalto University, Tampere University of Technology and Oulu University.

Toni Kotnik, Professor in Design of Structures at Aalto University School of Arts, Design and Architecture, involved in his Keynote lecture mathematics and formal design. He also covers new, emerging methodologies in architectural design that extensively use the computer as a design tool; this has generated a varied set of digital skills and a new type of architectural knowledge. An example of reshaping of discipline-immanent thinking by means of computation, is the paradigmatic shift in sciences like physics or biology caused by the introduction of the computer as the primary tool for simulating and modelling natural processes; this has resulted in a successive modification or even replacement of reductionism as the predominant paradigm of research by a systemic, bottom-up understanding. As a consequence, architects have become interested in these systemic models of nature. Moreover, during the past decade, systemic notions and concepts from science have diffused into architectural discourse and are currently being explored for design purposes. Hereby is published his article "On the Role of Geometry in Formal Design".

Petter Næss, Professor in Planning in Urban Regions at the Norwegian University of Life Sciences, addressed during his lecture some characteristics of critical realism, interdisciplinarity, the causal status of the built environment, impact assessment and prediction. He argues that "critical realism" is "a viable path between the trenches of the science war", instead of positivism, empiricism, or even postmodern relativism. His lecture was based on the newly published article:
Petter Næss (2015): Critical Realism, Urban Planning and Urban Research, European Planning Studies, DOI: 10.1080/09654313.2014.994091

This first issue of Architectural Research in Finland (2017 Vol.1,no.1) will also publish eight selected papers from the 7th symposium which have gone through the double blind peer-review process. The themes vary widely, from philosophical applications and cultural heritage issues to new design methods and technical solutions.

In their article *"Architecture in Suspension, Disruptive practices within the state of exception"*, Francisco García and Fernando Nieto are transferring into architecture philosopher Giorgio Agamben's concept called "spaces in suspension", where the rule is the exception in the form of the suspension of the legal order, the anomie. This approach is based on the analysis of some case studies, which are considered as disruptive practices since they are proposing new ways of practising architecture.

In her article "*Paimio Sanatorium: interrelationships within a technological system",* M. Heikinheimo uses the actor-network theory of Bruno Latour, and argues that the examination of the relationship between architecture and technology revealed the critical issues for the architect and for the other actants. This explains how a certain system was developed further than another, and also how modernism came to be expressed in Paimio Sanatorium.

B. Grahn Danielson, M. Rönn and S. Swedberg argue that several instruments, for compensation measures in planning processes, can be found in the law and land use of the Swedish planning system; however, these are not being used properly, which results in a negative impact on the cultural heritage. After two years of analysing and discussions in workshops and conferences, they are writing a conclusion in the *article "Cultural Heritage: Changing Ideas on Compensation in Planning",* and claim a strong need for clarifying planning instruments and professional practices dealing with compensation measures. However, it is one matter to rebuild a swamp, marshland or habitats, which is not too difficult to conceptualise, but how to compensate the impact upon an old building, archaeological site or cultural heritage values in the landscape?

Two articles are discussing about learning in architecture: 1) E. Becker in *"Design Cognition: Optimizing knowledge transfer in digital design pedagogy"* explores how knowledge transfer may be impacted by digital design as an architectural

medium. He uses a research conducted by Ausubel, R. Oxman, Schön, Sweller, and others, to expose the cognitive logics associated with introductory digital design and digital skill thinking. 2) *"Spatial solutions supporting information exchange and knowledge creation*" by S. Peltoniemi together with J. Poutanen, A. Ahtinen and H.Salonius, presents information exchange and knowledge creation as essential components of architects' profession. The objective of the study is to analyse how the mobility of the different types of workers effects on the information exchange and knowledge creation, in a team-based office layout.

Two articles present housing research: 1) E. Hasu and A. Tervo write about *"Playing with Townhouses – a Design-Based Research Method for Housing Studies"*. The paper focuses on a design game, which provides tools to examine, reinvent, and verbalize the residents' innermost housing preferences. The game allows themes such as spatial flexibility and adaptability, to be studied, which in other situations might be difficult to study. 2) In the paper "*A Townhouse for Life"* I. Verma and E. Hasu study townhouses as a potential solution for lifetime housing. The study focuses on people over 55 years old, as they represent an age group relatively free from many aspects limiting housing decisions. In Helsinki, Finland, the townhouse is seen as a sustainable urban version of single-family house that can reduce urban sprawl.

Y. Cronhjort argues, in her article *"Standard Timber Structures for Lean Architectural Design"*, that building production development is required for timber-building to compete in the world market. She explains, how lean construction research has defined lean and industrialized processes, identified the differences between mass-customization and mass-production, and finally she emphasizes the importance of standardization. This study explores pre-designed details as a means to reduce work in building design.

The Road to Masterplanning for Change and the Design of Resilient Places

Ombretta Romice
Urban Design Studies Unit (UDSU) Department of Architecture Unit University of Strathclyde Glasgow UK
ombretta.r.romice@strath.ac.uk

Alessandra Feliciotti
Urban Design Studies Unit (UDSU) Department of Architecture Unit University of Strathclyde Glasgow UK
a.feliciotti@strath.ac.uk

Sergio Porta
Urban Design Studies Unit (UDSU) Department of Architecture Unit University of Strathclyde Glasgow UK
sergio.porta@strath.ac.uk

1. Introduction

Knowing what to design is the foresight that tomorrow's cities need more than anything. This paper presents the Urban Design Studies Unit of the University of Strathclyde in Glasgow's coordinated approach to research in different areas of urbanism, and how we used such approach in evidence-based masterplanning. To explain what is unarguably a complex approach to the design of the city, this paper will start with an overview into our group's point of view on cities, and continue with a short summary of our journey to learn some aspects of how cities are. We will touch upon a few milestones only, but hopefully enough to explain the questions that have led us to what we call 'Masterplanning for Change', our normative approach to city design.

To us, cities are the cumulative effort of millions of actions constantly evolving in time, owned by none and belonging to all, affording unique possibilities under certain complex conditions and causing inequality, alienation and disfunctionality under others (Romice et al 2016a). This seems to suggest an inherent contradiction: cities need design, but are at the same time too complex to be designed. Such contradiction, however, is only apparent: if we look at the most successful historical parts of our cities we will find that most of them, though by no means all, had been masterplanned at least to some degree, at some point in time, and yet have evolved constantly and restlessly, adapting to changing conditions and new opportunities along the way. This proves two things: a) cities do not necessarily need design to adapt and thrive; b) if designed at all, which is the rule more than the exception, they can nevertheless adapt and thrive as well, if not better. Differently from other complex systems in nature, society and technology, comprehensive centralized design appears to be much more the pre-condition for self-organization than the alternative to it in most of our successful urban places. On the other hand, we also can easily observe that urban areas masterplanned after WWII have in fact repetitively turned out into rigid containers of separated and over-scaled features, often ending up in failures spanning across too many interconnected aspects of their functioning to be recovered (Romice & Paul, 2015). In short, the issue does not appear to be one of design vs. complexity, but rather one of "blueprint" design vs. design for change. Or, from the point of view of the type of knowledge involved, one of design against the city

(that implies an ideology of what cities ought to be, of which we have plenty) vs. design with the city (that requires a science of what cities are, which we don't have, as yet). Our key interest is therefore the design of adaptable resilient cities, what it implies, how it is done and by whom. We want to understand how to help give character and soul to cities (Jacobs, 1961, Alexander, 1965) so that soul and character can be pursued by their users over time through innumerable uncoordinated actions along a line of informal participation to change.

In urban matters, what we know and can learn about cities is practically infinite, with dramatic recent peaks thanks to new technologies and ways to acquire and map data. When some of the authors started working over 20 years ago we were gathering new information in different areas: urban form, housing and neighbourhoods, sustainable transportation, complex spatial networks, human behavior, decision making, the impact of space on people's images and views on place. We didn't have a coordinated plan; we were not working as a team yet and yet we shared the same passion; some of us had not even entered the field! Getting together in the mid 2005 on a shared book project (Thwaites et al, 2007) was the catalyst to make the point on the state of the art in urbanism and gather diverse interests into complementary strands. The first question that we started asking in this book was if we, as city-makers, are equipped for the challenges that tomorrow's cities are confronting us with. Standing on a few giant's shoulders, we begun to understand places as constantly subject to circumstances of different nature (social, economic, institutional, cultural, environmental) and therefore in a state of continuous change, with many demands upon them. This was a perfect starting point to structure and guide our following years of work.

The step to form the current UDSU team was then both fortuitous and somehow a given: we knew we needed an intellectual home for our then developing perspectives. Once UDSU was re-grouped at Strathclyde after the departure of the founder, Dr Hildebrand Frey, we needed to set rules on what pieces of knowledge we would be seeking and which should become priorities. We had at the time a newly established Masters in Urban Design attracting students from a variety of built environment and other backgrounds, also joined by numerous students in their final year in architecture, and several requests from local authorities to provide concrete ideas for strategic areas in the city, at a time when investment in infrastructure was critical. The research group was small (Porta and Romice, a handful of PhD students and vising researchers), and the potential offered by Masters students was great, hence the decision to tie teaching and research, thus making the learning path of Masters students exciting as they would see their contribution shape new knowledge, and ensuring precious material to base observation and develop ideas on (Romice et al, 2012). Many of such students are those that in time have become key members of our research team.

Furthermore, all keen travellers, we also brought to the table a vast collection of experiences of successful and less so places around the world, places that have evolved consistently with their original design, and are still cared for, with their simple splendor enriched and expanded in time, and others that have been changed beyond recognition, or demolished times and times again, tarred and vandalized. As urban designers, we wanted to know how cities work, the impact they have on quality of life, efficiency and justice, but ultimately we wanted to know how to design them. Our second question was then what determines this different fate? This was a difficult question indeed, which we unpacked into many more – how have different urban forms held up in time? Are there certain forms more likely to succeed in time than others, and if so, what properties make them perform differently when faced by unforeseeable challenges? Are these properties always and only context specific or is there something, at a basic level, "universal", "structural" about them? And if so, what part of this structure is actually spatial in nature, so that we can design it?

The ideas, events, experiences and questions cited above are what has shaped our research efforts into three broad parallel areas, which hold obviously many overlaps.

1 – *the **form** of cities, studied across space and time, as complex systems.* Through this strand of investigation, which is in the field of urban morphology and touches the physics of complex spatial networks and the ecology of space, we wanted to establish if, and at what level, cities of different historic and cultural origin share physical features; if urban elements at various scales link in consistent, predictable patterns of form, and if combinations of physical forms and uses are linked. Furthermore, we wanted to understand if these relationships were the outcome of formal planning or the simple outcome of need, logic and life overall. The study of cities as complex systems focused instead on street networks, their form and behavior in relation to intensity of use.

2 – *the **impac**t of cities on their inhabitants.* Here we wanted to establish how use, perception and behavior are linked to urban form, at large and small scales. To do so, we used lessons learned in morphology and applied to the observation of cities. For example, work on street networks (referred below as street centrality) has helped us understand the relationships between the properties of such networks (of our cities and their parts), and the social potential of space, suggesting that the structure of the network itself can affect the social and economic performance of places. Work on networks and street fronts has allowed us to observe gentrification in relation to the structure of places, and historic comparisons on the changing morphology of urban plots in different areas in Glasgow has allowed us to observe variations in the social and economic profile of these areas.

3 – *the **form and design** of sustainable and resilient cities, as complex systems.* How do we help shape places that will remain in time, be adapted and maintained, that will foster attachment and generate a sense of identity, that will be efficient and effective? The issue of urban resilience drives this normative aspect of our work and aims to embed all fundamental aspects resilience in the design urban form, when we design for an uncertain future. The link between resilience and urban form is by no means straightforward, and has implied a deep dive into the study of ecological systems, to understand how to break resilience down into manageable elements, to study through correlations with urban form. This work is again heavily based on urban morphology, to understand what different effects have different forms had on the resilience of place in time.

The combination of these three stands has defined our normative approach to urban design into a *process* of *shaping* the spatial structure that creates opportunities and sets limits to the development of places, by enabling or discouraging change to take place (Porta & Romice 2014; Romice et al 2016b; Feliciotti et al 2016). The key question here is: which features of urban form constitute the *structure* of places (that must be designed), and which don't (that must be left to self-organization)? Concepts such as *time, unpredictability, change, resilience, social sustainability* (next to environmental sustainability), are at the heart of the generation of quality in space and the foundational environment of place evolution, not just goals to pursue. The difference is immense, and sets our approach apart from others.
The following 4 sections in this paper will illustrate the context of our work, as a justification for the search for this new approach to designing cities, and some elements of the three research strands. A full account of individual pieces of work is listed in the bibliography. To ensure methodological rigor, the studies mentioned in the next sections focus on common morphological elements and measurements, across a range of scales, from the metropolitan to the very local. Some of our work has identified, defined and studied such elements in their forms, geometries and relationships to each other; others have observed the relationships of these elements (or their combinations) to other aspects of urban life – social, economic and behavioural. Overall, these elements represent both

the objective ground on which our research is built (science of cities), and the ingredients of our *normative* approach to the design of cities, as the following sections will show.

2.The context of urban design, and a change in mindset

We are well into the century of urbanisation. Recent OECD predictions set urban population to reach the 9 billion mark by 2100, representing around 85% of the total world population (OECD, 2015). In the span of 150 years, from 1950 to 2100, we will have experienced a net growth of 8 billion people. At first predominantly in the West and North hemisphere, this wave of urbanization has more recently targeted the "Global South" (U. N. H. S. P. UN-Habitat, 2013), putting cities under a strain hard to conceive. The issues that cities pose today and for the future are consequently very different from what they were in the past; and so are the geographies of such issues, with very different patterns of growth across the continents.

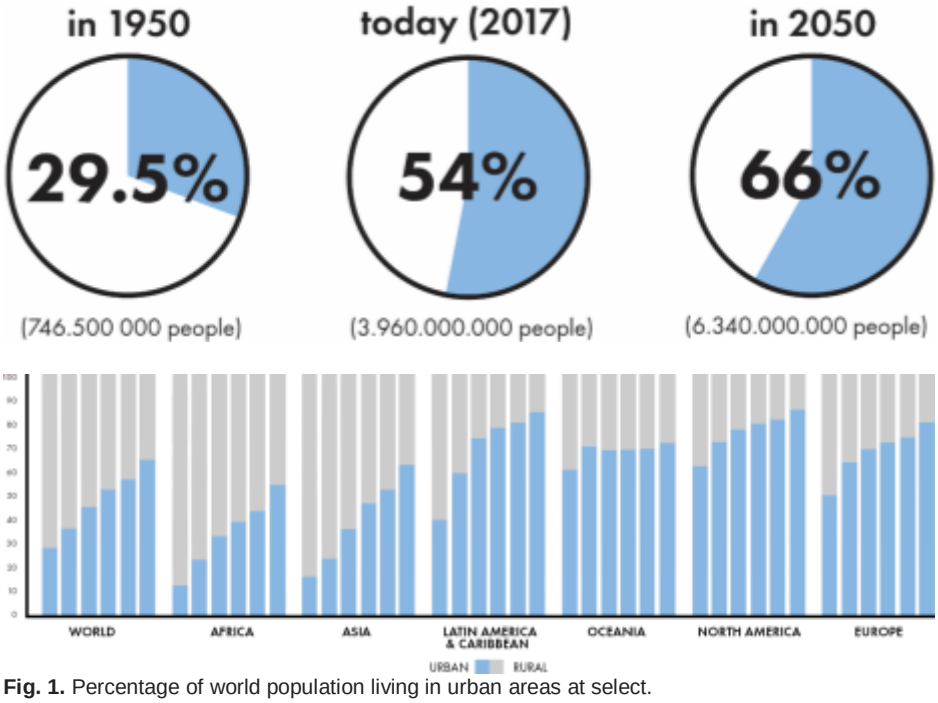


Fig. 1. Percentage of world population living in urban areas at select.

Having already been through two periods of Industrialisation, the first causing the sudden and rapid creation of urban centres and the second the equally rapid transformation of such centres, and having survived them, should we worry about a third world-wide period? A recent article by Steffen (2015) argues that the last 150-200 years of population growth and industrial development have had such a significant impact on the land that for the first time in history, Earth's most fundamental natural forces are affected, climate change being an example. According to them, the magnitude of this pattern is such that we have entered a new geologic epoch, named "Anthropocene", with metrics of this global dynamic increasing particularly after the Second World War ("The Great Acceleration"). The current process of urbanization is one face of such Great Acceleration, and the task of shaping tomorrow's cities is a very different challenge from what we have had to address to date, hence our questions and our search for a new normative approach to designing cities.

3. City forms and urban theories

Cities are a product of human culture. Human beings have been a cultural species for about 50,000 years, but cities are a late product of such human cultural evolution, coming to be only about 6-7,000 years ago. Urban planning and design though, as we know it, only emerged around 100 years ago, when what we call Professional Theories of Urban Design (Porta et al, 2014) were

developed and discussed publicly within a fully defined disciplinary context, to address the first wave of urbanisation. Historic cities, built before and after 'professional theories' are very different (Porta & Romice, 2014), across a number of indicators, social, economic, and physical. What, in their form, differs, at what scales and how so? And could this knowledge explain the variable longevity and fortunes of places built under different circumstances?

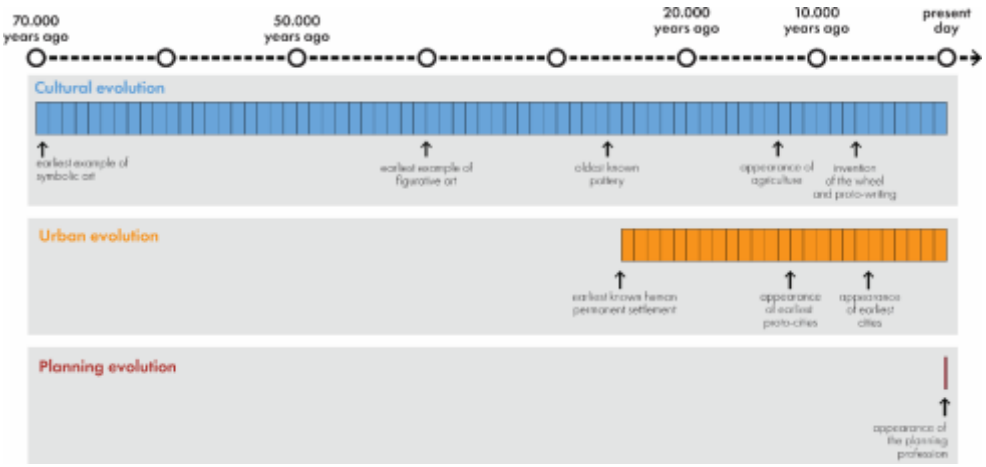


Fig. 2. Evolution of urban planning as a discipline, Cities and human culture: co-scalar comparison

As complex spatial entities, cities have traits that can be described with a high degree of precision. These, like the "phenotypic" traits of living organisms, differ between individual cases, being linked to the origin and the driving ideological principles, local customs and cultural evolution, which together shape the form of the city, and yet similarities can be found between places with similar historical origins (Dibble et al, 2016).

Because networks of streets shape the overall structure of our cities (Kostof, 1991), most of our work starts at their scale. Our initial research (Mehaffy et al., 2010) introduced the notion of '400 mt rule', i.e. that historic cites have evolved through time around urban networks whereby main streets were laid at rather regular intervals of about 400mts or less, bounding rather *uniform* portions of territory named "sanctuary areas". This suggestion was initially based on a few cases of diverse but equally historic urban layouts. If on the other hand we could observe the same behaviour in a much larger diversity of cases, we could assume that the '400' mt rule was actually a precise, utilitarian, efficient dimension used by different cultures in different contexts independently. In urbanism, 400 mt is also associated to a 5 minutes walk, which ties well with the street pattern observed. Comparing the road layout of equal portions of over 100 cities of different historic origin through the use of Google Maps, we discovered both temporal and geographic consistencies in road networks and, importantly, a significant sudden 'revolution' which affected the most diverse centres in the last 100 years or so (Porta et al, 2014). This prompted our conclusion that until intentionally set by our planning and design profession, main streets were laid at rather regular intervals of about 400mts or less. After that, when professional theories came to stage, the pace between main streets increased remarkably, with implications on use and movement. Interestingly, informal settlements in developing countries that are contemporary but have not been informed by professional planning theories, seem to share the "historic" 400mts pattern. The '400 mt rule' and the concept of sanctuary area constitute the first *two ingredients* of our normative approach, representing respectively persistent, consistent and uniformly developed subdivisions of urban territory.

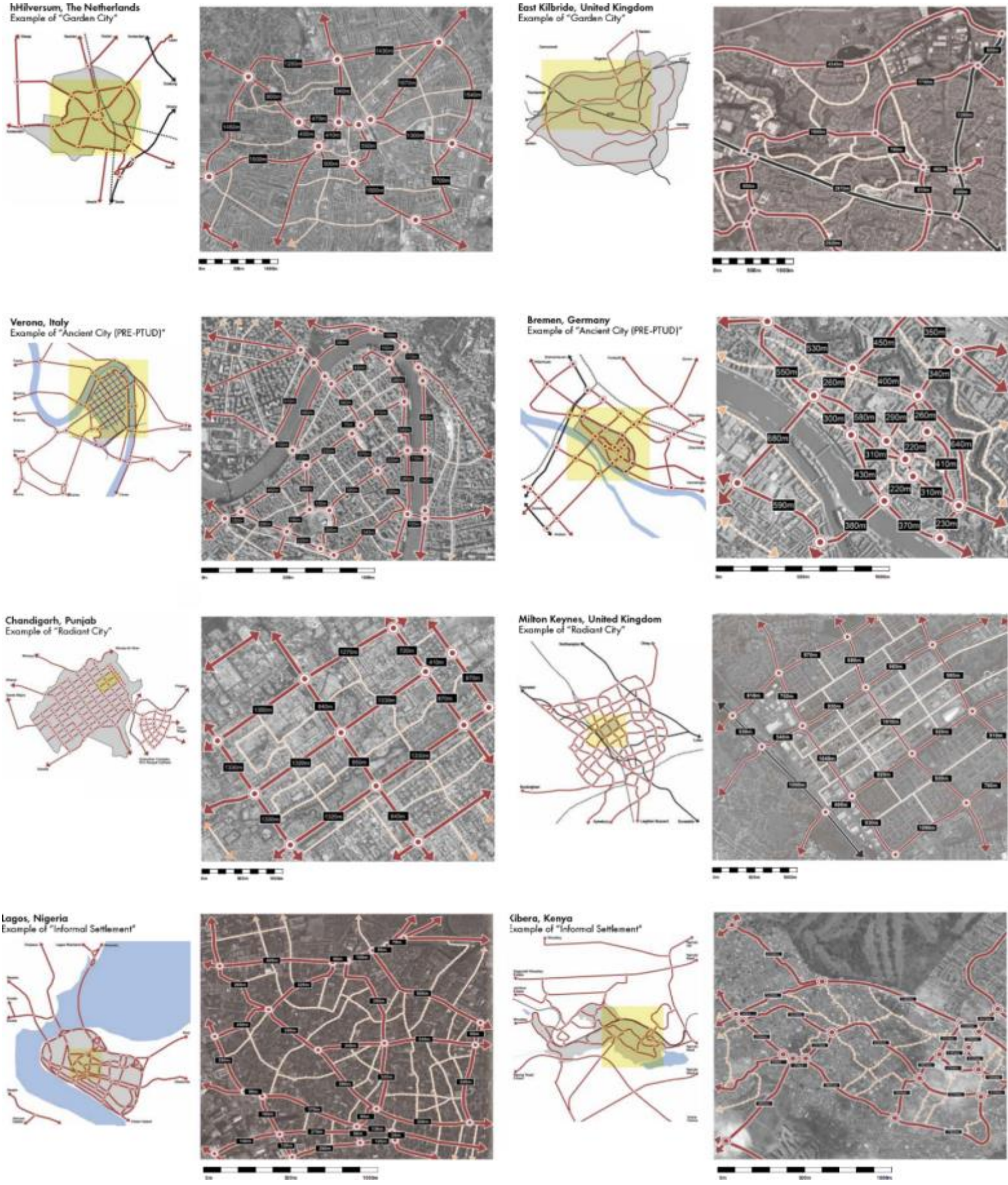


Fig. 3. The '400m' rule as it appears across different types of cities in urban history. Source: Baird et al., 2010.

Our next quest then, was about finding any further consistency, persistency and uniformity of behaviour within sanctuary areas of different historic origins. Unlike the Alterations in Scale comparison, which was conducted over 100 samples around the world, this second study focussed on 40 samples within the UK only, for the simple reason that it entailed the study of over 200 measurable characters of the urban form each. This work revealed that fundamentally, the patterns and coherence we found at the main street level both historically and geographically, can be traced down key levels of urban scale, from 'sanctuary areas', to street fronts, blocks, plots and the built form. In particular, the relationship between built form, street types and their shapes, and open space is consistent, historically and typologically (Dibble et al, 2015). Nothing is incidental, and the consequentiality between scales is either dictated by principles of efficiency (historic examples) or determined by design (modern examples). This principle of consequentiality is a key organisational rule of our normative approach to design, and our *fourth ingredient* of our normative approach. Statistical work conducted on all 207 characteristics that describe the key levels of urban form, has confirmed that just 9 of these can distinguish between or relate together different forms, suggesting that they are dominant in determining the character of place. They are therefore the *fourth* (set of) *ingredients* for our normative approach to design.

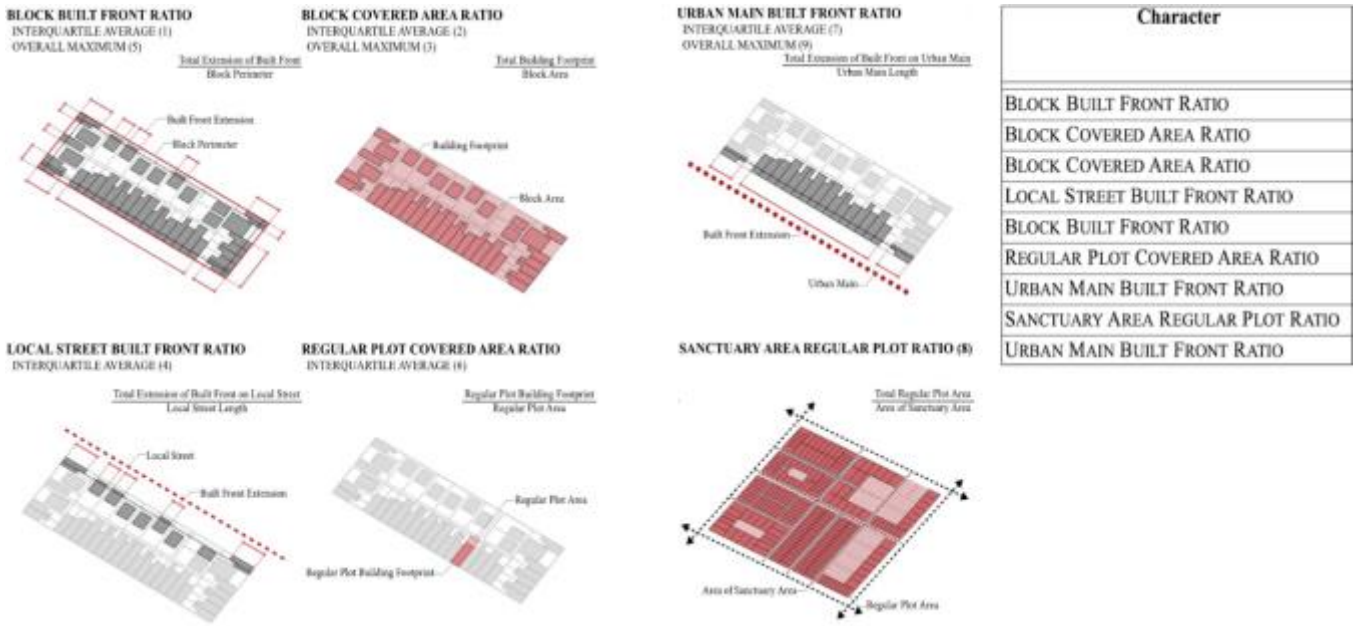


Fig. 4. The nine most discriminatory variables that, alone, seem to capture the distinct identity of urban forms: these reflect three characteristics: 1) block perimeterness, or the way buildings define the street-edge; 2) building coverage, or the way buildings cover the land; and 3) regular plot coverage, or the extent to which blocks are made of plots that have main access from a street. Source: Dibble et al., 2016).

Taken together, these two main areas of research have led us to the following observations: historic street patterns are complex and highly interconnected, having grown on evolving demands in time (Porta et al, 2014), and yet main streets appear to be surprisingly stable in time (Strano et al., 2012). The relationship between a street type, the plot structure and the built fronts on such street types (the essential elements of city character) are intimately connected, showing a significant 'bifurcation' of urban form in evolutionary terms from pre-modern to modern cities (Dibble et al., 2015). In particular, modern street patters show reduced complexity and interconnectedness, and a completely subverted relationship between street type and built form (Dibble et al, 2016), which confirms previous studies (Salat, 2012). The consequent character, uses and possibilities afforded vary in the two (historic and modern) instances, and these variations can be observed. Therefore, form a purely physical, measurable point of view, and leaving aside cultural and ideological discussions of merit and value, we suggest that on the data we have collected, historic cities tend to offer to greater extent a particular quality that works for people, individually and collectively. We may call this quality resilience. Because historic cities have never been fully designed at the scale we are used to nowadays, certainly not as

wholes, we suggest a second conclusion: that this “quality without a name”, or “beauty” as Alexander would call it, does not come by design per se, but by use, life and time; in short, it is an evolutionary product generated by the hands and values of many (Porta et al., 2016).

4. The impact of cities on their users

The effect of the street network’s configuration on cities filters from their overall structure (macroscopic scale) down to all their smaller elements and uses – from movement and circulation, to the location and access to services, down to the built and open forms they bound – thus playing a key role in how we live and use places. Then the question here is how? What is it exactly that streets do to cities that exerts on their form as well as their life such a profound influence? We invested a considerable amount of research on this matter, and found out that, essentially, everything here comes down to what we have indicated as one of the major evolutionary forces in cities: *centrality* (Porta et al., 2010). Inspired by previous research developed at UCL London (Hillier and Hanson, 1984; Hillier, 1996) and directly built on several decades of studies in the physics of complex spatial networks, our Multiple Centrality Assessment (MCA) mapping tool allows a quick and reliable visual investigation of centrality over networks of urban streets and intersections (Porta et al., 2006). Understandings developed in this area have deeply informed our successive research as well as our normative approach to masterplanning. They helped to identify the portions of street networks to use as case studies in Alterations in Scale, then the Sanctuary areas in research on neighbourhoods and the spatial indicators in Urban Morphometrics (Dibble et al, 2016; Venerandi et al, 2016). In essence, MCA visualizes the extent to which a street (or a space) is *cen*tral within the system of all the streets (or spaces) to which it is connected. It mainly uses three indices of centrality, namely closeness, straightness and betweenness, each of which is calculated differently to capture characters of the space that appear to be linked to human behaviour. For example, “betweenness” captures the extent to which a street sits on the shortest paths linking each street in the system to each other or, in short, its “ability” to stand “in the middle” of all other spaces. A street with high “betweenness” is more *likely* than one with low “betweenness” to be traversed by passers-by moving from their point of origin to their destination.

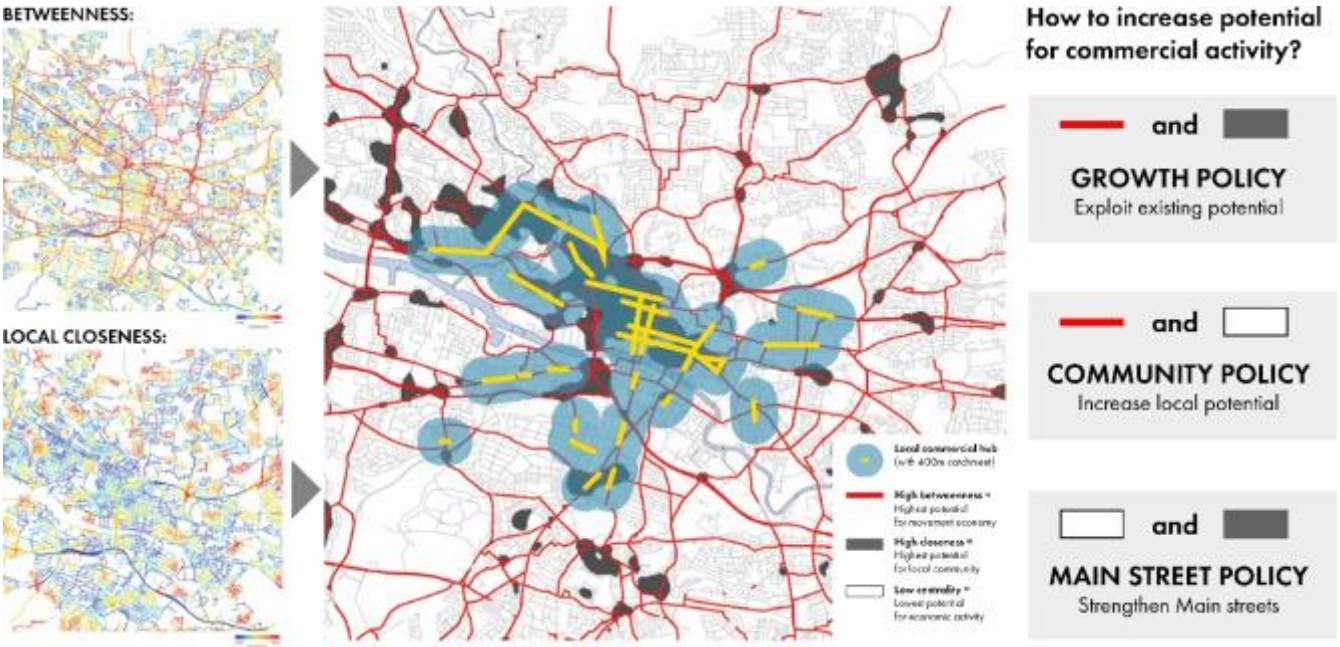


Fig. 5. Street centrality as a primary environmental driver in both urban evolution and the master planning process. Source: work conducted in UDSU design studio (Johanna Roswall; Anges Sandstedt, 2014-15).

We have used MCA to confirm an association between street network and the strength of socio-economic phenomena around it, as in a complex system. In particular, we have observed patterns of correlation of street centrality with location and type of services (Porta et al., 2012; Porta et al., 2009), street quality and life (Remali et al, 2016), land values (Pasino, 2016), land-use intensity (Wang et al., 2011) and building density and scale (Dibble et al., 2015). We also recently used MCA (combined with morphological studies at smaller scales) to find consistencies between the form of several London neighbourhoods which underwent gentrification, to ascertain if gentrification as a socio-economic process has *parallels in the types* of urban forms in which it occurs (Venerandi et al, 2016). Summing up, MCA offers an important base of evidence to inform decision-making in masterplanning, suggesting by fine-tuning strategically the spatial distribution of centrality that we can exert a measurable environmental pressure on the evolution of a number of dynamics that are in fact crucial to urban life, such as prosperity, safety and attractiveness. This knowledge is extremely valuable in taking strategic decisions in relation to the distribution of resources and urban densities in the city: it therefore constitutes our *fifth set of ingredients/principles.*

Less focused on morphological analysis, but on existing evidence of effect between space and human activity, we include in this section a detailed review of work in the area of environmental psychology, where urban scales (metropolitan, neighbourhood and local) have been studied in relation to personal, social and material effects (Romice et al 2016), to illustrate the important impact that single and combined (cross-scale) physical elements will have on the use and life of urban space. Read in combination with the researches cited in Point 3, we obtained a rich array of design tools for our normative approach to design. Linked to this review, through comparative historic work on housing development in Glasgow we studied the links between land ownership (size and ownership of plots) and models of housing development between mid 1800 to today, and observed the related changes in the complexity of urban form of two key areas in the city (Barbour et al, 2016). From these two latter works, we identified the issue of relative control that users can exercise on space, as an important thermometer of the relationships that will be established with such space, closely following Akbar's work on the relationship control-ownership-occupation (Akbar, 1988). Control can be exercised at different scales, and is linked to urban form, limiting or enhancing user informal participation in the design and management of place; it is therefore the *sixth ingredient of our approach.*

The work presented in the latter two paragraphs on morphology, at different scales, geographies and periods is our contribution to a descriptive science of cities, and has added evidence to Jane Jacob's proposal that the complexity of urban systems is 'organised complexity', not random and unpredictable. Such complexity is generated through life over time unless, of course, alternative orders are imposed. And yet, whilst 'beauty' is a quality that comes with time, design needs to happen to allow such beauty to occur, though spatial *rules* and principles that combine the morphological elements we have studied, through principles of justice, efficiency and change. In response to the new challenges posed by the recent waves of urbanisation, we suggest that planning and design must be substantially re-defined to understand, shape and manage cities as complex systems (ibid.).

5. A normative approach

Urban systems are complex by virtue of the relationship between their constituting components (Holling & Goldberg, 1971). Changes at each level of the morphological scale affect the others in non-linear and non-predictable ways (ibid; Romice et al forthcoming). This goes both ways, large to small, and small to large, echoing quite significantly the form of the cross-scalar process of change characteristic of all complex adaptive systems, as described under the name of "Panarchy" (Gunderson and Holling, 2002).

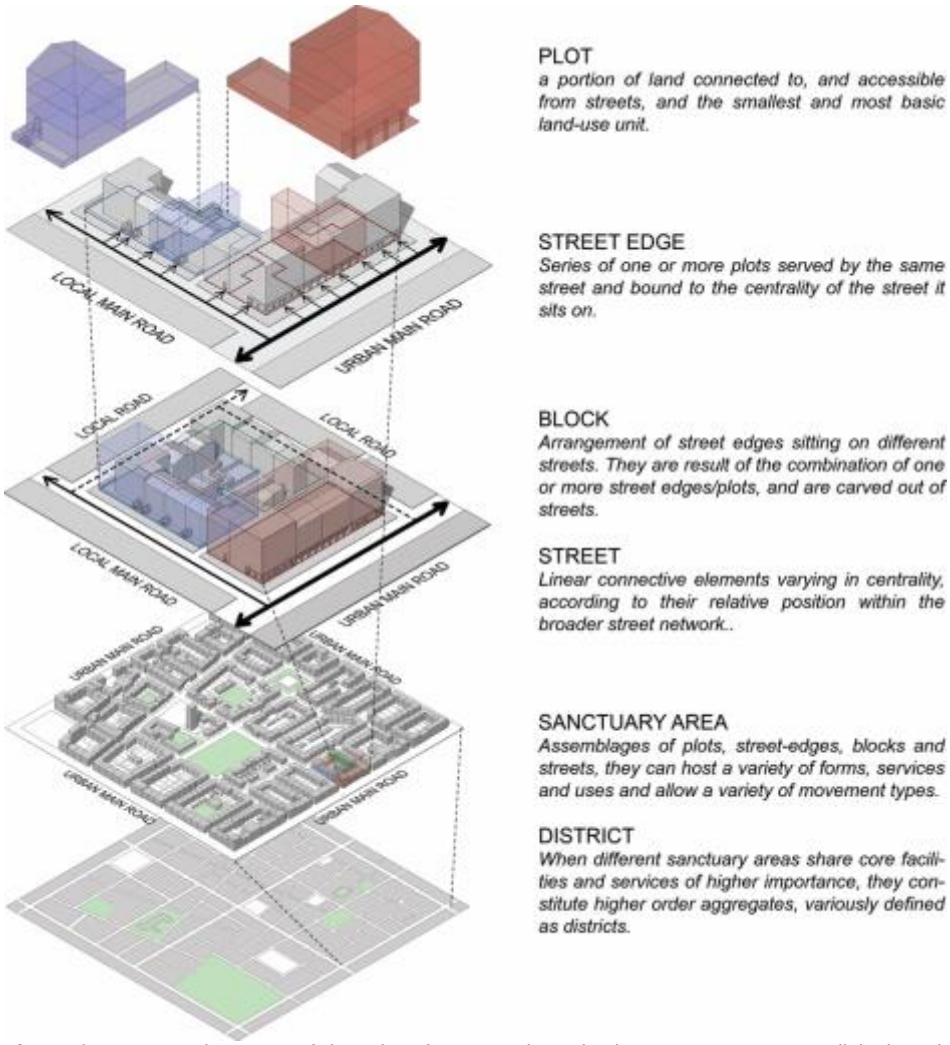
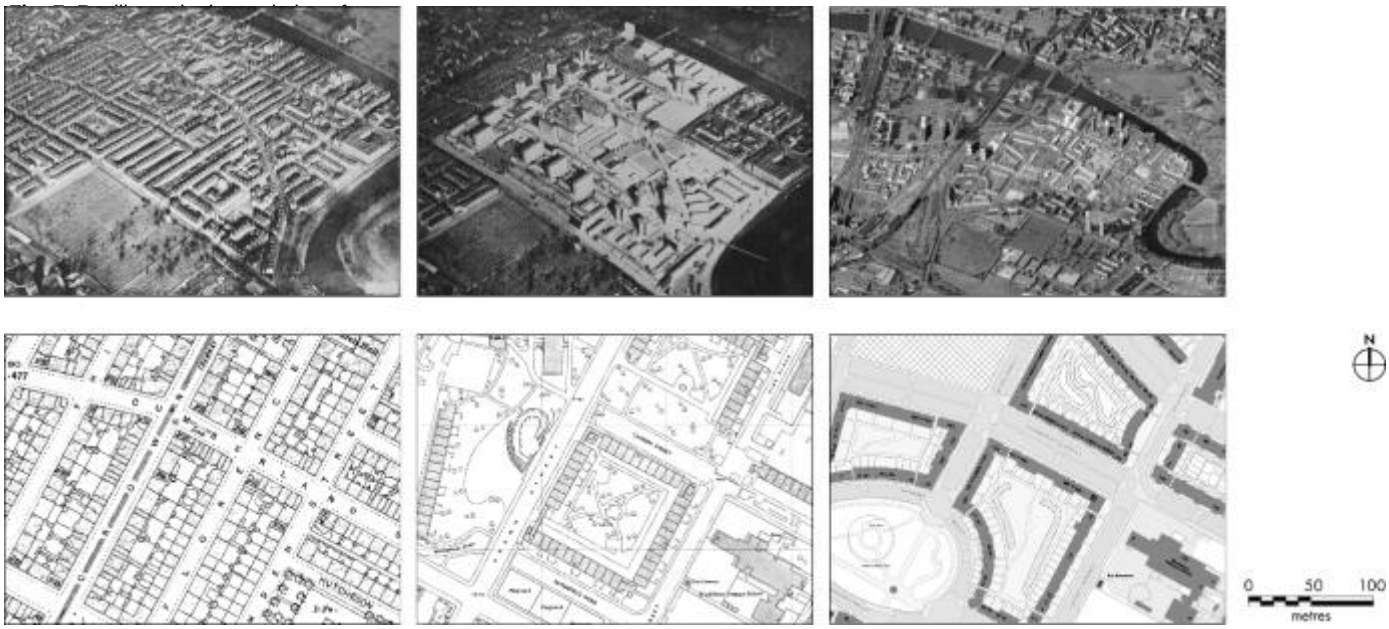


Fig.6. The cross-scale nature of the urban form complex adaptive system. Source: Feliciotti et al, 2016.

Concentrating on one single component and trying to optimize its individual performance therefore, does not guarantee anything about how the rest of the systems will respond, especially at different scales and in the medium-long term. As each and every level of the morphological scale matters, intervention on cities ought to understand the links between scales and be able to acquire knowledge and adapt its tools to the requirements of each such scales. The manifestations of problems may be very different, but the approach should be consistent, and be centered around the idea of change, and the capacity of a system to respond to change in a positive way. With this in mind we have started investigating the concept of resilience The concept was born in system ecology, but was recently identified as a promising way to understand and engage with a changing world and is increasingly used in urban studies as crucial to help creating places better suited to endure and adapt over time to socio-economic, political and environmental fluctuations. Applied to placemaking, resilience highlights the need to incorporate explicitly the element of change and the dimension of time in the understanding of, and intervention on, the form of cities. In this sense, sustainability remains the goal of placemaking, but intended not as a static goal, rather as a moving target whose path cannot be charted in advance. Resilience, or *"the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks"* (Walker et al, 2004:4), as applied to urban form, is the capacity of places to progressively retune and redirect their trajectory as the target moves in time. Whilst well understood in system ecology, resilience is still a vague term when it comes to cities. This suggested us the need for a much

closers look at the actual form of cities in search of their *model of change*. Our previous research and experience have in fact at numerous points suggested that the form of cities – at all scales - plays an important role in their resilience.

From a detailed literature review we have identified a number of characteristics, namely modularity, redundancy, diversity, efficiency, connectivity (Feliciotti et al., 2016), that have been recognised as significant enablers or inhibiters of resilience and that are clearly recognisable in the urban form across the same scales. We combined these characteristics to the form of cities, hence extending our cross-scale approach to morphological analysis. These scales correspond to the same morphological elements that we found as interlinked in previously mentioned studies on main streets and urban morphometrics studies (street network, sanctuary area, blocks, fronts, plots). A detailed historical comparison of a neighbourhood in Glasgow (Gorbals) over three periods (historic, modern, post modern), also corresponding to the historic classification used in Alterations in Scale, has compared morphological properties at all scales, with socio and economic data available for the three periods, revealing a very clear correspondence between physical, social and economic diversity (Feliciotti et al. forthcoming). Whilst it is not possible to draw conclusions as to what forms and their combinations can determine greater or lesser degrees of resilience in urban form, the study has illustrated how modularity, redundancy, diversity, efficiency, connectivity are important measures of resilience and embedded in urban form across scales. This set constitutes the *seventh ingredient* of our approach to design.



On all this combined knowledge and findings, we went back to our considerations on many of our contemporary and historic places. We felt that so many, all in fact, of the weaknesses showed by otherwise positive place-making initiatives, including lack of adaptability, persistent gigantism, low place-attachment despite community engagement and routine or purely administrative community participation practices, could be attributed to a lack of attention to the factor of time in place-making.

Hence the decision that the overarching objective of our work should shift from the design of a good place to the design of the spatial conditions under which change can initiate and sustain its development appropriately, through dynamics of self-organization (Romice et al 2016b). The goal of urban designers should be to build the “environment” for the city to develop and flourish, rather than building the city itself. The prerequisite for this, is a good knowledge of what shall be

designed and, fundamentally, what we shall not design. The ingredients, and the relationships that tie them together in design, are the accumulated knowledge we gained through our descriptive work. The design of cities becomes structural and enabling rather then defined and per-parts.

We have named this call for 'less but better' planning, Masterplanning for Change. The decision to maintain the masterplan at the core of this new approach is deliberate: it is after all what distinguishes our profession, holding therefore a symbolic and societal value. We have nevertheless turned around its aims: a masterplan is not about realizing a finalized product, but about establishing possibilities for progressive completion.

The 'masterplanning for change' approach then is funded on the ingredients listed and principles:

- City *structure* is made of Street Centrality, Sanctuary Areas, Street Edges, Plots, Buildings Types. They are linked together by a set of spatial and functional *relationships* to create the key unit of development, which is for us the Street Edge (not the block, which is generally considered the building block of our cities - as a unit the block in fact does not possess enough flexibility to respond to different street conditions unless conceived as independent fronts).
- The *relationships* that tie all elements of the city structure together as a system, should be learned from history, as they evolved in time.
- *Plots* should be small; history has taught us that this grants the deriving system greater resilience overall.
- There should be *coherence* between plots and the street they abut on, in terms of density, the choice of building types, the orientation of the plot.
- We should follow the *400-Meters* rule, i.e. main streets should be spaced around 400mts apart.
- We should set in place a structure which allows *disjointed development* to take place, that is each individual plot should be implemented independently from each other.
- This will grant a more significant role to *informal participation* which has historically proven to be more important for the success and longevity of places than formal participation, as it extends to the management and adaptation of place. As a consequence, development regulations must be elementary, comprehensible and, short.

On these principles, we devised an approach to urban development that is deployed through a series of interconnected steps. These tie infrastructure, densities, services, to give spatial substance to local aspirations and formal planning decisions.

At the start of the paper the paper we cited a particularly challenging context of current and future urbanisation, implying that the effects of poor development would put our resources under too much strain for recovery. The *challenge* consists in the scale of growth; the *risk* in the cost of remediation if tomorrow's cities lack the capacity to reinvent themselves, displaying the necessary resilience to pursue new sustainable goals and aspirations.
Masterplanning for change is a scientific approach that aims to enable this process when dealing with urban development, where we propose to *reduce risks* by learning to design from evidence of what has worked in history and what has proven capable of re-tuning itself to changing circumstances, to be more safe-to-fail and less fail-safe, thus reducing the impact of all those economic, social and environmental costs associated with repair and reconstructions in case of failure. We *propose to respond to the challenge* of growth by implementing sound structures that *can* grow, following precise rules and relationships.

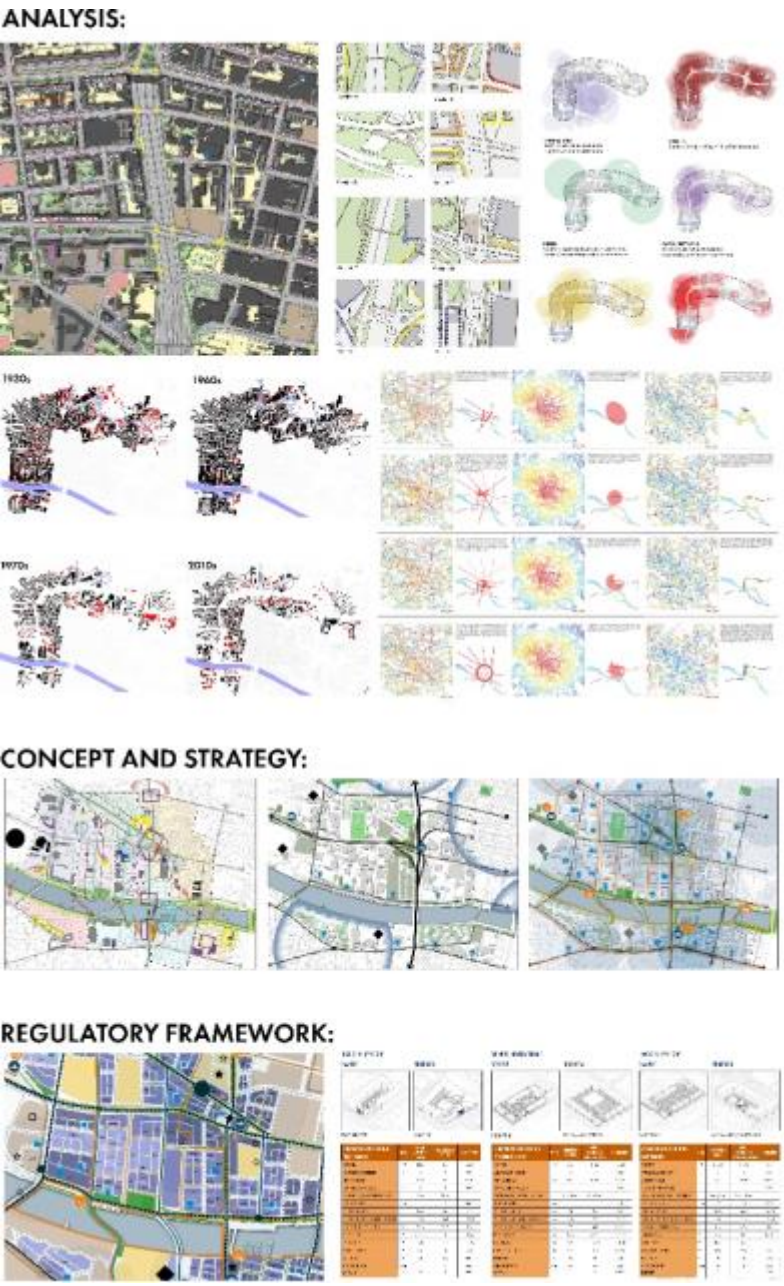


Fig.8. A typical set of graphical products in the Masterplanning for Change process. Source: work conducted in UDSU design studio (various students, 2011-2012).

Masterplanning for Change is now well-rehearsed approach we have used several years in both teaching and consultancy. We are currently working to make it operational by the public sector – the city authority or for profit social housing provider - taking on the enabling role of infrastructure and rules provider (Romice et al, 2011), and establishing an intervening process between large vacant sites and small-scale housing providers.

The key is the planning of land subdivision down to the level of the individual plot, which triggers the opportunity for small-scale development within a coherent urban structure. If this land subdivision is right, and supported by light touch design codes, we can capture the power of small-scale enterprise to develop new housing, a big challenge for all governments.

A full operative manual for Masterplanning for Change and its step-by-step application will be available in Summer 2017. All work by the Urban Design Studies Unit can be found online at: www.udsu-strath.com.

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Landscape planning: from theory to teaching

Juan Jose Galan Vivas
Aalto University (Finland)
Department of Architecture & Landscape Architecture
PO Box 16500 FI-00076 AALTO (Finland)
juanjo.galan@aalto.fi

Abstract

Following the signing of the European Landscape Convention by different Spanish regions, landscape became a specific and necessary issue in regional and local planning. However, and after almost ten years, the results remain unclear and a constructive review, affecting also education, might be convenient.

The lack of specific degrees in landscape architecture in Spain might partially explain the difficulties in the dissemination of the newly created landscape planning tools, although the introduction of consistent subjects in consolidated degrees like architecture, geography, agronomy, etc. or in some related masters, could have also served this purpose. The reality was nevertheless quite different since that teaching was seldom included in the university curricula, and when that happened, it tended to focus its attention in specific aspects, losing the transversal and proactive role that landscape was expected to have.

Some of the most positive academic experiences came from those subjects or courses which tried to work hand in hand with this new planning context, enhancing a holistic perception of the territory, promoting a global understanding of urban, agricultural and natural areas, reading processes and patterns and, specially, emphasizing the proactive character of the landscape planning tools by overtaking formal description and by producing new models and clear spatial or normative determinations which could be conveniently introduced in the planning context.

Also in those cases, multidisciplinary work, effective use of classical or new concepts like landscape unit, landscape assessment or green infrastructures, and a general understanding of the socio economic forces involved in the management or transformation of any landscape, proved to be a very useful tool to create both imaginative and realistic proposals, providing at the same time the global vision that landscape planners should have to establish the most harmonic possible dialogue between all the elements, interests and actors coexisting in any territory.

Keywords: *“Planning; “Land use”; “Green Infrastructure”; “Multidisciplinar”; ”Education”*

KEYNOTE SPEECH

1 From theory…

1.1 The goals

Landscape planning could be defined as the branch of landscape architecture which tries to establish the conditions for the most harmonic and sustainable relationship between the different land-uses, elements, interests, demands and actors which coexist in any territory. In order to do this, it needs to integrate environmental, cultural and visual factors and create the sustainable conditions for social, economic and individual development.

1.2 The boundaries

By considering landscape as the perceived dimension of any territory (European Landscape Convention, 2000), landscape planning will have to deal with the wide group of natural and human systems and processes which create, maintain and modify any territory and subsequently its human perception. This wide task requires necessarily a holistic approach in which the traditional compartmentalization of professional and academic fields or the physical boundaries between urban, rural and natural areas are inevitably questioned. Landscape Planning tends to escape the strict academic or geographical zoning and it is precisely in this transversal quality where rests the most important educational challenge.

1.3 The background

The European Landscape Convention remains as a permanent and essential reference for all those interested in understanding the motifs which justify Landscape Planning. As a road map, it succinctly defines the key objectives, terms and necessary concepts, leaving to the international, national, regional or local signers the freedom to define the most adequate ways for its implementation.

1.4 The challenge

Although the goals of landscape planning tend to be unanimously supported, it often remains at the sphere of good intentions due to its transversal character, its long run projection and the need of getting a shared vision for the future.

The main challenge in landscape planning is therefore overcoming those difficulties by finding the right mechanisms to make of landscape a proactive element rather than a passive result. In addition, landscape planning should respond to the common argumentation that landscape quality is just a question of personal taste, to the general prevalence of short run thinking and, last but not least, to the professional and academic compartmentalization, which tend to advocate for specific and punctual solutions in the belief that their addition will necessarily produce a positive global result.

1.5 A travel partner

Sustainability shares with landscape planning its transversal, systemic, long run and inter-scalar character and also the fact that, in spite of being publically supported, cannot be achieved without a holistic approach.

Actually, a sustainable and a well landscape planned territory seem to be complementary since both of them are, by definition, based in a positive relationship between the human being and the environment and both of them need necessarily to work with fluxes, processes, “elusive” indicators and systems rather than with isolated elements or spaces.

This convergence can also be extended to the teaching sphere, where sustainability and landscape planning seem to exceed the limits of the existing curricula and where the creation of bridges between sustainability, landscape and ecology, seems at the very least, promising.

1.6 The concepts

Landscape planning has generated its own concepts in order to rationalize the analysis, diagnosis and definition of proposals:

Landscape characterization is understood as the identification of patterns, elements and dynamics which explain the origin and evolution of any landscape. The bibliography about this subject is quite abundant but the British experience has become a worldwide reference with its hierarchical system of "character types" and "character areas", defined at national, regional, county and local levels (Landscape Character Assessment, 2002). In the same line, *"Landscape Units"* are understood in the Valencian planning system as continuous pieces of land sharing similar patterns, potentials, problems and processes and, by considering not only their physical conformation but also their dynamics, they are expected to become functional and management entities. (Reglamento del Paisaje, 2006).

Landscape Assessment is concerned with the highly controversial topic of assessing landscape quality and it could serve a triple function, firstly it can guide the rational and justified prioritization of actions and measures, for instance giving preference to those areas with lower landscape values; secondly it permits monitoring landscape changes and thirdly it can become a design tool by detecting which aspects contribute more significantly to landscape value. The vast research developed in this field has permitted us to know better how we perceive, process and give preference to some landscapes (The Visual Landscape Reader, Steinitz, 2008) but the final equations explaining landscape quality remain still unveiled in the undecipherable array of physical, cultural, social and individual factors which are attached to landscape.

The methodology developed in the Valencian Region for the assessment of landscape units and landscape resources assumes this challenge and calculates those values by combining people's preferences and experts' judgments (landscape preference and landscape quality). (Figure 1)

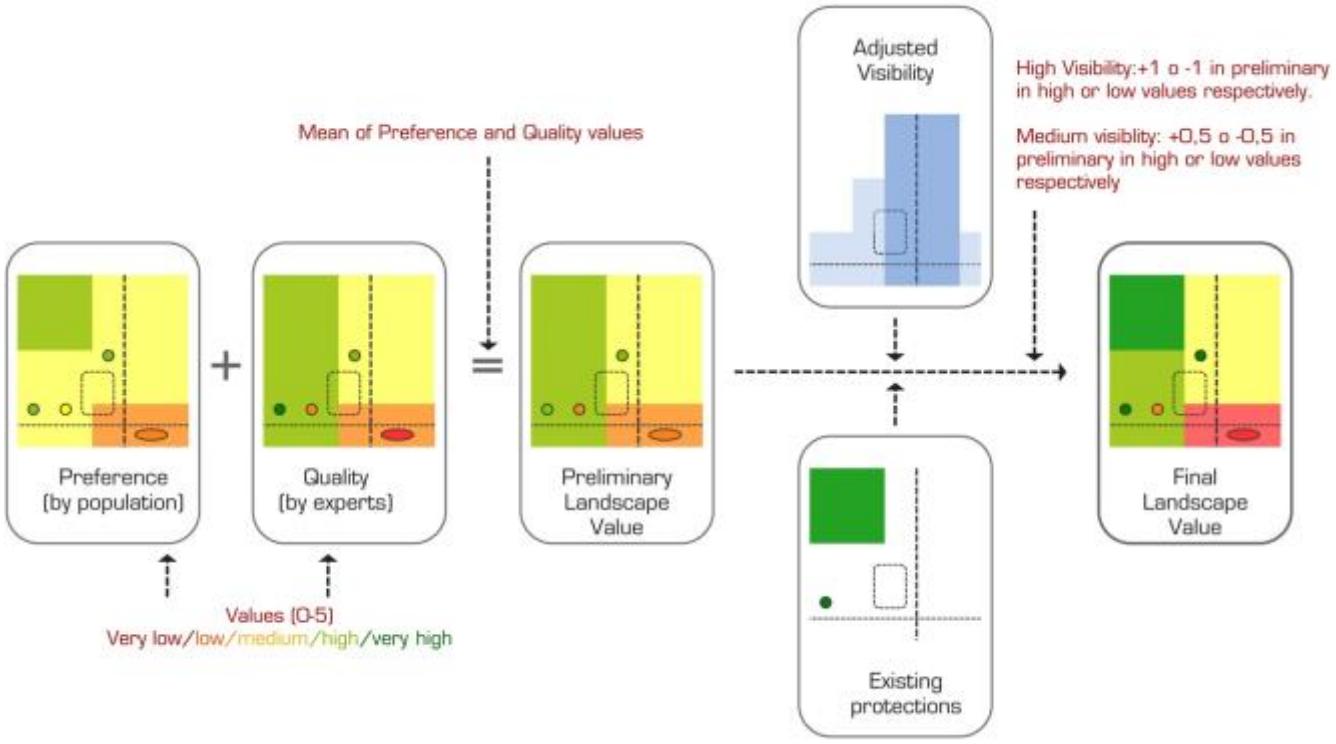

Figure 1: Assessment of Landscape Units and Resources according with the Valencian methodology

Visual Analysis: Landscape visibility is understood as the physiographical visibility of one area adjusted by the position and amount of possible observers. This analysis identifies the most exposed areas and permits to concentrate the attention on them.

Landscape Quality Objectives are defined by the European Landscape Convention as "the formulation by the competent public authorities of the aspirations of the public with regard to the landscape features of their surroundings". They are the keystones to pass from the analytical stages to the development of landscape policies and proposals. Following this idea, the Objectives are expected to envision a new and improved scenario for Landscape Units and Resources.

Landscape Policies can be defined as the "expression by the competent public authorities of general principles, strategies and guidelines that permit the taking of specific measures aimed at the protection, management and planning of landscapes" (European Landscape Convention, 2000). Those measures can include specific projects, *landscape programmes, landscape regulations* or even *physical demarcations* (figure 2). Landscape policies and their associated measures are by definition *proactive* and *propositional,* surpassing the descriptive or intentional approach which has often been associated with landscape planning.

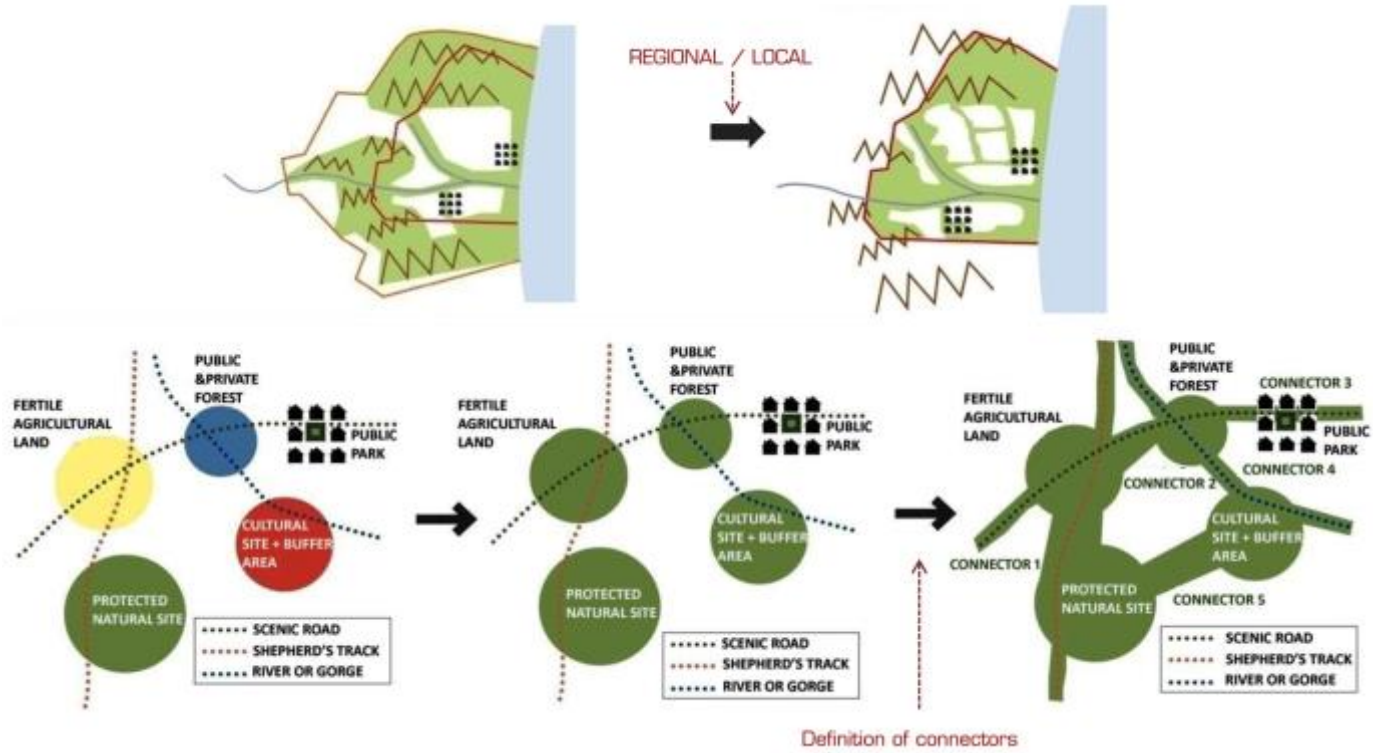

Figure 2: System of open spaces or Green infrastructure according to the Valencian methodology

Landscape Tools: As stated in the European Landscape Convention, landscape protection, management or planning should be firstly backed by the *legal recognition of landscape* and should be implemented by integrating "landscape into regional and town planning policies and in cultural, environmental, agricultural, social and economic policies, as well as in any other policies with possible direct or indirect impact on landscape" (European Landscape Convention, 2000). This last requirement opens a crucial disjunctive, either to incorporate landscape into other policy sectors or to create specific landscape tools and policies. Thus, in the Netherlands, with a long tradition of multidisciplinary collaboration, "landscape policies are integrated into several other (secondary) policy sectors of which spatial planning must be considered

the most important" (Wascher & Schröder, 2009). Conversely, in Spain, with a strong division of professional scopes, the tendency has been to create independent landscape tools like the Landscape Plans in the Valencian Region or the Landscape Catalogues in Catalonia.

1.7 Some frameworks

Following the signing of the European Landscape Convention, the Valencian and the Catalonian Regions developed their respective legal and normative contexts in order to integrate landscape into their planning systems (Table1).

In the Valencian Region, Landscape Plans were supposed to be developed simultaneously at different scales (supra-regional, regional and local), whilst in Catalonia, Landscape Catalogues were just prepared at the regional scale following a prefixed time schedule. In relation to their enforceability, the determinations included in the Valencian Landscape Plans have to be automatically assumed in the regional or municipal plans whilst, the determinations of the Catalonian Landscape Catalogues have a guiding character and could be later adjusted or adopted in regional or municipal plans (table 2).

REGION	VALENCIAN REGION PUBLIC PARTICIPATION	CATALONIA PUBLIC PARTICIPATION
TOOL	LANDSCAPE PLAN (ESTUDIO DE PAISAJE)	LANDSCAPE CATALOGUE (CATALOGO DE PAISAJE)
SCOPE OF APPLICATION	SUPRA REGIONAL..... REGIONAL ..... LOCAL ..... Hyerarchical implementation?: NO	SUPRA REGIONAL..... REGIONAL ..... LOCAL ..... Hyerarchical implementation?: YES
METHODOLOGY AND PHASES	CHARACTERISATION & DIAGNOSIS - Landscape Units - Landscape Resources (environmental, cultural and visual)	CHARACTERISATION & DIAGNOSIS -Landscape Units - Special Landscapes
	QUALITY ASSESSMENT - QUALITY: by experts + PREFERENCE: by people - Adjustments by DEGREE OF VISIBILITY - Visual Analysis based in observation points/lines	QUALITY ASSESSMENT - No included
	LANDSCAPE QUALITY OBJECTIVES (LQO) - 3 general LQO for the VALENCIAN REGION. - LQOs for each Landscape Unit and Landscape Resource	LANDSCAPE QUALITY OBJECTIVES (LQO) - 10 general LQO for CATALONIA. - LQOs for each Catalogue's Area - LQOs for each Landscape Unit
	DETERMINATIONS - SPATIAL: System of Open Spaces (Green Infrastructure) - PROGRAMMATIC: Landscape Programmes - NORMATIVE: Landscape Regulations - General Regulations - Specific Regulations (for all the scope / for the System of Open Spaces / For the catalogued areas or elements)	**DETERMINATIONS** - CRITERIA (for each LQO of the Catalogue's Area) - ACTIONS (for each LQO of the Catalogue's Area) - DEFINITION of Specific Areas for: - Landscape protection - Promotion of Landscape management - Possible Landscape transformation

Table 1: Contents and Scopes in Valencian Landscape Plans and in Catalonian Landscape Catalogues.

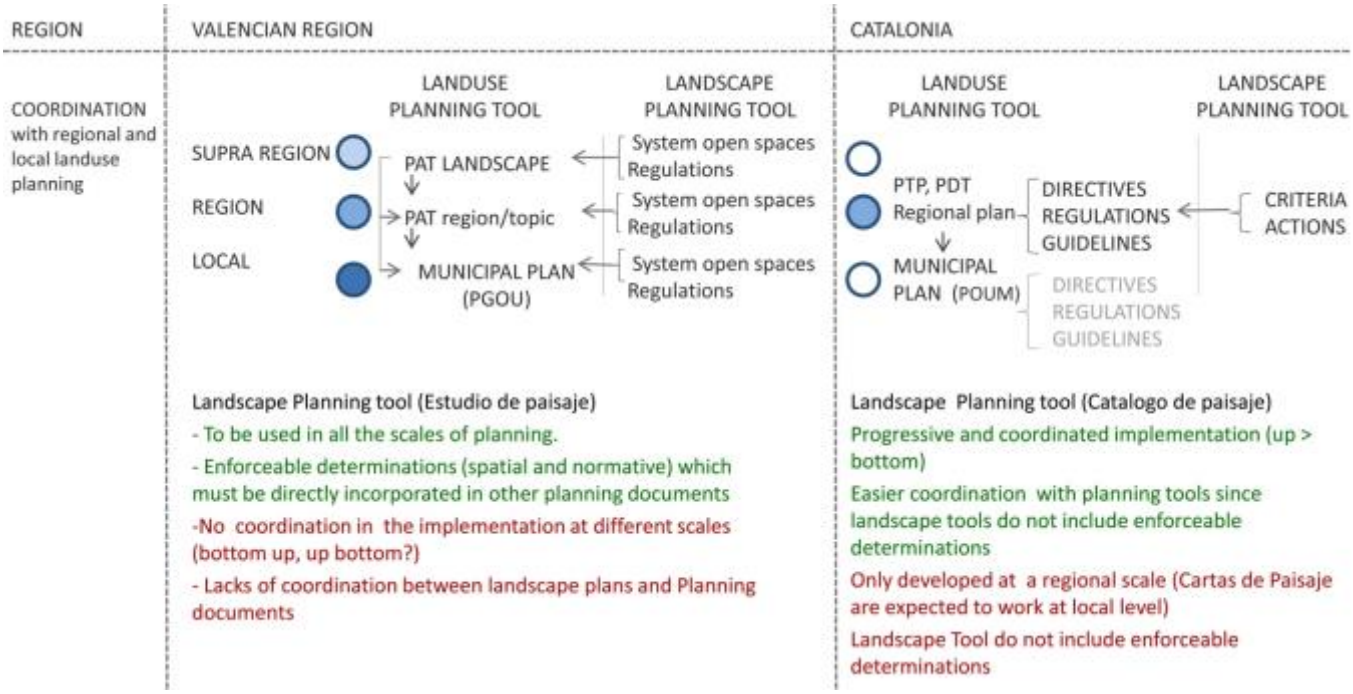

Table 2: Landscape Planning Tools and Land-use Planning Tools in the Valencian and the Catalonian

2 …To teaching

After having highlighted some of the most important theoretical aspects of landscape planning, the current paper analyses how this discipline can be integrated in the academic world, focusing the attention in the Spanish context, where the signing of the European Landscape Convention by some Autonomous Regions, opened a promising new scenario.

2.1 Landscape planning in study plans:

The teaching activity in Spain during the XXth Century cannot be fully understood without noticing the traditional separation between “humanities” and “polytechnic” universities. In the first ones, researchers have usually analyzed the landscape in a descriptive way and quite often in the big scale. In contrast, the polytechnic schools have tended to focus their attention on safe and efficient land-use planning, and, very punctually on landscape integration, especially in sensitive or protected environments.

The introduction in the 1980’s of the Environmental Impact Assessment (EIA) marked a clear threshold. Somehow, the Spanish universities had to respond to this new legal and administrative context, and although most of the courses which were created at that time were mainly concerned with landscape integration, a consistent and more open reflection about landscape also took place.

In a second stage, the signing of the European Landscape Convention by some of the Spanish Autonomous Regions provided a more transversal and proactive vision of the landscape which crashed with the existing professional and university structures. Firstly, it was difficult to be transversal in the very specialized university system; secondly, it was hard to be proactive in a discipline that had been traditionally approached in a descriptive or preventive way and thirdly, Spain did not have any specific public university degrees in landscape architecture, design or planning. Due to this, landscape planning was optionally taught in complementary subjects and, only at master level, it was possible to find some titles partially related with that matter.
This situation was partially improved when some regional governments and some professional associations became increasingly interested in landscape planning.

However, the expansion on landscape education that took place during those years was basically implemented trough monographic courses and through some new or existing masters, which were generally very influenced by the "humanistic" or "polytechnic" character of their own universities. Since then, and with some remarkable exemptions, the education on landscape have tended to readjust the academic background of their students (architects, engineers, geographers, sociologist, biologists, environmentalists, etc.), in the general belief that the transversal character of the landscape required multidisciplinary teams rather than multidisciplinary individuals.

2.2 Some academic experiences

The following examples are based in the personal experience gained as teacher and coordinator of the Master in Landscape and Garden Design and as teacher of the subject "Landscape and Environmental Planning", included in the Master in Advanced Architecture, Landscape, Urbanism and Design (Polytechnic University of Valencia).

In both cases, the subjects and master thesis were designed to support from the university the implementation of the Valencian Landscape Policy by teaching the methodologies and basics for the preparation of "Landscape Plans" (the landscape planning tools required by the Valencian Legislation in any regional or municipal Plan).

About territorial analysis

The understanding and graphic representation of the natural and human systems, patterns and processes was always the first step. This stage was also particularly important to introduce the students in those aspects which were unfamiliar for them (agricultural and natural areas for architects, urban fabrics for engineers, etc.). (Figure 3)

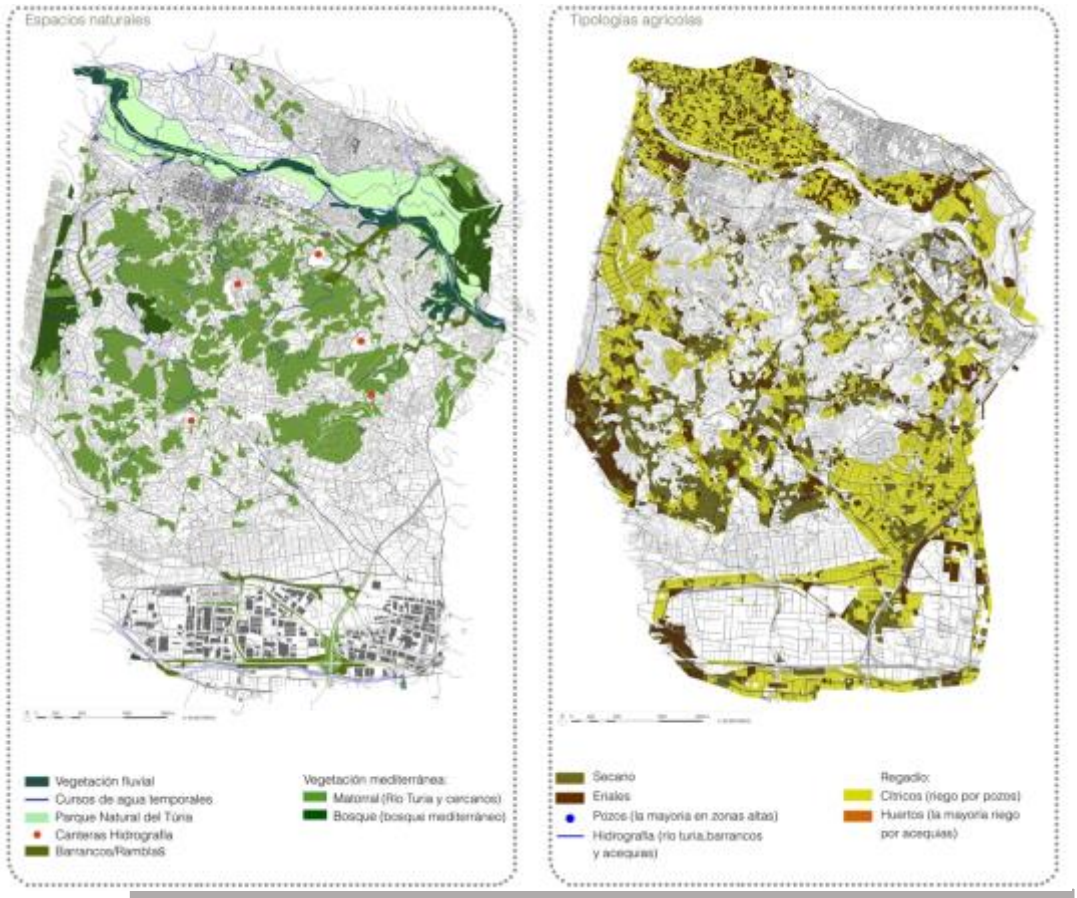

Figure 3: Natural and Agricultural systems in Ribarroja del Turia (students: Cao, Y., Falqui, R., Ferrandis, E., Pérez, M. I.

About landscape characterization:
The definition of Landscape Units and Landscape Resources required the intentional integration of all the layers developed in the previous stage. It was particularly important to show how land uses and land covers do not necessarily correspond to landscape units and how the working scale can modify the characteristics of the unit. Additionally, it was essential to integrate processes, tendencies and dynamics in order to create functional landscape units which, by sharing the same systems, problems and potentials, could receive similar treatments. (Figure 4)

About landscape assessment:
In this point, the very same concept of landscape quality opened very fruitful discussions. The methodology proposed in the Valencian Region for the assessment of Landscape Units and Resources was found particularly interesting and lead to the need of considering relative or local values rather than absolute or universal ones. (Figure 4)

About visual analysis:
This step was particularly demanding since the calculation of visual basins with GIS programs had to be always adjusted with onsite visits. The selection of observation points or lines was also a critical issue since it determined completely the whole structure of the visibility map.

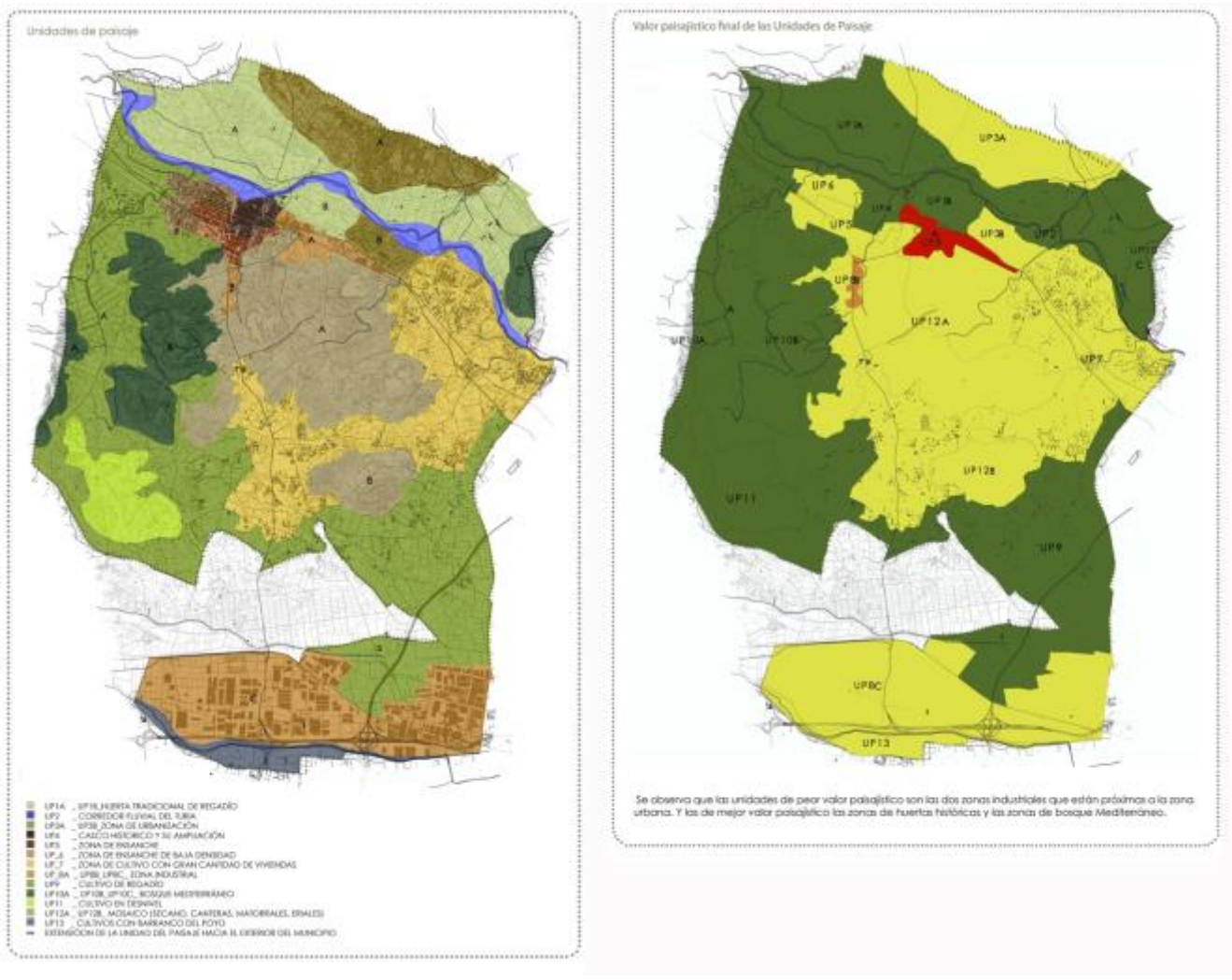

Figure 4: Landscape Units and Values in Ribarroja del Turia (students: Cao, Y., Falqui, R., Ferrandis, E., Pérez, M. I.

About landscape quality objectives:
Due to its abstract and intentional character students tended to forget the importance of this stage. In order to highlight its importance, they were asked to enunciate them very synthetically and to represent them graphically, generating also new territorial models. (Figure 5)

Figure 5: Landscape Quality Objectives for Moncada (student: Ripoll, M. J.)

About systems of open spaces (green infrastructures):
At this stage, the students were invited to define an interconnected system of open spaces integrating the most strategic urban, agricultural and natural areas and to think about the very diverse functions and ecological services that could be attached to it. The creation of connectors and the need of discriminating some areas, mainly in the rural and urban contexts, proved to be the most critical parts. (Figure 6)

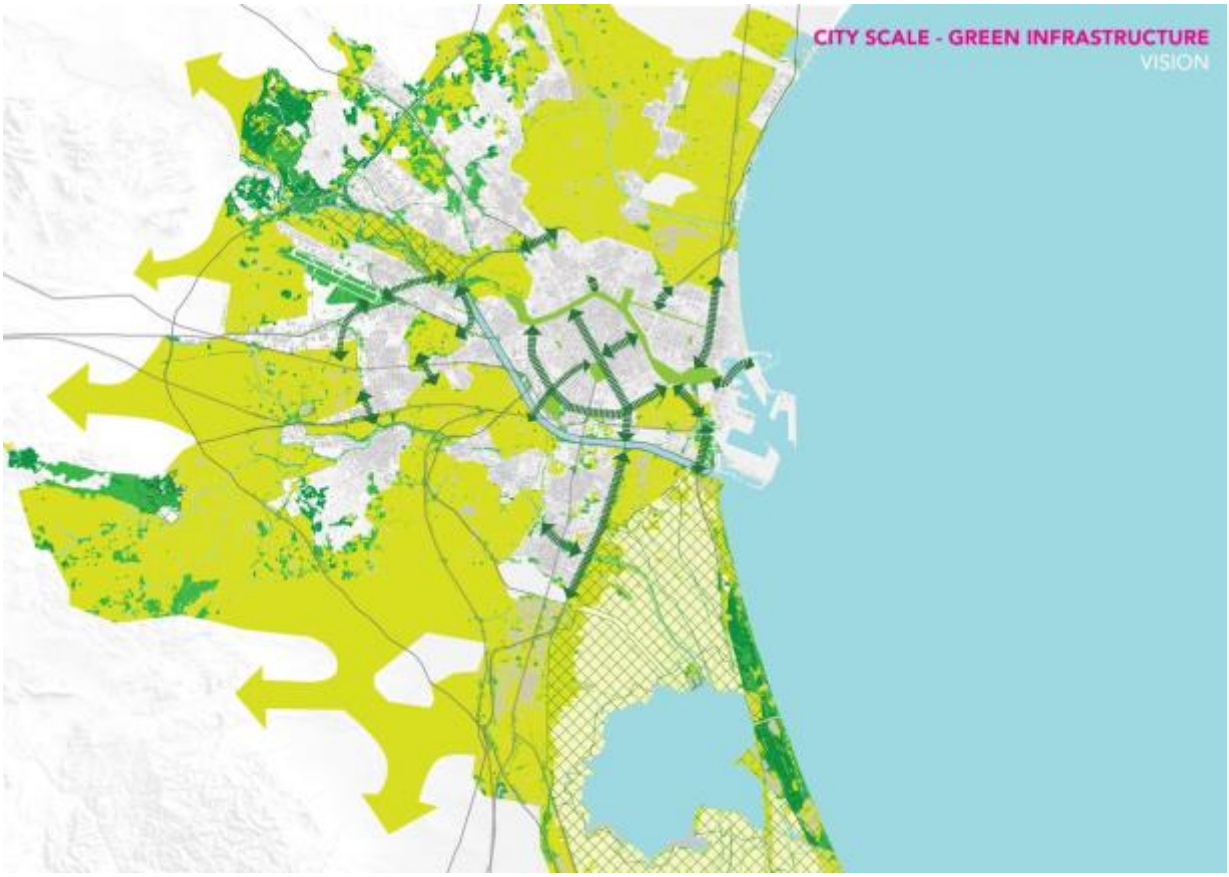

Figure 6: System of Open Spaces or Green Infrastructure for the Metropolitan Area of Valencia (students: Norros, I., Varpio, M., Juurinen, I., Kauto, E.)

KEYNOTE SPEECH

About landscape programmes:
In addition to the geographical demarcations associated with the System of Open Spaces and to the guiding character of Landscape Regulations, Landscape programmes included the construction, management and societal actions or projects to fulfill the landscape quality objectives. (Figure 7).

About landscape regulations:
Landscape regulations were organized in geographical scopes (urban, rural and natural) and were understood as the guidelines that should be followed by different collectives (planners, constructors, farmers, etc.) to protect, manage or create a more consistent, harmonic and identity based landscape. (Figure 8)

About public participation:
The definition of meaningful participation processes is one of the most challenging issues in landscape planning. At this point, the students had to define the methods, schedule, stakeholders and demographic samples that should be considered in their public participation plans and, additionally, test them by assuming different roles.

Figure 7: Landscape Programmes for Moncada (student: Cano, Laura)

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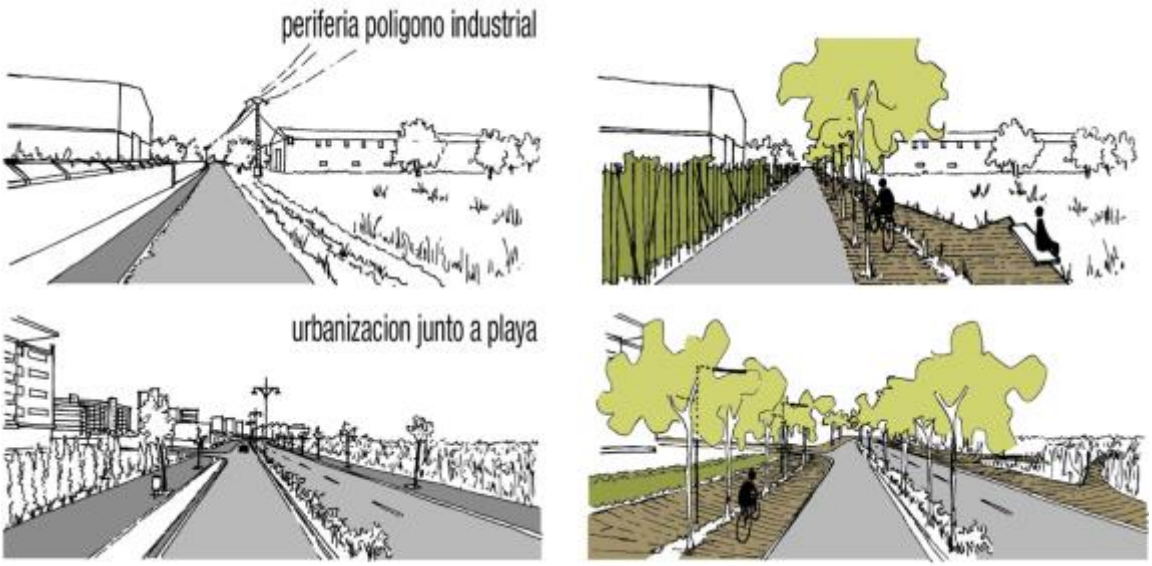

Figure 8: Landscape Regulations for El Puig (students: Belda, E., Muedra, R., Mendez, S., Salvador, N.)

3. Conclusions:

Landscape planning shares with other disciplines or concepts (land use planning, ecology, sustainability) a highly transversal character which seems to be difficult to integrate in an increasingly specialized teaching system.

The education of multidisciplinary landscape planners, trained to understand the wide variety of human, natural and visual aspects involved in the creation, protection and management of landscapes, should be based in an adequate knowledge of those aspects and in the capability to use and combine them in a proactive way. The study plans serving those purposes should compensate the specialized profiles that most of the students tend to have and should provide the transversal fundaments and basic concepts at the very early stages.

In addition to this, the study plans should incorporate and support the wide range of landscape planning concepts, tools and methodologies which are already available and that can be reformulated by advanced students. This explorative attitude should be always kept in mind in order to promote a creative analysis of the territory, the generation of models and future scenarios, and the definition of imaginative but well justified proposals.

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On the Role of Geometry in Formal Design

Toni Kotnik
Aalto University
toni.kotnik@aalto.fi

Introduction

In recent decades, new methodologies have emerged in architectural design that exploit the computer as a design tool. This has generated a varied set of digital skills and a new type of architectural knowledge. This means, architecture is taking part in an "intellectual revolution [that] is happening all around us, but few people are remarking on it. Computational thinking is influencing research in nearly all disciplines, both in the sciences and the humanities. It is changing the way we think." [i] A good example of such reshaping of discipline-immanent thinking by means of computation is the paradigmatic shift in sciences like physics or biology caused by the introduction of the computer as the primary tool for simulating and modelling natural processes (Figure 1). Since the 1950s, this has resulted in a successive modification or even replacement of reductionism as the predominant paradigm of research by a systemic, bottom-up understanding. It is not surprising that architects became interested in these systemic models of nature due to related new methods of organization and form-generation provided by computers and appropriate software. As a result, over the past decade, systemic notions and concepts from science have diffused into architectural discourse and are currently being explored for design purposes.

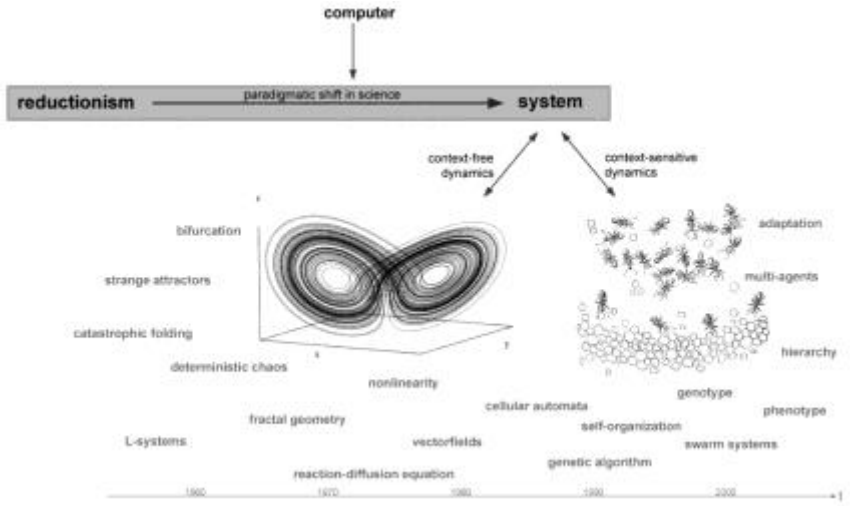

Figure 1: Paradigmatic shift in science from reductionism to systemic thinking and related concepts of exploration that have been taken up in digital architectural design with some delay

The systemic perspective of digital design and the interest in formation processes in science has also caused a renewal of the notion of materiality in architectural design.[ii] This time, however, materials are not viewed from a phenomenological perspective as it has been the case in architectural discourse of the 1980s.[iii] Rather, focus is on the use of quantifiable material properties and their influence on architectural form and construction processes.[iv] The reason is that quantifiable entities can easily be described within a computational environment and, therefore, enable parametric and algorithmic design approaches.[v] Mathematics, hence, plays a key role in this current shift towards materiality in architecture. It is the mediator between form and matter, between architectural design and engineering.

Because of this close relation between quantification and materiality it does not surprise, that current computational approaches to architecture are dominated by an engineering paradigm: the use of mathematics as precise tool for the description of various material phenomena and its application for questions of predictability of behavior, the economic use of means, and for reasons of efficiency. Thus, within digital architectural design mathematics is mainly related with the notion of simulation, optimization and performance. This specific understanding of the role of mathematics within design often results in a typological fixation with respect to structural design and emphasize in the exploration on the spectra of possibilities within a well-defined typology rather than an exploration of new structural and architectural solutions for a given problem.[vi]

As a result of this it can be observed that architects interested in computational means increasingly work like engineers but not as designer, or as Le Corbusier has put it: “Engineers: that means analysis and calculation; Constructor: that means synthesis and creative action”. In a similar way, Hanif Kara has coined the notion of design engineer as an “emphatic model that requires inhabiting the mind of the architect … while thinking with the knowledge of the engineer.”[vii] As this ability for transdisciplinary transgression is rare, digital trained architects often end up in so-called geometry units of larger offices, or as specialized consultant and technical support within the design process.[viii] But very rarely do digital designer end up as responsible design architects. It is this development that marks the starting point of the subsequent rethinking of the role of mathematics within contemporary design thinking.

Mathesis

The reduction of mathematics to a tool for the description of quantifiable relationships does not reflect the essence of mathematics. Already Edmund Husserl had pointed out that the scientific method of quantification of causal relationships is an emptying of mathematical thinking.[ix]

Etymologically, mathematics has its roots in the Greek *ta mathemata*, which means what can be learned where learning, *mathesis*, is about the recognition of the unchanged, the stable, of the Being in a world of constant Becoming.[x] For Martin Heidegger “this genuine learning is an extremely peculiar taking, a taking where one who takes only takes what one basically already has. … The mathemata, the mathematical, is that ‘about’ things which we already know. Therefore we do not first get it out of things, but, in a certain way, we bring it with us.”[xi] *Mathemata*, therefore, is bound to the human perception and its ability to identify reoccurring pattern.

Mathematics is the science of patterns! It is about the examination of numerical patterns, patterns of shape, patterns of motion, and patterns of behavior. They can be real or imagined, visual or mental, static or dynamic, qualitative or quantitative.[xii] *Mathemata* is the human search for patterns as a means of orientation. A fact that Penelope Maddy has pointed out in her exploration of mathematics: “Imagine the purely physical world. This would have to be a giant aggregate composed of all the physical stuff in the universe. There is nothing

nonphysical in this, but most philosophers prefer a less amorphous characterization; they begin with all physical objects, or all particles, or all space-time points. ... To add even this small amount of structure - the differentiation of the amorphous mass into individuals of some kind - is already to broach the mathematical."[xiii]

Order in nature, therefore, is not only based on the laws of physics but also very much the result of perception as an active act of filtering and structuring sensorial information. This means, order is the result of the human capacity to constantly organize and structure perceived information for the sake of orientation. With other words, the world is a construct whose main reference point is the here and now of the body. It is from the body that surrounding reality is perceived, structured, and accessed.[xiv] In its original meaning, mathematics is about relating the body with the world around. As such, *mathemata* is about orientation.

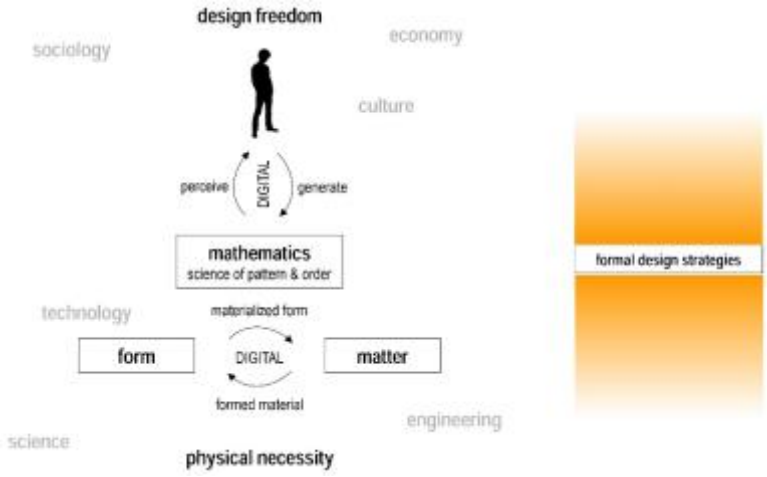

Figure 2: a more general understanding of mathematics can open up the potential for formal design methods as bridge between the technical and the artistic

Because of this, mathematics as a discipline primarily is not a collection of technical tools for precise description and forecasting but rather a way of thinking in structures and organizational pattern. What the discussion above also shows is that contrary to common belief mathematics is not about absolute truth but rather a man-made construct that helps us as humans to formulate and discuss ordering principles and with it the possibility to order and organize the world in which we are living, mentally but also physically. And this characterization as activity of mental and physical ordering is true for architecture, too. Architecture is a man-made construct and a form of expression of the order and organization of our *Lebenswelt*, as Edmund Husserl has called it, of our mental and physical Being-in-the world.

Formal Design Methods

With this in mind, architectural design and its inherent question for spatial order and organization in has to be seen as a mathematical issue, as a question of *ta mathemata* with the mathematical as a way to understand, on one hand, the interaction of form and matter in the physical world and at the same time as a means of human expression. It is in this field between the necessity of physics and the freedom of design that mathematics functions as mediator. This means, mathematics is not limited to the description of the quantifiable causalities in the realm of the physical. But it is an essential part of the design exploration (Figure 2). It is through the architectural organization of form and matter that we as humans are getting aware of related patterns of organisation like social, political or cultural relationships that frame human life.

Formal design strategies in digital architecture, therefore, should not only be discussed with respect to the technical content and requirements but should also

be seen as operations that influence the perception of the underlying configuration. The building up of for example associative geometries and parametric variations are steps in the construction of forms and relationships between parts that introduce information through organization of pattern, through differentiation and disruption of order.

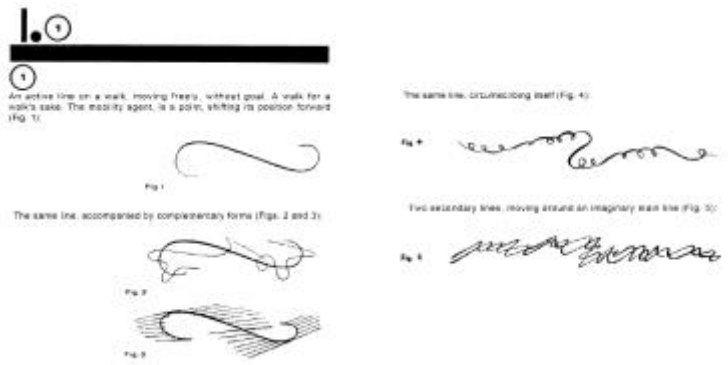

Figure 3: illustration of dynamic visual principles by Paul Klee: the line as trace of a moving point and the change of visual expression of the line by means of simple transformations

Such understanding of digital design as construction of information relates back to similar attempts of exploration of form at the Bauhaus and especially to the systematic teaching of a design theory by Paul Klee in his famous *Pedagogical Sketchbook* (Figure 3).[xv] Klee used it to introduce students into the dynamic principles of visual art that is into principles of *Gestaltung*, into principles of formation.[xvi] Such visual concepts are often acquired through experience. But Klee argued that reflection upon the visual grammar opens up the possibility for a more conscious process of creation.[xvii]

And this argument stays true even more today. Contemporary engineering-driven incorporation of formal method of computation into the design process has introduced the problem of communicability into the discipline of architecture. A problem that is already common to science and engineering. These disciplines have a strong dependency on methods of abstraction and techniques of higher mathematics. Contrary to science or engineering, however, architectural design does not only aim at functionality of its outcome but also at some iconographic readability, of information by gestalt. This does not mean that architects should avoid digital design techniques all together. But it means that formal design methods have to be evaluated not only from a technical point of view but also from a point of view of human perception, similar to Klee's approach to *Gestaltung.* What is required is a human-centered perspective of computation.[xviii]

Spatial Diagrams

This request is the starting point of an ongoing design research that returns to the question of comprehensibility of architectural form and explores the possibility of computational design process guided by human perception. Such a coupling is based on the simple observation that a low-dimensional space of parametric variation of a configuration can be scanned efficiently by humans if a family of variations is looked at simultaneously (Figure 4). This way, the logical-analytic design tool of formal description transforms into a visual design tool that enables intuitive-creative thinking.[xix] The field of variations thereby functions in a way comparable to the imprecision of sketching which evokes visual-spatial thinking. By comparison within the parametric field of configurations, emerging spatial phenomena can be identified more easily and linked to a specific parametric setting. This enables the controlled use of spatial phenomena and their combination within the design process.

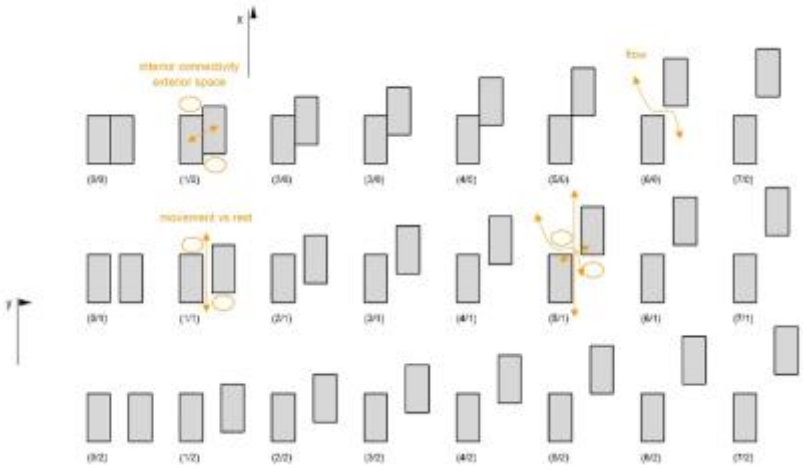

Figure 4: visual identification of spatial phenomena within a field of parametric variation of a simple spatial configuration

Such linking between the computational and the perceptible provides the basis of a design process that has its origin in the detailed study of simple primary forms and their possible variation (Figure 5). These studies are exploring potential spatial transformations that is they are explorations of spatial dynamics and transitions aiming at the production of operative diagrams of spatial conceptions.[xx] As Rudolf Arnheim has already observed in his famous *Dynamics of Architectural Form* "space is created as a relation between objects. These relations persist in perceptual experience. … There are many aspects of experience of which we are not explicitly conscious that nonetheless tinge our awareness in important ways. The visual relations between objects are of this kind. Space between things turns out not to look simply empty."[xxi] The resulting spatial diagrams, therefore, can be seen as the condensed description of the underlying field condition given by the parametric variation, of the "form between things" as Stan Allen has defined it.[xxii]

It is the dynamic of space captured in the spatial diagram, its rhythmic change, its speed of flow, its directionality that defines its architectural potential, its usability for specific program and organizational schemes. In other words, within this design approach it is not a given program that drives the creation of a specific architectural form but rather the architectural form that defines the appropriate program. It is the spatial dynamics of form that informs the architecture and defines its functionality. The generative force of the spatial diagram, however, is not rigid. Rather it is a topological description of a set of relationships that has not solidified into a fixed architectural expression yet. This immanent flexibility enables an adaptation of the internal structure of the diagram to a given context by means of translation of the external conditions into formative sets of geometric rules that help to actualize the spatial diagram based on the inherent dynamic of space.

In contrast to Lynn's urban strategy of NURBS-based deformation of a given geometric configuration this design approach can be viewed as actualization: an abstract spatial diagram is translated into an architectural concept through configurational concretization like for example the interpretation and adaptation of a spatial diagram as schematic sectional drawing. The concretization and contextualization, thus, happens on an intellectual level inspired by perception and visual thinking and not so much by an algebraic transformation driven by quantifiable input data. The resulting architectural conception is still rather schematic and requires further elaboration. It is still abstract but through the additional level of architectural interpretation a path for design development has been opened up that enables and guides further concretization.

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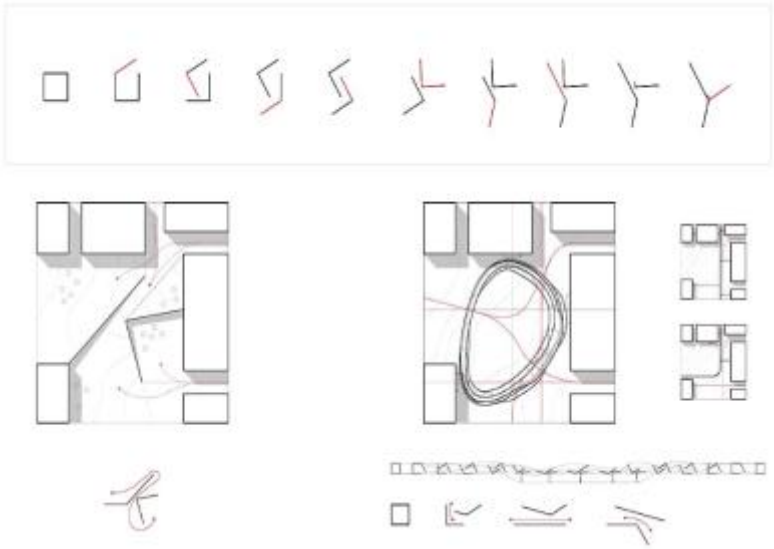

Figure 5: spatial diagram based on a sequence of parametric variations and contextualization of the diagram in a prototypical urban environment (Formal Design Studio, Aalto University, fall 2015, student: Hanna Jahkonen)

First Principles

Central to this further concretization of the spatial diagram are structural considerations because the physical presence of architecture, its corporality requires structural integrity. “Every physical being, living and non-living, has to support its materiality against the various forces that are imposed upon it by its environment, such as gravity, wind or atmospheric pressure. Philosophically speaking, the materiality of physical beings can be thought of as embodiment of two intrinsic coincident principles: primary matter itself and its form, its gestalt in space. Both principles are intricately interwoven, and in the physical world one cannot occur without the other: no material is without form and no form exists without materialization.”[xxiii] Structural design, thus, is used to actualize the spatial conception and give it a physical, tangible expression.

In this regards, structural design is not understood as composition of building elements but rather as flow of forces through space and the interaction of this flow with form and matter, with a material system that tries to give shape to an underlying spatial idea. Such a structural thinking is necessarily not bound to typological fixation but aims for topological flexibility that can cope with the topological softness of the spatial diagram. Because of this, the force distribution in space is not simply visualized using contemporary computational tools like FEA but rather it is constructed step-by-step in a geometric manner based on simple vector-based operations that have their origin in plasticity theory.

Contrary to the widely used elasticity theory, plasticity theory evaluates the structural behavior of a material system, not with respect to the usability based on elastic deformation, but rather, with respect to its load bearing capacity based on the plastic behavior of the material. This approach enables a decoupling of material effects, kinematics and equilibrium[xxiv], and the application of the First Fundamental Theorem of Limit Analysis makes it possible to reduce the question of structural design to equilibrium solutions during the conceptual phase of the design process.[xxv] These equilibrium solutions are based on resultant forces of underlying stress fields, and can be represented by inscribed strut-and-tie models and corresponding tension and compression forces. With this, plasticity theory provides a solid theoretical foundation for a simple vector-based method of structural design that has its origin in Karl Culmann’s *Die Grafische Statik* from 1866, and is able to illustrate the reciprocal relationship between shape and stress in load-bearing elements.[xxvi] In addition, the formal character of this description of the flow of forces enables the direct implementation of a parametric

strut-and-tie geometry that maintains major structural behavioral characteristics under transformation.

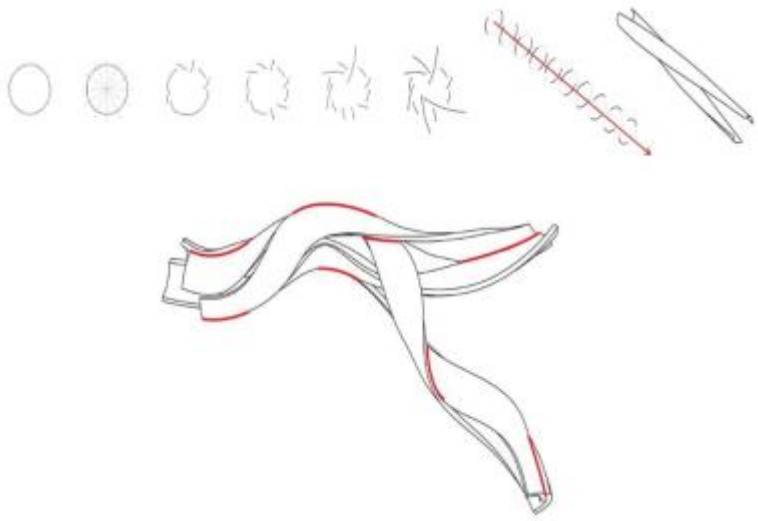

Figure 6: actualization of spatial diagram through geometric stiffening of surface and spatial network interaction (Formal Design Studio, Aalto University, fall 2015, student: Salvador Hernandez Gazga & Laura Zubillaga)

Due to the focus on the flow of forces through space and the topological flexibility of the flow and of the geometric diagrams, the actualization of the spatial concept can easily be freed from the use of predefined structural systems and buildings elements. What gets more important are basic structural principles that can provide an adequate framework for the concretization and the physical manifestation of the spatial diagram. Thus, the conceptual idea of a space as dynamic center that opens up in a fluid way to its surrounding finds its expression in a twirling sheave of concrete strips that stiffen itself locally through the activation of curvature and globally through a weaving strategy that ensures a network of connection points for structural interaction (Figure 6). This means structural design is seen as an active part of the design process out of form and matter emerges according to the underlying spatial concept. Furthermore, structural thinking is not understood anymore as abstract calculus and as analytic activity but much more as synthetic form of thinking that is tangible and aims at a corporal expression of concepts which results in a proto-architectural proposal (Figure 7).

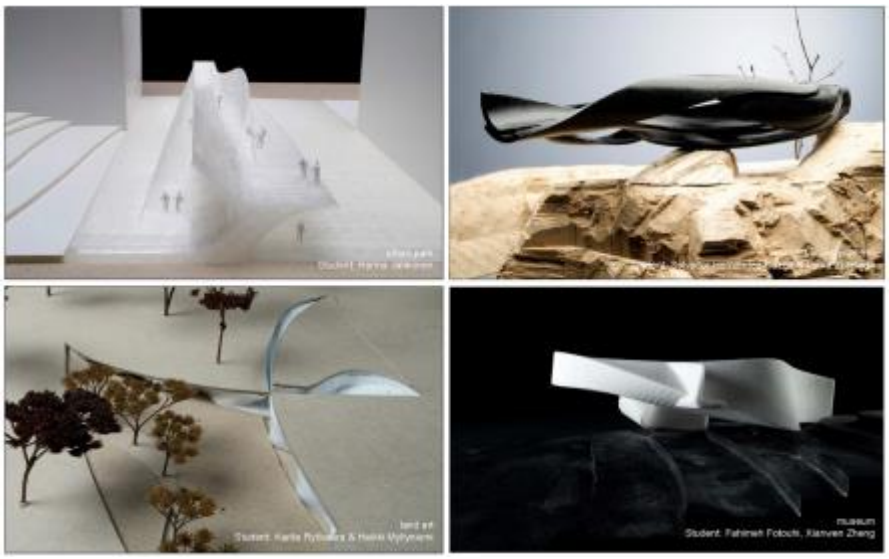

Figure 7: an urban park (student: Hanna Jahkonen (top left)), a cliff-diving platform (Salvador Hernandez Gazga & Laura Zubillaga (top right)), a plaza (student: Karita

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Rytivaara & Heikki Myllyniemi (bottom left)), and a museum (student: Fahimeh Fotouhi & Xianwen Zheng (bottom right)) as proto-architectural proposal (Formal Design Studio, Aalto University, fall, 2015)

Conclusion

The discussed design process describes an approach to conceptual design which understands formal methods not as rigid tools but rather as flexible diagrams. Such a perspective enables an integrative design approach that can help to activate knowledge from science and engineering as supportive part of the design process already at an early phase. The possibility of integration is based on an opening up of the underlying mathematics to creative interpretation induced by an understanding of structures and organizational patterns as visual grammar. From a teaching perspective this reading of structures results in a paradigmatic shift that can be described best in three related moves: from precision to principle, from typology to topology, and from computation to construction.

Strive for precision is omnipresent in applications of mathematics. But precision is not of too much relevance in the conceptual phase of design. Rather it is about directing appropriate fundamental design decisions that will determine the future design development to a large degree. This requires flexibility and the ability to constantly recombine and adapt design schemes and basic concepts. That is why working with principles is of greater relevance at this stage of the design process.

Working with principles immediately implies a rather soft and malleable topological understanding of relationships between entities. Fixed scheme of solutions, typologies, are of less importance in an open and creative process. Typologies are stabilizing factors in a design process. Especially in an integrative approach such standardized schemes can form an obstacle. Topological flexibility, thus, is a key element. It also implies that not the final form is the main driver of the design process but rather the process of formation, i.e. the process of coherent integration of information.

Because of this required flexibility, computational approaches and the underlying well-defined and deterministic procedures often can play only a supportive role in the conceptual phase of the design process. What is of more importance at that stage, therefore, is a building up of the inherent logic of the design, it is the construction of the organizational pattern. Constructability, thus, plays the major role in the conceptual phase. And it is constructability that relates back to the importance of mathematics for design: mathematics emphasizes geometrical construction and problem solving.[xxvii] “Rather than reiterating ontologies of sameness, modem mathematics produces difference through new constructions.”[xxviii] And it is this new construction, this new organizational patterns that an integrative design aims at.

This article is a revised version of parts of a lecture titled ‘On Design of Structures’ presented at the Annual Symposium of Research in Finland at Aalto University, Helsinki, on 24th October 2015 and a lecture titled ‘Design of Structures’ presented at the 3rd Symposium Transformation of Architectural Education at the Izmir University of Economics on 17th June 2016.

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[ii] Oxman, Rivka & Oxman, Robert: *Theories of the Digital in Architecture*, Routledge, 2014

[iii] See for example Norberg-Schulz, Christian: *Genius Loci, Towards a Phenomenology of Architecture*, Rizzoli, 1980 or Pallasmaa, Juhani, 1996. The Geometry Of Feeling, A Look at the Phenomenology of Architecture, in Nesbitt, Kate (ed.): *Theorizing A New Agenda For Architecture: An Anthology of Architectural Theory 1965–1995* ,Princeton Architectural Press, 1996, 448–453

[iv] See for example a series of issues from AD like *Emergence: Morphogenetic Design Strategies*, 2004 or *The New Structuralism*, 2010 or *Material Synthesis: Fusing the Physical and the Computational*, 2015

[v] Kotnik, Toni: *Digital Architectural Design as Exploration of Computable Functions*, International Journal of Architectural Computing, Vol.8, No.1, 2010, 1-16

[vi] An example for such a typological fixation are popular software applications like Rhinovault or RhinoMembrane, both plug-ins for Rhinoceros.

[vii] Kara, Hanif: *On Design Engineering*, AD Architectural Design, Vol. 80, No. 4, 2010, 46-51

[viii] This development has resulted in the upcoming of new types of specialized consultancy practices like *DesigntoProduction*, spezialized in digital fabrication, or *Evolute*, spezialized in panelization.

[ix] Husserl, Edmund: *Die Krisis der europäischen Wissenschaften und die transzendentale Phänomenologie. Eine Einleitung in die phänomenologische Philosophie*, 1936

[x] Compare Platon in his creation story *Timaios*

[xi] Martin Heidegger: Modern Sciences, Metaphysics, and Mathematics, in Krell, David F.: *Martin Heidegger: Basic Writing*, Harper Collins, 1992, 271 – 305

[xii] Devlin, Keith: *Mathematics: The Science of Patterns*, Scientific American Library, 1994

[xiii] Maddy,Penelope: *Realism in Mathematics*, Oxford University Press, 1990

[xiv] Zec, Peter: *Orientierung im Raum*, Mabeg, 2002, 17 – 19.

[xv] Klee, Paul: *Pedagogical Sketchbook*, Praeger, 1953

[xvi] There is a close relation between Klee's principle of Gestaltung and results made in experimental Gestalt psychology at the beginning of the 20th century. For more details see van Campen, Crétien: *Early Abstract Art and Experimental Gestalt Psychology*, Leonardo, Vol. 30, No. 2, 1997, 133-136

[xvii] For a contemporary collection of the visual rules see for example Leborg, Christian: *Visual Grammar*, Princeton Architectural Press, 2006

[xviii] While most computing-based design tends to emphasize the formal aspects of architecture, overlooking space and its users, early computational design approaches first spearheaded in the UK in the 1960s and 1970s tended to be focused on behavioral and occupational patterns. Over the last decade, a new generation of design research has emerged that has started to implement and validate previous investigations into spatial computation. See for example Derix, Christian & Isaki, Åsmund: *Emphatic Space: The Computation of Human-Centric Architecture*, AD, Vol 84, No 5, 2014

[xix] Gänshart, Christian: Tools for Ideas: An Introduction to Architectural Design, Birkhäuser, 2007, 121

[xx] In the given situation, the underlying parametric description ensures the operativeness of the diagram. For a detailed definition of the notion see Kotnik, Toni & D'Acunto, Pierluigi: *Operative Diagramatology: Structural Folding for Architectural Design*, Proceedings of the Design Modeling Symposium, Berlin, Springer, 193-203

[xxi] Rudolf Arnheim: *The Dynamics of Architectural Form*, University of California Press, 1977, 17

[xxii] Allen, Stan: "Field Condition" in Davidson, Peter & Bates, Donald L: *Architecture After Geometry,* AD, No.127, 1997, 24-31

[xxiii] Kotnik, Toni & Weinstock, Mike: *Material, Form and Force*, AD Architectural Design, Vol. 82, No.2, 2012, 104-111

[xxiv] See for example Marti, Peter: *Theory of Structures*, Ernst & Sohn, 2013

[xxv] Muttoni, Aurelio / Schwartz, Joseph / Thürlimann, Beat: *Design of Concrete Structures with Stress fields*, Birkhäuser, 1996

[xxvi] Lachauer, Lorenz & Kotnik, Toni: *Geometry of Structural Form*, Proceedings of Advances in Architectural Geometry, Springer, 2010, 193-203
[xxvii] Lachterman, David Rapport: *The Ethics* of *Geometry:* A *Genealogy of Modernity,* Routledge, 1989, vii
[xxviii] Mertins, Detlef: Bioconstructivism, in Spuybroek, Lars: *NOX: machining architecture*, Thames & Hudson, 2004, 360-369

Architecture in Suspension

Disruptive practices within the state of exception

Dr. Francisco García Triviño
Department of Architectural Design, Universidad Camilo José Cela, Madrid, Spain
francisco@hipo-tesis.eu

Dr. Fernando Nieto Fernández
Group X, Department of Architecture, School of Arts, Design and Architecture, Aalto University, Espoo, Finland
fernando@hipo-tesis.eu

Abstract

In his work *State of Exception*, the Italian philosopher Giorgio Agamben has recently studied the consequences of the exception becoming the rule. He explains a situation where the law requires the partial exclusion of the legal order so as to preserve its legitimate character. It forms the basis of the so-called "spaces in suspension", where the rule is the exception in the form of the suspension of the legal order, the anomie. In those spaces the act of government is located in a threshold area of ambiguity between general and particular spheres.

The transference of Agamben's concept into architecture is possible. There are physical scenarios where the norm is not a security shield since it is accomplished and questioned at the same time. What type of architecture is responding to those spaces in suspension? Is there a critical attitude boosted by those kinds of architectural practices?

The paper approaches the topic through a theoretical contextualization of the idea of the state of exception in architecture. This approach is based on the analysis of some case studies, which are considered as disruptive practices since they are proposing new ways of practising architecture. They utilize strategies such as new interpretations of the law (urban prosthesis, occupation of public spaces), the replacement of the authorities' duties (occupation of public buildings and empty plots) or the proposal of new teaching practices. Their analysis let the authors define a specific context in architectural practice, which reflects a new paradigm called "architecture in suspension".

1. Introduction

The Italian philosopher Giorgio Agamben has recently studied the consequences of the exception becoming the rule, and furthermore, when the law requires the partial exclusion of the legal order so as to preserve its legitimate character. It forms the basis of the so-called "suspended spaces" or "spaces in suspension", where the rule is the exception in the form of the suspension of the legal order, the anomie. Spaces in suspension are the basis of the state of emergency or state of exception (SoE), in which the act of government is located in a threshold area of ambiguity between general and particular spheres (Agamben 2005).

PEER-REVIEWED ARTICLE

This paper proposes a relationship between the SoE and architecture. Architecture with SoE is not understood here as the discipline for creating buildings within a political system governed under that state. However, it concerns architectural works that are self-sheathed within that state to achieve their survival. The SoE intervention comes from the citizens themselves and not from the institutional bodies. The relationship analysed here deals with a situation in which the architect becomes an agent who establishes his ways of doing between something that is neither inside nor outside the regulations. Therefore, he suspends the rule of law to be undertaken precisely to ensure its continuity.

What would be the translation to the physical space, inherent to architecture, of the political space within the SoE? If, according to Agamben, the situation of exception is becoming the norm nowadays, what are the mechanisms or strategies used in architecture to confront the SoE with the established rules, to create those spaces in suspension?

Including its benefits and dangers, SoE is a new paradigm of the institutional governments in order to safeguard certain objectives. In the context of the Spanish institutional, economic and social crisis of recent years, is the architecture for the SoE reflecting a dislocation between state and life? Is the architecture responding to that state a proper way out of the crisis? Alternatively, is it perhaps a way of questioning and simultaneously updating the process to produce architecture itself?

2. State of exception and regulations

The main characteristic inherent in regulations is the promotion of the collective good, i.e., to put forward the norm as a public right over private interest. Therefore, it establishes the limits of individual liberties as opposed to the interest of the community. Therefore, the norm is understood as a social conquest and, as such, it is a parameter showing the development of a society, since it determines the rights of action for individuals in relation to the group interest. Namely, this legal meaning of the norm leads to mass welfare and implies social progress, as well as democratization by way of establishing limits to the standard.

All rules entail a key question: at what point do the rules become unnecessary when regulating a reality accepted as normal? If a situation is perceived as normal and, therefore, legitimate, there is no need to regulate it. In this sense, norm and habit are closely related, with the order of the factors that form the binomial becoming increasingly important. While the usual sequence is that the norm regulates the subsequent events, the tradition of a customary law, where the norm originates from common usage or custom, has historically been present.

The legislation as a collective achievement is interesting for two main reasons. On the one hand, it is an update on the concepts referring to a certain time and place, since a norm regulating obsolete material loses its reason for being. Moreover, it is a true reflection of a particular culture (Nieto, 2014).

The state of exception as a form of government should not be confused with a special law or right. As in architecture, a specific urban development or a special plan are not related to a certain space of exception. It is a period of emergency, such as certain actions in architecture or urbanism as a special urban development plan, which does not confer a special right but results in a unique situation since it evades the ordinary. It is exceptional legislation that via a government decree becomes a common practice in European democracies.

Including its benefits and dangers, SoE is a new paradigm of the institutional governments in order to safeguard certain objectives.

Agamben defines the state of exception as a threshold situation, such as those that occur when the rule of law is suspended to ensure its continuity. According to him, the state of exception is the political situation that lies between anomie and the rule of law, between violence and law, between staying outside and being within government institutions. It is defined and explained through public law and

constitutional law, between the legal order and life itself. Agamben demands the need to investigate the reason for the disconnection between opposite poles, not so much to articulate them but to get to know them from the perspective of this intermediate situation.

It is a period of emergency, such as certain actions in architecture or urbanism as a special urban development plan, which does not confer a special right but results in a unique situation since it keeps away from the ordinary.

In a republic, a president can order a SoE on three grounds: national independence, territorial integrity, or execution of its international obligations. In the sphere of architecture, architects also apply a self-designated SoE under similar conditions, in situations that are neither totally outside the urban regulations nor completely inside. It is an ambiguous situation of non-institutionalization, not sufficiently appreciated nowadays, although it is a common practice and an additional field of action for architecture.

The suspension of the norm does not mean its abolition. Instead, it creates an ambiguous scenario whereby those situations that are neither inside nor outside do not exclude it but make it indefinite (Agamben, 2005). It is not anomie, since it is still associated to the legal status. Therefore, the SoE for Agamben carries the concept of *nuda vida* (bare life), which refers to a situation where life is unprotected since it is neither within the law nor outside of it.

As it occurs in politics, the SoE in architecture is not based on a state of necessity since this necessity does not become objective, but it is also a norm. It is a way of being outside and yet belonging the structure of the state. The SoE in architecture is undoubtedly a time of violence without logos.

3. Disruptive practices within the state of exception

The following case studies illustrate the translation of the situation previously explained in relation to architecture. In these, architects utilize a sort of SoE to ensure ethical guidelines are retained in architecture, both to avoid costly and numerous legal procedures at the institutional level and the dangers of unstable conditions arising from illegality. All except for last one are focused on the contemporary architectural context in Spain.

Agamben argues that when there are no fixed rules or principles for all, management imposes itself to solve the problems in whichever way it deems necessary (Rojo, 2004). The case studies shown here share an emphasis on management procedure, over other instruments explicitly drawn from the field of architecture (*the great principles are increasingly useless*, Rojo, 2004).

All the following cases are based on a temporary situation, which is closely linked to the character of a SoE, i.e. as if everything is about return to a normal situation even though it will not. The analysis of the case studies are used to draw conclusions that lead to a theoretical categorization of what we have called architecture in suspension.

All examples deal with spaces in suspension from different perspectives. Each one is explained through a dichotomy (tangible and intangible): an intellectual space (what kind of SoE is proposed) and a physical space (what spatial, material means are used to define that SoE). The examples have in common the importance given to participatory management, since the citizens take the lead in the situations shown. They are classified according to the response offered to the SoE in which they negotiate their conditions:

- State of exception through… urban prostheses
- State of exception through… the occupation of public buildings
- State of exception through… the occupation of public space
- State of exception through… replacing roles
- State of exception through… disruptive teaching projects

3.1. State of exception through urban prostheses

3.1.1. Housing extension on a scaffolding, Seville, 1998

In 1998, the Spanish architect Santiago Cirugeda proved how someone can get to build a physical SoE in response to the regulations of a historic city center. In the city of Seville, very strict protection regulations seek to value the historical architectural qualities, but fail to recognise the changing needs of its inhabitants. Hence, the simple need to expand a dwelling can become an insurmountable problem, unless exceptional tactics are used.

To expand an existing dwelling, Cirugeda uses a request to install scaffolding to the City Planning Department, in order to repaint a facade where he had previously painted graffiti. After making the usual health and safety project, required for such installation by the city regulations, he gets the license from the Professional Association of Architects and then from the City Council of Seville. Therefore, he can place the scaffolding in the street (Figure 1).

The importance of space in suspension in this case lies in disrupting the idea of temporality conceived by the municipal authority when granting the permission to build a private premise on a public plot.

Once the scaffolding has been installed and the 4-square-meter expansion of the dwelling executed through this legal void, the architect denounces himself and notifies the municipality of what has occurred. He acts this way neither to let the authorities improve the regulations, nor to make them more specific or define further ones, but to raise awareness of the social need for the temporary growth of some housing in the city.

The importance of space in suspension in this case lies in disrupting the idea of temporality conceived by the municipal authority when granting permission to build a private premise on a public plot, although this specific site is a suspended plot over the public street. The public nature of the plot enhances the achievement of the construction permit due to its ephemeral character. If the same action had been proposed on private land, it would have been considered as susceptible to be consolidated over time, and most likely, it would not have been accepted.

Figure 1. Subversive strategies of urban occupation: scaffolding. Recetas Urbanas (Urban Prescriptions) by Santiago Cirugeda, Seville, 1998. Image source: www.recetasurbanas.net.

3.1.2. Housing prosthesis on rooftops, Seville, 2008

Something similar happens in Seville's historic downtown with the occupation of houses on rooftops (Figure 2). In this case, an internal contract or procedure agreement between the architects and the residents whose roofs are occupied solved the legal problems of a settlement without any plot cost. Here the SoE to the established regulations has to do with a perversion of the idea of temporality in the solution proposed, through the contrast between the final solution executed as semi-permanent cabins, and the ephemeral character supposed in the placement of light structures on rooftops, solutions completely accepted by the regulations.

Figure 2. Housing prosthesis on rooftops. Recetas Urbanas by Santiago Cirugeda, Seville, 2008. Images source: Quaderns magazine (April 2005, n. 73. p. 245) and www.recetasurbanas.net.

3.2. State of exception through the occupation of public buildings

3.2.1. La Tabacalera (The Tobacco Factory). Self-managed social center in Lavapiés, Madrid, 2010

The former tobacco factory in Madrid La Tabacalera is a space with about 32,000 square meters located in the central district of Lavapiés, a very typical neighbourhood in the city where a large population of immigrants are located and where social problems exist. The building structure, finished in 1790, is a classic typology of manufacturing facilities from the eighteenth century, with large structural spans and three courtyards (Figure 3). After the privatization of the company La Tabacalera/Altadis, the building was closed for ten years without any maintenance.

In 2009, the Ministry of Culture released an architectural competition to convert the building into a cultural centre dedicated to visual arts, a museum with aspirations to be a national reference, due to the building's strategic position in the city centre. The economic crisis paralyzed the project and pushed it into a legal limbo. In early 2010, the Ministry commissioned an art installation from a cultural association. This non-profit association responded with a proposal to reopen the building and boost its self-management by utilising involvement from all the neighbours. The government accepted the proposal and since then, through renewing one-year or two-year contracts, the license for self-management and building occupancy has been continued.

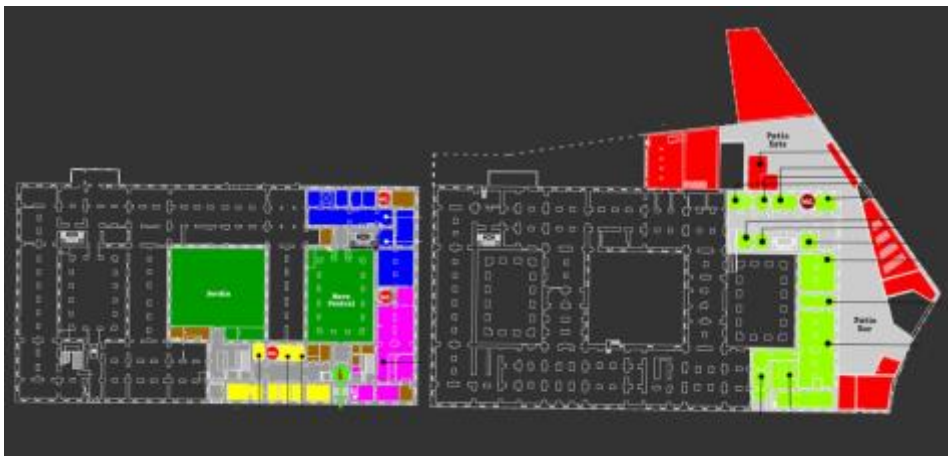

Figure 3. La Tabacalera. Self-managed social center in a former tobacco factory in Lavapiés, Madrid, 2010. Image source: www.latabacalera.net.

3.2.2. La Casa Invisible (The Invisible House), Málaga, 2007

Something similar has happened in the social and cultural centre of self-management, the so-called *La Casa Invisible* (*The Invisible House*) in Málaga, on the coast of Southern Spain. This bourgeois house completed in 1876 and approximately 2000 square meters in size (Figure 4), was abandoned for many years until an occupation in January 2011. The main difference with La Tabacalera is that this building was occupied illegally from the beginning. With the support of certain social groups and intellectuals, it finally got a contract to legalize the occupation of the building, which has been renewed every so often.

The physical spaces generated in these cases are organized by active self-management, which constitutes a suspension of the law that results from the collective occupation of an empty building. There the management of the activities offered is boosted through assembly decision making by their users, based on an actual participatory democracy.

In both cases, the abandonment by the institutions of historic buildings in places with strong social demand is an opportunity to respond to those social needs. Buildings with strong potential in space qualities and strategic urban location are able to welcome numerous public activities. Again, a temporary contract continually renewed becomes an established law that orders the architecture invisibly. Activities and spontaneous refurbishments carried out in these buildings are designed and developed based on this feature, since temporary premises can hardly get building permits or develop an official program of activities.

However, these activities ensure the liveliness of the buildings and help to uphold their maintenance, since the programs housed by such buildings prolong their useful life.

Figure 4. La Casa Invisible. Málaga, 2007. Image source: www.lainvisible.net.

3.3. State of exception through the occupation of public space. Acampada Sol (Occupy Puerta del Sol), Madrid, 2011

On May 15, 2011, against the backdrop of the Arab Spring, within a hectic economic crisis in Spain, amidst the highest rate of unemployment in the European Union, and a continuous reduction of social rights for citizens by the government, the so-called Acampada Sol took place in Madrid. It was a peaceful occupation of public space in the emblematic square Puerta del Sol in the city center, which spontaneously gathered more than 19,000 people in the square and surrounding streets, before fading away after a few weeks. Due to its starting date, the movement was well known in Spain as the 15-M movement. One year later the architectural value of that event was recognised with the award of the best European public space (Figure 5).

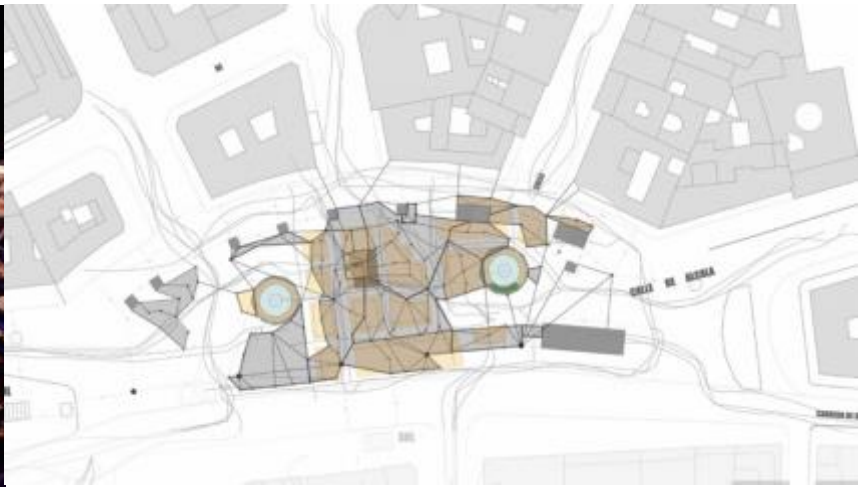

Figure 5. Acampada Sol. Floor plan of informal growth and general view, Madrid, 2011. Images source: www.publicspace.org.

The concentration of people in and around Acampada Sol began during the days leading up to the regional and municipal elections. The protest-camp took place under the right of freedom of assembly afforded by the Spanish constitution. It allows indefinite and peaceful meetings in a public space without prior notice being given to the authorities, provided that there is no public manifestation of opposition to or in support of any particular political party. Such partisan political expression would have not been allowed due to the established period of "ideological silence" in the days previous to all elections.

Nowadays, this kind of concentrations could not have been held because of the so-called "Ley Mordaza" or "Gag Low", an Act relating to public safety that was adopted by Spain in March 2015. This law prevents actions such as demonstrations near to Congress or Senate buildings, taking pictures of police officers, stopping an eviction, protesting on top of public monuments, or meeting for peaceful sittings and resistances. Basically, social actions usually used as protest towards official institutions are punished.

The camp in Puerta del Sol consisted of a spontaneous, lightweight construction, carried out without permission. This ephemeral construction was based on ropes, garbage, plastics and tapes, which formed textile covers with the help of various urban elements in the square (poles, fences, monuments, urban lighting). The construction management and development acquired a complex organization based on street-like corridors and specific areas for activities, including a library and a kindergarten among other facilities. The construction was carried out without infringing any damage to the elements that already existed in the square. Acampada Sol disappeared a few weeks after its appearance, and cleaning groups formed by the same citizens who stayed there left the existing space as it had been before the occupation.

Acampada Sol emerged from illegality since it was a delicate situation for public safety and civil rights of protest and demonstration. A SoE where architecture was able to respond to the lack of a precise link between protest and law.

The SoE that occurs here is once again an ambiguous situation that takes place under the protection of the law, which subsequently had to be modified to avoid similar situations. Acampada Sol emerged from illegality since it was a delicate situation that blurred the needs of public safety with those of civil rights of protest and demonstration. It supposed a SoE where architecture was able to provide a link between civil protest and the law.

3.4. State of exception through replacing roles. El Campo de la Cebada (The Barley Field), Madrid, 2010

In 2009, the City Council of Madrid demolished a municipal sports facility in the central district of La Latina. The plan was to build a replacement and respond to the pressing demand for public facilities in the city center, in the context of a considerable lack of such facilities. After demolishing the existing building, and

before the beginning of the construction of the new premises, the economic crisis emerged and the project was interrupted. The result was an empty plot of more than 5,000 square meters, surrounded by a fence in the middle of one of the most popular and inhabited districts of the downtown area.

Since 2010, an exemplary model of management by citizens has transformed the plot into a lively space full of activities of all kinds, involving the local community and attracting new visitors (Figure 6).

This is an example of casual participatory planning, similar to Acampada Sol, but here with a broader content of activities replacing those of municipal management. It is a public space limited by a fence, with multifocal space development and a sporadic but constant celebration of activities, different from the 15-M Movement, which was a continuous occupation during only a certain period.

In this case, the suspension of normality occurs from transiency, the main characteristic of the SoE. Therefore, it is a project with an expiration date, the one corresponding to the re-establishment of the new premises planned for the site. Here a situation of anomie occurs in the municipal management as a rule of law. It is a suspension of the norm in the sense of an exception to a normal situation, where the City Council is supposed to be in charge of providing uses or activities in relation to public buildings or spaces.

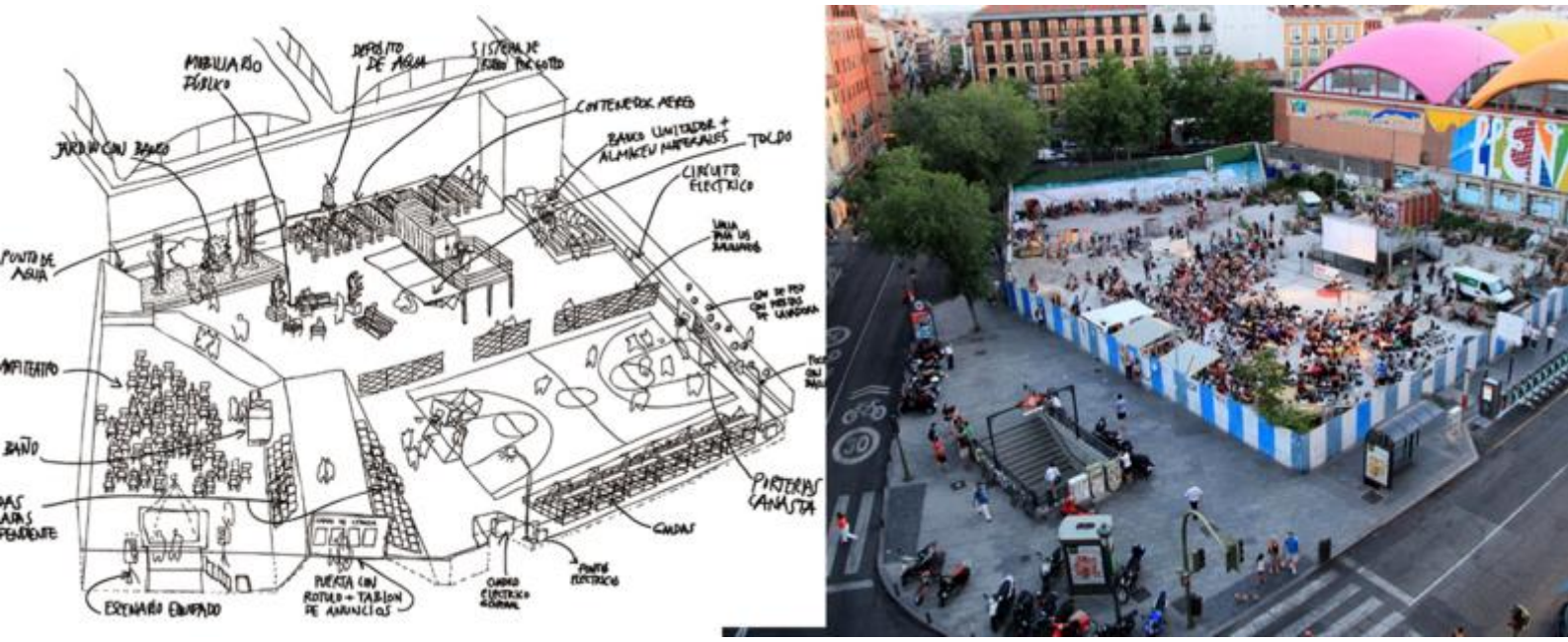

Figure 6. El Campo de la Cebada. Madrid, 2010. Images source: www.publicspace.org.

3.5. State of exception through disruptive teaching projects. Workshop on minor developments, Architectural Association, London, 2010

The next case study consists of an exercise in the Architectural Association School of Architecture in London. It shows how the Academy can assume the condition of infringement or infraction as a project strategy or planning tool for students (García Triviño, 2014b). In 2010, David Knight and Finn Williams developed a studio course focusing on recent minor developments in the context of urban planning and building construction.

The government had introduced changes to the regulations in the General Plan for Development. In order to control and reduce the number of requests for building extensions, the exercise of the studio course engaged in locating those

extensions made under the control of the new regulations. Based on this situation, small urban development extension projects were analysed (home entrances, temporary structures or small entry pergolas).

After their field work, the researchers suggested the generation of a catalogue listing the new constructive possibilities for urban growth, making strict utilization of regulations but also utilizing the ambiguity within the rules. The prohibition for adding new rooms to existing house structures, together with the lack of regulation in the number and size of roof pipes that can be added to any building, ended with a student proposal to create chimney-cabinets that solved the need for space in the dwellings (Figure 7).

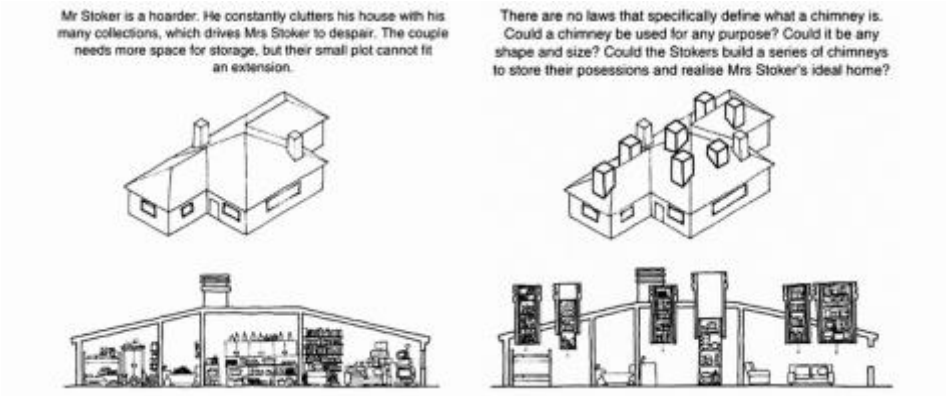

Figure 7. Students' exercise in a workshop on minor developments. Architectural Association, London, 2010. Image source: Knight, D., Williams, F. et al. 2009. SUB-PLAN. A Guide to Permitted Development. Research work at Architectural Association Summer School. London: Lulu.

4. Architecture in suspension

Throughout the previous case studies, the SoE in architecture brings along a number of principles that directly question the conventional approach to producing architecture. They all reflect an understanding of the architectural project from a context that does not necessarily coincide with the strategies or tools of architectural production in previous decades.

The state of suspension in architecture involves a rethinking of the value of the established "normal" architecture, i.e. one that meets the law firmly and consciously. Such architecture is the precise result of what is required by the regulations, applauded by the established media and valued by professional groups. Architecture in suspension is not an emotional activism without consequences, but has become a response to legislation and to the latest architectural creations. It is a new form of production that has not been recognised so far, involving possibilities that professional ingenuity has failed to realise before. The mere presence of an architecture in suspension not only puts the institution on notice of its inability to respond to social concerns, but demonstrates the inefficacy of architecture to accommodate what is really happening in contemporary society.

The state of suspension in architecture involves a rethinking of the value of the established "normal" architecture.

Housing expansions in historic city centers, social centers in abandoned buildings, or public spaces experienced as collective protests, are all spaces with a strong political reading. They are born under social demands and transmitted through communication methods that are a world away from the usual media of professionals. Architecture in suspension is transmitted digitally and almost virally, as if it is seeking to teach others how to break the law under the yardstick of the suspension.

It is not an object or a work that can be transmitted, but a system that is formed through the linking of different social agents who exist outside of normative architectural practices. Hence, the importance in the first case study of

transmitting how to get a building extension for your home regardless of its consequences. Likewise, in other case studies analysed here, the occupation of buildings not only challenges the exclusivity of activities that have previously occurred in those spaces, but anticipates new ones yet to be realised or enacted there.

Space in suspension is the key to activate lethargic public spaces.

Architecture in suspension is read differently from the way we are used to. It is not a result but an information system where agents previously unknown to each other become related. They are not only systems built as information to be shared, but indissolubly they are also political systems demonstrating their makers' ability for self-management. That is the reason for space in suspension to become part of the answer concerning where the public space should be enclosed today. This is because it is able to gather users and creators, who really become the same. Space in suspension is, therefore, the key to activate lethargic public spaces.

Nowadays, under a new society of easy access to information, the potential of public space can be redefined to combine improvisation and societal demands while avoiding exhibitionism of social life. Within this new society, away from anomie, there is a new situation where citizens are able to act upon the information they have and co-create public space without the need of professionals. Citizens or, according to Pekka Himanen (Himanen, 2004), hackers are able to use their skills in information management, to make use of the present to transform it and act ethically against a sleeping architectural system (García Triviño, 2014a).

On the other hand, architecture in suspension questions the temporary condition of architecture itself. It is not about the portion of time that buildings take to be completed, but about multiple new readings that do not fit into the current social rhythms. Therefore, architecture in suspension demands a new time for a discipline capable of responding to spontaneous social needs, and new game rhythms for action and participation. A new reading of our time and stability in architecture means observing the cityscape as changing, as if everything was in flux and part of a constant process of trial and error learning, where the temporary or momentary becomes usual.

According to Olafur Eliasson's deliberation in his book *Models Are Real*, we can claim to live within a new temporary situation. He argues that earlier models were conceived as rationalized stations in the way to achieve a perfect object. For instance, a model of a house would be part of a time sequence, as the refinement of the house's image, but it was considered that the true and real home was a static and final result of the model. Thus, the model was simply an image, a representation of reality that was not real in itself (Eliasson, 2009). The process for making models was a trial and error refinement process over time. The model was a trial tested as a reflection of reality. The accuracy in the model enabled control over the final aesthetic result to be attained.

Furthermore, Eliasson explains how we are witnessing a change in the relationship between reality and representation. It is no longer about the development of a creative process to move from model to reality, but from model to model, since both are equal realities. Everything around us is potentially a model; everything acquires a different temporality.

Two consequences follow when tackling this productive perspective. The first is that a new reading needs to address and to confront reality with established models. Namely, we need to understand any architectural situation as if it was inside a continuous production time, as if any work is partly unfinished or waiting for changes according to future reactions. This is something all the case studies proposed here share in common, which are based on intervening in an existing architectural product, such as housing, public spaces or abandoned buildings.

The second consequence deals with the fact that when we approach reality, it opens and becomes politicized, so that we can all be co-producers of a reality made only through "models". Again, this is shared in all the case studies presented, whereby under this new vision for architecture, it becomes equally accessible to both people and authors, usually professionals. It is an architecture that results in a permanently open, modifiable city, which consciously allows and accepts a need for the updates demanded by contemporary society.

5. Conclusions

Architecture in suspension:

o represents a new paradigm that responds to unstable political situations. Does it pre-suppose, therefore, a renunciation of all that has been considered as stable architecture so far?
o turns the law into a decisive tool in its development. Should we understand the law as a tool or as a restriction? Accepting the law as it is, are we exempted of our ethical responsibility?
o uses the exception to the rule as a rule. Fulfilling the law, it takes advantage of the rule gaps to propose a new situation. Should we take into account what is omitted from the agreements? Is there any possibility for recognition?
o uses the state of exception as an escape hatch, capable of letting us out through an existing disconnection between the law and the pursuit of desire. Should we formalize escape hatches in order to safeguard alternative ways?
o is a way of activating the public space, to awaken the sleeping field of architecture through some agents who are at the same time its users, creators and hackers as well. Why do not we value those agents as makers who can compete with the same responsibilities and demands as other professionals?
o questions architecture as a stable, immovable value. It makes other types of architecture understandable as stages in a process of infinite manipulation. How should we assume the existences of those kinds of architecture?
o the project of architecture in suspension utilizes renunciation as an inalienable starting point. Why do we continue understanding new buildings as the most valid architectural response to space demand?

Architecture in suspension turns the law into a decisive tool in its development, uses the state of exception as an escape hatch, and questions architecture as a stable, immovable value.

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Paimio Sanatorium: interrelationships within a technological system

Marianna HEIKINHEIMO
marianna.heikinheimo@arkbyroo.fi

Abstract

This paper discusses the water, sewage, ventilation and electrical systems at the scale of the patient room, as well as the scale of the site, in the Paimio Sanatorium (1928–1933), designed by Alvar Aalto. The theoretical underpinning for the study is the actor-network theory developed by the French sociologist Bruno Latour. Besides the social theory, it also assigns a role for material factors in the evolution of technological systems. In this theory, the relationship between social and material *actants* is reciprocal, an observation which opens up interesting angles into architectural research. The study aims to answer the questions: which *actants* modified the decisions regarding different technological solutions; how did they mediate this input; and what kind of impact did the processes make, in themselves, in return?

I deduced, that the building process of the sanatorium involved a lot of new technology, the application and development of which was an integral part of the architectonic meaning creation in a large-scale institutional construction such as this, and it succeeded in varying degrees. The success or failure of the design largely depended on how viable a network the *actants* were together able to assemble.

The examination of the relationship between architecture and technology in the building process of the sanatorium reveals which issues were critical for the architect and for the other *actants* in shaping the different solutions, and helps us understand why a certain system was developed further than another – and how modernism came to be expressed in Paimio Sanatorium.

Keywords: Alvar Aalto, Actor Network Theory, Paimio Sanatorium, Finland, Construction history

PEER-REVIEWED ARTICLE

Figure. 1. This photo shows the key hygiene fittings for the patient room. Photo ark-byroo, 2015.

1. Introduction

Beatriz Colomina has argued that, in the 20th century, the production of architecture shifted from the building site to the immaterial domain of the media: architectural publications, exhibitions and journals (Colomina,1998,14–15). However, when a building is eventually constructed, the architect has to face the local culture, other social stakeholders and the material reality. The architect's vision of a building is tested when it must be reconciled with various phenomena, and hence loses its autonomy.

When a building is eventually constructed, the architect has to face the local culture, other social stakeholders and the material reality.

I have studied Paimio Sanatorium (1928–1933), which is considered Alvar Aalto's international breakthrough design; on the one hand from the perspective of the architect's discourse and on the other hand, of the realisation of the building. I have examined the chain of events at the construction stage of the solutions that were ideologically important for Aalto within the framework of the interaction between the different stakeholders, employing Bruno Latour's Actor Network Theory.

Like Latour, I have understood technological systems as being heterogeneous, and not merely physical or mechanical. Social actors, such as individuals, companies and institutions, were equally treated as parts of technological systems. Moreover, they represented different values and attitudes, which also formed a part of technological systems. In this study, I approached the building process as a technological system. It then followed that the different *actants* were seen as shapers of the technological system.
The examination of the relationship between architecture and technology in Alvar Aalto's Paimio Sanatorium reveals which questions were critical in shaping the different solutions, and helps us understand why a certain system was developed further than another – and ultimately how modernism came to be expressed in Paimio Sanatorium.

1.1 Research question

A new architectural ideology was championed in the Europe of the interbellum period by architects active in CIAM[1], who embraced in their professional discourse the rationalistic management techniques developed in the United States (Brunnström, 1990, Standertskjöld, 2010). Aalto drew influences from this culturally radical Modernistic discourse and applied new ideas to his work. He felt

that architecture should respond to the demands of the age, that is, modernisation (Schildt, 1984,1997). Although the ideology of Modernism ignored the significance of local culture in construction, buildings are inevitably cultural objects that are tied to both time and place (Hartoonian, 1997, 34–42). What is interesting to analyse is how did Aalto manage to reconcile international ideology and local building culture in a country where the degree of industrialisation in the building sector was relatively low, and in which way international discourse was brought into practical solutions in the Paimio Sanatorium project.

The systems for heating, ventilation, sewage and electrical installation developed rapidly in the early decades of the 20th century and the demand to incorporate them into the architectural overall design became paramount. Who knew how to employ these new systems and what were the critical points to consider in developing solutions? Were the systems sufficiently ready to be used as such, or did the architect or other project stakeholders contribute to their development? Special attention was paid to find out which building parts of the sanatorium Aalto was most interested in. The question that emerged from this is: Were these building parts that he paid special attention to the same that were highlighted the international discourse? And again, which technological systems did he pay little attention to? I will compare Aalto's approach to water, sewage, ventilation and electrical systems at a scale of the patient room, as well as the scale of the site. The subject matter of this research was to study in what ways specific architectural solutions were developed in the interaction between different *actants* in the heterogeneous building process, comprising both human and mechanical factors: who and what influenced the technological solutions and systems of Paimio Sanatorium, and in what way did these players influence the process, and how did the process affect them? This research attempts to bring out the interplay, especially between the architect, the client, the engineers, the builders and the building materials.

Special attention was paid to the role of the architect, whose aim was to convince all the other stakeholders of the superiority of his solutions: how did he express his ideas, justify his views and act to reach his goals? The working hypothesis was that the architectural solutions were influenced by the process of materializing the building by the other *actants* than the architect. The focus of this study is therefore on the process of design and construction.

1.2 Exploring documents in multiple archives

I allowed the actants I focused on to lead me to the salient perspectives and discourses. Also the architectural discourse relating to the technological system was seen as part of the reality of the research object, and of the architect in particular. Besides the written sources and archive material, the building itself served as evidence as it in some cases revealed something else than for example written documents and drawings. Different tactics were used in regard to the evidence; for example, the minutes of the Building Board and the Building Committee meetings, important source material, were considered both as determinative and as inferential evidence, and the contemporary literature as contextual evidence.[2]

The research focuses on the making of the building, the interplay between the stakeholders and their decision-making process. The timeframe of the building project extends from 1928, when the decision to build Paimio Sanatorium was taken by the Federation of Municipalities of South Western Finland and the architectural competition, open to Finnish architects, was launched, until 1933, when the sanatorium was inaugurated.

Texts written by influential architectural ideologists of the 1920s and the 1930s were analysed. In this research closer study of the international discourse was limited to the printed presentations of Le Corbusier and Walter Gropius at two CIAM seminars.[3] The selection of Aalto's texts was based on date of publication

and the value of the information.[4] The textual analysis was done by identifying ideas or ways to understand the relationship between the architecture and technology of the period. It focused on the strategies of the writer, and tactics dealing with the topical focal points of this research. Aalto's own texts were analysed in the same way as Le Corbusier's and Gropius's texts.

For the research into the execution of the building design, one of the two archives of major importance was the archive of the hospital itself. The minutes of the Building Committee and the Building Board are records of decision-making during the building process, of which most are preserved for posterity. The hospital archives also contained contracts, as well as the drawings and specifications of the engineers and companies responsible for executing different parts of the building. In both of these administrative bodies, the Board and the Committee, the same person acted as secretary. Most of the minutes are typed, and some are handwritten. In each document there are several sections, each one dealing with one subject matter only. The style of the documents is objective, the texts are short, and most often only the decisions are recorded. In the minutes of the executive body, the Building Committee, the discussion of alternatives and the grounds for decisions are mostly omitted. A robust narration of each building component or technological system was first compiled on the basis of the minutes of the Building Board and the Building Committee, the written contracts and the inspection records, which were arranged in chronological order. On the one hand, these documents were considered as factual documentation of the course of events. This narrative of each building part was compared with other source materials, such as drawings, specifications and the building itself. On the other hand, the minutes are part of the reality of the research object, the social interaction of the decision making process. The minutes reveal, e.g., the intentions of different parties and answer questions, such as who proposed what, whether someone objected to something, whether the administrative bodies altered the plans, in what way the solutions and decisions evolved, and who was entitled to act as the representative of these bodies in different situations. The matters that were not discussed in these meetings also reveal characteristics of the process. Besides the courses of action, the minutes reveal what was important for the body to record and how decisions were recorded.

Architectural drawings and other design documents were grouped to match the topical focal points of this research. The groups included drawings from the competition phase to the working drawings, and from elevation drawings to the smallest details and standards drawings. Within each group the drawings were arranged in chronological order. This method was useful for understanding the way in which the design was altered and, e.g. which solutions were abandoned. These considerations were then juxtaposed with the analysis of the minutes and the workshop drawings. Through this method I was able to trace which building parts received the most design effort and who participated in the process. Prior to this analysis, I compiled a database of the entire drawing material, which I would use as support for my analysis. The database also enabled me to carry out image searches.

1.3 Theoretical framework

I approached the relationship between the architecture and technology of Paimio Sanatorium through the perspective of the French sociologist Bruno Latour's Actor Network Theory. I have discussed the design and the construction of the building as a process of innovation. According to Latour, a new hybrid, which in the present study was represented by a building, acquires its shape simultaneously as a social, subjective and material entity. According to Latour, the success of any technological hybrid depends on how strongly interlinked is the network of *actants* representing different ontological categories. In the context of the Paimio case, I have investigated the developers, designers, builders and the material dimensions as such *actants*, who come together, connect and change one another to form a network. Latour uses the term to translate, when referring to the active changing. Below, I have applied Latour's theory in a critical

discussion of the delimitation of the research object and the nature of the groups affecting decision-making.[5] My aim was to reveal the interrelationships within the technological systems at Paimio Sanatorium.

The idea of reciprocity lends particular interest to the actor-network theory from the specific perspective of interpreting architecture, as it provides tools for tackling the interplay between social networks and the material reality in a technological process.

Rather than "actors", the actor-network theory, developed by Latour and his colleagues, talks about "*actants*" that are heterogeneous in scope. *Actants* has been attributed with the ability to act. This attribution can be the result of a proposition, a technical artefact or another *actant* through *trials* of strength. An *actant* is ultimately defined by its strength. They form heterogeneous networks, in other words, they involve *actants* from many different ontological categories, and the strength of the collective thus formed depends on the strength of the hybrid that these *actants* have managed to constitute (Ylikoski, 2000; Latour, 1988, 252; Latour, 1999, 303–304). Action is something that takes place between people and things. Latour urges the researcher to observe the details in view and map out the chain of events. His example directs our attention to what networks reflect of themselves to the outside world (Lehtonen, 2000). In this work I have aimed to adhere to this type of anthropological approach in my analysis of the construction process of Paimio Sanatorium and have focused on the specific chain of events at the construction stage that somehow proved critical and that were taken under discussion.

Using Latour's set of concepts I have looked into the hybrids of architecture, at once both material and social. From Aalto's perspective, the aspects of ideological importance were, among others, the patient rooms and the district systems. For the client, however, providing care for the sick and to do so economically were the primary concerns.

The actor-network theory is interested in the processes through which *actants* mutually build and modify their respective operative situations and objectives. The mobilisation and persuasion of *actants* and the translation of their motives so that their inclusion in the network becomes a necessity are essential (See e.g. Latour 1999 [1987]; Ylikoski 2000) Although the *innovator* of the network, who initiates the formation of the hybrid network, is in a key position, success is primarily determined by the quality and quantity of the tools of cognition rather than, for example, the superior mental abilities of the *innovator (*Latour 1988; Ylikoski 2000).

Another methodological principle of the actor-network theory is the principle of generalised symmetry, which attributes equal footing to both human and non-human *actants* assigning the same explanatory weight to both. In other words, Latour aimed to erase the distinction between the subject and the object, or society and nature. The principle of generalised symmetry is linked with the aim of seeing the object as an active entity participating in a construct as well as with a serious attempt to investigate the significance of objects in human activity. The effect is not one-directional.

Regardless of the criticism[6] it has elicited, I find the actor-network theory a relevant angle to architectural research. By applying Latour's approach, I have given the *actants* a chance to "speak for themselves" about where their interests lay in the design and construction task of Paimio Sanatorium. Furthermore, understanding the master of design as a collective emphasises the nature of design and building as a collaborative process. Like Latour, the point is to see one's hero as a collective and not as a historical person (Ylikoski 2000). The impact of the collective on the architectural solution is particularly interesting in the case of a building that holds a canonized status. When discussing Aalto's buildings we fail either to see or to understand the input of other designers. This

is the very aspect into which the approach and analysis suggested by Latour, provides useful insight. I would also argue that it is possible to make the inanimate architectural hybrid "speak". For example, designs that have been discussed and explained through text and images express the designer's knowledge of the material's behaviour and his intentions regarding the material. The transition of the production method from manual construction towards industrial building methods was also in line with the architectural ideology of the time. The architect aimed to realise his view, to make the material speak, by applying industrial production methods. The reciprocity in the material becomes apparent in, for example, the aesthetically inspired use of material, low production costs or the qualities attributed by the material to the hybrid of which it is part, by way of its fire-resistance or heat-isolation quality. By scientific investigation of the architect's work, I specifically mean his communication with other designers, the client, the builder and product manufacturers, in addition to the actual design work.

2. Analysis

The examination of Aalto's texts and architectural work proved that the source of Aalto's inspiration during the Paimio years were the informal discussions, seminars and exhibition held within the sphere of CIAM. Modernisation and the post-World War II housing shortage led the European debate towards town planning and, furthermore, architects were keen to respond to the challenges of their time. CIAM's 1929 conference, which Aalto attended, was held in Frankfurt am Main, where an ambitious housing programme had been implemented, headed by the architect Ernst May. May extended the scope of design from *Siedlungen* to include the design of objects. Similarly, Le Corbusier stressed the large scale in his urban utopias, as opposed to the small scale in his theories about the biological needs of human beings and the examination of them within the confines of a dwelling. In his paper at the 1930 Brussels seminar, he likened human action with architecture as opposed to the static frame (Le Corbusier, 1931, 48–57). Aalto's article "Asuntomme probleemina" (Our housing as a problem) from 1930 and "Bostradsfrågans geografi" (The geography of the housing question) from 1932 reflect these two scales and reveal the architect's interest in both. In the next chapters I will discuss how Aalto succeeded in integrating the installations into architecture in the Paimio Sanatorium project, in other words, a conscious approach of issues in two different scales: the patient room, and the site.

2.1 Minimum apartment

The examination of the architect drawings revealed that Aalto conceptualised the two-bed patient room as a "minimum apartment". The room was small in size, making space-saving design solutions necessary. Aalto improved the functionality of the room by way of adding details of his own design, and by approaching the room as a holistic problem. To approach the design problem from the perspective of a minimum apartment was justified by a number of factors: the serial production – the patient room was not a singular space, but was repeated 120 times in an identical form; space-saving, which resulted in meticulous scaling and placing the radiator on the ceiling; multiplying the space through added functional features, with the bedside table and night lamp as good examples; and emphasising individual patients' privacy in a twin room by various acoustic means. Aalto had addressed the importance of acknowledging patients' psychological and physiological needs as the basis for design in a talk he gave in 1931 in Oslo (Anon, 1931). The architect meticulously studied each individual solution for the patient room. When the project was nearing completion, he drew numerous diagrams analysing the functions of the space.

Owing to the small size, holistically designed furniture and integrated technical systems, the twin patient room of Paimio Sanatorium is based on an idea similar to the small apartments in German housing estates of the time. The centrality of

the patient room for Aalto becomes evident in the sheer number of drawings related to it. Aalto standardised the patient room with the objective of introducing the furniture designed for the room into serial production. He succeeded in integrating technical systems into his own design as advised by medical experts as well as sub-contractors and manufacturers. The essential values informing the design of the patient room were a quiet environment, preventing the spread of disease, fresh air, good heating and eye-friendly lighting. I interpret Paimio Sanatorium as a collective dwelling house, where each resident was reserved a private space, albeit small, and a great deal of consideration was given to facilitating shared activities and practicality.

The light fittings were a topical design task, as electricity was being used to a greater degree, and the quality of light bulbs was improving (Norvasuo, 2009, 33). Helge Kjäldman had introduced three principles of overhead lighting in a 1927 issue of the Finnish Architectural Review: direct, semi-diffuse and diffuse, which were similar to the principles discussed by Gispen in his article of the following year in the Deutscher Werkbund publication Innenräume, a volume that Aalto had in his library (Kjäldman, 1927, 37–41; Gispen, 1928, 147–152; Norvasuo, 2009, 37). Markku Norvasuo (2009, 53-54) argues that Poul Henningsen related to Aalto the method by which analytical and empirical approaches converged and were utilised in creating the form of a light fitting. Norvasuo also maintains that the overhead lighting in the Paimio patient room represented the view that gained popularity among architects in the 1930s, according to which light-coloured ceilings or walls could be used instead of reflecting surfaces incorporated in the lamp. According to Norvasuo (2009, 79), Aalto's patient room lighting design appears to be a compromise, in which technically appropriate lighting and an experientially satisfactory environment have been brought together.

Knowledge of electrophysics and the function of electrical equipment were essential for a lighting designer. Apart from the influences they apparently drew from Helge Kjäldman, Aalto's engineer, and Poul Henningsen, the Aalto couple were in a privileged position in terms of accumulating and absorbing knowledge about electricity, as Aino's brother and Alvar's brother-in-law, Aksel Marsio, was one of the first pioneers of the electrification of Finland (Suominen-Kokkonen 2015). At the time of the Paimio Sanatorium project, he was heading the Helsinki Electricity Works, and chairing the Lighting Economy Agency of the Finnish Electricity Association. The remit of the agency was to provide information and advice in all matters regarding electricity (Kjäldman 1930, 56–58; Norvasuo 2009, 35). Aksel Marsio's expertise must have had a crucial influence on Aalto's knowledge of lighting and electrical systems and encouraged him in the execution.

By juxtaposing the design documents and the realised lamps, I detected that the overhead light in Aalto's patient room underwent a transformation at the execution stage. Initially, the reflecting surface was part of the light fitting instead of a light-coloured area on the ceiling. The reason for the alteration of the solution was presumably the high production costs, with Paavo Tynell of the Taito Company, the designer and manufacturer of the lights, probably being able to help in reducing them.

Besides rays of light, Aalto also studied the reflection of sound. It would seem that a calm acoustic environment was an equally important factor as lighting in the sanatorium environment. This would be the rationale behind the splash-free, noiseless wash basin; the requirement of silent heating, water and drainage pipes repeating through the work specifications; the use of Enso's fibreboard and wallpaper to create a soft surface on the patient room walls.

Aalto was also interested in developing panel radiators, as indicated by his contacts with Wärtsilä Corporation at the same time as the Building Board was

debating whether ceiling radiators should as a rule be used. The profile of the Rayard standard radiators used in the ceiling of the patient room allowed for the connecting pipes to run inside the radiator.[7] The Spanish architect Mateo Closa has perceptively pointed out that the technical features of the ceiling radiator were hidden beneath a decorative shell, and considered this a characteristic of the older architecture (Closa, 1991, 92–93). Closa was not, however, familiar with the story of how the ceiling radiators became part of the design. In reality, Aalto would have had no opportunity to influence the design of the radiators, even if he had wanted to.

Maintaining a high standard of hygiene was a key ritual at a tuberculosis sanatorium, and a designer's interest would particularly focus on furnishings that would allow for immaculate hygiene. The schematic diagram shows the shape and positioning of two basins, a spittoon with a drain placed between them, and a screen standing between the wash-basin area and the door. The diagram illustrates the placement of piping in the rising within the wall facing the corridor, with the service hatch placed on the side of the corridor.[8] The number of risers was adjusted to the rhythm of the patient rooms. The Building Committee authorised Aalto to negotiate with Arabia porcelain factory on an order of Finnish-made special wash basins, designed by the architect himself, for the patient rooms, provided that these would be less expensive than the foreign alternative and that the State Medical Board would approve of them.[9] Aalto, the designer, played on the fact that they were Finnish-made in order to win the assignment. In the standard drawing of the patient room basin, the basin has been given measurements and the water trap is enclosed in the riser.[10] The Building Committee decided to order the basins from Arabia.[11]

The patient room spittoon is presented in two standard drawings. They differ from each other in respect of the placement of the water trap, which is placed in the riser in one drawing and in the room in the other. Both drawings show a conical glass spittoon with an inward-curling rim, with water running inside the rim fed by a 20-millimetre pipe.[12] A third drawing shows two variations of the glass spittoon with a circular flush and bottom valve. Type A has a straight and Type B an angled rotational piece. Type A has been referred to as the perfect rotational piece. The drawing is probably by Alvar Aalto.[13] The drawings in question represent yet another attempt to develop a universal type.

2.2 District systems

With reverse logic, the building design and construction preceded a number of fundamental decisions made on district systems, including sewage and electricity. When the time came to make these decisions, real alternatives did not exist. The building frame is scaled so that separate grey and black water routes could not be arranged, and all waste water had to be directed along the same pipes, which in turn limited the options for the waste water treatment system. The size of the technical spaces was so small that the sanatorium had no realistic prospect of building its own power plant, which as late as 1931 was still being discussed as a serious alternative to purchasing electricity from the local grid. The local electricity supplier exploited its monopoly status and showed no willingness to negotiate on its tariffs. The report obtained by the client states that establishing a self-sufficient power plant for the sanatorium would require the acquisition of larger boilers, and if the sanatorium relied completely on its own power plant and not even reserve capacity was to be purchased from the outside, two boilers and machines would be necessary. The report did not discuss the profitability of a self-sufficient power plant to any degree, as there was not enough information to back up such calculations.[14] The alternatives in district systems or their spatial requirements were not observed in the early stages of the building project regardless of the fact that the background organisations of the Building Board, including the city officials of Turku, had a wealth of technological expertise. Neither the principal designer, nor any other stakeholder, ever demanded that the installation systems should be designed concurrently with the

architectural design. Aalto did not actively participate in the discussion on the electricity contract or the method of electricity production.

From the perspective of today's building design, it appears unfathomable that the water, sewage and heating systems, as well as the electrical installations, were designed only after the architectural design was complete. The knowledge and skills of different specialists were not at the disposal of the architect until the construction had progressed to execution. The architect was assumed to be able to accept the requirements of installation technologies without any interaction with specialists in their respective fields, at a time when heating, water and sewage technologies were still novelties in large, modern institutions. The architect's competencies were possibly subject to unreasonable expectations.

The work on water, sewage and heating systems was delayed by one year from the initial schedule, because the Building Board had initially, in spring 1930, requested for offers without a reference plan. As a result of the first contracting round, it first commissioned a plan on the basis of which the second round of tendering was held a year later. The one-year delay in the water, sewage and heating system contract had a direct impact on the overall schedule of the project. Collaboration between the architect and Radiator, who designed the water, sewage and heating systems, was fruitful and productive. However, the contract itself was given to another company, Vesijohtoliike Onninen, which had been carrying a smaller contract on the site and was therefore familiar with the developer. Cooperation between Aalto and Onninen was not without its difficulties, and resulted in excess billing on account of many details, for example, the water traps for the wash basins and spittoons in patient rooms. In June 1931, the contractor notified Aalto that the water traps must be connected, as there was not enough space in the wall cavity for them. In December of the same year, it transpired that the installation method of the spittoons and wash basins would have to be altered again, so that the spittoons would have a separate water trap, which incurred additional costs.

Besides holding the role of principal designer, Aalto also acted as the representative of the client to the contractors. He was in charge of purchasing and requests for contracting tenders. Aalto actively attempted to influence the choice of contractors on many occasions. He succeeded in engaging a contractor very close to him for the concrete frame at a very early stage of the construction work, based on a quote that was only the fifth cheapest. His conduct eroded the Building Board's trust in him. He failed in his attempt to exert his influence in the selection of the water, sewage and heating systems contractor so that the contract would have been awarded to Radiator, the designer of the concept. He did, however, manage to agree with the State Medical Board and the Building Board in the middle of contract negotiations on the use of ceiling radiators in the hospital. He believed he would in this way be able to unsettle suppliers other than Radiator, when suddenly faced with a new solution, which would force them to raise their prices. Eventually, all three tenderers were, however, willing to give a financial guarantee as requested by the Building Board, to vouch for the flawless operation of the ceiling radiators. In other words, Aalto's tactic backfired. The concept of Rayard ceiling radiators, which was originally conceived by Radiator, did not deter the other candidates and Aalto failed to secure the business partnership he had been planning. Using Latours's concepts: Aalto failed the *trial* and could not translate the Building Board's actions. It is apparent that the relations between Aalto and Radiator deteriorated as a result of the decision. Aalto had probably specifically contacted the owner and director of Radiator, Arthur E. Nikander, who had contributed to the design by expending his know-how and had trusted in a gentleman's agreement with Aalto regarding the contract.

Aalto and a major Finnish plumbing company, Huber, had probably clashed in the course of their earlier collaboration - the innovative plumbing system at Turun Sanomat - as Huber elected not to place a tender in either of the contracting

rounds. Huber would have been able to provide Aalto with the necessary expertise as early as 1930.

Another unusual detail is that no actual ventilation design was made at any stage, and it simply emerged as part of the heating plan. Had Aalto been in the position to travel to the Brussels seminar in November 1930, he would have been able to listen to Le Corbusier's paper in which he discussed the provision of ventilation and daylight as separate issues. In terms of ventilation, Aalto took a more traditional line and showed very little interest or mastery in resolving this system. The building was initially also to be installed with a central vacuum system, but this was never designed nor realised. Aalto requested for quotes on minute current devices, but as a designer he had no interest in these systems. In terms of electricity, his interest was limited to the light fittings as functional and design objects.

3. Discussion

One of the key questions in this study was to delimit the object of study. By analysing Aalto's writings as well as his drawings, I formed an opinion on which angles were important for the architect from the perspective of architectural theory. In addition, I also tracked the decision-making process of the Building Board and identified a number of topics that it discussed intensely and that caused conflicts. I followed these points of disconnect, which Latour has dubbed as *trials*. These *trials* of the building process, such as dissenting opinions and disruptions of production, revealed the intentions of actants, and because of them the technological solution often got a new direction.

I also applied Latour's theory in a critical discussion of the delimitation of the research object and the nature of the groups affecting decision-making.[15] My aim was to reveal the interrelationships within the technological systems at Paimio Sanatorium to the extent that they affected the architectural solution. However, the material posed certain challenges. The Building Board mainly recorded the decisions it made. This led me to assume that whenever debates or discussions were documented, they must have been crucial. In addition, there were several decisions made on issues that raised conflicts, and yet no discussion or decision had been recorded.

Latour's observations on descriptions of innovation and the intertwining of forces as events that do not lend themselves to generalised concepts formed, in my judgment, a sound basis for selecting a case study as the angle to my topic. Aalto absorbed international influences and applied them in practice in his home country which was still deeply agricultural and struggling in the throes of economic depression. In the field architectural research, Annemarie Adams, among others, has stressed that doctors and architects both left an imprint in hospital design and that modern hospitals in turn shaped medical practice. In line with the theme of reciprocity, I have discussed in this study how the prevailing material reality affected the design solution.

The standards that Alvar Aalto designed for Paimio Sanatorium can be interpreted through Latour's theory of the locality of scientific knowledge. Firstly, Alvar Aalto insisted on including the master drawings, cost calculations, work specification, working drawings and the standard drawings as part of the working drawings in his design contract,[16] which shows that it was somehow necessary to establish the concept of the standard in relation to the client, as the concept was in this context in all likelihood completely new to the latter. The architect created a large number of standard drawings in conjunction of the design work for Paimio Sanatorium; a practice that the contract thus legitimised. Some of the standards were enclosed with the application addressed to the State Medical Board, based on which the state authority decided to grant the permit and funding for the project.

Aalto's intention behind this course of action was to bring an interesting phenomenon into his own designer's studio, and under his scrutiny, so that he could work it the way he wanted to and eventually to the design standards that could enter industrial production - an interpretation that has only grown more convincing in the course of investigation into Aalto's tactics as the chief supervisor of Paimio Sanatorium acquisitions and purchases. Latour's thesis of the locality of knowledge and knowledge management seems to be highly accurate. According to Latour, the secret of an *innovator's* success lay in the material practicality of the innovation, not in the intellectual superiority of the *innovator (*Lehtonen, 2000).

According to Petri Ylikoski, there are three salient themes that run through Latour's later work. Firstly, Latour pays attention to the material aspects of scientific enquiry and aims to incorporate the fields of objects and non-human actors in his social research. His second major theme is the locality of knowledge and management. Scientific knowledge is valid only in the special conditions of a laboratory and when analysing any given piece of knowledge, it is essential to know where, how and by whom it was produced. Thirdly, Latour has no intention of sharing the understanding of scientific activity held by his object of study and uses his own set of concepts instead of those of the latter, since, in his view, the understanding held by the object of study is something to be explained, not an explanatory resource.[17]

The winning competition entry showed that Aalto was capable of taking the objectives of the clients, that is, the federation of municipalities and the State Medical Board, which oversaw the construction work, and turn them into action that were in consensus with his own objectives. Aalto was keen to make sure that the progress of his hospital project was reported by the press in a positive light. A delegation from the 1932 Nordic Construction Days, held in Helsinki, also paid a visit to the hospital building site. Aalto was made into a hero, while the other parties who had contributed in an essential way to the project did not actively feature in the publicity, although some of them were indeed mentioned. The project presentations in Arkkitehti (Finnish Architectural Review) did not include information about any other designer's innovative solutions for the hospital.

In a Latourian reading, the collective remained invisible apart from its *innovator*, which was enough for the audience. The other actors and their crucial input were forgotten. In conjunction with the project description of Paimio Sanatorium in Arkkitehti the feats of modern engineering, such as the ventilation system, were not highlighted as would have been customary for other hospitals of this calibre. The credit for the success, which was the result of the work by the entire collective, went to Aalto alone.

Latour would talk about the achievements of the collective referring to the individual's name, while he would point out that the collective comprised of entities belonging to different ontological categories. In the case of Paimio Sanatorium, Alvar Aalto would stand as a reference to a collective formed by all the social actors and inanimate entities together. In my opinion, Latour's description of the collective reveals something quite essential about architecture, and is well-suited to the study of architecture, in which the role of the designer is traditionally, and often disturbingly, assigned to a single individual, although anyone familiar with the field will know how necessary it is to see architecture as a collective and an applied undertaking.

It is much easier to make the inanimate speak in the field of architecture that in many other disciplines – an aspect for which Latour has been criticised. For example, architectural drawings are an essential part of the development of ideas, as well as their communication or translation, if so wished. It is the architect's job to understand the material and let it speak its own language.
Latour's view that a project will never amount to anything as long as its idea remains pure, is fascinating from the perspective of architecture. A project can

only materialise if it is exposed to and intermingles with other elements. And only when the resulting machine or object becomes unquestionably established, so that this synthesis is forgotten, can an idea be perceived as “pure” (Lehtonen 2000). When examining the relationship between architecture and technology, it would be unrealistic to remain exclusively in the domain of ideas.

According to Latour’s theory, the *actants* produced affect the nature of scientists, laboratories and external actors, and thought, by partly redefining them. This process of production is not one-directional. In my discussion on the architecture of Paimio Sanatorium in the light of this theory, I pondered whether the outcome was one that Aalto had hoped for, and arrived at a conclusion that in a way, it was not. At least, the sanatorium did not turn out the way Aalto had wanted at the competition stage or in April 1930, when the master drawings were created and the State Medical Board approved them. Tracing back the evolution of design solutions exposes the transformation, adaptation or development of the architect’s thought.

4. Conclusions

For Alvar Aalto, the social dimension of the Paimio Sanatorium project was about contributing to the defining of the human network for the project and communication with the network members. Attaching competent collaborators to the project was of decisive importance. The technological process of Paimio Sanatorium found its shape through Alvar Aalto’s subjective vision, which was informed by the international architectural discourse. Personally witnessing and participating in this discourse strengthened Aalto the project *innovator’s* confidence and courage. Aalto developed his vision through interaction, by participating in exhibitions and expressing himself in writing. The sanatorium project developed simultaneously as a social and material undertaking, through *trials*. In other words, the heterogeneous *actants* were placed under constant testing. This process also served to change the train of thought for its *innovator*. For example, the concept of the minimum apartments, with which he was able to personally familiarise himself during the design work for the sanatorium, inspired him to develop the daily environment of the patient. In Paimio, a new type of consumer found a home in the patient room, which Aalto designed based on the international discourse he had embraced. The focal points of his interests are revealed in the successful integration of the different installations in the patient room, although these very systems proved a problem in a larger context, in which the installations were designed only after the architectural design was complete. Aalto’s conduct during the contract negotiations reveal his aim to direct the actions of the social community, even by overstepping or stretching the boundaries of his role, if need be. In Latour’s terms, the question was about translation or attempted translation. It is clear that he also learnt a great deal from the processes that he was unable to control, and the outcome of which was not architecturally sound. The task of the researcher is to follow the *actants* and to register any changes in them and the impact resulting from these changes. As Latour points out, a social scientist cannot know before the fact, what society is made up of. It is something that only the *actants* themselves can disclose (1988a). In a similar vein, an architectural researcher cannot know in advance what architecture is made of, as I myself learnt from this work.

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Verbal information has been provided by Renja Suominen-Kokkonen in personal conversation on March 18, 2015.

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[1] The French name of the CIAM organization was Congrès Internationaux d'Architecture Moderne, and the German name was Die Internationale Kongresse für Neues Bauen.
[2] David Wang classifies evidence of interpretive-historical research in four categories: determinative, contextual, inferential and recollective evidence. Wang 2002, pp. 154–158.
[3] CIAM's seminar held in 1929 in Frankfurt am Main, Die Wohnung für das Existenzminimum, and the one held in Brussels in 1930, Rationelle Bebauungsweisen.
[4] I used as primacy sources those articles that Göran Schildt has discussed in *Alvar Aalto in His Own Words*, edited by him. See Schildt 1997.
[5] In his work *Reassembling the Social*, Latour argues that, instead of preconceived theories and methods, researchers ought to pay attention to oppositions and uncertainties, the five most salient of which according to Latour are the nature of groups, action, objects, knowledge and sociological research. Latour 2007, passim and especially pp. 21–22.
[6] Reijo Miettinen has identified three problems in applying the principle of generalised symmetry in innovation studies. Firstly, limiting a network of entities to serve empirical analysis is difficult. Secondly the theory relies on a one-dimensional view of human activity. Thirdly, the principle of generalised symmetry is ill-suited to describing non-human actants and their activities. Latour's assumption of each actant's ability to speak has also been considered problematic. Miettinen 1998, p. 30–33. See also Lehtonen 2000, p. 292, for the third point.
[7] Contract No. 4 of Vesijohtoliike Onninen, July 9, 1931. Documents related to the Paimio sanatorium project. AAM.
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[14] The letter of Central Co-operative Hankkija to engineer Kilpi, October 16,

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[15] In his work Reassembling the Social, Latour argues that, instead of preconceived theories and methods, researchers ought to pay attention to oppositions and uncertainties, the five most salient of which according to Latour are the nature of groups, the nature of action, the nature of objects, the nature of knowledge and the nature of sociological research. Latour 2007, pp. 21–22.
[16]The contract signed between the Tuberculosis Sanatorium of Southwest Finland and architect Alvar Aalto, dated June 28, 1929. AAM.
[17] Ylikoski refers to works following the seminal 1979 work Laboratory Life, which Latour co-wrote with Steve Woolgar. Ylikoski 2000, pp. 297–298.

Cultural Heritage:
Changing Ideas on Compensation in Planning

Benjamin Grahn Danielson
Kulturlandskapet
benjamin.grahn@kulturland.se

Magnus Rönn
KTH / Architecture
magnus.ronn@arch.kth.se

Stig Swedberg
Kulturlandskapet
stig.swedberg@kulturland.se

Abstract
Compensation measures are a new method for handling impact on cultural heritage in land use planning. The idea with compensation measures can be understood as an extension of the polluter pays principle. Today, compensation measures are mainly used when natural environments are damaged by development, but it is also possible to use compensation measures when a project results in negative impact on cultural heritage. However, there is a lack of experience in using compensation when it comes to the latter.

In our work as heritage consultants, we have experienced difficulties in implementing compensation measures in projects and assignments. Since 2013, we have organised a research project dealing with compensation measures and cultural heritage; aiming towards a new practice and better use of planning instruments. With this paper, we want to share our results from four case studies where development impact on cultural heritage has led to discussions about, and implementation of, compensation measures, find patterns in the use of compensation measures in planning processes. The results show an uncertainty in understanding compensation as a concept. This is due to an absence of practice dealing with compensation measures; cultural heritage values are not addressed in a proper way in negotiations over land access.

Several instruments for compensation measures in planning processes can actually be found in the law and land use of the Swedish planning system, but they are not being used properly, which results in a negative impact on the cultural heritage. After two years of analysing and discussing our case studies in workshops and conferences, we have concluded that there is a strong need for clarifying planning instruments and for developing a professional practice dealing with compensation measures.

Keywords: *cultural heritage, compensation, planning, values, impact, planning instruments*

PEER-REVIEWED ARTICLE

Introduction

Since 2013, the cooperative Kulturlandskapet has been working with a research project about compensation measures, which can be seen as a new approach to community planning related to cultural heritage issues. The purpose of this paper is to describe our conclusions concerning planning instruments and compensation measures for impact on cultural heritage. Furthermore, we want to introduce the concept and ideas of compensation measures, and show examples of different applications of compensation and the planning instruments that have been used in these cases. Our objective is that the reader should understand what compensation measures for impact on cultural heritage in community planning are all about, and what types of planning instruments that can be used according to the professional practice in a Swedish context.

The research project developed from the experiences we, in the cooperative, had when we worked as nature and heritage consultants in several large wind power projects in Sweden. For many years, our cooperative carried out several studies and environmental impact assessments (EIA) for wind power projects. A basic idea of the cooperative was to work across disciplinary boundaries, and we developed a method where both archaeologists and biologists collaborated from the start. Archaeological heritage work took place side by side with the biologists' work of making an inventory of natural values (Grahn Danielson & Gustavsson, 2011; Grahn Danielson, 2012). This collaboration between professsions gave us new understandings of the landscape and changed our approach to both nature and cultural heritage. The paradigm of natural sciences met the humanistic sciences, which led both biologists and archaeologists into new ways of thinking. This made us pay attention to phenomena otherwise overlooked. One of the experiences was that the biologists had different legal instruments and possibilities compared with the cultural heritage sector. The idea of compensation for negative impact by constructing projects was a central point in the different conditions we had to work with as consultants.

Those of us working with cultural heritage started to understand that the juridical toolbox used by the nature conservation sector in Sweden was more stringent than that of the heritage sector. An instrument used in nature conservation was compensation measures. In some projects, we also discussed the possibility of working with compensation for the impact upon cultural heritage values. From our point of view, it appeared to be a constructive approach. Moreover, both developers and municipality officials realised that it was reasonable. But how would one proceed? Admittedly, our attempts were tentative and creative, but the issues often fell because of a lack of established practice and due to unclear legislation, often with vague answers from the officials who had to approve the project. Therefore, we applied for funding from the Swedish National Heritage Board for a research project about "compensation measures and planning instruments in the cultural heritage domain", an application that was granted in 2012.

The idea behind compensation measures

The background to compensation measures as an instrument for nature conservation is the debate about human impact on the environment that started to flourish in the 1960s. The growing environmental movement, arousing public opinion on environmental issues, and getting them on decision-makers' agendas, prepared the ground for compensation measures as a method (Persson, 2011). Different compensation systems developed in parallel in Germany ("balancing") and in the US, spreading to the rest of Western and Northern Europe. Nowadays, most countries in the EU have a system for compensating loss of natural environment values (Skärbäck, 2015).

In this way, compensatory measures are a part of the polluter pays principle. However, it is one matter to rebuild a swamp, marshland or habitats, which is not too difficult to conceptualise, but how do we compensate the impact upon an old building, archaeological site or on cultural heritage values in the landscape?

Research Strategy

The research project started in January 2013. Besides Kulturlandskapet, other contributors to the project were researchers from the University of Gothenburg, Uppsala University, Lagtolken AB, the Swedish University of Agricultural Sciences (SLU) and the Royal Institute of Technology (KTH), together with a reference group representing the City of Västerås, Gothenburg City Museum, the County Administrative Board of Skåne and the Swedish National Heritage Board. To understand the concept of compensation we contacted Julia Nordblad, lecturer and researcher in History of Ideas at the University of Uppsala, to make a conceptual analysis. At the same time, we asked Peggy Lerman, environmental lawyer at Lagtolken AB, to make a study about the legal background of compensation (Nordblad, 2014, and Lerman, 2014). Simultaneously we conducted an inventory of Sweden over cases where compensation measures for impact on cultural heritage had been discussed/carried out.

Based on findings in the inventory we chose to conduct four case studies, involving various types of architecture, urban design and construction projects with an impact on cultural heritage. The case studies are presented below. Each case study was evaluated in a workshop led by a researcher from a university. The workshops were divided into three sections: presentations of the case study at hand, analysis of the theme in parallel group sessions and a general discussion at the end. 10 to 16 individuals took part in the sessions. The workshops sought a width of participants with different professional experiences, and each workshop was combined with an overall theme (like planning instruments, compensation as a concept, compensation and European Landscape Convention, degeneration of cultural heritage). We also organized a conference about compensation measures in Gothenburg (in December 2014), which resulted in an anthology, published at the end of the summer, 2015 (Grahn Danielson, Rönn & Swedberg, 2015).

Compensation – Discources, confusing concepts and planning instruments

The word compensation is used in several different legal contexts. One example comes from the Swedish Tort Liability Act (SFS 1972:207: chapter 5, § 1), where the term compensation is used as a synonym for recompensing those exposed to violation. There are also examples of compensation in the form of redemption, in which the compensation applies to restrictions on the private ownership. Such cases apply to heritage building statements (SFS 1988:950 Chapter 3, §§10-14). However, this is not the kind of compensation we will discuss in this paper. Instead, we will focus on compensation for damage and loss caused to general values in the landscape and built environment, specifically cultural heritage values.

Two different fields of knowledge

The common thread in the concept of compensation is that it is all about making amends for loss. The word compensation is of Latin origin, meaning to replace, compensate, equalize, indemnify etc. The reason why we wanted Julia Nordblad to conduct a history-based analysis of compensation was to get a better understanding of compensation as a key concept in the research project and as a professional practice, both in the nature conservation sector and in the cultural heritage sector.

Nordblad (2014) sets her starting point in the end of the 19th century, a time when the protection of the natural environment slowly began. In the US and in Sweden, the first National Parks were founded, areas where “pristine” nature should be protected against civilisation. Nature conservation, however, had received inspiration from the cultural heritage sector, but the humanistic tradition of enlightenment of the latter was now being replaced by a scientific, “objective” view of the world. To explain the different discourses, Nordblad used Sven-Eric Liedman’s description of the natural sciences as nomothetic and the arts and humanities as ideographic. The different fields, or rather views of knowledge,

have their own scientific traditions, academies and official authorities – simply their own worldview.

The differences in thinking gives rise to implications when we discuss compensation measures for impact on cultural heritage. The environmental sector is largely controlled by a nomothetic thinking where nature has been equated with the environment; the Swedish environmental legislation is highly influenced by this. When the balancing principle was applied in Germany in the 1970s (Persson, 2011; Skärbäck, 2015), it was within a paradigm of the natural sciences, and it is obvious that the Swedish legislation is highly influenced by the German. When the Swedish environmental legislation was compiled in the Environmental Code (SFS 1998:808) in the 1990s, the cultural heritage sector chose not to be a part of it. According to the Swedish National Heritage Board, cultural heritage was not something that could be readily measured, weighed or described from a scientific position (Nordblad, 2014). Instead, it was strongly linked to humanistic streams of thought in which history, values, readability and personal experience are important. This is seen as a "subjective" understanding of the landscape.

The thoughts of compensating damage to natural environment values were applied to cultural heritage values in the late 1990s and early 2000s. But it was not on the initiative of heritage management. Instead, these discussions began within community planning. Therefore, when compensation measures for impact on cultural heritage values are discussed, problems arise. Heritage managers are often protesting, for how can you compensate and replace values if they are unique and connected to a specific site. Confusion arises because most of the persons operating in the planning processes are not used to dealing with compensation in terms of cultural heritage values.

A Confusing Concept

The confusion over the term compensation is not surprising. In the various literature and case studies, we have found that compensation measures occur at three different levels. Firstly, it can represent an *instrument for community planning* that relies on the Environmental Code; secondly, it can form a *method in land use planning*; thirdly, it can be *a set of actions in projects*. In other words, it is a broad concept with many meanings; for this reason, the context is crucial for understanding compensation. Compensation becomes a confusing concept, in general use out of its specific context. The reason for this is that compensation measures taken in detailed planning are dependent on the purpose behind the actions in projects.

Since the concept of compensation is ambiguous and controversial, and therefore seldom used in community planning, or even rejected and sometimes described in other words, we analysed the use based on some criteria. Measures that are taken are not always seen as compensation. We need a clarifying definition. In community planning, certain conditions need to be fulfilled before measures are regarded as compensation. There must be a case of 1) land development of a cultural heritage area, which 2) leads to a negative impact (damage or loss of cultural value/qualities), in turn 3) requiring physical compensation or measures. This has to be 4) regulated in an agreement with the developer or appointed in a decision taken by the authorities and should 5) be carried out within a certain time. If these criteria are met, then the case can be considered as compensation in community planning regardless what words the key players are using. By applying this definition, compensation becomes an empirical issue.

Types of Compensation

During the research project, a model (Figure 1) has been developed to be used as a basis for discussions on compensation measures in the case studies. The model is originally designed to fit ecological compensation (Persson, 2011) but has, after adjustment, worked well as a tool to discuss compensation measures for cultural heritage in workshops. The model has also been useful as a theoretical tool in order to classify compensation measures in chosen case studies in the research project.

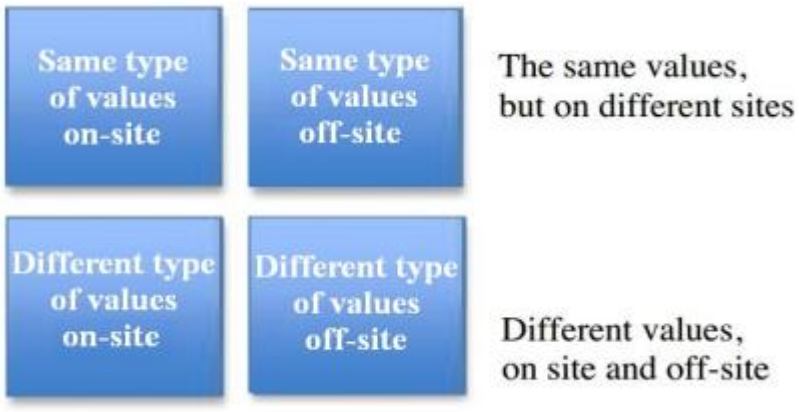

Figure 1. Four types of compensation measures.

The professional purpose of the model is to be a usable instrument to analyse and investigate the existence and the need for compensation measures in the community planning. The model might enable the key players to think more broadly in assignments, and it might act as a help in the design of appropriate measures in the reconstruction of cultural values. The four boxes present different types of compensatory measures as principals.

Starting from the upper left, the first strategy is to restore the same type of values as those that were lost, either in the same place or adjacent to the intervention. In this case, damage and compensation measures are spatially connected. The second strategy is to restore the same type of values, but in another location in the landscape. The total value of the heritage is constant, but in order to assess the fulfilment of objectives, two different contexts must be considered. The two bottom boxes contain strategies with other types of cultural heritage values, with direct spatial connection and without any at all respectively. In the first box, the damage remains, even if the surroundings are supplemented with new equivalent values of another kind. The last strategy consists of reconstructing other values in a new location in the landscape. Damage and compensation are then spatially separated and contain different features. In other words, it is all about weighing the importance of the spatial relationship and the relationship between cultural values. The model places great demands on descriptions and assessments of the cultural heritage.

Control principles and positions taken by key players

The Swedish legislation is a very restrictive tool when applied in decisions concerning compensation measures, which is reflected in practice. However, the need for compensation measures is real, and the market parties, including local politicians and municipal administrations, have taken the initiative to produce solutions. Municipalities prefer agreement by negotiation with developers. Consultants and actors defending cultural heritage values are looking for support in regulations and from the County Administrative Board. Compensation by law or by agreement are two different instruments of control in social planning that can be analysed using the following model as support:

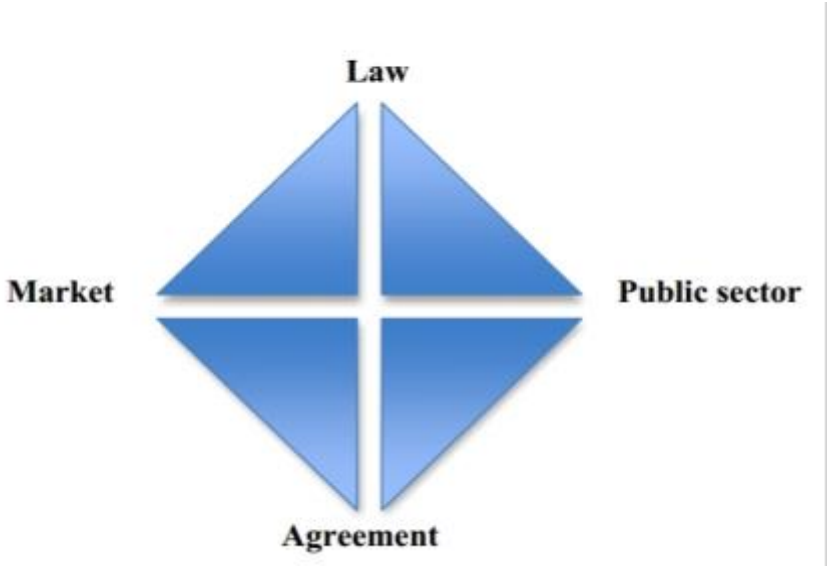

Figure 2. Actors and regulation principles

Depending on their role as key players in the community planning, the stakeholders will adopt different strategies along the way when dealing with matters concerning compensation. With inspiration from von Wright (1963), we can find four different strategies towards compensation among key players (Figure 3). They can push on and support the use of compensation in cultural heritage; pull back compensation proposals in planning processes; let the proposals become conditions for implementing construction projects; or retreat from this demand.

Figure 3. Strategies among stakeholders in community planning processes.

In two of the case studies, the municipality's legal right to make demands about compensation measures have been questioned by the government authorities (Grahn Danielson, 2014; Swedberg, 2014). These actions can be seen as "pull back". The more progressive municipalities are leading the development of solution for compensation measures by facilitating agreements between the key players on the market. They "push on". In this case, the land becomes available for exploitation through land development agreements, connected to detailed plans (Rönn, 2014). Several municipalities set up requirements that compensation measures should be implemented in sensitive environments with high cultural heritage values. Then compensation becomes a condition for building permits. The dynamics between the solutions of the law and the market are also reflected by the key players' different positions (see fig 3). Their roles are not fixed. In the four case studies the key players changed positions during the planning process from "push on" to "let retreat" or "let go" when proposals on compensation measures from consultants did not receive support.

Means of Control

During the research project and the case studies, we have identified several planning instruments that are being used or can be used in community planning to control the development led impact and to conduct compensation measures (Grahn Danielson, Rönn & Swedberg, 2015). The planning instruments can be attributed to the following categories:

- Legal instruments (laws, regulations and rules in the community planning)
- Plans and permit instruments (municipal plans and trial of building permits)
- Administrative instruments (routines of municipal/authority administrations)
- Financial instruments (costs in planning, fees and allowance)
- Informative instruments (requirements of assessments, documentation and consultations)

An underlying idea is that the planning instruments should induce the involved stakeholders to meet the political objectives in the community planning, providing them with a guide in the processes. The usefulness of the planning instruments differs, but also the ability and willingness to use and apply them, which is found in public as well as private sectors as “pull back” or “let retreat”. The degree of usefulness of the planning instruments depends on the stage of the planning process. The instrument that is chosen differs depending on whether it is applied in a comprehensive plan, detailed development plan, trial of a building permit or in authorization for a project. Several planning instruments are used in the same project and at the same time. They are used to control the impact on cultural heritage values and to create measures to compensate for the same.

Legal instruments

The legal instruments are laws, regulations and statutes that regulate the structure of society. This type of instrument exists at three different levels in a hierarchical order. At the top of the hierarchy are the laws. Relevant in a Swedish context are the Heritage Conservation Act (SFS 1988: 950), the Planning and Building Act (SFS 2010:900) and the Environmental Code (SFS 1998:808), but only in the latter are compensation measures available and are clarified. The relevant sections of the law are found in the general rules of consideration in Chapter 16 §9 of the Environmental Code. Neither the Planning and Building Act nor the Heritage Conservation Act have any sections concerning compensation measures in community planning conducted by local authorities (municipalities/cities).

The laws are followed in the regulations produced by the government, but in the context of cultural heritage and compensation measures, they lack clear connections. Active planning instruments emerge only in the third level, which contains official regulations. The Environmental Protection Agency's general advice (NFS 2005:17) about “significant damage” is an effective means of control. Various authorities’ interpretations of how the regulations should be applied appear further down in the legal hierarchy. These are of great importance for how the municipalities act in their planning.

Plans and permits

Among the identified planning instruments, under the category of plans and permit decision instruments, are comprehensive plans, detailed development plans and different policy documents. Comprehensive plans could handle the matter of compensation at an early stage. The City of Gothenburg and Lomma municipality are a couple of examples of municipalities handling this in their comprehensive plans (Grahn Danielson, Rönn & Swedberg, 2015).

The comprehensive plan for the City of Gothenburg states that removed natural, cultural and recreational values are to be compensated and the municipality should strive to "develop and use methods of compensation measures for the

natural, cultural and recreational values in the community planning" (City of Gothenburg, 2009a, p 91). The municipality of Lomma (2010) points out areas in their comprehensive plan where compensatory measures for impact on landscape values can be performed. Lomma use the German balancing principle in which impact should be compensated as far as possible.

The City of Gothenburg also developed a policy for compensation measures concerning impact on nature and recreational values (City of Gothenburg, 2009b). Although the policy does not explicitly mention cultural heritage, it contains clear demands for investigations about the need for compensatory measures. Other municipalities that have developed clear policies or procedures for handling compensation measures are the cities of Nyköping (Skyllberg, 2015) and Västerås (Melander, 2015). These procedures can also be attributed to the category of administrative instruments since they constitute procedures for municipal officers.

Financial instruments

Financial instruments act primarily as costs or fees for developers in planning, for permits and implementation of projects. Several countries use a financial instrument in the form of so-called mitigation banking (Persson, 2011). The developer has to pay a sum to a fund that pays for compensation measures where needed. In Sweden, financial instruments instead appear as municipal fees used to fund detailed development plans and the processes of building permit applications. Assessments on impact on cultural heritage values can also act as financial instruments if they are imposed on the developer by municipalities and authorities. If the costs for the assessments become too high, the developer might choose to avoid an obvious impact. Economic instruments can also occur in the form of public allowance to property owners to preserve and maintain cultural heritage values.

Informative instruments

As authorities can impose on developers the obligation of conducting assessments of the potential impact on the cultural heritage involved in a project or a plan, this becomes an instrument in itself. A study of the impact on the cultural heritage may result in the conclusion that the project should be changed and the planned development should be moved to another site or be rejected (Skyllberg, 2015). In such a case, an assessment becomes an informative planning instrument. Nonetheless, if the informative instruments are to work, certain conditions need to be fulfilled. The presented information must provide an accurate picture of the project/plan and its impact. Firstly, this condition is based upon the consultant's professionalism, on whether they have the right knowledge and have a strong integrity. Secondly, the assessments must be utilized in plan proposals and/or designs of projects, after which they should be presented for decision makers and the public. However, even if the first two premises are crucial, the studies of how the cultural heritage values are affected need to be communicate in a proper way, so that the public and involved parties can form an opinion and take a stand.

Compensatory measures and planning instruments – case studies

The four case studies carried out within the research project are presented below, as well as some conclusions from the workshops (Grahn Danielson, Rönn & Swedberg, 2015). In this part, we want to use our theoretical models and present some examples of how compensation measures for impact on cultural heritage have been handled.

The People's Park in Linköping

The first case study presented is about the development of the People's Park area in Linköping (Rönn, 2014). People's Parks (Folkets park), as a concept, evolved during the 1900s as a re-creational area for the emerging labour movement. They are found in nearly every town in Sweden and are a sort of public

recreation space or amusement park (figure 4). In the beginning of the 21st century, the Folkets park had had its day as a place for entertainment for large parts of the society. But the setting still tells the visitor about the struggling labour movement, the developing democratic society and the modernistic 1900s.

Figure 4. The entrance to the People' Park in Linköping at night (Wikimedia Commons, photo Lars Aronsson, Linköping)

Due to severe economic problems, the association that ran the park in Linköping sold the area to a private developer (HSB) with far-reaching plans of an architectural project aimed at building a new housing area. To start with, the park association considered keeping and renovating one of the buildings for its own purposes; but after a while, the association went bankrupt. According to the proposed plan, essential elements of the park would disappear through demolition and/or change of use. Even if the park was not a protected area, the different stakeholders were aware of the cultural heritage values of the park and agreed that the impact in some way should be compensated. In the combined planning and architectural project, the cultural heritage issues were discussed, involving such issues as demolition/preservation, adaptation of a new development to the area's history and compensation for the damage. Nowhere in this process can the word compensation measure be found. However, the action is compensation as a professional practice.

A heritage assessment was conducted, but no overall documentation of the area was undertaken (which the first study pointed out as crucial) and when the detailed development plan was processed, the heritage assessment was ignored. The process lacked deeper cooperation with heritage consultants and the town planning office. The municipality's contract with the developer stated that the latter would partly pay for the relocation of a building to the city's open air museum, and would moreover renovate two other buildings within the park a. The municipality itself would also contribute to the relocation of another building.

Is it good policy to move a house out of context and then designate it as a compensatory measure? Based on our criteria, it is nevertheless clear that it was compensation measures for impact on cultural heritage values the key players were talking about, even if they chose not to address it in those words. First, there is a development in an area with high cultural heritage values (1). Crucial elements of the site will disappear through demolition (2). Since the stakeholders agree that they need to make amends for the impact (3) they write an agreement (4), which regulates when the measures are to be implemented (5). According to our model, this case involves different types of compensation (See Figure 1). There is the *same type of value on-site* for the detailed planned area (refurbishment of two buildings); meanwhile, the relocation of buildings is *the same type of value off-site*. The relocation of buildings can also be seen as

partly *different type of values off-site* because the buildings lose their original context.

The planning instruments used in the Linköping case involve the detailed development plan and the land and development agreement. There is no link to the legislation actually mentioning compensation measures. The heritage assessment can be considered as informative planning instruments, but in this case, the municipality ignored the study and therefore it had no effect.

The workshop evaluating the case (Håkansson, 2015) showed us that even the detailed development plan is a vague instrument since the area had already been identified as a good spot for development. Maria Håkansson believes that the comprehensive plan is a much better tool to apply in order to avoid negative impact on cultural heritage. If the authorities at Linköping municipality had worked with compensation measures within its comprehensive plan, it would probably have led to a more transparent process. Instead, financial instruments control the process in Linköping. Through the voluntary agreement with the municipality, the developer is obliged to pay for the relocation of a building and renovation of another (Rönn, 2014a).

Figure 5. The Port of Gothenburg with the fortress Nya Älvsborg and the two islands of Stora and Lilla Aspholmen. (Photo from the EIA 2013)

Port of Gothenburg and the island of Lilla Aspholmen

This case study is about the expansion of the port of Gothenburg and its conflict with a cultural heritage area of national interest (Swedberg, 2014). The process extends from the end of the 1990s to 2014, when a detailed development plan was adopted. A crucial point of the process involves two fields of national interest, set against each other: the port of Gothenburg, and the cultural heritage area of national interest including Nya Älvsborg fortress and the islands of Stora and Lilla Aspholmen (figure 5). The cultural heritage area comprises these important features:

- *The wide view, the silhouette of the outer walls of the fortress and the various buildings of the courtyard [...]*
- *The neighbouring islands Aspholmarna with the cemetery on Stora Aspholmen.*

Besides these features, there are also the remains of a salting house for herring, historical rock carvings, parts of a barrier of the channel and a harbour area, but there are also summer cottages from the 20th century. In the detailed development plan, parts of the cultural heritage were considered worth protecting, while other heritage values, such as those at Lilla Aspholmen were suppressed.

The expansion of the port is a long process resulting in the proposal of building new quays over Lilla Aspholmen and nearly up to the fortress island; Lilla Aspholmen would then be blasted to the level of the quays. A detailed comprehensive plan states that this would affect the area of national interest for cultural heritage, but it would be an acceptable damage that should be compensated. Ambiguities in how to use compensation measures allow the town planning office to believe this must be solved through voluntary agreements. The decision-making process is unclear and the city's different departments have different stands. The city is acting as the owner of the expanding port, but it is also managing the heritage sites in the area. The process is not helped by the County Administrative Board and the County Governor, who intervene in the process. The adopted detailed development plan, however, states that the damage on the cultural heritage area of national interest should be regulated by an agreement on compensation measures. Again, the confusing term compensation measure is part of the problem. Many of the involved parties have been trying to avoid the term and instead discuss it in terms of mitigation, regulations, etc. In this case-study too, it becomes clear that the lack of established practice poses a problem.

The process ends with an agreement between the city's town planning office and the port. Unfortunately, the compensation measures cannot be seen as reasonable, as the parties agree on a sum (four million Swedish kronor). Bohusläns museum was later given the assignment to investigate what type of compensation measures would be suitable (Friden & Toreld, 2013), but the predetermined cost made a framework that did not facilitate the work, or leave much space for creativity (Swedberg, 2014, 2015; Axelsson, 2015). Finally, the proposed compensation measures consist of interactive reproduction of sight lines through film technology and the presentation of historical maps for the public. The compensation measures represent a *different type of value off-site*. Furthermore, in this case, the criterion for when compensation exists is clear, and the planning instruments that are activated in this process belong to the entire spectrum.

In his article, summarizing the workshop that evaluated the case study, Tony Axelsson (2015) describes a heritage management world that is stuck in thinking about conservation rather than thinking about creating. Starting from the case study, Axelsson sees opportunities to move away from, in this case, unwelcome conservation work and compensation according to the upper left box in figure 1, and instead use other strategies. Axelsson believes it would contribute to the democratization of the way we think about cultural heritage. The democratic heritage, or rather the right of the citizens to be involved in creating cultural heritage, has been discussed repeatedly during most of the 2000s. In the Gothenburg-case, it becomes interesting because only parts of features in the area of national interest have been highlighted (Swedberg, 2014). The fortress with its history is considered more important than the more general remains of working life. The narrative of the maritime fortress Nya Älvsborg is selected before the narrative of the shipyard and port dockers' self-built cottages on Lilla Aspholmen.

Wind Power in Tanum and Project Lursäng

The third case study is about the process behind the thematic municipal comprehensive plan for wind power in Tanum municipality (Grahn Danielson, 2014), and project “Lursäng”, a project initiated by a local wind power company, planning to build a small wind farm with five wind turbines (figure 6).

The Lursäng-area is located at the border to Strömstad municipality, where an adjacent cultural heritage area has been designated an area of local significance. The cultural heritage area features several cairns, tumulus and tombs from Bronze and Iron Age. The municipality authorities of Strömstad have committed themselves to preserve and care for the area, but they have not done anything so far. The wind turbines and the new roads leading to them, will not affect the area physically but there will be a visual impact and the noise will affect the area. The officials working with the municipality's wind power plan realised this and at an early stage in the process demanded an assessment of

the possibilities of compensating the impact. The public and authority consultation and design of the individual wind farm runs parallel with the proceeding wind power plan. Therefore, the experiences of the consultations in the individual project merge into the larger process in which the municipality operates. Compensation measures for impact on cultural heritage were therefore later included in the adopted wind power plan.

Figure 6. A photomontage over the five wind turbines planned at Lursäng. (Photomontage from the EIA of the Lursäng project).

During the consultation with the authorities, the initially proposed compensation measure was to put up some signs with information about the area. The county museum objected to this, with the argument that it was a cheap solution for a large negative impact from a multimillion investment. The heritage consultant presented a solution, a more ambitious proposal, which involved making the area more available for the public by a downloadable map with information about the sites. With the map, it would be easy to visit the area and the sites without signs and large efforts of constructing hiking trails. More important was that the information presented on the homepage, would be based in relatively extensive research about the ancient remains of the area. Compensation measures in this case represent *different type of value off-site and on site*. The involved parties agreed on this and the developer used the proposal in its application for permission to the County Administrative Board, stating that they had assessed the measures as both feasible and reasonable.

In the further process, the proposed compensation was never analysed by the County Administrative Board when the application was submitted to them. The developer felt cheated by the municipality's demands, while the consultant and the municipals officers considered that the County Administrative Board had not done its job. In turn, the latter argued that they could not handle the question in their permit, since they have not the authority to make claims on other land than the one directly affected by the development. Virtually all wrong and right at the same time. As the developer in the application stated that they were going to conduct the compensation measures according to the EIA, they were committed to do so. The present problem is that the municipality's officers have resigned from their jobs and none has taken over the case, the County Administrative Board does not consider it to be an issue for them to solve, and the developer believes that compensation measures were not necessary. It is all up to the developer whether the compensation will be implemented. The legal instruments are weak, and in this case, there is no adequate reference to the legal instruments that actually apply. However, in the discussion on planning instruments, the thematic municipal comprehensive plan proved to be an adequate instrument, which in this case acted both as a planning instrument but also as an informative instrument.

In the evaluating workshop, we wanted to discuss the case study in the light of the European Landscape Convention (ELC; European Council 2000). Could we

take further steps towards a sustainable landscape by using compensation measures in cases of impact on the cultural heritage? If so, how? The Tanum case is interesting from a landscape perspective because the tall wind turbines affect large areas visually. Ann Åkerskog who led the workshop emphasizes time as an important aspect of the landscape (Åkerskog, 2015). In line with Axelsson, she returns to a discussion about a democratic landscape. Whose experience of the landscape is to be compensated?

A large part of the discussion during the workshop was about whether a map with information, downloadable from the internet, could be seen as a compensation measure, and in that case how does it fit into our model (Figure 1)? Heritage managers have a special relation to conservation as well as *authenticity*, and it was very clear that the proponents for the heritage management point of view were not satisfied with the category *different type of value on the same* and/or *different site*. At the same time, those with a background in architecture had solutions in the early design of the wind farm. If the wind turbines where placed in another way, could this not be seen as compensation? The participants emphasized the importance of the municipality's wind power plan, but they also mentioned that the officials lacked professional knowledge about cultural heritage. This is a common occurrence. A majority of the Swedish municipalities lack staff with practical and theoretical understanding of current cultural heritage issues.

Figure 7. The Steam Ferry Station in Helsingborg. (Wikimedia Commons).

The Steam Ferry Station in Helsingborg

The fourth and last case study presented is an urban development project in central Helsingborg (Rönn, 2014b). The harbour area of central Helsingborg was to be reshaped and renewed, which would affect a cultural heritage area of national interest. A significant feature of this area is the old *Steam Ferry Station* (figure 7), a wooden building in national romantic style, erected in 1898 (Fredriksson, 2006). A large hotel- and venue-building was to be built in its place. The planning process began with an invitation to a land use competition in 2009, ending with the town planning office approval of the detailed development plan in 2013.

During the process, several critical voices were raised. First, the County Administrative Board criticized the proposed plan since it was not dealing with the cultural heritage of national interest in a proper way. Secondly, the cultural administration of Helsingborg felt that the proposed plan violated their own conservation policies. In particular, the impact on the Steam Ferry Station was criticized, especially from a loud public opinion.

Owing to the criticism, the town planning office assigned two different consultants to assess the impact on the cultural heritage. The first consultant concluded that the plan occasioned a significant negative impact. The second consultant, instead, concluded that alteration could be accepted if the Steam Ferry Station was moved within the harbour. The municipality adopted the latter

suggestion, and integrated it in the detailed development plan. The County Administrative Board, who were monitoring the process then intervened, stopped the plan on the grounds that it would cause significant damage to the cultural heritage of national interest. The municipality was therefore forced to rework the plan. As a countermove, they hired a new consultant to do an EIA and analysis of the cultural heritage. The studies concluded that the plan should be adapted to the criticism, in part, but that it was all right to move the discussed building some 70 meters. The re-vised plan was adopted by the municipality and County Administrative Board finally accepted.

As in the cases of Linköping and Gothenburg, the key player tries to avoid the term compensation measure during the entire process. In Helsingborg, they agree that the Steam Ferry Station could not be demolished, but according to the town planning office, the building has to be moved to another site in the harbour. In this case, we have also found a confusing use of concepts and uncertainties about how to handle compensation. According to our criteria, however, they perform a compensation measure, without using the word. The compensation measures includes both *same type of cultural values on site* for the detailed plan as well as *different type on values on site.* The compensation in this case is settled through both a land use agreement and the detailed development plan. It is clear that they are the most important planning instruments. The conducted assessments of the plan's impact on the cultural heritage are vague as instruments but are still a reason for the alteration of the first proposal.

Jonas E. Andersson managed the workshop that evaluated the case study. In his article (Andersson, 2015), he states that early on in the process, there were contradictions between the local policies and the public. However, there was also a conflict between the municipality's desires to appear modern, versus regional conservation interests, for which the County Administrative Board is responsible. An issue that became clear in the case study was the conflicting interests between the eagerness for conservation and preservation of the heritage management, and demand for change and development of the town planning office. Andersson believes that these differences are based in different professional approaches, an observation we have seen in the other workshops as well.

According to our model over compensation (Figure 1), it became obvious during Andersson's workshop that architects and planners had a different view than the heritage managers and archaeologists, concerning whether the case from Helsingborg involved the same type of value in the same place, or the same type of value elsewhere. It also became clear that the concept of compensation was complicated. The understanding of compensation as a concept is influenced both by the key players' training and by their professional background including their role or assignment in planning processes.

Discussion and conclusions

A point that all case studies show us is that compensation is a complicated matter. In the Gothenburg-case, the key players did not want to use the term compensation measures, the same applied to the key players in Linköping and Helsingborg. In the Tanum-case, there was not the same reluctance and the term compensation measure was not controversial, although it turned out to be problematic in the end.

All types of compensation in the case studies were criticised in the workshops. The consultants' proposed measures were undeveloped and were not connected to the specific loss of cultural heritage values. But there is no unambiguous connection between identified cultural values, damage/loss and compensation. The relations are complex. The conclusion has to be that in a development situation, there is a selection of values that can be highlighted and visualised in assessments, and somewhere someone has to choose. It is possible to make up for damages through several different measures, either in close

relationship to the impact or at another place. Obviously, compensation is a part of a creative process. Due to this, compensation measures for impact on cultural heritage values are essentially controversial arrangements.

With the criteria for when compensation measures occur, it becomes clear that it is all about compensation regardless of the terms used in planning processes. Another observation is the uncertainty when it comes to dealing with compensation. None of the key players know how to handle it, and the parties grope their way forward (se Figure 2). There is no clear connection in any of the four cases to the section of the law (Environmental Code) that actually governs compensation issues in cultural heritage. As we have no clear practice, local solutions occur alongside the Environmental Code, following planning instruments provided in the Planning and Building Act. Municipalities and consultants who propose compensation measures in their assignments are the driving force behind this local development of the use of compensation in areas with cultural heritage.

The most important planning instruments we can see in three of the case studies are the land use agreements between the municipalities and the developers in detailed plans. In municipalities, the town planning offices manage planning processes and demands for investigating values in the site. But it is the property development departments that negotiate over land use agreement, and these processes are not open consultations for the public to have their say. If, instead, compensation measures were handled at an early stage in public consultations concerning the municipalities' comprehensive plans, and if authorities and consultants used the legislative sections dealing with compensation, perhaps then a professional practice could be developed. This would be a way to handle the conflict between development projects and preservation of cultural heritage. Compensation is an issue for all the key players in community planning.

Final words

In this paper, we have presented criteria for when compensation measures occur. In this way, we hope to avoid the confusion that otherwise prevails, and instead discuss how the loss of value actually should be replaced. This challenge calls for research and development of theory, methods and professional practice in assignment, as well as feedback.

The lack of established practice along with a widespread uncertainty causes problems in planning processes. The legal instruments are not fully used; instead, local practices have emerged. Our re-view shows that the municipalities have a key role in the development of compensation measures but the involved heritage consultants play an important part too. There is a conflict between conservation and development that can be partly bridged over and could be handled in a more creative way by using the model presenting four different aspects of sites and values. The solution could be more oriented towards a dialogue-based production of knowledge about heritage issues in planning processses.

The key players in the case studies lack advice and guidance from the central authorities, who could show how compensation measures for impact on cultural heritage should be managed. Such guidelines would strengthen the position of the planning instruments and enable them to be utilized to a greater extent. This is an assumption. The research results point out a need for rethinking regulations in law and for the development of tools for compensation in practice.

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Design Cognition: Optimizing knowledge transfer in digital design pedagogy

Edward Becker
Aalto University School of Arts, Design and Architecture
ebecker@post.harvard.edu

Abstract

Digital design as a medium for design research, praxis, and education has fundamentally disrupted the structuring of analog pedagogical contexts through an increased diversity of ontological, phenomenological, and existential design conditions. In an educational discipline noted for its exceptionally inefficient degree of knowledge transfer, how can traditional architectural pedagogy bear the burden of rapidly increasing educational content without exacerbating its instructional inefficiencies? Furthermore, how can cognitive overload for novice learners in this context be mitigated?

The purpose of this paper is to frame, expose, and explore how knowledge transfer in regard to the novice learner may be impacted by digital design as an architectural medium. The design education literature in both analog and digital environments as well as cognitive theories of learning will be explored to construct a theoretical lens through which the learning affordances and challenges of digital design can be addressed. Research conducted by Ausubel, R. Oxman, Schön, Sweller, and others will be used to expose the cognitive logics associated with introductory digital design and digital skill thinking. Cognitive issues including meaningful learning, cognitive processing efficiency, and automative thinking will be considered.

Pedagogical strategies supported by the educational literature related to schema development and cognitive loading will be suggested for educating novice learners in digital design. Design cognition as a subject for future research holds seminal importance in modern design education. It cannot be assumed that the pedagogical methods that provided the cornerstones of architectural education in an analogue environment remain relevant in digital contexts.

Thus, the primary challenge of digital design education for novice learners is not simply the operational knowledge of digital tools nor the cognitive load resulting from "domain-general creative cognition (i.e. divergent thinking)" ...but rather the simultaneity of the aforementioned, differentiated cognitive processes.

PEER-REVIEWED ARTICLE

1. Introduction

The transformation of design fields due to the digital revolution in academia and praxis has yielded a novel field for cognitive studies in design education (Oxman, 2008). Acknowledging that digital design includes its own unique technical and theoretical bodies of knowledge, its experienced-based learning processes elicit both challenges and opportunities for design education (Oxman, 2006; Oxman, 2008). The integration of digital design in the architectural studio has induced an ever-increasing breadth of design applications and processes which require learners to develop technological proficiencies while simultaneously developing design expertise. These cognitive demands for the learner also create critical pedagogical challenges for educators as they consider how to most effectively incorporate novel digital design media, modes, and methodologies into an educational discipline already burdened by an exceptionally inefficient degree of knowledge transfer (i.e. learning) (Akin, 2002; Kirschner, Sweller, and Clark, 2006).

Due in part to the infusion of digital design education into the pedagogical agendas at various institutions by leading figures in the design profession, singularly-focused agendas are often explored that result in specific areas of expertise rather than a more encompassing agenda that focuses on widely applicable learning outcomes in digital design (Oxman, 2008). Although a plethora of practice-driven educational agendas has introduced new landscapes to architectural education, it has only been since the late 1990's and early 2000's that there has been a more concerted effort to establish a theoretical foundation for digital design education. The result has been an increasingly voluminous amount of research focusing on the emergence of digital architecture in design pedagogy, restructuring of academic curricula, performative design technologies, and the design processes associated with Rapid Prototyping (RP), Digital Design Fabrication (DDF), and other uses of CAD-CAM technologies.

Although significant scholarly attention has been paid to the aforementioned areas of educational research in architecture, the intensified cognitive challenges for novice learners in a digital era have yet to be explicitly addressed in architectural literature. As educators consider how advanced, diversified software and tooling technologies impact the pedagogy of the design studio, cognitive theories of learning relevant to the novice learner provide the anchor for innovations in instructional design.

The purpose of this paper is to identify and exploit the aforementioned gap in the literature by addressing the cognitive and pedagogical factors that may inhibit or amplify efficient knowledge transfer for the novice learner in digital design. This will be accomplished by first differentiating analogue design in a traditional studio environment from digital design in order to expose both the learning opportunities afforded by digital technology and the cognitive challenges it creates for the novice learner. In response to these exposed learning challenges and pedagogical implications, the educational literature particular to the cognitive architecture of the novice learner will be addressed. Finally, in response to the links that will be established between the challenges faced by novice learners in digital design and the relevant cognitive literature, a fundamental and critical impediment to efficient knowledge transfer in introductory digital design education will be identified and strategies that may mitigate its negative learning consequences will be discussed. Although these pedagogical strategies are suggested for digital design in architectural education, they are applicable to a variety of design disciplines in which novice learners encounter both the cognitive trials and opportunities that are engendered by the use of digital tools.

2. Framework for Pre-Digital Design

2.1 Learning in pre-digital contexts

Analog design development processes in architecture are grounded in the cognitive development research initiated by Donald Schön and his collaborators (Schön, 1983; Schön and Wiggins, 1992). In the early 1980's, Schön published research that helped establish a cognitive theory of design that was designer-centered, a shift away from prior design research that was directed towards the study of domain knowledge and design thinking (Oxman, 2008). Schön and Wiggins' research exposed the “reflective 'conversation' with the materials of a design situation” (Schön and Wiggins, 1992, p.135) that occurs within the mind of the designer. This research observation is now commonly known as 'reflection in action' and has become widely accepted by academicians, serving as a primary underpinning of modern design education (Schön, 1984). Perhaps most importantly, Schön subdivides this visual-tactile learning process into three operations that iteratively repeat to facilitate the design proposition's development: reception, reflection, reaction. As Oxman (2008, p.101) noted, this “paradigm of design, strongly predicated on visual reasoning has provided a strong influence upon design research and pedagogy for the last two decades” and “the general characterization of design as a reflection supported by representational processes has had an almost universal influence on architectural design education.” In addition to the work by Schön and his collaborators, researchers such as Akin (2002), Eastman (1969), Oxman (1999), and others have also provided important contributions to research on the cognitive aspects of design pedagogy and design thinking. Despite the breadth of research focusing on design cognition over the past three decades, the interrelation between visual reasoning and conceptual processes explicated by Schön is still the cornerstone of studies of cognition in design-focused disciplines (Oxman, 1999).

Prior to the introduction of digital design media into studio-based design environments, the associations between designer and material representational medium were relatively direct, a unique aspect of analogue design that has served as a basis for educational theories of design cognition and a challenge for theories of design cognition in an era of digital design. As Schön and Wiggins (1992, p.135) have described in relation to analogue design, “the designer sees what is 'there' in some representation of a site, draws in relation to it, and sees what has been drawn, thereby informing further designing. In all this 'seeing', the designer not only visually registers information but also constructs its meaning.” In other words, an exploitation of knowledge processes and knowledge structures allow designers to translate or re-represent conceptual schema onto a representational medium. In turn, designers re-encode a post-analysis conceptual description into their conceptual schema, allowing meaning to be developed and learning to occur via schemata enhancement. In her theory of representation-redescription, Karmiloff-Smith (1995) explicitly defines learning as a successive process of representations which become increasingly amenable, allowing conscious access to schema. Therefore, the process of learning can be described as the exploitation of previously stored schema through re-describing its representations. In architectural design, for example, the student may first represent the typological concept of a 'courtyard'. After building a physical model of the 'courtyard' type building, they may then describe the building as a 'wind-blocking' type of building, thereby illustrating an increased cognitive development by having added the characteristics of the courtyard type, such as having a central space that receives shadow and wind protection, to the pre-construction notion of a 'courtyard' type, or a building mass that exhibits some variation of a central void. This example not only illustrates Karmiloff-Smith's theory of representation-redescription, but it also demonstrates the direct designer-to-material characteristic of analogue design.

2.2. Limiting characteristics of analog design

Unlike the digital design environment, the analogue design environment can be understood as primarily compositional and formal in nature and defined by material-based developmental processes and allowances. Extensive analysis of these properties of analogue design has been well documented by researchers; however, it is worth briefly summarizing two aspects that are particularly relevant to this prospective paper regarding the novice learner in a digital design environment. The physical characteristics, or affordances of design materials, have had a fundamental impact on the representational and formal nature of analogue design. From introductory to experienced stages in design education, the understanding of representational materials through physical, formal traits and geometrical transformations that are applied during the design development process has served as a limiting framework for conceptual and pedagogical exploration. As was previously presented, visual reasoning is fundamental to design studies, yet visual discovery is primarily through formal referencing, modification, or reinterpretation. This limited 'matter and material' approach has been described as the 'antithesis' of digital design and as lacking the diverse ontologies present in digital design (Oxman, 2008).

The second limiting aspect of analogue design is its encompassing typological definition and the self-referential nature of the typological critique, a foundational concept of modern architectural pedagogy (Oxman, 2008). Affordances of materials utilized in the design process and a history of typologically similar precedents assist in the persistence of conceptually related design typologies. As a system in which conveyance of meaning is predicated on the recollection of precedent typological attributes, design pedagogy in architecture faces a vast array of challenges as digital design mediums move the discipline beyond its typological structuring.

3. Digital Design in Analog Pedagogical Contexts

3.1 Theoretical foundation for digital design

Digital design as a medium for design education challenges the structuring of analog pedagogical contexts through an increased diversity of ontological, phenomenological, and existential design conditions. New technologies promulgate novel design possibilities which, in turn, engender novel theory and critique. As new conceptualizations now exist between matter and form, functional and formal knowledge, temporality, solidity, and the structuring of generative logics in design, digital design pedagogy requires the conceptualization of a cognitive framework that can encompass the aforementioned enhanced knowledge base of design. Although the implications of digital design for design pedagogy are vast, educators and researchers have already done much to establish a foundational underpinning to digital design and its dissemination in educational environments. The extensive body of scholarly work by Oxman (1994; 1996; 2004; 2006; Oxman and Oxman, 2014) could well become foundational material in the studies of digital design as it frames various approaches to design education and pedagogy, reviews changes in design media, and presents the evolutions in architectural knowledge bases, processes, theories, and designer-to-material relationships derived from the emergence of digital design.

3.2 Disciplinary diversification for digital design: praxis as catalyst

As researchers and educators attempt to frame and structure the emerging architectural knowledge base of digital design skill and digital design models, practitioners continue to play a central role in the expansion of design methodologies and conceptual content derived from the affordances of digital technology. In addition to the foundational texts regarding paradigmatic shifts in architecture spurred by the digital revolution (Kipnis, 1993 cited in Lynn, 1998; Lynn, 1998), the expanding range of conceptual foci such as topological form or hyper-continuity

(Kubo and Ferré, 2003), tectonics (Reiser and Umemoto, 2006), parametricism (Schumacher, 2009), materialization (Kieran and Timberlake, 2003), evolutionary form (Hensel and Menges, 2004), and emergent form (Kolarevic, 2003) also includes design paradigms that adapt historic technique into novel conceptual content (Cohen, 2001). The degree of individual control in design - arguably the most integral component of cognitive educational theory in design and a critical, paradigmatic element of digital design theory - has also recently garnered attention in architectural publications via its historical (Wu, 2014) and procedural (Meredith, 2013) abstraction. The diversity of conceptual foci as well as the continued emergence of conceptual paradigms in architectural praxis exemplify the vast array of challenges faced by educators and learners in the first digital age.

3.3 Are existing knowledge bases of design applicable in digital contexts?

Despite the aforementioned theoretical foundation for digital design, a lack of scholarly work exists that specifically focuses on the cognitive aspects of introductory digital design education. As questioned by Oxman (2008, p.100), “[h]ow can designerly ways of knowing, a concept so strongly derived from a paper-based culture of design, be adapted to the new situations of digital models and mediated design processes?” Oxman furthers the question by asking, “[a]re we encountering the same cognitive phenomena of known processes of design in the new digital media? Or are we encountering new forms of knowledge, new scientific foundations, and new models of design?” Questions such as these by leading figures in the field of design studies underscore the importance of research that theorizes and structures the role of cognition in digital design education. The literature clearly establishes that we are indeed encountering new forms of knowledge in digital design and that digital design is a methodologically unique form of design (Oxman, 2006; Oxman, 2008). Thus, it is important to reiterate that existing theories of cognition in design were developed in an age of analog design, or via paper-based representational re-descriptions, and note that the consideration of digital design cognition enters upon novel ground as cognition in a digital age has yet to be thoroughly theorized. Although the cognitive logic of 'visual reasoning' as defined by Schön and others that underlies analog design is still applicable to digital design, the diversity of 'challenges' or facets associated with digital design relegates the usefulness of this methodology to only a small segment of digital design studies.

3.4 Challenges of digital design pedagogy

The literature related to the traditional design studio environment and its cognitive underpinnings has been reviewed as well as the literature concerning the emergence of digital design in academia and its differentiation from analogue design. Building upon this cognition-focused foundation of digital design education, the following challenges of digital design pedagogy relative to the novice learner can now be addressed: 1) increased exposure of novice learners to advanced digital design media and materialization technologies; 2) vast array of digital technologies and associative specializations; 3) required specialization or 'elitism'; and 4) relative lack of pedagogical strategies anchored on cognitive theories of learning.

3.4.1 Misuse of advanced technology

Regardless of disciplinary thresholds, introductory education is characterized by the calculated-structuring of foundational schema, both paradigmatic and skill-based. While limited exposure to higher-order knowledge in introductory education can enhance learning (Kalyuga, Ayres, Chandler, and Sweller, 2003), the misuse of advanced technology

is a common plague in introductory digital design education as affordances of advanced technology are exploited. For example, the user-defined associative compositions or frameworks that control parametric operations offer opportunities for explicit knowledge transfer and formative assessment in digital design education, but such affordances are also two-faced with opportunities for enhanced knowledge-transfer being abused for quick results via ease of transference and formal complexities that mask a lack of intellectual rigor. Thus, a significant challenge for educators in introductory digital design education is determining how to introduce, develop, implement, and control higher-order generative frameworks for effective knowledge transfer while still providing enough flexibility for student exploration of the new media.

3.4.2 Expanding digital design specializations

Highly sophisticated digital media has spurred a plethora of digital sub-specialties including the designer's role as tool-builder. This seminal differentiation from historical roles of the architectural designer poses exceptional challenges to architectural pedagogy. If digital design thinking is a necessary skill for praxis, how can design pedagogy possibly accommodate the diversity of advanced specializations and emerging professional roles? Should alternative curricula be developed for the 'digital design specialist'? The development of adaptable and easily-deployable knowledge structures may be essential to this inquiry, and such development begins at the introductory level.

3.4.3 Diversity of interactions in digitally mediated design

Digital design positions the designer in novel relationships with design media, a key characteristic of this field of design. Although the designer continues to occupy a central role in design schema, the nature of interactivity and the type of control make this form of mediated design unique. In digital design, the designer faces an increased range of roles regarding the condition of interaction with design media as compared to the analogue designer. The digital designers control generative and performative processes, structures and designs the material of information or data, and thus have their role symbolically represented via the link created between designer and sub-processes.

One such designer-to-material relationship in digital design is that of bi-directional information transfer, a complex interaction not encountered in analogue design. This complexity presents challenges to the design educator relative to the learner's cognitive capacity and the specific type of modeling processes employed. Unlike the early a posteriori Computer-Aided Design (CAD) models that exhibited a minimal differentiation from conventional design models, current digital models' efficient integration with material logics and the materialization processes of DDF and RP afford designers increased opportunities for information transfer. Physical designs can be scanned into a digital medium, manipulated, and printed back into physical form. The method by which digital ideational representations are developed is highly diversified compared to the analog era. Digital models are hierarchically organized by complexity – formation models, generative models, performance models, and integrated compound models – each differentiating the manner in which designers interact with design representational descriptions within the design process. Parametricism, BIM, shape grammers, evolutionary models, and dynamic design including animate form and morphogenetic models are included under the topic of bi-directional transfer in digital design (Oxman, 2006). Because BIM modeling in particular is rapidly expanding in breadth and complexity, it is also particularly apt for explicit knowledge evaluation (Eastman, Eastman, Teicholz, and Sacks, 2011).

3.4.4 Digital 'Elitism'

Digital 'elitism' is a term used to describe the specialist skills required to utilize advanced digital technology (Oxman, 2006). Considering that digital design media often requires knowledge of multiple software packages and advanced technical knowledge for operations such as scripting, parametric framework development, and managing of complex data models (Oxman, 2006), the requisite knowledge structures necessary for such advanced processes demand extensive development. How can design educators enhance development of digital media's technical skills or 'digital skill thinking' without over allocating curricular focus on this one learning outcome? In introductory architectural education this is especially important as digital design skill and knowledge of emerging theoretical frameworks for digital design are added to an already bulging curriculum. If trends in praxis continue, digitally 'elite' graduates may be increasingly prioritized, suggesting that higher-level technical and theoretical knowledge of digital design will be prioritized at increasingly earlier stages of design education.

3.4.5 Dearth of cognition-based pedagogy

Deliberate and well-researched pedagogical strategies to elicit efficiency in learning are increasingly important in the digital design environment. Yet, the rich body of research related to cognitive load, schema development, and knowledge transfer remains relatively untapped in design education. Anchoring digital design pedagogy in cognitive theories of learning appears to be especially promising due to the following two factors: 1) the increased importance of effective knowledge transfer to accommodate digital design's expanding knowledge base and 2) the un-tapped, intrinsic affordances between digital tooling processes and schema development. The following sections discuss aspects of cognition supported by educational research and affordances of digital technology that are especially relevant to the novice learner in digital design contexts. Affordances for the novice learner's cognitive development related to digital technology will be considered through the exploration of two relevant cognitive theories of learning, recognizing that other significant theories of learning may also apply to digital design education.

4. Cognition in Introductory Digital Design Education

As previously suggested, the beginning digital design student's intellectual development can be enhanced via the construction of higher-order, adaptable knowledge structures or schema capable of flexible re-appropriation in a variety of academic and professional environments. However, the development of schema in novice learners is particularly challenging due to pronounced learning curves for both 'digital design thinking' and 'digital skill thinking'.

As Akin (2002) suggests, students who are developing design skills typically must grope (i.e. problem domain) for a needle (i.e. knowledge) in a haystack (i.e. solution domain), a cumbersome cognitive task due the student's lack of knowledge concerning their own process and the 'happenstance' or 'loose' pedagogical context within which they are immersed. In addition to these design-related struggles, students in digital design contexts must also grapple with the technical challenges of digital tooling methods and related representational media. Students must rapidly shift their cognitive capacity between the knowledge induction methods of didactic cognition (i.e. the development of technical software knowledge) and design thinking (i.e. methods related to Finke,

Ward, and Smith's (1992) theory of Creative Cognition). This bi-modal learning process can quickly overload cognitive capacity, thereby inhibiting effective knowledge transfer.

Thus, the primary challenge of digital design education for novice learners is not simply the operational knowledge of digital tools nor the cognitive load resulting from “domain-general creative cognition (i.e. divergent thinking)” (Beaty, Silvia, Nusbaum, Jauk, and Benedek, 2014, p.1186), but rather the simultaneity of the aforementioned, differentiated cognitive processes. Based upon research from the fields of educational theory and digital design, an effectual educational strategy for teaching novice learners in digital design may be a combination of pedagogical techniques that enhance schema development and knowledge transfer efficiency through cognitive load mitigation. Thus, the structuring of digital design pedagogy based on the general principles of schema development and cognitive load theory (CLT) may be particularly beneficial for novice learners (Ausubel, 1968; Dansereau, 1995; Van Merrienboer and Sweller, 2005).

4.1 Schema Development

Considering the continual stream of new or upgraded software packages necessary for higher-level digital processes, the 'novice' learner in digital design is an inherently abstract categorization. Novice learners are assumed to be those students lacking necessary technical, creative, and combinatory schema to facilitate effective digital design production. For the purpose of clarification, this discussion is also based on an assumption that 'near transfer' (Perkins and Salomon, 1992) likely occurs between analogue and digital design media, suggesting that the design knowledge (i.e. schema) formalized, represented, and re-transcribed (Oxman, 2000) via representational re-descriptive processes (Karmiloff-Smith, 1995) is not media specific. This assumption is reasonable due to the wide-spread ability of students to transfer established design knowledge from analogue to digital environments as well as the lack of understanding regarding the cognitive foundation for creative thought (Beaty et al., 2014).

A schema, also known as a mental configuration or cognitive framework, is the structure comprised by the learner's organized knowledge in a particular subject (Ausubel, 1963). Considering a schema's function as the “Velcro of the mind to which new information sticks” (Cross and Steadman, 1996, p.41), the organizational efficiency - particular to the individual learner - behind its underlying associations of related concepts is critical to the subsumptive process (Ausubel, 1963). The acknowledgement by design educators of factors affecting the subsumptive process is the first step to developing curriculum that supports effective meaningful learning and retention. One such factor particularly relevant to digital design is that of the hierarchically organized cognitive structure. Ausubel describes the epitome knowledge structure as one of highly inclusive “conceptual traces under which are subsumed traces of less-inclusive subconcepts as well as traces of specific informational data” (Ausubel, 1963, p.217). This organizational logic of “progressive differentiation” (Ausubel, 1963, p.217) is in essence a network of malleable, top-down cataloging, thus supporting the position that 'explicit pedagogical frameworks' (Mcalpine, 2004) for well-defined problem/solution spaces are beneficial as they enhance conceptual clarity and encourage deep processing strategies in students (Muis and Franco, 2009).

Although schema development in learning is but one of the many foci of cognitive studies in digital design education, it is the fundamental goal when teaching novice learners (Sweller, 1988). For the purpose of

facilitating meaningful learning, rather than rote learning, goal-specific pedagogy with well-defined problem and solution spaces may be extremely beneficial (Eastman, 1969). Alternative techniques, such as those based on the theories of situated cognition (Lave and Wenger, 1991 cited in Mcalpine, 2004) including scaffolding, direct feedback, and supported trials (Mcalpine, 2004) are also particularly relevant for schema development.

4.2 Cognitive load theory in digital design education

The well-researched field of cognitive loading offers a foundational framework for introductory digital design pedagogy as teaching strategies based on the implementation of its core principles can reduce cognitive burden, increase clarity, and thereby enhance knowledge transfer efficiency for novice learners. The simultaneity of creative cognition and operational knowledge of digital tools makes cognitive load theory especially pertinent to digital design studies.

The primary presupposition of CLT is that learners, particularly those that are novices, have a limited capacity working memory when exposed to unfamiliar information (Sweller, Van Merriënboer, and Paas, 1998 cited in Artino, 2008). Learners also have “an effectively unlimited long-term memory holding cognitive schemas that vary in their degree of complexity and automation” (Van Merriënboer and Ayres, 2005, p.6). As such, a core objective of CLT has been the development of instructional methodologies that reduce “unnecessary cognitive burden on working memory” (Artino, 2008, p.146) so as to prevent a learner's limited working memory from being overwhelmed, thereby hindering learning (Artino, 2008).

4.2.1 Expedited schema development via cognitive load reduction

One important aspect of CLT for design educators is that a student's expertise is not based on their processing efficiency of information located outside long-term memory but rather the quality of, and accessibility to, knowledge contained in schemata. Consequently, the construction of expertise - a process involving the conscious combination of simple ideas into those with greater complexity (Van Merrienboer and Sweller, 2005) – can exploit the affordances of digital technology for enhanced schema development. For example, the seminal cognitive process in design of 'reflection in action' can be expedited due to the swift materialization capabilities of rapid prototyping (RP). With effective curriculum structuring and well-designed instruction (Van Merrienboer, 2002 cited in Van Merrienboer and Sweller, 2005), students can more quickly carry out their exploration of the design problem's conceptual and solution spaces via representational formalisms such as ICF (Issue-Concept-Form) (Oxman, 1994) and other knowledge acquisition processes via the use of RP. With digital technology, amount, diversity and complexity are no longer limiting factors in artifact production (Sass and Oxman, 2006).

4.2.2 Prioritizing early automation

Design knowledge is acquired as solution spaces and the development processes responsible for their emergence are reflected upon and transferred into long-term memory. As student's tap solution-space knowledge stored in long-term memory, limited working memory is freed for further application. Additionally, highly complex schemata can become automated through repetition, a natural cognitive load mitigative process uniquely applicable to machine operation and software applications (Van Merrienboer and Sweller, 2005). This cognitive affordance supports a pedagogical strategy in design that prioritizes the development of student's automative processes for software usage early in their education so as to curb superfluous computational cognitive load

in future, higher-level design courses. The relevance of this perspective is amplified due to the design learner's near-complete incapacity to automate solution space knowledge of ill-defined problems, the type of problems comprising design-studio courses.

4.2.3 Intelligent precedent libraries

Novice learners in design are particularly prone to quandary or “stuckness” (Sachs, 1999), a state resulting from numerous contextual factors (Lewin, 1966 cited in Sachs, 1999). However, cognitive overload induced by the inductive reasoning processes associated with ill-defined problems is arguably a major contributor. Novice learners, by definition, lack advanced schema in the particular area of concentration, thus knowledge is not available to structure information. Information must then be organized randomly prior to being tested for effectiveness (Van Merrienboer and Sweller, 2005). It is processed linearly while the possible combinations of linear elements erupt exponentially, a cognitive complication particularly relevant to the ill-defined problems of design.

The existing literature indicates that enhanced schema development by means of intelligent, digital precedent libraries may help alleviate the severity of 'stuckness' – 'intelligent' meaning planned or algorithmically controlled precedent libraries that provide design information as well as offer related design solutions based on the queried topic. Even though design education utilizes precedent study to build concept and solution space schema – a seminal aspect of meaningful learning in design (Akin, 2002; Oxman, 2004) – precedent knowledge is particularly apt for near transfer in design problems and digital technologies can amplify this affordance. Logics of the associative and controlled-attention theories of creative thought each support the prior statement as well, given the assumption that constructing greater depth to, and a wider range of, creative thought can assist in 'stuckness' mitigation. On one hand, the associative theory (Mednick, 1962 cited in Beaty, et al., 2014, p.1186) suggests that flat associative hierarchies in semantic memory enable creative thought. The controlled-attention theory, however, hypothesizes that creative thought results from differences in the goal-directed, top-down, balanced control of attention and cognition (Beaty, et al., 2014). Research in both theoretical areas indicates that more encompassing precedent exposure in creative disciplines can induce expanded process and solution space schema, thereby supplying the learner with greater cognitive resources to tap into as they attempt to move beyond their quandary. 'Intelligent' precedent libraries can help supply knowledge concerning both how to design and knowledge of existing designs.

5. Discussion and Limitations

The aforementioned pedagogical strategies should be considered initial explorations of cognitive research applied to digital design education, especially in terms of the novice learner. The simultaneity of digital skill thinking and creative cognition warrant further development of this line of inquiry so that instruction can be designed to maximize schema development and enhance knowledge transfer. The dynamic nature of digital design and the rapidly evolving cognitive developmental sciences collectively indicate that there is ample opportunity for future research in this area of instructional design. What toolset of digital design knowledge is most appropriate for the architectural learner in the contemporary professional context? Structuring curricula and designing instruction around knowledge-transfer optimization strategies and compiling related, empirical results could be a valuable next step to further development of this line of inquiry.

6. Conclusions

The fundamental disruption in analog pedagogical environments resulting from the digital revolution in architecture suggests that the pedagogical methods which have provided the cornerstone of architectural education in an analogue environment must be re-conceptualized and restructured relative to the expanded knowledge base of digital design. This paper attempts to begin such reconceptualization by differentiating between analog and digital learning environments and identifying the unique challenges and affordances associated with digital design. The primary challenge for novice learners in digital design may be the simultaneity of operational knowledge of digital tools and the cognitive load resulting from domain-general creative cognition. As such, relevant learning theories including schema development and cognitive loading are proposed as they hold substantial promise for addressing the teaching and learning complexities associated with the simultaneous cognitive processes inherent in digital design.

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Spatial solutions supporting information exchange and knowledge creation

Sanna PELTONIEMI
School of Architecture
Tampere University of Technology
Korkeakoulunkatu 5, FINLAND
sanna.peltoniemi@tut.fi

Jenni POUTANEN
School of Architecture
Tampere University of Technology
Korkeakoulunkatu 5, FINLAND
jenni.poutanen@tut.fi

Aino AHTINEN
Human-centered Technology
Tampere University of Technology
Korkeakoulunkatu 1, FINLAND
aino.ahtinen@tut.fi

Henna SALONIUS
Novi Research Center
Tampere University of Technology
Korkeakoulunkatu 8, FINLAND
henna.salonius@tut.fi

Abstract
Architectural practice is a creative, knowledge-based organization, and therefore information exchange and knowledge creation are essential components of architects' profession. However, these aspects of architectural practice are not studied widely. The objective of this study is to analyse how the mobility of the different types of workers' effects on the information exchange and knowledge creation in a team-based office layout. The research material was collected from a semi-large Finnish architecture office. The methods employed are qualitative: theme interviews with the employees and the executives of the office, together with the informal on-site observations.

The preliminary analysis of the research material indicates that the team-based office layout supported tacit knowledge exchange and creative group work. The team rooms, however, did not support the individual working preferences of the participants. Furthermore, the tacit knowledge remained inside the team and did not spread through the whole organization. Therefore, as a downside, the team-based working inhibited the information exchange and knowledge creation between different teams.

Introduction
Knowledge in its various forms has become the most valuable asset in modern organizations and societies (Chatzkel, 2003; Brooking, 1996; Grant, 1996; McIver

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et al., 2013). The ability to mobilize and harness knowledge has been on the special agenda of researchers and practitioners from the late 20th throughout the 21st century, but it was already in 1939 when Robert S. Lynd, for instance, pointed out that people need to build their organisations so that knowledge flows freely to create opportunities and solve problems. Therefore, knowledge and its importance in work life is not a sudden insight, but a view that needs reconsideration time after time.

The study by Winch and Schneider (1993) defines architectural practice as a knowledge-based organisation. The distinctive characters of knowledge-based organisations are that they sell intangible service, which varies from client to client, and this service cannot be stored. In other words, the expertise of the staff, and their ability to provide promised service, is the main “product” to trade for knowledge-based organisation (Winch & Schneider, 1993).

Furthermore, architectural practice is a creative organisation. (Martens 2011; Winch and Schneider 1993) The creative process includes different stages and creative behaviour is also perceived in different ways (Martens, 2011). The possibility for interaction, the reflection of work, knowledge sharing and coordinating work are considered important for supporting creative interaction (Martens 2011). Hence, facilitating creativity in workplace requires various spatial configurations according to the activity, the stage of the creative process and personal preferences (Martens 2011, Gibson 2003) and knowledge worker type (Greene and Meyerson, 2011). Therefore, it is essential to identify different types of knowledge workers in the creative organization in order to respond to their spatial requirements.

Architects learn and transfer knowledge about their work procedures mainly by doing, because a great deal of architect’s profession includes tacit and “intuitive” knowledge. (Schön, 1983; Styhre, 2011) According to Schön (1983) this kind of knowledge reveals itself in actions, recognitions and judgments, which architects can carry out spontaneously. Furthermore, architects can rarely specify how they have learned to do certain things in their professional practice; they just simply do them(Schön, 1983). Moreover, the tacit components of the work are difficult to communicate to colleagues as well as external stakeholders (Styhre, 2011). In the process of design, an architect reflects the situation or the design problem, by exploring different solutions (Schön, 1983). In addition to visual aids, architects explain and discuss the design ideas and concepts with their colleagues. However, these discussions often derive from visual references, which support the verbal communication. (Schön, 1983; Styhre, 2011) Under these circumstances, face-to-face contacts in architects’ profession are important in considering the transfer of “intuitive” knowledge and tacit components of the works.

In other words, information exchange and transfer of tacit knowledge are essential components of architectural practice. Therefore, also the layout of the architectural office should support these different perspectives of work. This article focuses on architectural profession and work practices, and ponders on how the office layout of an architecture office supports information exchange and knowledge creation in relation to different types of knowledge workers.

The study aims to answer two following questions: RQ1) Which different mobility types of office workers can be identified among the participants? RQ2) How the mobility of the different types of workers affects on the information exchange and knowledge creation within the office?

The paper is structured as follows. First, drawing in relevant literature, the concepts of information and knowledge, more precisely the knowledge creation process and its relation to spatial solutions, are discussed. This is followed by literature on how different types of knowledge workers and their mobility effect on office layout and spatial solutions. Secondly, the detailed methodology of our study is presented. Thirdly, the results are discussed in relation to the theory: we

identify different types of knowledge workers and analyse how the case study office layout supports their mobility. Furthermore, we discuss what kind of impact the mobility of the workers has on the information exchange and knowledge creation. Finally, concluding remarks and recommendations for the further research are made.

THEORETICAL FRAMEWORK

The knowledge creation process

The concepts of information and knowledge tend to mingle or be used as synonyms in colloquial language, whereas in academia they are distinguished and defined differently. One way to approach knowledge is to categorize it in a hierarchical relationship: data (unstructured data and figures), information (structured data), knowledge (integrated and interpreted ranges of information) and wisdom (the use of information and knowledge with sound judgement) (Ackoff, 1989; Thierauf, 1999; Rowley, 2007.) The hierarchical relationship intends to simplify that mere data possessed by a person is not useful without ability for interpretation.

The concept of knowledge can also be approached by the observability. Explicit knowledge refers to knowledge that can be codified in writing or some other form of systematic language or code being declarative by nature (Nonaka and Takeuchi, 1995). Tacit knowledge is something personal (Polanyi, 1966) context-specific, procedural and difficult to put into words (Nonaka and Takeuchi, 1995). Self-transcending knowledge is understood as tacit knowledge prior to its embodiment proposing a distinction between two types of tacit knowledge. It is precognition, or ability to sense and presence the emerging opportunities. To see the coming-into-being of the new is usually associated with artists (Scharmer, 2001).

The implicit goal of the information flow is that it becomes knowledge; knowledge that is valuable for the organization in concern. However, the information without considered actions may not result in desired outcomes if the process behind it is not understood properly. One of the most referred theories for the knowledge creation process is the SECI model developed by Nonaka and Takeuchi (1995). The model lays its foundations on the idea of knowledge conversion where knowledge is often considered being of two types – tacit and explicit - implying that collective learning process increases knowledge in the organizations, and that the SECI model is to produce a learning spiral by continuous knowledge conversion. The knowledge conversion takes place through four sequential modes of knowledge conversion: (1) Socialization, (2) Externalization, (3) Combination and (4) Internalization. The SECI model has been extended and two phases, potentialisation and visualisation, of knowledge conversion were added by Harmaakorpi and Melkas (2005) and Uotila et al. (2005). They incorporated self-transcending knowledge, because a need for dynamic capability that is to be able to plan for the future while taking into account the dependency of the past had been recognized (Uotila et al., 2005). The incorporation of self-transcending knowledge can be viewed also as “a gate to gaining new insights” that enhance the knowledge creation process. New and unorthodox ideas need to be allowed to join the knowledge creation process. Othewise, there is a risk that circulating knowledge builds heavily upon previously created knowledge and becomes repetitious, conventional and exclusive (Salonius and Käpylä, 2013).

Workplace for knowledge creation

Nonaka and Konno (1998) have elaborated the SECI model with the concept of “ba” that roughly translates into the English word “place”. “Ba” is a shared space for emerging relationships and therefore serves as a platform for knowledge creation. The space can be physical (e.g. office), virtual (e.g. e-mail, internet), mental (e.g. shared experiences, ideas) or combination of any.

According to Nenonen (2005, p. 56), four types of workplaces for knowledge creation can be identified: *connective, structural, formal and reflective*, with each

supporting different phases of the knowledge creation process. However, not all of the workplaces should incorporate all of these different spaces, but instead some of them can be partly or fully virtual (Nenonen 2005).

The connective place brings people together and therefore, supports the first phase of knowledge creation, socialization, during which individual tacit knowledge is converted into group tacit knowledge (Nenonen 2005, p. 235). Then again, in *the structural place* tacit knowledge is converted into explicit knowledge. This place supports concentrated work and guided work processes by an atmosphere, which is task-oriented, and the focus is on tangible performance. Meeting rooms are examples of a structural place (Nenonen 2005, p. 58).

The formal place supports the phase of knowledge creation where separate explicit knowledge is converted into systemic explicit knowledge (Nenonen 2004, p. 235). This place offers room for privacy and repetitious routine tasks. Atmosphere is closed and silent and, on the contrary to the structural place, the formal place supports the role of the individual. Individual office rooms, for instance, can be seen as formal places.

During internalization, the last phase of knowledge creation, explicit knowledge is transformed back into tacit knowledge (Nonaka et al., 1995), which is supported by *the reflective place* hosting a relaxed and sometimes even lazy atmosphere. The sharing of knowledge and innovative spirit is essential part of this place. For example, coffee areas or informal meeting places with sofas can be identified as reflective places (Nenonen 2005).

Different types of knowledge workers and their mobility

According to Fischer et al. (2004) three major aspects, which influence on workspace satisfaction, are individual differences, organizational context and environmental features. Individual differences consist of the role and responsibilities of the worker, the nature of the work tasks, individual wishes regarding the workspace type and level of satisfaction in general. Furthermore, according to Greene and Myerson (2011) organisations tend to perceive knowledge workers as a homogenous group supposing individual's work similar ways and have identical needs and due to this fail to provide the appropriate work environment. They suggest that better understanding about the movements and motivations of knowledge workers can inform office design towards increasing the productivity of knowledge work too (Greene and Myerson, 2011).

The mobility of the knowledge workers can be categorized several ways (Greene and Myerson, 2011; Schaffers et al., 2006; Vartiainen et al., 2007). In common for all of these categorizations are that they identify roughly four types of different knowledge workers based on the frequency of changes in location and the actual location. For example, Greene and Myerson (2011) call their four types of knowledge workers the Anchor, the Connector, the Gatherer and the Navigator. Anchors have the lowest mobility of all different types of knowledge workers. They come to the office everyday, working at their desks most of the time. According to Greene et al. (2011), anchors have the essential role in knowledge transfer within an office, because other employees go to them in order to get information. Connectors move around the office building and spend their working hours at meetings or talking to colleagues. Connectors interact a great deal with different people, but they stay within the office building. Then again, Gatherers spend half of their working hours away from the office at different meetings. At the office, Gatherers do not necessarily require their own office desk; instead they need different types of working stations, which offers space for concentration and collaboration. Navigators are key figures of the organization and their work is highly mobile including the global network. Most of the current knowledge workers fit to the types of Anchor and Connector, then again Gatherers and Navigators imply towards office design and work environment principles in which an infrequent presence of certain workers should be provided for in a comprehensive way (Greene and Myerson, 2011).

Effects of workers' mobility on information exchange

As the categorization of different knowledge worker types indicates, the mobility of the workers can happen either within one location or between multiple locations. Traditionally, all kinds of work carried outside a main office are referred as "telework" or "remote work" (Vartianen et al., 2007). Pyöriä (2003) has analysed challenges to implement teleworking more widely among the knowledge workers in Finland. One of the most challenging problems is to establish the effective human communication in virtual environment. Even with the most advanced video-conferencing technology, it is difficult to express and respond to social clues, which are essential in human interaction, and therefore, the risk of misunderstandings increase. Furthermore, Pyöriä (2003) pointed out that the use of electronic interfaces restricts, and sometimes even inhibits, the transfer of tacit knowledge. Moreover, in the field of architecture, where the visual communication and conversations are essential part of the job description (Schön 1983), the physical presence is necessary (Pyöriä 2003).

The knowledge creation process has affected research on workplace design for the past two decades. The trends have been facilitating communication for information sharing, together with flexibility (Appel-Meulenbroek et al., 2011; Gibson, 2003; Peponis et al., 2007). Interaction and communication in offices are important for knowledge work and creativity. These are manifested usually in open and flexible layouts. However, openness has its disadvantages: for instance, talking in open-plan environment may disturb colleagues (Värlander, 2012). In order to address the problems related to open layout offices, the activity-based office concept was developed. That is, workers can choose an activity-based workstation that best suits the tasks in hand and supports also workers' personal preferences. Then again, activity-based offices have likewise drawbacks, for example, in the loss of identity and critical design failures such as lack of soundproofing (Appel-Meulenbroek et al., 2011).

According to Gibson (2003), in management of organisations the flexibility is acquired through project-based teamwork, where teams form and evolve constantly. Among other things, flexibility also derives from the changing working patterns to better suit individuals' and company's needs of time and place for work, i.e. from where and when people work.

Peponis, et al. (2007) proposed two models of workspace designs, which influence on information exchange and communication, thus improving productivity. The first, called "*the flow model*", argues "*communication is the most effective if the office layout directly reflects the required flow of information, such as by placing people who need to communicate near each other*" (p. 816). However, the problem of this model occurs if workers need to communicate with great number of colleagues or the patterns of interaction are irregular. The second called "*serendipitous model*" suggests "*providing informal nodes, such as cafes, helps to bring people together outside of normal workspaces*" (p. 816). This partially balances the problems of the first model and encourages unplanned interactions with various colleagues. In their work, Peponis et al. (2007) suggested that physical design of the workplace creates framework that supports distributed understanding in organizational setting. Thus, physical workplace can act as enabling and generative mechanism for information exchange (Peponis, et al., 2007).

To sum up, varying theories and research on office layouts impact on creativity, information exchange exists. Hence, creative organizations such as architecture offices need to consider their own office layout from different angles. For instance, it is important to consider how to facilitate the creative process and production of new knowledge, forms of information exchange and communication, as well as the mobility of different types of knowledge workers. In addition, the spatial configurations should support their organizational goals, working methods as well as employees' preferences.

METHODOLOGY

Research Context
This chapter describes the methodology of our study and provides an overview of the research context. The study focused on an architecture office that is a semi-large company and located in Tampere, one of the biggest cities in Finland. At the time of the study, there were 26 employees consisting mainly of architects. The office was established in 1982. The office is located in the city center and it had moved to the new premises in the spring of 2014.

The current office environment consists of a public lobby space and a kitchen area, meeting room facilities and small team rooms located along a circular corridor. Most of the employees are located in the shared rooms with approximately three people, based on team projects. The executives and a financial officer have individual offices. Glass walls separate the team rooms from the corridor. The combined lobby space and the kitchen area are mainly used for in-company and customer meetings, coffee breaks and breakfast events. The negotiation rooms are reserved for official and formal meetings.

According to the executives, the aim of the layout of the new premises is twofold. Firstly, the layout aims to support changing teamwork and enhance information exchange between people in the same room: project teams could be assembled flexibly in the need, and each employee could change the working station according to the project at hand. Like this, each project member could receive information easily from the other members of the project in the same room and, for example, overhear the phone calls related to the project. Another aim of the spatial organisation is a distribution of tacit knowledge among the employees. More experienced designers, could share their knowledge and expertise to younger designers by working in the same room with them. Therefore, an extra table was furnished in each of the rooms, so the more experienced designers, for example the executives, could change their workstation flexibly and guide the younger designers when needed.

The latter aim of the spatial organisation also supports the company's policy of working patterns: the employees are expected to be at workplace approximately during regular office hours, from about 7 to 9 until 4 to 6 pm, unless they need to participate in some work-related meetings outside the office. Furthermore, the technological resources limit the possibility for remote work, since almost all employees have desktop computers. However, company has a couple of shared laptop computers for the employees who occasionally work outside the office. In other words, excluding some occasional exceptions, the work patterns are relatively fixed on location.

Participants
There were 18 voluntary participants in the study (F=8, M=10). The age-range of the participants was from 27 to 59, the average being 45 years. Most of the participants were architects, involving many roles: managers, financial control, senior architects, project architects and assistant architects. On average, the participants had worked in the office for 12 years, when the working experience in the office varies between 0,5 years and 22 years.

Data Collecting Methods and Data Analysis
Semi-structured theme interviews (N=18) were conducted as a data collection method. Interviews lasted about one hour, and there was a moderator and an observer present in most of the sessions. The interview discussion framework consisted of the short background questionnaire, followed by three main themes 1) Job description in general, 2) Flow of information within the office (between employees), 3) Flow of information outside the office (between the architect and client). Each theme included approximately 10 questions, for example “Describe your typical workday and tasks” (theme 1), “Do you think that the layout of the office has an impact on the information sharing in the office? How?” (theme 2)

and “How do you gain essential information about the needs of the client or user during the project?” (theme 3). The interviews were tape-recorded and transcribed. The material analysis of the interview transcriptions was conducted with the qualitative content analysis method (Zhang and Wildemuth, 2009). First of all, the moderator and the observer of the interviews went through the material and discussed the emerging findings of the material. Then, the main author of this publication conducted the content analysis with the Atlas.ti programme, where the analysis unit was a part of a sentence.

As an additional and informal data collection method, the on-site visits to the architecture office allowed to conduct observations about the context. The observations and interviews were used to identify the workers' behavior in order to analyse the mobility of different types of office workers. The mobility analysis was based on the categories by Greene and Myerson (2011), Schaffers et al. (2006) and Vartiainen et al. (2007). Furthermore, the layout of the architecture office was analysed in order to examine the effects of workers’ mobility on information exchange. In this preliminary analysis of the research material, we concentrate only on the physical facilities of the case study architecture office. We focused on the role of the main office facilities on the information exchange. Most of the participants worked at least sometimes out of the office, if they attended, for instance, meetings with clients in other places. The functional and spatial qualities of these other locations are not analysed here.

FINDINGS

The tacit knowledge remained inside the team and did not spread through the whole organization.

The preliminary results show how the current layout of the office has been experienced by the employees and the executives of the architecture office. The findings also present the different types of knowledge workers and their level of mobility. Furthermore, the results show how the mobility of the workers impact on the information exchange within the office.

Two types of mobility

In general, the results indicate that the mobility can be seen happening not only physically but also mentally. That is, the mobility of the participants can be observed through the mobility of thoughts and mind-sets, for example the need to transfer between different projects. The interviewed participants told they were involved from 1 to up to 11 projects at the same time. On average, senior designers were in charge of 2 to 4 projects simultaneously. Obviously, these projects were in different phases and hence, the efforts needed from the individual worker varied. However, according to the participants, concentrating on multiple projects simultaneously takes time and sometimes causes stress. Based on the interviews, it seems that this mental mobility has actually more impact on the fluency of the work than physical mobility. The interviewed participants recognized that when concentrating on one project at the time, the work proceeds more smoothly.

“*Of course sometimes you have to transfer from a project to another in the middle of your workday, if you receive some urgent e-mail or phone call. Nevertheless, sometimes you can concentrate on a specific project and that is nice, because then the work proceeds a lot more smoothly*” (male)

“*Unfortunately, you have multiple projects on-going, and you just have to choose the one that is the most urgent.”* (male)

All participants agreed that the physical mobility of work depends greatly on the phase of the project. Most of the participants worked 80-90% of their working hours at the office. The remaining 10-20% is spent at different appointments outside the office. However, in a few cases, the physical mobility of work increased momentarily, especially if the project involved a lot of meetings. Quite naturally, the senior and more experienced architects seemed to attend meetings more often than younger designers, as they were usually in charge of the projects.

Based on the interviews, 3 out of 18 of the participants were identified as Gatherers (Greene and Myerson, 2011): they interacted mainly with people outside the office and brought back new business and relationships and they had a need to work in various locations, for example at the client or partners' offices. Then again, altogether seven Connectors (Greene and Myerson, 2011) were identified amongst the participants. They spent most of the day within the office, managing multiple projects, interacting with various people and advising younger designers. They also attended meetings outside the office regularly, but the main part of their work concentrated within the office. Furthermore, eight of the participants were identified as Anchors (Greene and Myerson, 2011). They worked normally within the office, concentrating only on one or two projects at the time. This group included mainly architecture students, younger designers and assisting architects, who were not in charge of the big projects. None of the interviewed participants were identified as Navigators (Greene and Myerson, 2011). Even though some of the participants used to spend major part of office hours outside the office, it still remained the focal point of their workweek. To summarize the categorization of the participants according to their physical mobility (Figure 1).

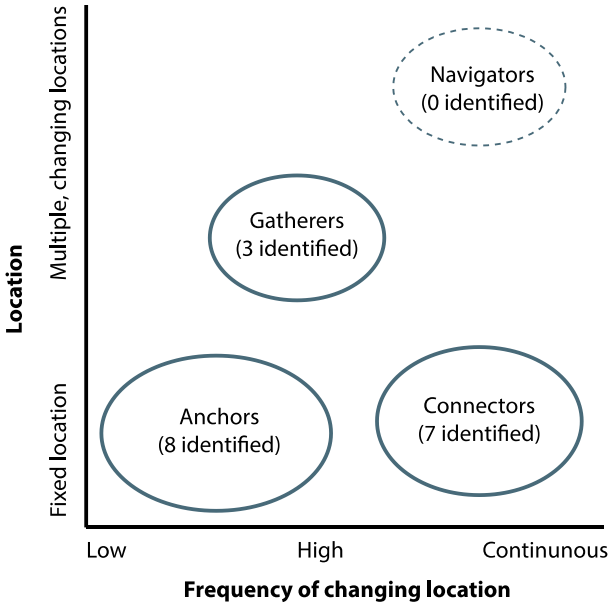

Figure 1: The categorization of the participants on four types of knowledge workers in relation to previous studies of Greene and Myerson 2011 and Schaffers et al. 2006.

However, noteworthy is, that identifying the participants as certain types of knowledge workers may vary greatly depending on the day. On one day, more experienced designers were Gatherers, spending their time in various meetings, and on the other day, they were Anchors, drawing up technical plans at their desk. This reveals a great deal about the varying nature of architects' job description.

According to the participants, information and communication technology have diminished the need to move physically from a place to another: most of the different design issues were handled with phone call or e-mail. In addition to this, several construction sites were located in another city and hence, due to the distance, the actual meetings were kept as minimum as possible. Major decisions and other complicated matters required face-to-face meetings with other designers or client(s). For example, site activities and supervision always required a visit to the construction site.

Layout to support information exchange

The current office layout represented by our case study follows “the flow model” workspace design (Peponis, et al., 2007) as the layout supports team-based working (Figure 1). This followed two organizational goals of the architecture office that are enhancing information exchange and distributing tacit knowledge among employees. Based on the interviews, it seemed that the information exchange within the team room was excellent: when one person received project related information, he or she could pass it on immediately to the other members of the project. In addition to this, all the participants felt free to ask help from their colleagues in the same room. This implies that besides project related information, the tacit knowledge transferred well between the people in the same room. Furthermore, the team rooms were furnished by placing a low shelving unit in each room, which could be used as an extra table in order to support conversation and sketching within the room. The results indicate, that the team-based workspace supports especially the Anchor type workers, since they have low mobility during the workday. Each individual had his or her own desk, which was located in a team room with 2-3 other people. Based on the observations and the interviews, the participants worked mainly by their desk when being present at the office.

Employees, who participated in a project for a longer period of time and actually moved their workstation to another room, were quite happy about the arrangement. As said, passively gained information, such as overhearing the phone calls were considered a very efficient way to transfer information about the project. Those employees, who did not change their workstation and possibly participated the project only for the short period of time, were not happy about the information exchange within the project team, and felt stressed because they were thrown suddenly into a new project without any or with only a short introduction to the main features of the project. Especially these short-term project members would have benefit from the information exchange which happens between the team members within the same room. Often these short-term project members participated to the project during the busiest phase of the project and therefore, other team members had lack of time to familiarize the short-term members with the key features of the project.

On the other hand, it seemed that the layout did not support the mobility within the office, that is, Connector types of workers. Connectors were involved in multiple projects at the same time and therefore, they belonged multiple project teams as well. As a consequence, Connectors had a need to communicate and exchange information with several people during the day. Part of the Connectors required space to work more freely and talk to people. They wanted to work in even bigger rooms where they could interact more with the colleagues and talk more about design tasks in hand.

On the contrary, part of the Anchors expressed need for quieter working environment. These individuals had developed different kind of aids to concentrate on their work: some of them listened to music via headphones in order to tune down the distracting conversations. Some of them arrived early at work, because they felt they could focus better in the morning when it was quieter. If all the people in the same room wanted to work in silence, they would close the door to the corridor.

The Gatherer type of workers used mainly their own allocated desks in the office rooms. In addition to this, Gatherers frequently used meeting rooms. Gatherers were happy about the spaces provided for them, but in the terms of effective space utilization, having the separate office desks for Gatherers may not be the most efficient solution. Furthermore, two of the Gatherers had single offices, and this seemed to cause some problems on how to exchange information. The Gatherers participated the meetings outside the office and when being present at the office, they needed to share the gained information to the Anchors and Connectors. According to the participants, this caused some conflicts and frustration, since several people wanted to discuss with the Gatherers at the

same time. However, the same person could adopt very different roles depending on the urgency of the projects at hand. Hence, the categorization of the participants described before needs to be seen as suggestive.

Even though the spatial solution of the office seemed to enhance information exchange between the employees in the same room, the communication between people in different rooms was considered weak. Many of the participants claimed that they had only little or no idea what their colleagues were doing in other projects. The employees socialized during the lunch or coffee breaks and refrained discussion about work-related topics. Hence, it could be claimed that the office layout, in certain parts, limits the communication between teams.

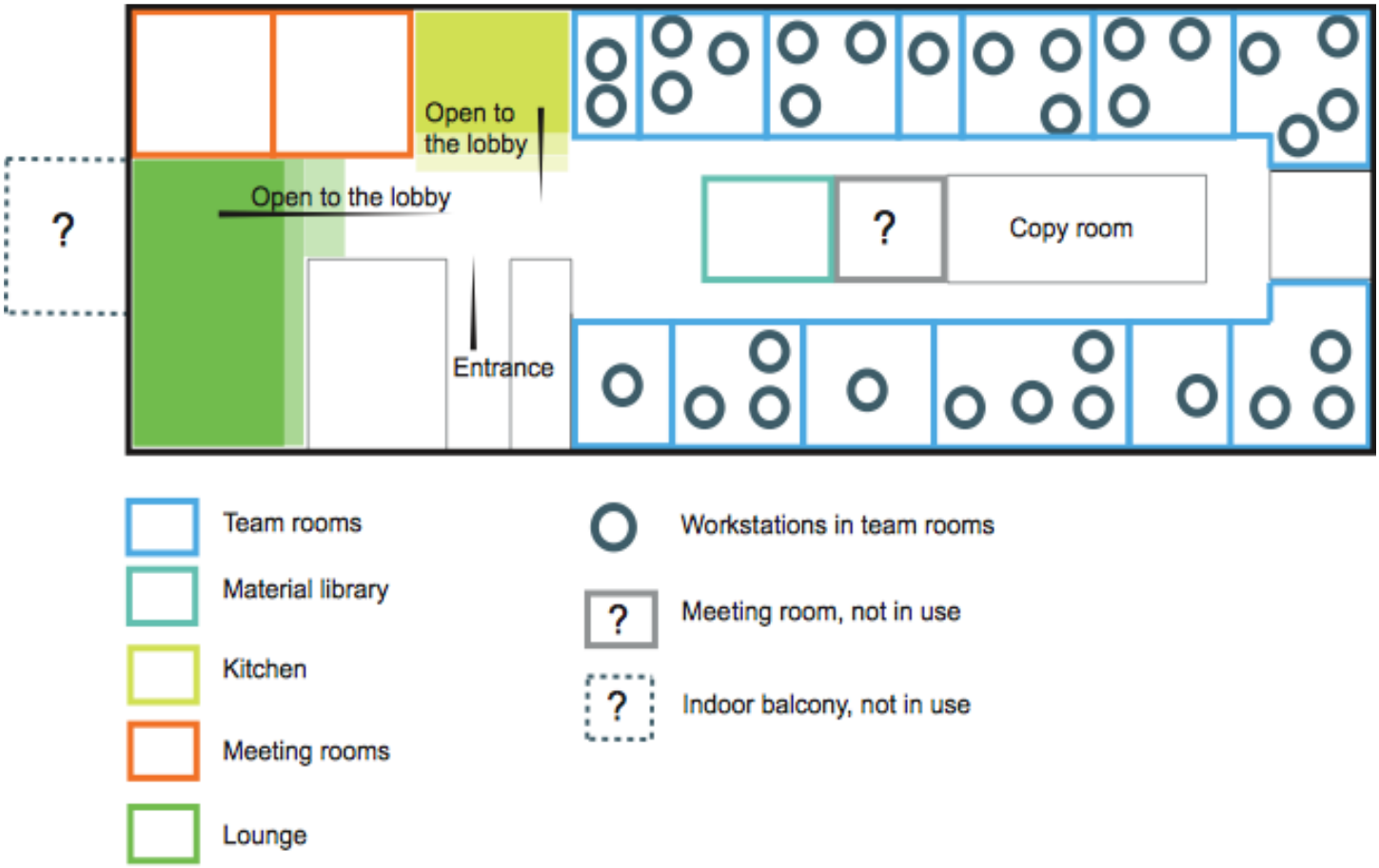

Figure 2: Layout of the case study office.

DISCUSSION

Team rooms support tacit knowledge exchange and creative group work
The tacit knowledge, gained little by little during the education and working life (Schön, 1983), seemed to transfer well between the employees within the team rooms. The organizational policy, the requirement of employees' presence during working hours, supports the reflective conversation (Schön, 1983), where the situation and the colleagues require almost invariably face-to-face contact. Furthermore, in design and planning processes the physical co-presence is necessary (Pyöriä, 2003), because drawings and other visual aids are essential part of communication (Schön 1983). Therefore, the team-based office layout together with the organizational policy supports the transfer of tacit knowledge and face-to-face contacts, and hence, should support creative work as well.

The team-based office layout is not the most commonly used layout for a creative organization. Instead, the open-plan layouts are commonly used to facilitate collaboration and changing team compositions as well as peer-to-peer help (Martens, 2011). Open plan layouts are thought to increase spontaneous interactions and knowledge sharing between colleagues. However, open plan offices, while affording flexibility in general, may have unpredicted influence hindering the use of spaces, such as discussions, which disturb colleagues in the same space. (Värlander, 2012). Hence, if compared to open layout, our case study, on the other hand benefits from the smaller team rooms.

From the point of view of knowledge creation, it seems that the team rooms support at least first two phases of knowledge creation process that are the socialization and externalization (Nonaka and Takeuchi, 1995). The team rooms bring people together and hence, physical presence of the team members supports the socialization phase. Furthermore, team rooms offer a place for the team to process the design tasks together and therefore, the team room supports also the externalization phase of the knowledge creation.

The team rooms support only partially the combination phase of the knowledge creation. According to Nenonen (2004), the combination phase concentrates on the role of the individual and therefore, the space should also support privacy and silent routine tasks. However, based on the interviews, the team rooms did not support the individual working preferences and some the Anchor type workers expressed the need for quieter working environment.

Moreover, it seems that the team rooms did not support the internalization phase of the knowledge creation. The internalization phase requires informal, cozy and even lazy atmosphere (Nenonen 2005). However, these qualities do not describe the atmosphere of the team rooms, but rather the atmosphere in the kitchen area or lounge. The kitchen area and lounge are equipped with more informal and relaxed furniture, such as sofas. Hence, these spaces support better the internalization phase of the knowledge creation. (Figure 2).

Even though the team rooms seem to support knowledge creation process at least in two phases, the knowledge remains inside the team and does not spread through the whole organization. Therefore, as a downside, the team-based working inhibited the information exchange and knowledge creation between different teams. In order to support the information and knowledge exchange between project teams, the information and the creative work should step out of the team room. The sharing of ideas, communication and shared search for alternative solutions during the non-routine phases of knowledge work could even indirectly contribute to the productivity of the work (Peponis et al. 2007).

Flexibility of the layout could support different types of workers

Even though the layout of the office appears to support organizational goals through certain flexibility, individual working preferences are somewhat unrecognised in the spatial organization. Different types of workers have different needs in terms of office layout. Even though the team-based working that seemed to support the low mobility of Anchors works quite well, it did not support the Connectors mobility within the office. In order to better support Connectors work, the office layout needs more flexibility. Essential for flexible working is to encourage staff to work in the most appropriate location, the place and space - whether in or out organisation- according to the activity on hand (Gibson 2003).

Obviously, there are possible downsides to increase the flexibility within the office. For example, if the Connector types of workers move between multiple team rooms, does the information exchange within the team interfere? On the other hand, the Connectors may transfer the tacit knowledge to the team rooms and as a result, for example, the knowledge about the best working methods spread throughout the office. Especially Connector and Gatherer types of

workers may benefit the activity-based office (see Appel-Meulenbroek et al. 2011). Offering different types of workers possibility to choose their workstation or adjust work environment according to their individual preferences could enhance their job satisfaction, as stated also by Värlander (2012).

Limitation of the study and further research

In order to provide a more comprehensive view, the data collection should be extended by collecting more systematic observations about the usage of the space. Furthermore, the intensive observation of one or two members of the organization could provide additional information about the work tasks conducted outside the main office and moreover, information about the mobile work and its effects on information exchange. Finally, further research should include the examination of virtual work environment and its impact on the mobility of work and information exchange.

CONCLUSIONS

The team-based office layout is supported generally the Anchor type workers, since they had low mobility during the workday. Furthermore, the office layout supported organizational goals of the architecture office: enhancing information exchange and distributing tacit knowledge among the project team. Team rooms supported tacit knowledge exchange and creative group work by bringing team members together and offering them a space to process design tasks in-group. However, the team rooms did support neither individual working preferences of the Anchors nor the Connector type of workers, who would benefit from more flexible office layout and various workspace configurations. Furthermore, the tacit knowledge remained inside the team and did not spread through the whole organization. Therefore, as a downside, the team-based working inhibited the information exchange and knowledge creation between different teams. The office layout is not in causal-relation to the behaviour, but the work environment in its full meaning – together with the organizational aspects – affects the work practices. Therefore, more important than the physical environment itself, is how people utilize the space.

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Playing with Townhouses – a Design-Based Research Method for Housing Studies

Anne Tervo
Aalto University, University of Arts, Design and Architecture, Department of Architecture
anne.tervo@aalto.fi

Eija Hasu
Aalto University School of Arts, Design and Architecture, Department of Architecture
eija.hasu@aalto.fi

Abstract

Housing preferences are inherently based on the existing housing examples and the current housing supply. Thus, revealing the lay perceptions of a relatively unfamiliar housing typology invites new methodological approaches. These approaches have been investigated in the context of Finnish Dream Home (FDH) study focusing on townhouse living and related design issues. The FDH is a three-phased mixed method study, the objective of which was to examine and discover the design solutions that would increase the attractiveness of townhouse living among different types of households in Helsinki metropolitan area.

This paper focuses on a design game, which provides tools to examine, reinvent and verbalize the residents' innermost housing preferences. The game allows covering themes such as spatial flexibility and adaptability, which are otherwise difficult to study. Simultaneously, such context-sensitive game, designed to steer the focus on design-based questions, reveals the residents' decision-making processes. The discussion and negotiation of the possible design solutions with the fellow players are the essence of this method.

Supporting the participants' ability to discuss and present their subjective housing choices, the game has been verified as a tool adjustable for different types of research settings to value residents' opinion. Therefore, the townhouse game is an example of practice-based research diminishing the gap between housing studies and housing design.

PEER-REVIEWED ARTICLE

Introduction

How is one to construct a research setting in a situation where the residents are unidentified and the housing typology in question only vaguely familiar? This was the starting point in the Finnish Dream Home (FDH) study that aimed to define the design solutions, which would make townhouse living an interesting housing typology for different kinds of households in the Helsinki metropolitan area. Thus, the objective was to identify the urban households that could be interested in townhouses and to recognize potential barriers and boosters related to the typology. The results were intended to support the work of design field professionals – planners, architects and landscape architects – in developing townhouse concepts. To highlight the residents' perspective, the framework of the FDH combined the aspects of planning and housing design, which are meaningful in relation to urban ways of living. As such, we use townhouse living to indicate the objective of this study.

The Finnish townhouse discussion dates back to the beginning of this century. Combining the traditional preference for small-scale living with an urban location, particularly the planners have promoted townhouses as a potentially affordable housing choice for families in Helsinki metropolitan area. Townhouse has not, however, become popular among the urban families and the existing examples remain few. While a substantial body of reports (e.g. Jalkanen et al. 2012; Mälkki 2010; Manninen & Holopainen 2006) describes the benefits of townhouse living, the lack of residents' perspective is evident.

Thus, in order to examine the residents' perspective, a three-phased mixed method study (see Creswell, 2009) was developed. Contributing to housing research, and more precisely to the methodology in the field of environmental design studies, this paper presents a design game developed for the third phase of the FDH. To embrace the active role of participants, the design game approaches participatory design methodology in which the laypersons are valued as a source of tacit knowledge (Spinuzzi, 2005). The flexibility of the game also enabled investigating the potential end-users' housing decision-making from the chosen viewpoints of planning and housing design. The research findings of the FDH study are presented in more detail elsewhere (Hasu et al. forthcoming; Huttunen et al., 2016)

The concept of townhouse and related typological issues provide a pragmatic framework for the methodological inquiry throughout this paper. Thus, the second section explains in more detail the importance of Finnish townhouse discussion. The third section discusses the pragmatic perspectives of planning and housing design in relation to a constructed mixed method study. The fourth section presents the methodological understanding behind the design game, which is explained in detail in the fifth section. The sixth section discusses and evaluates the use of design game followed by the concluding remarks in the seventh section.

Research Setting: Why Townhouses?

Compared with urban development in other western countries, including in Finland, and within and around the Helsinki metropolitan area, housing is challenged by the urbanization, increasing housing costs and shrinking household size. Combining the traditional preference for small-scale housing with an urban location, particularly the Finnish planners have promoted a townhouse typology as a potentially affordable housing choice for families (Kuittinen, 2014; Jalkanen et al., 2012; Mälkki, 2010; Manninen and Holopainen, 2006).

Attempts to define a Finnish townhouse are many. According to the most simplified definition, a townhouse is a private house with two to four storeys on its own plot and it is connected to neighbouring houses with firewalls. Whereas previous definitions have stressed the importance of owner-occupancy (e.g. Manninen & Holopainen, 2006), a more recent attempt is to redefine the concept

in such a manner that it primarily enables to create pleasant small-scale environments (Huttunen & Kuittinen, 2014). A possibility to include shared domestic spaces with townhouse living is a part of a discussion related to the definition of a townhouse.

Due to a similar appearance, townhouses are often confused with row houses. The main difference between the two is that row houses are without exception managed by housing cooperatives, thus limiting the sovereignty of residents. The definition is significant because it interacts with building regulations, thus creating a basis for design solutions. As such, paralleled with detached houses, a Finnish townhouse cannot, for instance, contain separate apartments on top of each other without being redefined as an apartment building, for which design processes follow typology-specific building regulations. A possibility to divide a house into smaller housing units could be an answer to changing life situations and new forms of urban life including an increasing number of one-person households. Furthermore, the aspect of affordability is significant as the floor area of a multi-storey house has a tendency to increase due to the vertical circulation and related design solutions.

A need to study the townhouse typology intermediating between the detached houses and apartment buildings is highlighted by the understanding that despite the growing interest in apartment buildings, people living in the cities still show interest in detached houses (Strandell, 2011). On the other hand, a preference for urban living has been recognized among inner city families (Lilius 2014). However, the families alone have become more diversified, whereas the frequently cited statistics fail to embody the contemporary forms of living together. Such families with unique housing needs include parents living partly alone and partly with their own children or children of their new partners, and children having more than one home. Similarly, the increasing number of one-person households with varied life situations challenges the family-centred reasoning. As there are several reasons to broaden the urban housing supply, diversifying housing preferences are a significant issues to take into account when discussing new forms of housing (Jansen, 2012; Floor & van Kempen, 1997).

Mixed Method Research Strategy

The methodological choices were based on the fact that townhouse typology is not familiar in Finland; hence, we could not simply ask the respondents' opinions of townhouse living. Another significant aspect affecting the methodological choices was the applied nature of the FDH study referring to the transferability of the results. In other words, the research findings were expected to be useful for the planners and architects developing townhouse living. Thus, the research question was: *Under what conditions living in a townhouse (later referred as townhouse living) could appeal different kinds of resident groups in Helsinki metropolitan area*?

The task was to establish a data collection method, the findings of which would merge the perceptions of professionals developing townhouse living and the perceptions of yet unidentified urban townhouse residents. For this purpose, a mixed method research strategy[1] based on three interrelated data collection phases was constructed. Each data collection method was chosen by its ability to provide data from different aspects of the same phenomenon, that is, townhouse living: (1) literature review followed by expert interviews clarifying the perceptions of the professionals (e.g. planners, architects, researchers and building supervisors); (2) a survey covering the residents' interest towards

[1] This is also known as triangulation or combined strategies. The confusion around the definition of the mixed method research has emerged due to its association with different levels in a research process (e.g. Du Toit 2010; Creswell, 2009; Groat & Wang, 2002).

townhouse living; and (3) a design game where the typology was discussed and developed free from the limitations of the prevailing definition.

The purpose of the expert interviews (n=11), carried out in October 2013, was two-fold: first, based on the literature review, to confirm that we have chosen the relevant questions for the upcoming survey; and, second, to increase our understanding concerning the nature of research findings meaningful to the interviewed experts. The interviews covered the following aspects: the definition of a townhouse, location and areal differences, resident profiles, layout and design solutions, outdoor areas, different ways of building townhouses including group building that is somewhat new in Finland, and the reasons hindering the popularity of townhouses. In relation to the definition of a townhouse, the interviewees often pointed out the obstacles constricting the development of the otherwise protean typology. Interviewees demanded more compact solutions in order to reduce the building costs and to provide housing alternatives for a growing number of small households. The interviewees also considered the accessibility regulations partly responsible for the multi-storey houses becoming too large and expensive. One of the main characteristics of the typology, namely the connection with the urban space via the small front yard was considered both intriguing and challenging starting point that resonates with the lively urban environments admired in other European cities, where the typology was developed often due to scarcity of land. The typology-specific issues were clearly pointed out by expert interviews and further transferred to the survey, where, for instance, the size and use of private outdoor areas were studied in more detail.

Along with housing preferences, the respondents were profiled based on two indicators: the built environment structure (urbanity) and the attitudes towards local community (socialness).

The survey was conducted at the beginning of 2014. The main group of respondents consisted of web panellists (n=1214) living in the Helsinki metropolitan area. The respondents, aged between 25 and 80 years, evenly covered one-person households, two-person households, and families with children. Along with housing preferences, the respondents were profiled based on two indicators, which were defined from the survey results: the built environment structure (urbanity) and the attitudes towards local community (socialness). Four profile groups were classified as follows: *Urb*an describes the preference for a dense, city centre type of a structure with a reduced amount of green window views compensated with a vivid cityscape and bustling street life, and *sub*urban to describe a less dense structure, encompassing less vivid environment and more greenery. The other dimension, socialness, is described by *socials*, the social-minded residents in the one, and ano*nymous*, the private-minded in the other end of the axis. As a result, we were able to define four residential profiles: *urbsocials* and *urbnymous*, as well as *subsocials* and *subnymous*. As the profiles interact with lifestyles, they are an important addition to the more traditional approach of profiling residents. (Hasu et al. forthcoming) Furthermore, the survey also revealed that besides families, townhouse living also attracts both solo dwellers and couples, a notion to further underline a more in-depth understanding about townhouse related housing preferences and potential target groups, which are of key importance when aiming to develop both the townhouse concepts and the consumer understanding within the concepts. In terms of townhouse research, this notion invites the act of segmentation, a performance which allows recognizing potential target groups of reasonable size, sharing similar housing preferences and profiles (cf. Hyysalo, 2009; Kotler et al., 2005).

Based on the combination of expert interviews and the survey, we were able to identify four design-related themes that required more detailed investigation in the last data collection phase: private outdoor areas, typology, shared domestic spaces and spatial flexibility. These themes were defined as the research themes for design game sessions. Although the questionnaire covered the themes to some extend, the limitations of the survey were obvious, as the findings were partly too general and thus disconnected from pragmatic design problems. For example, the respondents who were interested in townhouses preferred the shared domestic spaces, however in a variety of ways. Of the respondents

interested in townhouses, 38% would appreciate spaces that provide a room for hobbies (other respondents, 28%). Simultaneously, 50% of townhouse-minded respondents informed that the shared domestic spaces would interest them only if the spaces were reserved solely for their own use (others, 44%). Furthermore, the open-ended questions revealed negative attitudes towards these spaces whereas the survey did not provide a possibility to cover novel ways of sharing housing related spaces with neighbours. Consequently, as another example of how the data was transferred from one methodological phase to another, the shared domestic spaces, which were already recognized as a significant topic in the survey, were further examined in the design game phase.

In order to enhance the interconnectedness of the data collection methods, the survey respondents were asked if they were interested in attending a workshop to discuss townhouse living in more detail in a small group, which emphasizes the cumulative character of the data collection method. Altogether 221 respondents answered “yes” or “maybe”, and out of these, 104 found the proposed dates suitable. Eventually, due to last-minute cancellations, we got 61 enthusiastic participants to play the game with us in seven game sessions.

Design Game Activates

Each person’s housing preferences and understanding of housing possibilities relies strongly on their housing history as well as on the current housing supply – what housing solutions are experienced as possible (Clapham, 2005). For these reasons, the challenge in this study was to create a method that would assist participants to express their housing preferences in a context defined by the unfamiliar housing typology.

Design games and other forms of co-designs fall into a category of tacit knowledge with a capability to reveal the underlying ideas and dreams of participants

Comparable with a design workshop, a design game was chosen for this study because it has a capacity to cover multifaceted design problems free from the limitations of more structured research methods (cf. Forsyth et al., 2010). Using a game as a method is based on the understanding that embraces housing as a complex phenomenon and as a reflection of the social reality as suggested by Du Toit (2010). To provide a deeper understanding of the game method, Halmeenmäki (2012, 29) presents a synthesis of the human-centred design methods, which are divided into explicit, observable and tacit based on the nature of the knowledge under investigation. Design games and other forms of co-designs fall into a category of tacit knowledge with a capability to reveal the underlying ideas and dreams of participants. As such, design game functions as a technique, which transforms the tacit knowledge into explicit knowledge (see Horelli, 2005). In the much-cited paper, Spinuzzi (2005) discusses the participatory design as a research method. The perceived knowledge is similar to that of Halmeenmäki: ”[T]o understand knowledge-making in participatory design, we have to understand that much knowledge tends to be tacit. Tacit knowledge is implicit rather than explicit, holistic rather than bounded and systematized; it is what people know without being able to articulate.” (Spinuzzi, 2005, 163). A participatory design approach has been widely used in various research contexts, including urban design, planning and geography. To empower the participants, such approach aims to provide positive, more or less immediate outcomes to their everyday environments. Ideally, the design process is iterative and involves an intensive collaboration between all parties. (Du Toit, 2010; Sanoff, 2007; Spinuzzi, 2005.) A participatory design approach has also been applied in housing studies (Vestbro et al., 2005). The design game developed for the use of the FDH contains features of participatory design insofar as the participants are valued as experts and a source of tacit knowledge.

The essence of a game method lies in co-design. The core idea of co-design is to support the collaboration of people with diverse backgrounds with the help of informal game setting (Halmeenmäki, 2012). The strength of a group lies in communication as “the group format allows people to build on each others’ comments” (Forsyth et al., 2010, 37). Co-design typically entails compromises

and trade-offs, and the discussion among the participants was considered an essential dimension of this method. Reasoning the various townhouse design solutions during the on-going design phase revealed participants' values, attitudes and mental representations appreciated by housing preference research (Coolen, 2008), thus adding on the richness of the data. The game enabled the participants to test and develop various design solutions, which often resulted in innovative and inspiring outcomes. For instance, although flexibility was not a matter of interest according to the survey, the game inspired residents to design townhouses shared by several households. Additionally, residents noted a need for different types of business premises. As such, the solutions by residents challenged the prevailing townhouse definition underlining the marriage between the house and domesticity. However, it is essential to stress that the design solutions as such where not the reason for utilizing the game method (cf. Bayazit, 2004).

Clapham (2005) emphasizes the need to grasp a better understanding of household decision-making processes and dynamics, especially regarding the gap between housing and lifestyle choices. In order to meet this gap, the game dimension was enhanced with fictional end-user profiles, "personalities", which were derived from the analysis of the preceding FDH survey. The fictional profiles crystallized the features of main target groups, presenting a combination of demographic information, such as age, residence, occupation and ways of living (Halmeenmäki, 2012; Hyysalo, 2010). Simultaneously, it is important to bear in mind that although the residents' subjective experiences and preferences are the profoundest ones within housing research; in reality, the inhabitants often need to adjust their wishes with the desires of others, which is, for instance, a typical decision-making process between spouses (Levy & Lee, 2004).

Design Game – Process and Analysis

Two townhouse block types were developed for the design game. Both block types were characterized by semi-public urban spaces, thus providing a platform to study the use of shared domestic spaces and areas in addition to the private housing arrangements. The first block was based on a courtyard framed by rows of townhouses. A mixed-used street as a place of activity for the residents of all ages created the foundation for the second block type. The block types were used as a basis for game boards (Figure 1). The use of two different scales, 1:200 and 1:50, allowed participants to develop design of the house and outdoor areas in parallel with the block level solutions to mimick real-life design processes. To serve the aspects of both planning and housing design, the scalability also made it possible to study the home-related concepts of privacy and spatial hierarchy, which "are relevant to all parts and at all sizes of the built environment" (Habraken & Gross, 1988, 151).

The design tasks were mainly conducted in scale 1:50 in a situation where the participants were allocated an empty plot from a row of townhouses. The neighbouring houses were provided as wooden scale models in order to enhance the three-dimensionality as a significant part of housing design. The neighbouring houses also increased the authenticity of the starting point in the design process and clarified the specific design-related characteristics of the typology: The floor plan is long and narrow, and the entrances and windows can be placed only at the ends of each building, thus challenging the organization of indoor spaces. Additionally, the design of private outdoor spaces, including roof gardens, balconies and terraces, must consider the immediate vicinity of neighbours. (Figure 2).

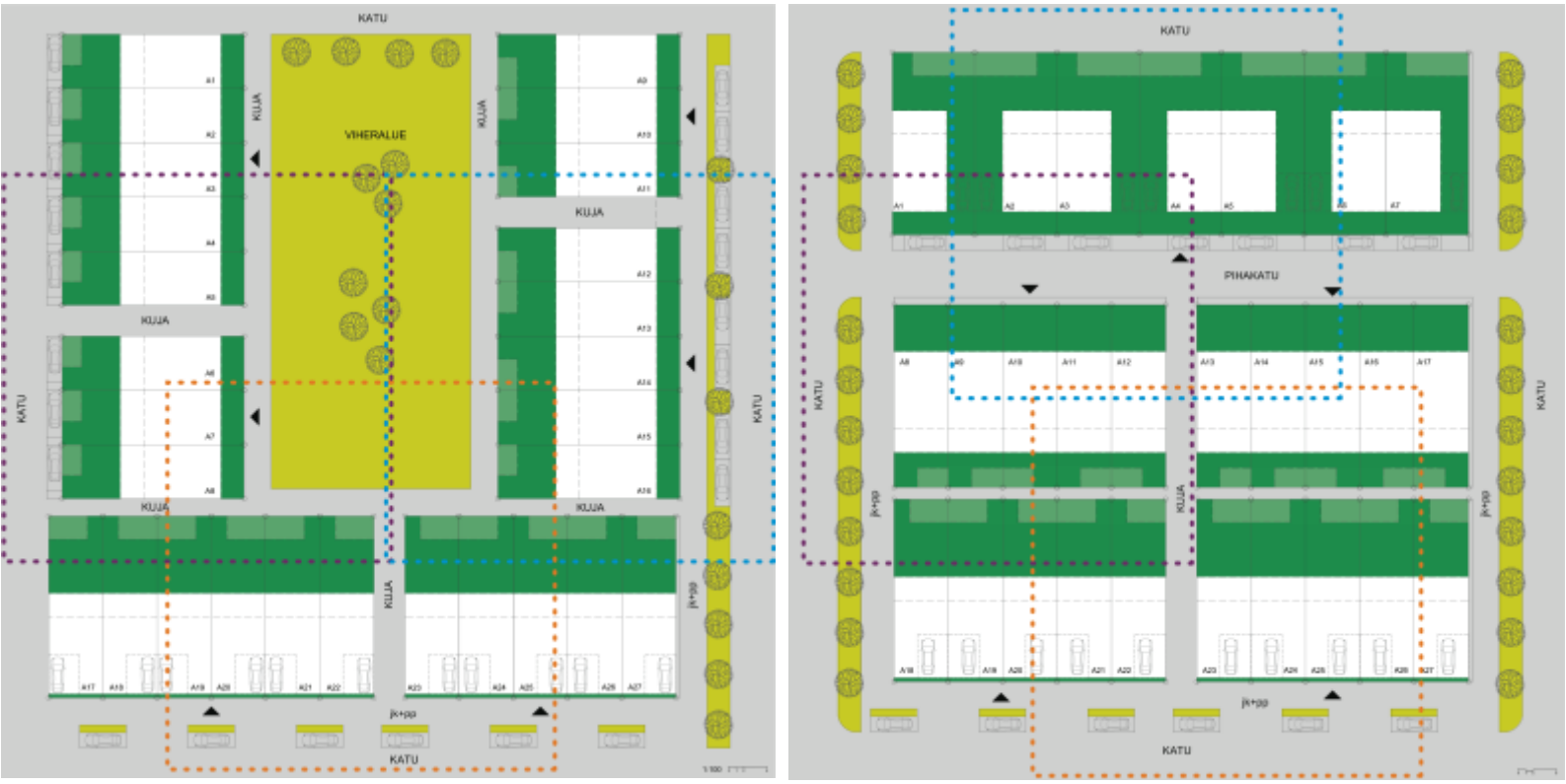

Figure 1. Game boards: "A courtyard" and "A mixed-used street". Picture: Tina Ullrich

Plots were equal in size (7x23,5m) with an exception of a semi-detached house (duplex) plot (10x23,5m) as suggested by the literature and expert interviews. The measurements of the first floor plan had two variations (7x10m, 7x13m) similar to the measurements presented in a previous study about Finnish townhouses (Takano & Verma, 2014). The game boards presented three variations on how the townhouses were located on the plot, which specified the sizes of private outdoor areas at the ground level. In the context of dense urban structure, the meaning of a front yard was particularly interesting. While the front yard creates a buffer zone between the private and the public, the survey respondents placed little interest in that area. Reflecting a contradiction between the perceptions of the intervievewed experts and the survey respondents (laypersons), the design game method provided a starting point to study more detailed the use of private outdoor areas and related perceived value experienced by the participants.

Figure 2. Neighbouring housing in scale 1:50. Picture: Anne Tervo

Figure 3. Developing the ground level solutions 1:50. Picture: Reko Laurilehto

Additionally, the game material included a number of design materials, such as furniture symbols and different types of vegetation, toy cars and other illustrative material to nourish the participants' imagination. The objective was to provide inspiring material that was easy to use (Mattelmäki & Vaajakallio, 2011). As we did not want the ready-made objects to unnecessarily restrict the design process, the participants were encouraged not only remodel the material but also draw and write down the important aspects in order to support the individual ways of expression (Figure 3).

Compared with interactive web-based design games, the tangibility of this design game, namely building, drawing, writing and cutting with scissors, proved to be a fundamental part of the process: it aimed at activating the participants by providing different ways to express both for individual and household related housing needs and wants, and to address trade-offs and compensative design solutions. The game sessions started with a presentation covering the main findings of the survey, the game rules, and the theme for the session: "the design of the day". The participants in each session were divided into two or three groups, in which the members primarily represented a similar household type. Thus, the fictional end-user profile chosen by the group members often reflected the one they represented in reality. In order to assist the groups to profile their townhouse resident(s), a selection of ready-made reference profiles was provided since the first sessions demonstrated that defining the profiles from the scratch was time-consuming. Each reference profile included a photograph and other information such as, name, age, profession, hobbies and other lifestyle related aspects that participants could develop further. The group sizes varied between two and seven participants. Groups of more than three people were further split in two subgroups, which then ended up becoming neighbours in the game board. Each session lasted 2.5 hours.

The game sessions proceeded in phases by starting with a warm-up task and ending with a discussion (see Halmeenmäki, 2012). The warm-up task focused on naming the positive and negative aspects of each person's current housing situation. The answers covered a variety of aspects, such as the proper size of a kitchen and the lack of places for snow piling. The warm-up task had two objectives: to get acquainted with the fellow players and to create a relaxed and easy-going atmosphere and to share information about each participant's housing history, attitudes and preferences. The warm-up task was followed by an actual design task, which was divided into timed phases with a narrative approach to everyday living. The game settings were expanded, for instance, by asking groups to imagine what their townhouse resident(s) wanted to do at home after a long day at work and how the spaces should be designed in order to meet these needs.

Altogether seven game sessions were organized around the research themes derived from the previous data collection phases: outdoor areas, typology, shared spaces and spatial flexibility. The themes and main focus points were outlined in advance for the first five game sessions, while the last two sessions were left undefined in order to provide time and space for the unfolding topics. This way we were able to reflect on the collected data was also during the last data collection phase. Flexibility and the privacy of the entrance area, reflecting the closeness of the mixed-used street, were chosen as themes for the last two game sessions. Despite the differing thematic focuses, the game sessions ended up repeating specific themes from one session to another. Emphasized by the immediate vicinity of the neighbours, particularly the privacy of domestic environment proved to be an important aspect in all sessions and was also raised spontaneously even when not specifically asked.

The game board used in each session was selected based on the design task of the day. In terms of shared spaces, i.e., green and domestic spaces, both variations were examined: The use of shared green space was studied using the

courtyard model, which also provided a place for a communal house to further elaborate the issues of shared domestic spaces. In relation to this, the mixed-used street model with speed limits provided a means to study mundane encounters and possibilities of a street area to become a collective space. In addition, the nature of the front yard along with the ground level plan solutions and parking were included in the investigation.

The significance of discussion as a source of information cannot be overstated since many great ideas and analytical statements could not be included in the actual design outcome

By the end of each session, the groups were asked to imagine a situation in which they would sell the townhouse and provide five selling arguments, which offered a basis for the final discussion. Additionally, the participants were asked to independently fill in a form about the benefits and drawbacks of townhouse living. As a result, the analysed material was a combination of six data sets: (1) warm-up tasks describing a person's current housing, (2) outcomes of co-design presented in the scale model 1:50, (3) five selling points crystallizing the design solutions, (4) independently filled-in forms about pros and cons of townhouse living, (5) videoed end-discussions and (6) notes taken by the facilitators and student assistants.

The significance of discussion as a source of information cannot be overstated since many great ideas and analytical statements could not be included in the actual design outcome. Therefore, the detailed notes and impressions written down during and after each workshop by facilitators and student assistants were invaluable. Facilitators and student assistants working in pairs processed the notes from each session in MS-Word documents according to a thematic structure. The theme-based structure enabled comparison between different groups, since it became evident already during this phase that residents in different life stages and household types may share similar housing aspirations. In order to use the results already in the upcoming game sessions, the facilitators discussed and analysed the results throughout the process, which helped to identify new themes, such as the maintenance of housing.

After the final session, the researcher-facilitators re-evaluated the material by examining the household types and workshop themes once more. At this point at the latest, the traditional household classification based on a number of people belonging to a household was confirmed to be an inadequate approach to profiling the possible townhouse residents. Instead, the attitudes and values towards different design settings enabled a more accurate approach to identify potential target groups for townhouse living in such a manner that the lifestyle profiles identified from the survey were possible to include in the findings.

One of the main research themes, flexibility, although having several interpretations depending on the target group in question, emerged as a cross-cutting theme and was thus chosen as a starting point for the following concept designs. By representing flexibility in a different manner, the concept designs also demonstrate that such typology can provide an answer to a variety of housing preferences and lifestyles, if the limitations related to its definition can be overcome. Since the concept of flexibility can have many meanings, the decision of presenting the findings in a form of concept designs was based on the understanding that the lists of design objectives would not serve the purpose. Particularly, the aim of combining the lifestyle-based profiles and the design solutions required a representation that explains the solution at one glance. (Huttunen et al., 2016).

Discussion

The concept of flexibility characterized the research strategy of the Finnish Dream Home (FDH), as often the case with studies focusing on pragmatic research problems (Du Toit, 2010). The combination of three interrelated data collection methods allowed crosschecking the preliminary analyses throughout the data collection phase. A significant part of the three-phased research strategy was the analyses conducted during and after each data collection phase. Since

the expert interviews and survey channelled the last data collection phase, the design themes and lifestyle groups derived from the survey defined the design game focus. Hence, supporting the mixed method research strategy, the design game developed for the purposes of the FDH allowed structuring the already collected research data (Mattelmäki & Vaajakallio, 2011). The data analysis of the FDH followed the flexible, design-driven pattern, as the concept designs were used to test the transferability of findings. Thus, the concept designs were exploited as a medium and not as a research method as such, enabling us to present the findings covering design solutions and lifestyle profiles in tandem (cf. Forsyth, 2007).

The design game provided a tangible tool for examining, reinventing and verbalizing the residents' housing aspirations, needs, and even fears, in the context of townhouse living.

The design game provided a tangible tool for examining, reinventing and verbalizing the residents' housing aspirations, needs, and even fears, in the context of townhouse living. Since the game was steered to focus on design-based questions, it both tested the previous findings and revealed the participants' decision-making processes and attitudes motivating housing decisions, both in terms of the individual and the entire household. To understand both actors is a constant challenge for housing research (Clapham, 2005). For this reason, the discussion and negotiation of the possible design solutions, and underlying motivations and attitudes with the fellow players was the essence of the game. The location and price tag of the design solutions, which are important aspects of housing preference studies, were not included in the game setting for several reasons although location as such has been acknowledged as important choice criteria (cf. Floor & Van Kempen, 1997). Since our main interest was related to a typology, the game boards were presented without a place-specific context; however, the workshop participants were able to express their location-related preferences during and after each game session. Second, to calculate a price for each design solution would have required us to define the possible design solutions in advance. To reach the objective of the FDH study to understand the design solutions that make townhouse living appealing to different target groups, this study did not restrict the design options with pre-made solutions. Therefore, the game phase was conducted without specific price tags for housing solutions, yet bearing in mind that in the following research phases the overall goal is to recognize the core concepts of affordable townhouse solutions.

The implementation of residents' housing preferences is restricted by a variety of factors, including the available housing choices, namely the housing supply, in addition to beliefs and expectations (Clapham, 2005). Thus, it was crucial to allow participants to overcome these biased beliefs and assumed limitations. In this research setting, the question of group dynamics was also essential. The role of facilitators was to ensure that all group members had a chance to participate in a co-design task regarding their personal abilities and ways of expression. The active role of a facilitator cannot be underestimated as the game allows participants to pose more detailed questions in a similar manner as in semi-structured interviews. The researchers must be experts in the field in order to ask relevant questions in situ. In the field of environmental design studies, this means that the researchers also have expertise in design processes.

In a similar manner as with interviews, the facilitators should not put words into respondents' mouths. For this reason, the most significant question in the design game was "why" thus aiming at understanding the reasons for the design solutions. Consequently, the aim was to understand what each participant pursued with a chosen solution: By placing the staircase next to the entrance, a participant may wish to have an open room plan; to have an easy access to upper floors in order to make it easy to use them as a home office; to enable renting out a part of the house; or to create a buffer between the street life and home environment. Understanding this type of reasoning was an important part of the research process, as the needs and wants, in other words the aspired housing experiences, can be reached in many different ways when the planners, architects and landscape architects conduct the design processes.

Using reference profiles proved to be a good choice, as the profiles enabled the participants to work with design solutions less common in typical home environments, such as spaces for rent and various ways of using shared domestic spaces. Although subjective housing experiences and dreams were mostly reflected openly with those of imaginary residents, the reference profiles provided a shield for participants who felt less comfortable discussing their personal views. The profiles were also one solution to the challenge placed by research settings to encounter the yet unknown residents, which was one of the starting points of the FDH study. Because the profiles provided a shared starting point for the design task, they also inspired the participants to imagine the daily lives of residents in relation to design solutions throughout the process. Therefore, the design game activated the participants on many levels, which a highly important aspect of a participatory game approach (Mattelmäki & Vaajakallio, 2011).

Conclusion

The methodological choices were guided by the high-level transferability of research findings for the use of planners and architects developing townhouse living.

In this paper, we have presented a design-based research method, a design game, and the preceding data collection phases of a three-phased mixed method research strategy. The methodological choices were guided by the high-level transferability of research findings for the use of planners and architects developing townhouse living. For instance, it was not enough to confirm the already known fact that the residents value private outdoor areas, such as terraces and balconies. Instead, in the context of the given typology, we, for example, pursued to discover why a small front yard is perceived as either desirable or not, and what could be ideal design solutions for it in a given environment. We argue that the requirement of the transferability of research findings is an answer to many of the challenges related to constructing a solid research strategy for environmental design studies. Another challenge relates to the novel typology used in this study. Since there are only a few existing townhouses in the Helsinki metropolitan area and many of them resembling two-storey row houses, constructing a series of case studies was not possible. Moreover, since the aim was to reveal the potential of the newly emerging typology, we considered it important to find a method in which the existing examples would not influence too much the opinions of non-experts.

The design game developed for the Finnish Dream Home (FDH) study provided a tangible tool to examining, reinventing and verbalizing the residents' housing aspirations, needs, and even fears, in the context of townhouse living. Since the game was steered to focus on design-based questions, it also revealed the participants' decision-making processes and attitudes motivating housing decisions, both in terms of individuals and their households. To understand both actors is a constant challenge for housing research (cf. Clapham 2005); thus, the discussion and negotiating the possible design solutions and underlying motivations and attitudes with the fellow players was included as one of the game components.

The field of housing design in is characterized by the context-sensitivity and culture-specificity. Therefore, the game setting and materials had to be developed specifically for the use of FDH study. However, the game can be adjusted to examine other housing typologies and forms of urban living. This paper recommends the use of different scales because scales assist in the development of a chosen housing form in relation to a broader living environment. Since the Helsinki City aims to construct new housing areas fostering townhouses, or comparable small-scale typologies, the design game can be exploited in real-life urban development projects. The group-builders, particularly, could benefit from the use of design games, which has been verified as a method providing a means to discuss housing preferences in a context that is concrete enough. In addition to an individual design solution, the scale model 1:50 can assists the discussion related to issues such as the closeness of neighbours,

which is as a pertinent topic in relation to both building and living. To conclude, the townhouse game presented in this paper is a promising example of practice-based research method diminishing the gap between research and design.

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A Townhouse for Life

Ira Verma
Aalto University School of Arts, Design and Architecture,
Department of Architecture
ira.verma@aalto.fi

Eija Hasu
Aalto University School of Arts, Design and Architecture,
Department of Architecture
eija.hasu@aalto.fi

Abstract

In Helsinki, Finland, the townhouse is seen as a sustainable urban version of single-family house that can reduce urban sprawl. As the townhouse is a new housing type in the country and the number of apartments projected is considerable, further knowledge about potential resident profiles and their needs is required. This paper studies townhouses as a potential solution for lifetime housing. The study focuses on people over 55 years old who represent an age group relatively free from many aspects limiting housing decisions. This age group indicates the ageing populations' future housing aspirations. The aim of the study is to enhance the aspects of user-friendliness that make townhouses suitable for a variety of resident groups. Two townhouse surveys, Finnish Dream Home (FDH) and Townhouse energy and environment survey (Envi) as well as a series of workshops were conducted to gain further knowledge about residential preferencies. The results of the study indicate that not only families with children but also couples and one-person households in all age groups are interested in townhouses. In this respect, the themes of accessibility and flexibility are explored using the FDH and Envi results and reflected to German and Finnish case studies.

A Finnish townhouse may indeed answer the needs of lifetime housing if accessibility and ease of maintenance are taken into account. Accessibility nonetheless requires integral planning and realization of street, building plot, building and the apartment as a whole. For younger generations, the notion of accessibility may be transformed as flexibility in changing life situations. In that vein, seniors represent an important group whose needs and aspirations are to be integrated into future townhouse planning. The inclusive design of townhouse should include a variety of resident groups. All users may benefit a townhouse that provides accessible care-free housing and human scale urban milieu.

Introduction

This paper is introducing an ongoing multidisciplinary research and development project Energy Efficient Townhouse (EET). The project aims to develop a model for an energy-efficient, accessible, and affordable townhouse. The preliminary results indicate that a Finnish townhouse may provide novel housing options integrating aspects of privacy, sense of community, energy-efficiency and individuality. Especially ways to integrate solar energy and electrical cars in the building process is promising. (Huttunen et al., 2014, 2015a, 2015b.) This paper

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outlines a sub-project in the field of architecture focusing on the user friendliness and accessibility. The EET project is a multidisciplinary research and development project and part of a larger Aalto Energy Efficiency Research Program.

Even though a townhouse is a common housing model in central Europe (especially in the Netherlands and Germany) and in the UK, it is a newly emerging housing typology in the Finnish context. The definition of a townhouse adopted in this project is: a multi-storey single-family house with an own plot that is attached to similar houses by shared walls. The definition also presupposes that each house is unique and tailor-made for its residents. In Helsinki the townhouse is seen as a sustainable urban version of single-family house that can reduce urban sprawl. The new Helsinki City Plan projects around 20 000 new townhouse apartments. The townhouse is targeted mainly at families with children who tend to move to bigger and more affordable apartments in the outer parts of the city. As the townhouse is a new typology and the number of apartments projected is considerable, further knowledge about potential resident profiles and their needs is required. Therefore, two townhouse surveys were conducted: Finnish Dream Home (FDH) and the Townhouse energy and environment survey (Envi), respectively in 2014 and 2015. According to the surveys, not only families with children but also couples and one-person households in all age groups are interested in townhouses (Huttunen et al., 2015a; Hasu and Hirvonen, 2015). Thus, the diversity of households and resident profiles should be taken into consideration in the future townhouse planning.

In this paper, we focus on people over 55 years old who represent an age group relatively free from many aspects limiting housing decisions: Many have gathered wealth during their working life and have no longer small children in the house. In the city planning context, elderly people have been interpreted as one of the most important resident groups for apartment living. The elderly people have not found apartment design as desirable as expected (Strandell, 2011), which indicates a need for a closer examination of housing aspirations of ageing people.

Indeed, several studies see the baby boomers as a bridging generation that links both the past and the present—maybe even the future: “By examining boomer lifestyles, predictions may be made as to how the role of pensioners might change in the future” (Karisto, 2007). Furthermore, Healy, (2004) stated that this generation has greater economic and electoral power and higher expectations of their place in society: they will not be prepared to “go gentle” into a resigned and disengaged old age. The notions highlight the need to gain a deeper understanding about older adults housing aspirations and attitudes.

The aim of this paper is to study townhouses potential as lifetime housing. The goal is to enhance the aspects of user-friendliness that make townhouses suitable for a variety of resident groups. Therefore, the following discussions focuses on inclusive design and flexibility of the apartment. Inclusive design enhances the use of spaces of divers resident groups. A person using walking aid or pushing a pram have similar challenges, for example, at entrance of the apartment. The building regulations on accessibility are used to assess the existing buildings. The flexibility includes reflexion about adaptation and modification of the apartment for different life situations. The hypothesis is that if the usability and accessibility issues are taken into account in the building design and urban planning, townhouses may offer a sustainable and flexible way of living for senior dwellers as well.

Background

The increasing life expectancies, combined with a considerable amount of wealth and leisure time, make senior citizens an interesting consumer group for housing industry. Most have paid off their mortgages and are currently “empty nesters”.

Thus, the seniors may have the ability to fulfill their housing preferences without major limitations. The increasing number of wealthy elderly consumers will have influence on the design, production, and marketing of goods and services (Healy 2004). The location or relocation at old age, as well as housing choices, are complex. These choices do not aim only to satisfy basic needs but are also made in order to have a meaningful life in old age (Oswald and Rowles, 2006). The elderly want to maintain their way of living. Despite the diversifying needs, in Finland, the housing supply has remained relatively unchanged during the last decades. For example, the preference for small-scale living has not been recognized amongst the housing policies or design. The urban densification steer the housing supply towards more compact urban structures and high-rise apartments. The beliefs about future needs for care and services of ageing population support this development.

To anticipate the demographic development and people aging in their own homes, accessibility should be taken into account in all new housing types.

The Development program for housing for elderly people is a program launched by the Ministry of the Environment to enhance elderly living in their own homes as long as possible (Ministry of the Environment 2013). The program sets a target of one million accessible dwellings by 2030, which would cover 30 percent of Finnish housing stock. The number includes both apartment blocks and single-family homes. In 2011, less than half (44.5%) of the persons over 75 in Finland lived in apartment blocks. Most of them lived in small-scale housing solutions: in single-family houses (39.1%) and in row houses or in semi-detached houses (16.4%) (Ministry of the Environment 2013). Today, however, the Finnish building codes for accessibility are valid for "*a residential building with at least two storeys, consisting of several apartments where facilities in different apartments are one on top of the other*" (G1. Decree on housing design, Regulation 1.1.1). A townhouse, by definition, is a single-family home, therefore the regulations of accessibility are not automatically applied. According to the Finnish Decree on housing design (G1. Regulation 4.2.1) "*a route and an entrance leading to a dwelling on the ground level from the boundary of a site of a one-family house or of a building plot as well as from a parking space are also constructed to suit disabled people if it is possible when taking into account the shape of the terrain and the differences in level"*. The building decree seems to be open to several interpretations, and therefore, municipalities in different parts of the country may have some difficulties with the interpretation of the building code.

Studies on the housing of ageing people and housing preferences are contradictory, which influences for instance research hypothesis and settings. On one hand, the research show that people do not want to change their housing situation by the time of retirement (Myers and Ryu, 2008). On the other hand, some of the research emphasize that elderly people are becoming unable to cope in their own home in everyday life without major difficulties (Clough et al., 2007) and therefore urge relocation. Many householders do not alter their housing situation in later life. According to Smith, Rayer, and Smith (2008), the length of residence increases dramatically with age, rising from 4.3 years for householders under 35 to 30.2 years for householders aged 85 or older. This might lead one to presuppose that housing decisions for later life are made before retirement. Furthermore, according to Clark and Deurloo (2006), there is an over-consumption of housing in the old householders compared to young families with children. Old households occupy more spacious housing compared to younger households. In Finland, 80 percent of the persons over 75 live in owner-occupied apartments (Ministry of the Environment, 2013).

Previous studies indicate that the elderly tend to continue to occupy their houses. They prefer to use their savings before selling their current apartment and moving to a smaller one (Clark and Deurloo, 2006). Therefor, many of the senior inhabitants are supposed to remain in their existing dwelling. To anticipate the demographic development and people aging in their own homes, accessibility should be taken into account in all new housing types—including single-family houses.

Methods

Attitudes and interest towards townhouses were studied using several methods. the FDH (in 2014) and the Envi (in 2015) surveys. The research setting for the FDH survey was dictated by the need to identify different potential resident groups for townhouses in all age groups, and to investigate attitudes towards diverse design solutions. The second survey, Envi, examined attitudes towards environmental and housing energy-efficiency amongst residents living in Helsinki metropolitan area. The results of the two surveys provided an important cross-section with which to develop future townhouse concepts, and to gain an understanding about housing preferences amongst different resident groups. In this paper the attitudes of persons over 55 years old are compared to other age groups, in terms of housing preferences and accessibility, in particular.

In the FDH survey, the respondents were asked to identify their favorite dwelling type but also to indicate attitudes towards alternative housing types. The FDH setting provided information for design purposes, such as multi-storey housing and accessibility. In order to avoid possible presumptions and biased images about townhouse, the survey was constructed in such a way that attitudes towards townhouses were only asked at the end of the questionnaire. Since existing examples of townhouses in Finland are scarce, a short description of the Finnish townhouse concept was provided as an introduction to the final questions. The interest towards townhouses is described in Table 2.

For the FDH survey, total 1210 responses were collected from the web panelists that were located in the Helsinki region. Different age groups (ranging within 24–80) and household size (single: 31%; couple: 31%; family with children: 37%) were evenly chosen for the web panel. Men (45%) and women (55%) were almost equally presented. The survey was also used to recruit participants for seven workshops that were arranged over February and March 2015. Each age group and household type was presented in the workshop. In the Envi survey, the respondents (n=1017) described their housing choice criteria and preferences for urban milieu. Housing choice criteria were examined by asking the respondents to indicate the relative importance of different dwelling features, which would be used whilst choosing a new dwelling. The four most important criteria were: affordable monthly housing costs (extremely important 74%), affordable purchase price (66%), functional floor plan (58%), and the dwelling enables one's lifestyle (49%).

Figure 1. Participants discussing townhouse possibilities in workshops. Photo: Ulpu Kojo

The choice criteria indicate that the economic aspect of housing dictates possibilities to pay attention to other features, such as energy-efficiency and accessibility. If the features are available only through extra costs, majority can not afford to pay attention these features. Especially accessibility, if it is not an absolute necessity during the choice situation, may be discarded. Amongst the Envi respondents, only 19 percent considered accessibility as of extreme importance; 15 percent of the respondents placed extreme importance on renewable energy sources.

In between the two surveys, seven townhouse workshops were arranged to tackle questions about townhouse aspirations as well as the challenges associated with the housing type. In total 61 persons participated in the workshops (Table 1).

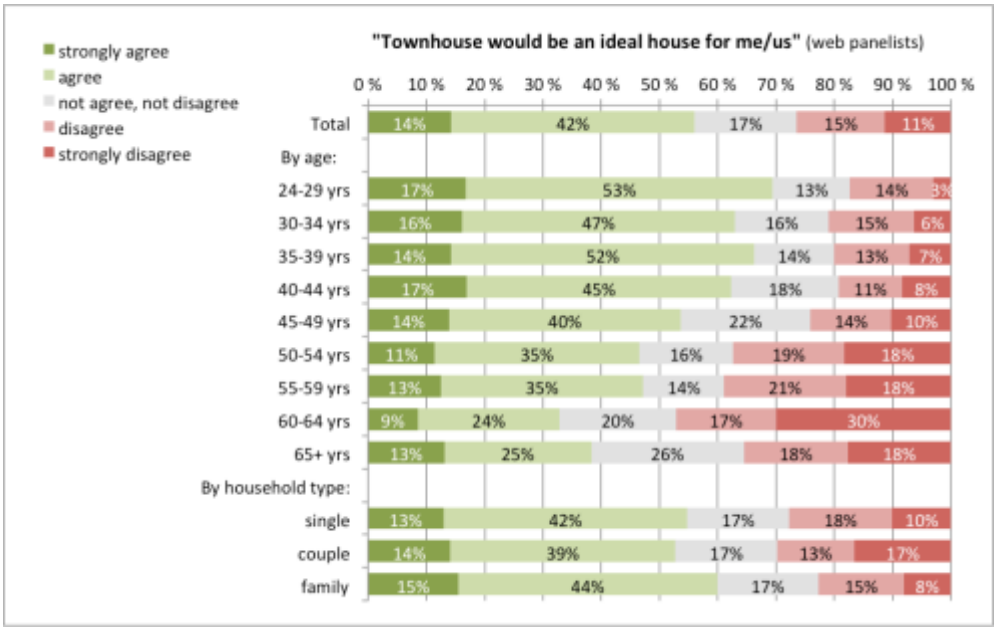

Figure 2. The FDH survey of interest in townhouses: the responses to the last question of the survey.

The same age categories and households were presented in the workshop as in the web survey. The workshops focused on a specific theme: the first workshops dealt with ground floor arrangements, including gardens; the following workshops studied housing typology, including the perceived possibilities and restrictions in terms of multi-storey living in different life-stages workshops focused on the way the dwelling relate to the streetscape and on the flexibility of townhouse dwellings. Each session investigated accessibility of a townhouse dwelling as well. The participants were divided into different groups according to their age and life stage. The workshops offered in-depth understanding about the perceived possibilities and limitations associated with townhouse living. Next, we will study the lifetime housing options from a residential perspective.

Results

The results of the user surveys

In this paper, our focus lies on the FDH survey, although some of the results are compared with the Envi survey. One of the most important findings in the workshops was the perceived adaptability of the townhouse for different life stages. The participant's pointed out of the possibility of lifetime housing and multi-generational housing. The results of the FDH survey indicate that preferences towards townhouses are similar amongst different household types. This suggests that housing preferences and styles are not life stage or age dependent (Figure 2). Families, couples, and one-person households show almost parallel interest towards the concept. Furthermore, even though the interest in townhouses decreases with age, a large number of residents over 55 years old showed interest towards the townhouse concept. The results were similar in the two surveys (FDH and Envi).

Table 1. Participation in the workshop by age and gender.

Age	Female	Male	Total
under 30	1	0	1
30–39	4	6	10
40–49	10	8	18
50–59	7	9	16
60–69	8	6	14
over 70	2	0	2
Total	32	29	61

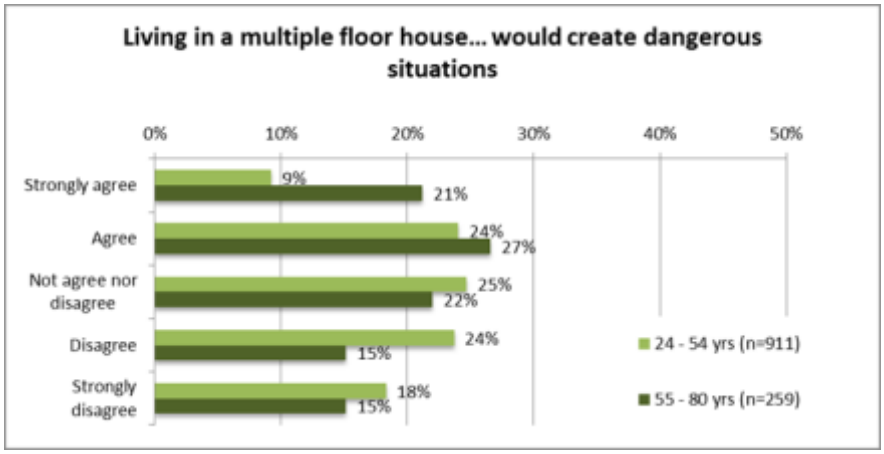

Figure 3. Were multiple floors to cause dangerous situations? (FDH) 30.2 percent of persons over 55 years old did not agree with the statement.

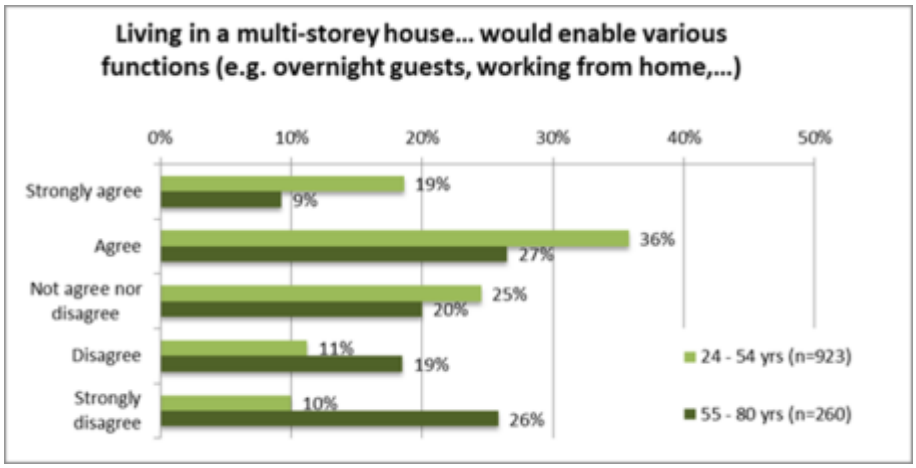

Figure 4. The perceived possibilities of multi-storey living, according to age (FDH).

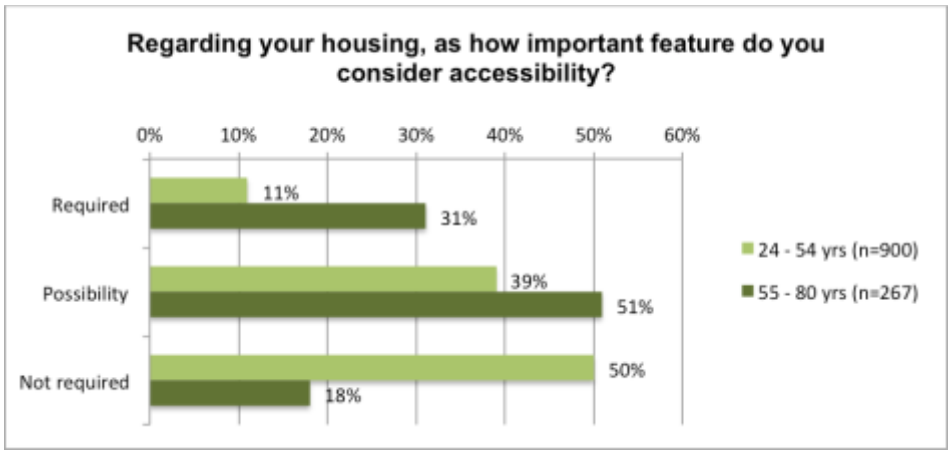

Figure 5. Accessibility. The respondents were asked about housing accessibility—whilst living in a dwelling, whether accessibility perceived as an absolute, non-tradable feature (required), optional (possibility) or not desired at all (not required). Of people 55 years old and older, 31 percent considered accessibility as an absolute feature. (FDH).

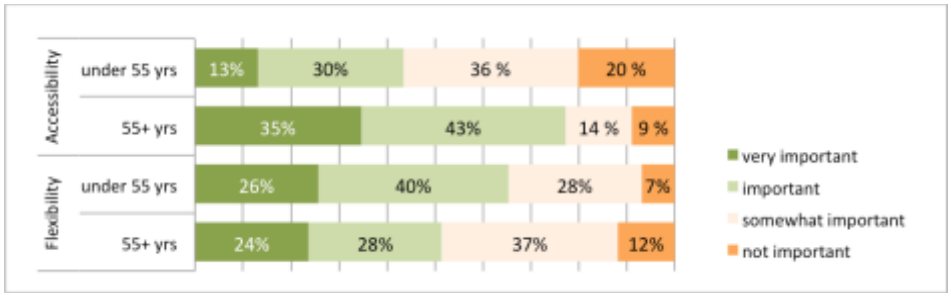

Figure 6. Accessibility and flexibility. A comparison between accessibility and flexibility as housing choice criteria (ENVI).

One of the most important findings in the workshops was the perceived adaptability of the townhouse for different life stages.

The survey explored respondents' perceptions and attitudes towards living in multi-storey housing. Respondents were also asked to give their opinions regarding different statements, of which one tackled the perceived safety of a multi-storey apartment. Many persons 55 years and over found living in a house with more than one floor as a risk factor creating dangerous situations (48% agreed or agreed strongly), but at the same time, 30 percent of the same age group disagreed or disagreed strongly with the statement (Figure 3). Younger age groups found living in a multiple story house less challenging, in fact 42 percent of respondents disagreed or strongly disagreed with the statement.

The respondents were also asked whether living in a multiple floor house would enable more flexible spatial arrangements, including social contacts (such as friends) staying overnight. Fifty-five percent of the younger respondents and 36 percent of the people over 55 considered that living in multiple floor house would provide more functions to ordinary living (Figure 4). At the same time, 45 percent of persons over 55 disagreed with the statement.

One of the questions was related to accessibility as design criteria. Accessibility includes level entrance and wider door openings. The results show that 31 percent of people over 55 years old define accessibility as an absolute criteria. Respondents under 55 years did not show a similar interest towards accessibility (11% regarded accessibility as required feature). This result was expected as the accessibility features are not often seen as necessary before they are required for one's own family (Figure 5).

In the Envi survey, the respondents were to state their housing choice criteria, as explained earlier. Both older households and younger generations considered the flexibility and possibility to adjust the house according to one's changing life-situation important (all respondents: flexibility, extremely important 25%; accessibility, extremely important 19%). However, people over 55 emphasized accessibility and 78 percent of them found accessibility important or very important (Figure 6). Both flexibility and accessibility features serve an equal goal—lifetime housing.

Narratives

Even though the surveys explained some pros and cons of townhouse living regarding senior residents, additional methods were needed to gain further knowledge. In this regard, the townhouse workshops explained the preferences in a more detailed way (Tervo and Hasu, 2016). The senior persons participating in the workshops presented several design options for how to make a townhouse suitable for their needs. The narratives help to better understand the requirements for accessibility and lifetime housing. The following two cases from the design game based workshops present examples of lifetime housing.

CASE 1. The first townhouse workshop case was designed by two women, aged 63 and 69. They described an example of a townhouse with inhabitants as follows: "Liisa," 70 years old, and her husband "Kalle," 72 years old have three children and six grandchildren. They like to invite their relatives, as well as friends, to spend time at their home. However, Liisa and Kalle spend relatively many weeks of the year at their summer cottage, therefore they value a care-free home.

The townhouse offers a *car parking space next to the entrance*, which makes it easy for Liisa and Kalle to handle the groceries and, most importantly, to handle the items needed for their summer cottage. The couple also underlines the *importance of the elevator* in a townhouse. A parking space next to the entrance and an elevator guarantee accessible housing for elderly people. Furthermore, the quality of life is appreciated. The garden, which is designed as an extension to the home, offers a place to enjoy outdoor life and to spend time with relatives and friends. The ground floor, with a spacious entrance hall, a kitchen with a flow of natural light, and *a large dining room with the option to have a very long dinner*

table ensure housing that meets the most important demands people like Liisa and Kalle may have.

CASE 2: The second townhouse workshop case was designed by two women, aged 62 and 69, and one man, aged 64. The portrait of the household was a family of three generations, which was based on the experiences and aspirations of the participants. The grandparents were named “Maija” and “Matti,” being some 60 to 65 years old. One of them was retired whereas the other was still in their working life. *The grandparents occupied the second floor.* The ground floor and the first floor were inhabited by one family: the parents “Pirkko” and “Pekka,” both aged 35, and their three children, “Topi” (two years old), “Lauri” (12) and “Liisa” (15).

The significant aspect of the townhouse design for this group was the flexibility of the house. An elevator offered accessibility for all the three generations, yet the privacy was well guarded since the *elevator was designed as an outdoor entrance*. Only the first two floors occupied by the young family had stairs inside. In terms of outdoor spaces, *the grandparents were to enjoy a spacious rooftop terrace*. The garden was mainly for the family with young children.

The grandparents were described as enjoying both their privacy and the closeness to the younger generations. Furthermore, the workshop participants underlined the flexibility: when the grandparents passed away, the eldest child could move to the upper floor or the family could either rent or sell the third floor apartment.

In both of the cases described above the street and garden arrangements were a matter of interest. The workshop participants appreciated their garden and roof terrace; however, the maintenance of these spaces was raised in discussion. The results of the FDH survey indeed emphasized the ease of maintenance, which was important or very important for 82 percent of all the respondents (Huttunen et al., 2015a). The challenging winter conditions were especially discussed in the workshop. The way townhouses are arranged in resemblance to Finnish terraced houses, nonetheless, feeds the image of housing company with easy maintenance.

In addition to the image of care-free housing, the townhouse was considered to be a housing type that guarantees accessibility in many ways. In general, the housing typology is considered to offer an accessible entrance at ground level. The townhouse typology creates a walking friendly streetscape and easy parking near apartment, which attract senior residents, in particular. Moreover, in both case examples, the importance of an elevator was raised. These examples emphasize design solutions offering accessible housing. The potential of a townhouse was hence considered as promising, since the typology enhances accessibility, privacy, flexibility, and intergenerational housing.

The Neighborhood

During the EET study several existing buildings in Helsinki and Berlin were visited and analyzed focusing on the accessibility of the building design. In Helsinki only a few examples can be found since it is a new typology in Finland, whereas, in Berlin the tradition of townhouse is longer. Only a few newly built houses were chosen for the site visits. One of the fundamental planning guidelines regarding townhouse typology emphasises the scale of neighborhood level. Human-scale housing and green streetscape are perceived as pleasant. A hierarchy of pathways and semi-private lanes increase the feeling of safety. One way to assess the accessibility in neighborhood level is to analyse the street connectivity. The townhouse areas where private yards open to common green areas provide safe walking paths and possibilities for social activities for residents of all ages.

The built environment has an influence on the use of the neighborhood and community on a daily basis. Residents may walk or bike to local destinations, such as schools, bus stops, or groceries, if these services are available in the proximity. Previous studies showed that more there are destinations in the neighborhood, more frequently and for longer time people walk (Wang and Lee, 2010). The urban mixity and multiple housing possibilities in the neighborhood enhance sustainable development and lifetime housing. Daily services and public transportation near home enhance coping in old age. The results of this study confirm previous findings of the importance of public transportation. Also, 80 percent of all the web panelists considered public transportation very important for the housing area. Activities in the neighborhood promote social interaction and inclusion. Walking route choices are influenced by the total length and connectivity of streets and sidewalks. A dense and uninterrupted network of pedestrian and bicycle lanes promotes sustainable ways of mobility. According to previous studies, a five-minute walk is considered the average distance that a pedestrian is willing to walk before choosing to drive (Diyanah and Hafazah, 2012). Some other findings suggest that the walkable neighborhood is geographically contained within a 1-km circle from home. However, the actual walking distance is often much longer than the shortest distance measured between home and destination.

According to Svensson (2009), residential areas where pedestrians and car traffic are completely separated provide the most favorable environment for persons with mobility impairments. However, according to him the complete separation of cars and pedestrians often also makes distance to the nearest public transport stop longer and, therefore, reduces accessibility. The distance to a bus stop should not exceed 250 m (Sahlsten, 2013). This can also be regarded as a recommendation for planning for the elderly. Previous studies in Finland show, however, that only a bus stop within 100–150 m from home promotes effectively use of public transport (Kosonen, 2007). An earlier study came to conclude that 15 percent of all car trips would disappear if all journeys shorter than 1 km were made by foot (Solheim and Stangeby, 1999).

Figures 7 *and 8.* Small-scale garden streets can increase intercourse and social activity with residents. *Photo* Ira Verma

Figures 9 and 10. A human-scale green environment enhances walking. Leipzig, Germany. Photos Ira Verma.

ACCESSIBLE Housing

As mentioned before, people over 55 are the target group of this paper. According to Oswald and Rowles (2006) the "third age" cover life-stages when people still are willing to move. The questions of accessibility are important when choosing the home for the "fourth age". The possibilities to remain in place are outlined according to the criteria used for future dwelling. Whether one is able to stay in the home in the future, is crucial. The proportion of the eldest (persons over 85) will grow fastest and, therefore, according to some studies, the disability rates of the population will grow faster than the general population. Even though the older generations are healthier than the previous generations, Smith et al. (2008) estimated that the proportion of the population with a long-lasting condition that limits one or more physical daily activity—such as walking, climbing the stairs, or carrying groceries—will increase to 11.6 percent by 2050. Moreover, they estimate that at least 25 percent of new single-family houses built today will be occupied during the lifecycle of the building by a resident with severe long-term immobility. The majority of persons want to remain in their current home for as long as possible, yet many are forced to move because of problems in accessibility. Therefore, designing a townhouse for a lifetime is long-term planning.

Visitability is term used to develop the accessibility of owner-occupied single-family houses. A few specific features regarding ground-floor planning—for example level entrance, door width, and an accessible toilet—help a person at any age to stay home in the case of temporary mobility impairment and to receive guests with a mobility impairment. The main target of visitability features is to create a continuous path from the street level to the apartment. The level of entrances and wider doorways benefit all residents in common tasks, such as moving furniture, pushing baby strollers, storing bicycles, and carrying groceries. Visitability also contains the recommendation of raised electrical outlets and lowered light switches, which increase the usability of the house. Wider doorways and corridors, as well as a low threshold entrance, may also increase safety in the case of fire or other emergencies.

Access and ease of use are also targets in the new Finnish townhouse concept under development. However, it is essential to note that visitability does not fulfill

the need of accessibility. To be able to fully make use of all premises and levels of a townhouse a vertical platform lift is necessary. The vertical lift also helps to move furniture, or carry laundry or groceries. Furthermore, when the apartment is provided with a lift, the ground floor plan can be designed more freely without the need for a wheelchair-accessible bathroom or a kitchen on the ground floor. We need further understanding of the ways to fulfill the diverse housing preferences of elderly people, especially in terms of the townhouse concept.

Analyses of existing buildings

Analyses of existing townhouse buildings revealed major differences in design solutions for the building plot in the city center and other parts of the city. The most apparent difference was due to the parking solutions. Parking solutions affect the costs of construction and, in consequence, the affordability of a construction. In Helsinki city center underground parking is a predominant solution, whereas in suburban areas street parking or a parking solution on the ground level are more common. In Berlin the parking on ground level seemed to be predominant, although, one of the buildings visited had underground parking garage. Parking solutions were also raised up in workshop discussions. A parking place or transit zone in the front yard enables diverse possibilities for managing the differences in height between the street and ground level entrance. A garage on the street level can offer a sheltered entrance. However, the size and layout of the front yard, as well as the street width, affect the streetscape of the neighborhood (Takano and Verma, 2014). The Finnish lifestyle generally requires a certain amount of privacy, which can be assured by a front yard.

In suburban areas, a parking place in the front yard or a private garage on ground level are the common parking solutions (Figures 11 and 12). A front yard allows to realize an accessible entrance, the difference of height between the street level and the entrance. Most of the townhouses visited during the project had an accessible parking place on the same side of the street as the building's entrance. A garage can also be used to realize a level entrance that will be sheltered from snow and rain. In the case of parking in the front yard, a slope was needed to adjust to the height difference. The minimum width for an accessible parking place is 3600 mm, therefore, a very narrow plot is challenging for a garage. It also limits the possibilities of the ground-floor plan.

Figures 11 and 12. The parking solution and the distance to the street affect the streetscape (Berlin, Germany). *Photos Ira Verma*

A short and accessible path to the entrance was realized in most visited buildings. This was possible when the building was not directly attached to the street. An accessible entrance with a level platform before the entrance door (min. 1500 mm x 1500 mm) was not realized even though in most cases the door width met the requirements (850 mm) (Figures 11 and 12). The slope to the entrance should not exceed five to eight percent and it should preferably be covered. Especially in Nordic countries, winter conditions are a major challenge for accessibility and the maintenance work of removing snow requires a big effort, especially for

elderly residents. Therefore, the paths to the entrance should be covered and wide enough for the mechanical removal of snow.

Figures 13 and 14. The incompatibility of street and building execution creates barriers (left). A narrow front yard ensures privacy and allows a sheltered entrance, if correctly dimensioned for wheelchair use. (right) (Kalasatama, Helsinki). Photos Ira Verma.

The affordability of accessibility

The affordability of housing is a current topic. The living area of the townhouse examples realized in Helsinki are from 140 m2 to 165 m2. They are quite large apartments by Finnish standards, which affects the building costs and affordability. The plot width in Berlin was in general narrower than in the Finnish cases. Most apartments there had an accessible entrance from street level but did not have lifts. In Finland in the public discussion, and opinions among the developers in particular, the accessibility regulations is argued to result in higher building costs and, therefore, non-affordable housing. According to recent studies the increase of costs for a visitable or accessible apartment (in an apartment block) is due to the 1–1.5 m2 of extra space needed for an accessible bathroom on the ground floor level. However, a home modification at a later stage would cost 3.5 times more than accessible solution in the initial stage (Kilpelä et al., 2014). A lift increases the building costs of a townhouse. When the a space reservation for a lift is in the original building design it can be realized at a later stage without any major modification on the building structure. The space reservation increases the flexible use of the apartment in long term. Therefore, the careful life-cycle planning of the house can help to manage the costs of construction in the building phase as well as in the use phase.

Underground parking is an expensive solution that increases the costs of apartments and is the main challenge in building an affordable townhouse. Furthermore, in the current economic situation in Finland, many new large apartments remain unoccupied. The possibility to divide large apartments into smaller ones has been seen a marketing tool for selling these apartments. The possibility to horizontally divide a townhouse into separate living units could help in marketing. It would also respond to the emerging needs for multigenerational housing solutions (revealed in townhouse workshops). It would enable also other communal housing solutions ensuring privacy and offering some commonly used spaces. A design solution with several apartments would, however, affect the interpretation of building regulations regarding accessibility and fire safety.

Discussion

The possibility to divide a multi-storey building into use by different generations, or by other persons interested to share a house is compelling.

Townhouse has the possibility to be developed as an interesting alternative housing typology for various resident groups. It has potential to enhance communal ways of housing for multigenerational families or students for example. It can also be an alternative for lifetime housing when accessibility is taken into account. At the moment, the Decree on Housing Design (2005) for accessibility leaves room for interpretation. The practice does not urge the accessibility of privately-owned single-family houses. Other means, preferences and subsidies for housing, can steer construction towards accessibility. Inclusive design of townhouse requires the comprehensive planning and realization of the building plot and the apartment as a whole connected to the neighborhood. For the younger generation accessibility is not a character per se, the flexibility for chancing life situations is perceived as more desirable. Some participant to the FDH workshop pointed out that the parking solution and accessibility are strongly related. An elderly person would profit from a sheltered parking place at the entrance of a building and a lift that enables the effortless use of the whole building (Huttunen et al., 2015a). Parking solutions is strongly related to the affordability of the building.

As the townhouse workshop cases suggested, the townhouse can meet the needs of all age groups in a flexible and accessible way. They also revealed, that a design that takes into account the possibility to divide a multi-storey building into use by different generations, or by other persons interested to share a house, is compelling. Townhouse provides possibilities for flexible living styles and privacy for the residents. Accessibility assessments are a way to develop townhouses for diverse resident groups and to promote inclusive housing design. A level entrance, both inside and outside the building, opens opportunities for trolleys and walking aids, as well as for prams and bicycles—for changing life situations in other words. Housing design that adjusts to changing life situations, at any age, offers affordability in the long run.

Finally, the findings may introduce new approaches, not only to townhouse options, but to other housing typologies as well. The townhouse is closely related to terraced housing and apartment buildings. The inclusive planning of a townhouse—with attention to accessibility, affordability, and energy efficiency—will promote a sustainable solution.

Conclusion

Helsinki city is strongly promoting townhouses as a sustainable urban solution to single-family houses. The FDH survey and workshops revealed that several possible resident groups are interested in this typology, regardless of the size or age of the household. Therefore, the planning should not be limited to young families with children but should consider a variety of resident groups. Seniors represent an important group of people that want to invest in the quality of housing. There is an aspiration for lifetime housing: flexibility in changing life situations and accessibility. Moreover, urban housing types, including townhouses, should be user friendly as 85 percent of all respondents of the survey considered ease of maintenance important for housing. The aim is to develop an energy-efficient, accessible, affordable, and “easy living” townhouse.

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Standard Timber Structures for Lean Architectural Design

Yrsa Cronhjort
Aalto University School of Arts, Design and Architecture
yrsa.cronhjort@aalto.fi

Abstract

The Finnish building stock is our most significant national asset and the construction industry an important source of income. By managing building production we affect the performance of this activity. Development is required for timber-building to compete in this market.

Lean culture is one approach to optimized production. Lean construction research has defined lean and industrialized processes, identified the differences between mass-customization and mass-production, and the importance of standardization. Redesign is a recognized cause of inefficiency, typical also for complex timber buildings. Development visions include building system based design automation and modularization. This study explores pre-designed details as a means to reduce work in planning processes.

The article bases on a comparative case study. Six collections of pre-designed details developed for building with timber are presented and compared regarding availability, formats, accessible material and structures. Usability in practice is assessed with one selected intermediate floor structure as a benchmark. Conclusions are that barriers exist for transnational use, in referencing systems and for the direct use of proposed details and structures in a CAD-environment. The amount of material varies greatly. However, the collections successfully act as an overview of solutions compatible with local building regulations, and the similarity of solutions offers an opportunity for European wide competition and implementation.

Research leading to these results is part of the transnational WoodWisdom-Net Research Programme, project Innovative lean processes and cooperation models for planning, production and maintenance of urban timber buildings, leanWOOD.

The article bases on a comparative case study. Six collections of pre-designed details for building with timber are presented and compared regarding availability, formats, accessible material and structures. Usability in practice is assessed with one selected intermediate floor structure as a benchmark.

Introduction

This research is part of the transnational project *Innovative lean processes and cooperation models for planning, production and maintenance of urban timber buildings* (leanWOOD). The project aims to develop timber-building with the design process as focal point.

Detailing is one issue to improve in building practice. For example, it is not uncommon for joints and structures to be first designed by the architect, redrawn by the structural engineer, possibly revised by a sub-contractor, and redrafted on site before final versions are agreed upon. This type of redesign can be characterized as waste of work and resources in the building design process.

The article includes a literature review of lean construction and design research, and a comparative case study of six European collections of timber-building details. The discussion evaluates the usability in architectural practice.

PEER-REVIEWED ARTICLE

This article presents a comparative case study of six European collections of pre-designed details for timber-building. Selection criteria are the familiarity and use in partner countries of project leanWOOD; Finland, France, Germany, and Switzerland. Research material includes additionally two Austrian collections known in both Germany and Switzerland. The availability and usability of presented material in design practice is assessed by comparing the collections regarding user interface, availability, formats and amounts of published material, and suggested solutions. A benchmarking exercise based on one exemplary structure complements the comparison.

Literature review: lean construction and design

Systematization and industrialized construction do not necessarily equal mass-production.

Project leanWOOD aims to develop the timber-building design process by building on the foundations of *lean culture* in the construction industry. Research in lean production and manufacturing started with the *Toyota Production System* (TPS) (Womack et al., 1990) but further development of the construction industry based on lean methodology has gained speed only in the 21st century. Due to the small amount of publications on lean timber construction the discussion below concerns general lean construction and design research.

Among the first to define *Lean construction* was Howell (1999) who concludes that "Essential features of lean construction include a clear set of objectives for the delivery process, aimed at maximizing performance for the customer at the project level, concurrent design of product and process, and the application of production control throughout the life of the product from design to delivery". Later, Lessing et al. (2005), and Bildsten (2011) identified *Industrialized construction processes* as characterized by the planning and control of processes, developed technical systems, off-site manufacturing of building parts, long-term relations between parties, integrated supply chain management, customer focus, the use of information and communication technology, systematic performance measuring and the reuse of experiences.

Systematization and industrialized construction do not necessarily equal mass-production. Bildsten (2011), Lessing et al. (2005), and Rich (2012) underline the difference between "*mass-customization"* and "*mass-production*". For example, in housing production the aim should be for high customer satisfaction and a bespoke building as end result - expressed in other terms as "/…/ a custom product exactly fit for purpose /…/" (Aziz and Hafez, 2013).

However, the application of standardized components aids improving the efficiency of its production. The view is supported by Aapaoja and Haapasalo (2014), who have explored the relationship between standardized products and building processes in the Finnish construction industry. As benefits of standardized components they identify a track record, increased productivity, decreased waste, replicable processes, shorter lead-in times, and a higher quality. Bildsten (2011) and Rich (2012) see standardized components as a means to achieve a continuous improvement of processes.

Design is identified as one barrier for improving construction processes. For example, Aapaoja and Haapasalo (2014) conclude that "(The) current design processes do not support using the standard products and components" and identify an "(The) inability to order (and offer) standardized products and solutions". (Aapaoja and Haapasalo 2014, Table 3, p 989). Bildsten (2011) sees the cost of development as one barrier. Rich (2012) reports on waste in the design process caused by an ambition to design beyond the limits of know-how or need, and by redesign. He sees potential in pre-developed detailed design and earlier collaboration with suppliers. The notion of redesign as a factor of waste in building processes is supported e.g. by Pasquire and Connolly (2003).

Various strategies to reduce design work have been explored. In the early 1900s architects aimed to lower the costs of housing production by an industrialized approach similar to mass-production. It was also widely applied in the reconstruction era after World War II. Regarding mass-customized building

production, Álvaro Siza was an early forerunner of end-user driven design for expandable homes. (Benros and Duarte, 2009)

Current development suggests module-based solutions. For example, Powell et al. (2014) see modularization as the future for producers of engineer-to-order products with little volume but high variety. One recent design-methodology is "*modular design of one-off projects*" introduced by Mohamad et al. in 2013. The strategy builds on the modularization of the building and the standardization of modules. Benros and Duarte (2009) propose a framework integrating architectural design with building construction aiming to speed up repetitive tasks when using a complex building system. Key attributes of their concept include a combination of (1) flexible design, (2) data communication (Computer Aided Design-application, CAD), and (3) industrialized building processes. Similar thinking is proposed by Jensen et al. (2012) discussing building system-based design automation to promote the use of modular standard objects in architectural design. Pasquire and Connolly (2003), developers of the "*design for manufacture and assembly (DFMA)*"-model, support decreasing unnecessary work and argue that designers should emphasize value for the client over detailed design.

Research on lean construction has identified redesign and unnecessary detail work as sources of wasted resources in the building design process. This study seeks to explore the availability of pre-designed details and assess the usability of them as standardized components to aid a more efficient design and production of timber buildings.

The literature review illustrates that research on lean construction has identified redesign and unnecessary detail work as sources of wasted resources in the building design process. Various optimization strategies have been explored including attempts to decrease detailing. This study seeks to examine the availability of pre-designed details and assess the usability of them as standardized components to aid a more efficient design and production of timber buildings.

Research material: pre-designed details for building with timber

This research presents six collections of pre-designed details for timber construction published in Austria, Finland, France, Germany, and Switzerland. The earliest publication is from 1999 and Holzforschung Austria was the first to publish online in 2003. Discussed material is freely and publicly available. Contents are compared regarding availability, offered formats, structures and solutions. The usability in practice and added value of other material is assessed. Table 1 presents selected collections.

Collections: availability and offered formats

RunkoPES 2.0 was published in Finland in 2013 by Finnish Wood Research Oy. It is an open timber element-standard for residential housing production in accordance with the National Building Code of Finland. It gives guidelines for designing multi-storey houses of fire classification P2 and large scale element production. It can also be applied to non-load bearing structures and spatial modules. Detail designs show the principles and are to be further developed by, for example, element manufacturers. All material is free, open-access to the public and downloadable at the website of the Finnish Timber Council (Finnish Wood Research 2013a). Structural solutions are collected into one overview publication in pdf-format and joint details to a separate document. The material can be printed but is copy protected. Additional materials consist of exemplary designs for a model multi-storey apartment building including HVAC- and building permit-drawings. CAD-objects are available in formats ArchiCAD 17, ArchiCAD 16, Revit 2014, and IFC 2x3. The language is Finnish only. Final structures are to be verified by a structural engineer separately for single building projects.

Compared online libraries include the Finnish RunkoPES 2.0, the Austrian Dataholz and IBO Passivhaus Bauteilkatalog, the Swiss Lignum Bauteilkatalog Schallschutz, the French Catalogue Construction Bois, and the German book The Erarbeitung weiterführender Konstruktionsregeln /-details für mehrgeschossige Gebäüde in Holzbauweise der Gebäüdeklasse 4.

The *Catalogue of reviewed timber building components for thermal, acoustic, fire performance requirements and ecological drivers* (Dataholz) published in 2003 was developed by the Austrian Association of the wood industry, HolzForschung Austria and proHolz Austria. It includes construction details for residential building in framework and massive timber designs. The material is free, open-access to public and downloadable at the dataholz.com-website (Holzforschung Austria, 2003). It consists of fact sheets and drawings in pdf-format. All can be both copied and printed. Language options include German, English, Spanish and Italian. The material is offered as suitable proof of compliance with Austrian building regulations. However, no liability is accepted.

Swiss timber construction details, *Lignum Bauteilkatalog Schallschutz* (Lignum Bauteilkatalog), were published by LIGNUM Holzwirtschaft Schweiz in 2014. It is a collection of intermediate floor structures only for acoustic design in accordance with standards SIA 181:2006, EN 12354:2000, ISO 717-1, and ISO 717-2 and to reduce low-frequent impact sound (below 100Hz). Framework and massive timber designs are included. The material is free, open-access to public and downloadable at the Lignum Bauteilkatalog-website (Lignum 2014). It consists of structural detail fact sheets and drawings in pdf-format. Documents can be printed and the information copied. It is published in German only.

The Erarbeitung weiterführender Konstruktionsregeln/-details für mehrgeschossige Gebäude in Holzbauweise der Gebäudeklasse 4 (GHG4) was published in 2014 (Gräfe et al., 2014). It promotes the design of multi-storey timber buildings in Germany up to 13 m height of upper floor level (Gebäudeklasse 4). Structures include framework and massive timber-designs. The publication is free, open-access to public and downloadable at the Fraunhofer IRB-website. It contains background and general information, structural and detail-solutions. Contents can be copied and printed. The book is published in German only.

The Austrian *IBO Passivhaus Bauteilkatalog* (Baubook) collection is published by Österreichisches Institut für Baubiologie und - ökologie (Verein) und IBO GmbH. The contents of 68 pre-designed structures support passive house design. They include framework and massive timber designs in a standard and an ecologically optimized version. The collection is open-access to public and material can be downloaded at the Baubook-website (IBO 2009). Fact sheets are available as separate pdf-documents and structures can be examined as 2D or 3D-images. All material can be copied or exported to pdf-documents. It is available in German only, with small parts translated to English. Materials and structures listed need no separate verification: they are accepted by the authorities and funding institutions as such. The online-version bases on the Passivhaus-Bauteilkatalog – Ökologisch bewertete Konstruktionen first published in 1999 (Passivhaus-Bauteilkatalog 2009). The latest publication from 2009 includes full text in both German and English and can be purchased through the Baubook-website.

L'Institut Technologique Forêt Cellulose Bois-construction Ameublement, FCBA, and the Comité professionnel de développement des industries françaises de l'ameublement et du bois, CODIFAB, have developed the French *Catalogue Construction Bois* (CCB). Wall details were published in 2013 and other in 2014. The collection includes structural and joint details, and guidelines for fire-safety design. It entails structural solutions in framework and massive timber for residential single family homes and multi-storey apartment buildings. The material is free, publicly available and downloadable at the catalogue-construction-bois.fr-website (FCBA 2013). All material is available in pdf-format, partly also in MS Word-format. It can be both copied and printed. Details are available as pdf-documents and in dxf-format (CAD). The material is published in French only.

Table 1. Online collections of pre-designed timber building details evaluated in this research.

Collection Country of origin	RunkoPES 2.0 Finland	Dataholz Austria	Lignum Bauteil-katalog Switzerland	GHG4 Germany	Baubook Austria	CCB France
Aim	To create a basis for the commissioning, design and execution of timber buildings in which: 1) a building can be designed without knowing who will execute building works or whose solutions are used, 2) suppliers of different solutions are able to make an offer coherently and cost efficiently, 3) and different manufacturers´ solutions are interchangeable in the design and on site	General construction details to serve as a start for conceptual, initial and detailed design and execution of residential timber buildings	To support the design of ceilings fulfilling impact sound criteria	To create a catalogue with thoroughly designed details and structures for timber building in accordance with the German building regulation code *Musterbauordnung 2002* and the guideline for fire-resistant timber structures from 2004	To offer details for the design and support for the ecological evaluation of passive houses	To aid the design of timber buildings in accordance with RT 2012 (Réglementation Thermique 2012, design for energy efficiency) and requirements set in NF DTU 31.2 (Eurocode compatible timber frames)
Structures	external walls internal walls intermediate floors wet spaces ceilings roofs balconies	wood, wood composites insulation, ligning materials and other external walls internal walls intermediate floors ceilings roofs windows doors other connections and joints	floors	external walls internal walls intermediate floors selected joints including joints between timber and massive wall structures (e.g. concrete or brick) window detailing	external walls internal walls intermediate floors windows roofs	external walls internal walls intermediate floors roofs ductwork integration
Construction types	massive wood framed structures	massive wood framed structures	massive wood framed structures	massive wood framed structures	massive wood framed structures	massive wood framed structures
Other material	Overview catalogue, example designs for a model multi-storey apartment building including HVAC designs, model building permit drawings	NA	NA	extensive guide book on the design for timber construction	Construction calculator (also available in English), Eco2soft calculation tool	General guidelines for the design of timber structure and separately for single family homes and multi-storey housing
Formats	Pdf-documents, objects in ArchiCAD 17, ArchiCAD 16, Revit 2014, and IFC 2x3	Pdf-documents	Pdf-documents	Pdf-book, available as CAD-objects for Dietrichs CAD/CAM	Pdf-documents, book published by Springer (in German and English)	Pdf and MS Word-documents, dxf-objects
Languages	Finnish	German, English, Spanish, Italian	German	German	German, online version only partly in English	French
Availability	Free of charge	Free of charge	Free of charge	Free of charge	Free of charge	Free of charge
Website	www.puuinfo.fi/suunnitteluohjeet/runkopes-20	www.dataholz.com/	bauteilkatalog.lignum.ch/?lang=de&page=home	www.irbnet.de/daten/rswb/14109008377.pdf	www.baubook.at/phbtk/index.php?SW=19	catalogue-construction-bois.fr/

Structures: case intermediate floor

Within the scope of this research, selected collections are compared based on suggested structures for intermediate floors as it is the only structure available in all.

The collections are compared based on suggested structures for intermediate floors as it is the only structure available in all. Floor type VP801KRL from RunkoPES 2.0 is selected as a benchmark.

RunkoPES 2.0 presents structural details in one pdf-document including guidelines for their use (Finnish Wood Research, 2013b). The publication includes ten different types of intermediate floors and eight solutions for bathrooms. Single details are shown on separate fact sheets with drawings in scale 1:10. A table explains structural layers and their task, like ensuring fire performance or sound absorption, material type and thickness of the layer. Performance data of the structure as a whole is also listed. Weight is excluded. To compare different collections, intermediate floor type VP801KRL is selected as a benchmark. It is dimensioned for a span of maximum 6 meters. Structural layers are listed in Table 2 and illustrated in Figure 1.

Table 2. Structural layers of intermediate floor type VP801KRL, RunkoPES 2.0. Performance characteristics: REI 60, $R_w \geq 55$ dB, $L_{n,w} \leq 53$ dB, U-value not listed. (Finnish Wood Research 2013b, 146)

Thickness	Layer
15 mm	floor surface, parquet
75 mm	concrete casting polypropylene sheet
18 mm	timber board
12 mm	sound absorption
360 mm	timber beam, including 100 mm thermal insulation (load bearing structure)
20 mm	gypsum board 2 x 10mm
500 mm	total structural thickness, weight not listed

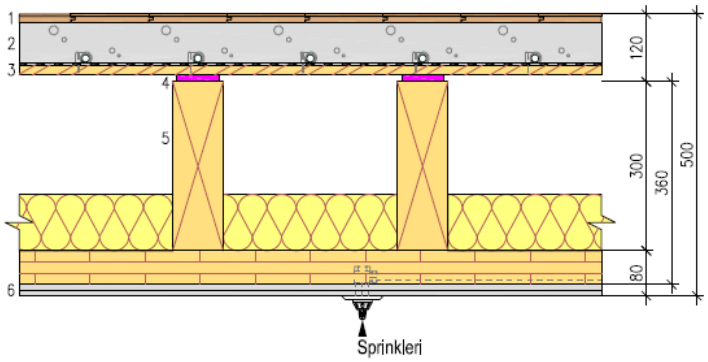

Figure 1. Build-up of intermediate floor type VP801KRL, RunkoPES 2.0.
Authors note: The structural detail drawing includes a sprinkler. According to the National Building Code of Finland sprinklers are mandatory in timber framed buildings from two stories upwards.
(Finnish Wood Research 2013b)

The *Dataholz* shows a list of structural types and details on first page. After selecting intermediate floors, a new page opens up with the possibility to select and organize solutions according to characteristics including fire, acoustic and thermal performance. Construction, floor assembly and type can also be selected. Detailed descriptions are examined directly on the website or as separate pdf-documents. Additional data include an extensive overview of sustainability impacts with calculated values for the Global Warming Potential (GWP, Equivalent kg CO_2), Acidification Potential (AP, Equivalent kg SO_2), primary non-renewable energy content (PEI ne, MJ), primary renewable energy content (PEI e, MJ), the Euthropication Potential (EP, Equivalent kg PO_4), and Photo-oxidants (POCP, Equivalent kg C_2H_4).

Based on the characteristics of RunkoPES 2.0 intermediate floor type VP801KRL, two alternative structural types are suggested. Type gdrnxn04b is

similar to type VP801KRL. After selecting this type, the site lists in this case 10 different alternatives with small variations in single components. Intermediate floor type gdrnxn04b-08 is closest to the benchmark. It is dimensioned for a maximum span of 5 meters. The structure is presented in Table 3.

Table 3. Structural layers of intermediate floor type gdrnxn04b-08, Dataholz.
Performance characteristics: REI 60, R_w = 55 dB, $L_{n,w}$ = 66 dB, U-value 0.28 W/m^{2}K.
(Holzforschung Austria 2003). Authors note: The online-version lists glass-wool as thermal insulation throughout the layers (both German and English version). However, glass-wool is generally not used in Austria in this type of structure due to fire precaution.

Thickness	Layer
50 mm	cement or anhydrite screed plastic separation layer
30 mm	impact sound absorbing subflooring MW-T
19 mm	particle board
220 mm	timber, including 100mm rock/or mineral-wool thermal insulation (online: glass-wool) (load bearing structure)
24 mm	cladding, spruce
25mm	gypsum plasterboards with improved properties at high temperatures (fire), 2x12,5 mm) or 25 mm gypsum fibre board 2x12.5mm
368 mm	total structural thickness, weight 161.8 kg/m^2

Intermediate floor structures of the *Lignum Bauteilkatalog* total 323 alternatives. Selection criteria for structures consist of acoustic performance, load bearing structure, filling finish, floor surface for dry or wet installation, fastening system of ceiling (intermediate floor), total mass, and building part identification number. Information of each item comprises a drawing of the detail itself, basic data of acoustic performance, thickness of the structure in millimeters and weight in kilograms per square meter. Single structural layers are described in a table including name of the suggested material, thickness of the layer in millimeters, weight when relevant, the manufacturer for selected components and possible other specifications. Fire performance is not listed. Several details can be selected simultaneously. However, this function did not work at the time of testing. Of each structure, a fact sheet in pdf-format can be generated. The intermediate floor type closest to type VP801KRL of RunkoPES 2.0 is type number A.2.01-01a-10-00a-01-110a-aa, identification number 298. Maximum span for the structure is not mentioned. Structural layers are listed in Table 4.

Table 4. Structural layers of intermediate floor type 298, Lignum Bauteilkatalog.
Performance characteristics: Fire performance not listed, R_w = 62 dB, $L_{n,w}$ = 53 dB, U-value not listed. (Lignum 2014)

Thickness	Layer
80 mm	cement screed (not the final surface)
30 mm	impact sound absorbing subflooring (impact sound insulation board)
27 mm	paneling/ planking with three-ply panels
240 mm	timber beam, including 160 mm thermal insulation (load bearing structure)
27 mm	paneling/ planking with three-ply panels
15 mm	gypsum board filled
419 mm	total structural thickness, weight 247 kg/m^2

The *Erarbeitung weiterführender Konstruktionsregeln/-details für mehrgeschossige Gebäude in Holzbauweise der Gebäudeklasse 4* (GHG4) detail catalogue is an all-inclusive publication. The amount of details is limited with only three types of structures for intermediate floors and showing principles and layer types only. Two intermediate floor types use solid wood as a load bearing structure, whereas the basic type TD1 is similar to type VP801KRL of RunkoPES 2.0. Maximum span for the structure is not mentioned. Structural layers are presented in Table 5.

Table 5. Structural layers of intermediate floor type TD1, GHG4. Performance characteristics: REI60, R_w = 60 dB, $L_{n,w}$ = 48 dB, U-value not listed. (Gräfe et al. 2014, 155)

Thickness	Layer
	floor surface
≥ 30 mm	cement screed or anhydrite screed
≥ 20 mm	impact sound absorbing subflooring
≥ 19 mm	timber
	timber, including thermal insulation
	(load bearing structure)
	air-tight layer if required
	Timber
36 mm	gypsum or gypsum fibre board 2x18mm
	total structural thickness, weight not listed

The *Baubook*-website introduces the collection on first page and structural groups on the next. After selecting floor structures, a new page opens with a list of solutions. Detail information includes the thickness of structural layers, information of thermal insulation capacity and performance, weight, primary renewable energy content (PEI e) and reference values for GWP ($kgCO_2/m^2$) and AP ($kgSO_2/m^2$). Fire or acoustic performance is not listed. Of the six available intermediate floors type GDl 01, version a, is closest to the benchmark VP801KRL of RunkoPES 2.0. Maximum span is not listed. Structural layers are listed in Table 6.

Table 6. Structural layers of intermediate floor type GDl 01a, Baubook. Performance characteristics: Fire performance or acoustic properties not listed, U-value 0.232 W/m^2K. (IBO 2009) Authors note: The online-version lists glass-wool as thermal insulation throughout the layers. However, glass-wool is generally not used in Austria in this type of structure due to fire precaution.

Thickness	Layer
10 mm	floor surface, parquet
50 mm	cement screed or anhydrite screed
0.2 mm	polyethylene (PE)
30 mm	impact sound absorbing subflooring, rock-wool or mineral-wool (online: glass-wool)
50 mm	bonded chippings
0.2 mm	polyethylene foil (PE)
22 mm	OSB-board
220 mm	timber, including 80mm thermal insulation and air-tight layer (load bearing structure)
22 mm	OSB-board
50 mm	rock/or mineral-wool 40 mm + air gap 10 mm (online: glass-wool)
30 mm	gypsum or gypsum fibre board 2x15mm
484.4 mm	total structural thickness, weight 266.6 kg/m^2

The website of *CCB* allows for selecting the type of structure on front page. After selecting intermediate floors, available types are listed on the following page. Four types of intermediate floors are included: (1) timber frame, (2) prefabricated element-structure, (3) double timber frame and (4) solid timber frame. For type 1 the following page shows several alternatives with joint details. One is similar to type VP801KRL of RunkoPES 2.0. Maximum span is not listed. The structure is presented in Table 7 and illustrated in Figure 2.

Table 7. Structural layers of intermediate floor type 1 with two layers of gypsum board, CCB. Performance characteristics: REI60, R_w = 63 dB, $L_{n,w}$ = 49 dB, U-value not listed. The structural principle is shown in the detail-document and dimensions listed separately. Structural layer descriptions refer to separate standard documents. (FCBA 2013)

Thickness	Layer
14 mm	surface layer, parquet
50 mm	concrete casting on polyethylene
18 mm	timber board
	timber, including thermal insulation
	(load bearing structure)
	impact sound absorbents
36 mm	gypsum board 2 x 18 mm
	total structural thickness or weight not listed

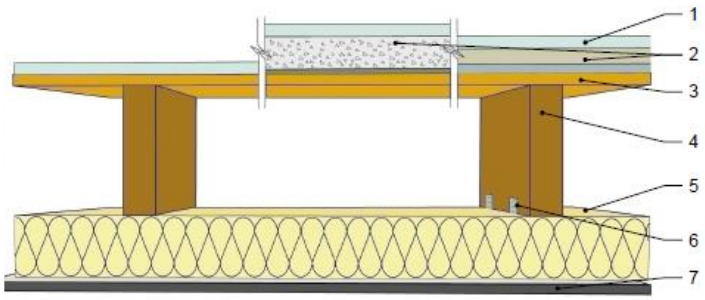

Figure 2. Build-up of intermediate floor type 1, CCB. (FCBA 2013)

Supporting material

In addition to pre-designed solutions, four of the discussed collections offer additional material like general guidelines for timber-building design. Exceptions include Dataholz and Lignum Bauteilkatalog offering fact sheets only. This chapter presents supporting material with information relevant for the application of intermediate floor structures discussed in the previous chapter.

Intermediate floor structures are part of the structural type catalogue of *RunkoPES 2.0*. (Finnish Wood Research, 2013b) The publication consists of a short introduction, tables with basic data of all structures and separate fact sheets of each. The table offers an overview enabling comparison of structures according to fire and acoustic performance, maximum span, U-value and thickness. CAD-objects are downloadable at the same website-page. The selected benchmark, intermediate floor structure type VP801KRL, does not as such exist as an ArchiCAD or Revit-object. However, a general intermediate floor object of same dimensions is available. Software for the dimensioning of intermediate floors is found on the website. Fire-safety design solutions for integrating e.g. ventilation ducts are shown in separate documents. Other joint details are collected into an own publication. Exemplary building permit drawings illustrate the design of a complete building.

The *GHG4* consists of one publication including an overview of building regulations, and solutions for e.g. integrating building technology. Fire performance, testing and recommendations are discussed in an own chapter. About one third of the publication is dedicated to suggested structures and details which are listed in overview tables according to type, description and index number. Separate fact sheets for each structure include a detail drawing, list of layers, and values on fire and acoustic performance. No additional software, calculation tool or material is offered.

In addition to timber building details, the *BauBook* online-collection does not include any other material. However, complementary software is available. Eco2soft-software aids in calculating the environmental footprint of a whole building. Attributes include U-values, GWP 100, PEI and AP. The Bauteilrechner offers an opportunity to compare, edit and save selected structures after a separate login (free of charge).

Supplementary information of the *CCB*-website includes information on design and dimensioning principles for attributes like thermal insulation, acoustic and fire performance, load bearing capacity, accessibility and durability. Documents on regulations, norms, and environmental impacts are available. The link to Eurocodes is highlighted. Principle designs are shown for a multi-storey residential building and single family homes including structural dimensions.

Discussion: usability in practice

Published European collections of pre-designed details could potentially support building system based architectural design. However, the comparison of available material in six detail collections for timber-building and the benchmarking exercise based on one selected structure revealed both barriers and opportunities for the applicability and usability of them in practice.

European collections of pre-designed details could potentially support building system based architectural design. However, the comparison of six libraries for timber-building and the benchmarking exercise based on one selected structure revealed both barriers and opportunities for the applicability and usability of them in practice.

Language is one obstacle. Only Dataholz is entirely available in several languages and the online version of Baubook has some material in English. The other four publish material in native language only. Increased language options would lower the barrier for implementation.

User interfaces and the path to find a specific detail vary. Dataholz and Lignum Bauteilkatalog proved practical as a result of the limitation options according to attributes like fire performance. The smaller amount of details in the four other collections made the task fairly simple as well. However, to find a detail or structure matching requirements set demanded work.

The conclusiveness of presented material varies. For example, Dataholz lists a vast variety of alternatives for each separate structural type, whereas GHG4 only contains a few principle solutions. The only collection clearly focused on large structures for multi-storey buildings is RunkoPES 2.0, whereas the other mainly introduce structures of less load bearing capacity, smaller spans, and very few alternatives developed for prefabrication. Then again, RunkoPES 2.0 contains solutions and principles for multi-storey housing only.

Some collections emphasize the aspect of general advice. For example, GHG4 contains advice for multi-storey timber housing and CCB works as an introduction to timber building with an informative overview of selected structures and details for single family homes and multi-storey residential buildings. RunkoPES 2.0 includes the largest variety of material from general guidelines to principles of detailing, exemplary building permit documents and CAD-objects. Dataholz and Lignum Bauteilkatalog do not contain any guidelines, but the variety and amount of details and structures is significant. RunkoPES 2.0 and the webpage of the Finnish Timber Council offer additional support for the dimensioning of structures and large amounts of information. A holistic ecological calculation tool is published only by Baubook.

All collections implement identification numbers. The numbering acts as an internal indexing system. Usability could be improved by referring to external sources like building regulations.

The vision of this study is for pre-designed details to enable reducing waste in architectural timber-building design processes caused by unnecessary work and redesign. For pre-designed details to be used it would require a complete, compatible, and established set of standard structural and joint drawings. Among discussed collections and in terms of extensiveness Dataholz responds best to this requirement whereas RunkoPES 2.0 offers the most holistic approach.

Another characteristic of lean culture is the use of information and communication technology to enhance efficiency, and CAD-software is an essential tool for planners. However, only a few of the collections offer CAD-objects. The most versatile collection in this respect is RunkoPES 2.0.

Selected collections are developed by the wood based products and timber-building industry in collaboration with research institutes. The aim is to aid and promote building with timber. However, this study revealed a vast amount of incoherent material. An efficient use would require more established solutions and easy-to-use interfaces.

However, the comparison based on one selected benchmark shows that suggested structures for building with timber are alike throughout Europe. Fire and acoustic performance is solved similarly. For example, fire performance is mainly ensured by structural encapsulation in gypsum boards. Due to the dimensioning for different spans beam heights of discussed structures vary and the only clearly different structure, designed for passive houses, is presented in the Baubook. These findings are significant as they illustrate a common basis for standardized timber building-design.

For a practicing architect the collections offer an overview of optional solutions and a means to verify the compatibility of designs with local building regulations. Additionally, similar structures can be found in all collections. This is an opportunity for the construction industry in the terms of European wide competition. Based on this study timber buildings in the countries of Austria, Finland, France, Germany and Switzerland could be designed and constructed with same structural solutions.

Conclusions

Research on lean construction has identified redesign and unnecessary detailing as sources of waste in the building design process. The vision of this study is that timber-building could be optimized by using pre-designed details, thus supporting reduced work and leaner processes.

To assess this option, six European free online-collections of pre-designed timber-building details were examined. The usability in practice was explored by identifying and comparing a similar intermediate floor structure and supporting material in all collections. Identified barriers include limited language options, the user interface, the variety of amounts and types among published material, and the identification systems. CAD-objects are absent in several collections, hence failing to efficiently support the use of information and communication technology, and automated architectural design processes. Based on studied material, some collections serve more as an introduction to timber construction and others as a direct design tool.

For a practicing architect the collections offer an overview of optional solutions and a means to verify the compatibility of designs with local building regulations. The discussed exercise also illustrates a minimal variation. Similar structures can be found in all collections. This finding supports the thought of limiting building specific detailing in the design process.

The similarity of structures is an opportunity for the construction industry in the terms of European wide competition. Based on this study timber buildings in the countries of Austria, Finland, France, Germany and Switzerland could be designed and constructed with same structural solutions.

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