Designing the Process.

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It first describes design as exploring the possible, yet unexpected future: the expected future does not need to be design anymore (we already know how it will be). In addition it relates design to study and research as well as teaching research and design.

Of all design assignments, designing the built environment probably is the most complex of all. The result needs to be coherent on all scale levels, now and in the future. The design directs the construction process, sets the conditions for managing and controlling the resulting built environment, to serve unknown users. The many parties concerned, all with their own interest complete its complexity. This problem is seen and shared by many and many contribute with solutions, from their own background and angle.

The concept of Open Building suggest a break down of the built environment in different territories or levels of decision making, such as the urban fabric, base buildings and fit outs, all with their dedicated designs, building contractors and life cycles to serve the decision making parties.

The concept of Integral Design was initiated as a reaction on the never ending Babel like confusion of tongues between the architect and structural designer on the one hand and the MEP/ HVAC designers on the other hand. Integral Design advocates the power of the team and suggests ways to communicate in order to create a better understanding between the parties concerned.

The concept of Lean Construction aims to banish waste by improving ways to add value and to improve the flow of the construction process. The end product benefits more from trust between partners rather than from precise but lengthy contracts.

The introduction to these concepts can help professionals to structure their work, students to better identify their personal goals and adapt their study accordingly and feed the discourse on developments in design.

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Key words: ways to study; open building; integral design; lean construction; teaching design.

1. INTRODUCTION

In 2001 a scheme of 450 dwellings in Almere, the Netherlands was completed, consisting of seventeen projects. The master plan required that all dwellings should be different, it was an experiment in mass customised housing. All architects involved designed Lego-like systems of different elements that could be arranged in different ways. Although they all strongly believed in this approach, they were not aware of the theory and practice of similar projects from the past (Cuperus, 2003).
Observations in master level teaching architectural design show emerging design skills on a conceptual level. Students get inspiration form architectural journals and see prima donna architects as their roll models. Some even mimic their idols with Le Corbusier glasses or a Rem Koolhaas haircut. They see their thesis design as their ultimate goal rather than mastering the skill to design. Design is applied to generate something 'unique' rather than planning a built environment that works and that will get better as it ages. Learning is fragmented over five years with different teachers, electives and individual study programmes. Tutoring design is very much done in a master – apprentice relationship, the student learns mastering design by doing and discussing. He/she is aware of and many times frustrated by not knowing how to control the design process from initial idea to investigating and selecting options and combining it in a plan that fits the requirements. It is neither fair nor realistic to suggest that students comprehend the scope of their study. But if they did, it would help them in strategically planning their design, their work and even their carrier.
First, the reach of the act of design needs to be understood. In addition, it offers the possibility to relate design to research and research to studying and learning. It allows the (student-) designer to plan the design process.
The concept of Open Building offers a framework for level oriented thinking. Integral Design and Lean Construction suggest ways how to deal with other disciplines and to think in terms of creating value for the end user instead of making architecture for architects.
A comparison of these concepts show their differences, overlaps and connections. They help us rethink the impact of design and research, in teaching, theory and practice.

2. WAYS TO STUDY AND RESEARCH

Universities have become commercial enterprises that are judged on their performances. In order to get funds, design schools such as schools of architecture have to compete with knowledge dominated faculties such as law and research driven faculties such as medicine. This was a good reason to reflect upon the position of design relative to empirical based faculties. Too this extend, the Faculty of Architecture in Delft has done some self examination and has published a long catalogue of their in-house qualities (De Jong and van der Voordt, 2002,1). The book was structured according to De Jong's interpretation of the position of design and its application areas, relative to science.

De Jong recognises a partly overlapping desirable, a probable and a possible future. The egg diagram makes clear that not everything desirable is possible and some of what we want it is probable. We don't have to design the probable future, we already know how it will probably be. The impossible future is the domain of science fiction (See Figure 1).
We do not know how the improbable future will be, because we can not imagine. Still, this is where many desirable solutions for problems can be found. This domain can only be explored by design.

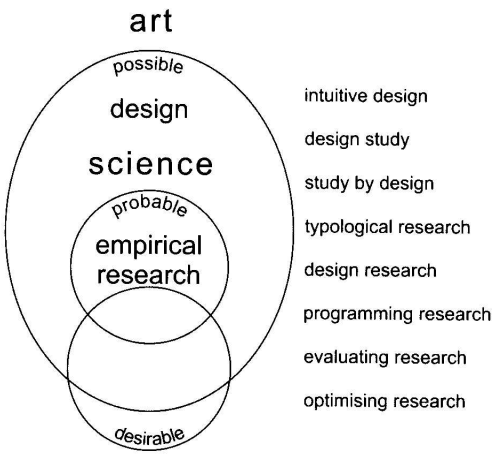

FIGURE 1, the Egg Diagram, Domains according to De Jong

The egg diagram became the under layer of the catalogue mentioned: 'Ways to study and research (urban, architectural and technical design)'.
In over fifty essays, the research and design activities of chairs and research groups within the faculty were described. They were arranged from empirical research towards intuitive design.
Empirical research coincides with the inner circle of the probable, science and design are needed to explore the possible. Art goes beyond the limits of the possible. The egg diagram in turn was completed with a column of a gliding scale, from factual research towards intuitive design. In between we find design research, typological research, study by design and design study. These variants of study and design are related to each other by their object and context. See Table 1).

TABLE 1.
Types of Design Related Studies

	Object known	Object varies
Context known	Design research	Design study
Context varies	Typological research	Study by design

Design research describes and analyses existing designs within a known context, often as a comparative study. If an identical architectural form, structure, technique, function or concept is recognised in different contexts, we talk about ‘type’. The study of these types is referred to as typological research.
Study by design: generating New knowledge and insight can be generated by designing solutions. This is called study by design, whereas design study means collecting information with regard to a design for a known location (De Jong and van der Voordt, 2002,2).

Both the egg diagram as well as the Ways to Study analysis contain elements of optimism. Due to environmental exhaustion we run out of options. However, design explores the possible but improbable, thus invisible options. The classification of design and science helps us to strategically get the best of both.

Indications how to connect Ways to Study and Research to practical implementation in the construction industry was beyond the scope of the book.

‘Integral Design’ was the name of a research project that took place at the same time and touches upon the relationship between design and the practice of building and teaching.

3. THE CONCEPT OF OPEN BUILDING

The origins of the concept of Open Building is best captured by one of John Habraken's finest quotes: 'We should not to forecast what will happen, but try to make provisions for the unforeseen' (Habraken, 196I). In order to accommodate unknown future change, he suggested to introduce different levels of decision making in the building process: tissue, support and infill, respectively referring to the urban fabric, containing base buildings with their fit-outs.

2.1 Mission
The raison d’être of Open Building can also be expressed in terms of care, responsibility and technology.
People, who care about the environment they live in, will make it a better and safer place. Therefore the built environment must encourage people to take responsibility for their own territory. An environment that clearly distinguishes those spaces and parts of

a building for which occupants should take responsibility, will address the user's needs to feel responsible. Therefore a building should be designed and built in such a way that both spaces and parts of the building can be clearly allocated to those parties and individuals that should take responsibility for them.
Buildings, which are designed and built with separate systems, can create conditions for responsibility and care. Therefore the subdivision of the building process needs to reflect the lines of decision making and the definition of responsibilities between the parties. This subdivision can then be translated into specifications for connections between building parts. This in turn creates buildings that can be modified and taken apart again (Cuperus, 1996).
It offers the basis for a well-structured building process with well-defined interfaces. It allows us, to at least partially transfer the construction process from building to manufacturing. It is the key to reducing waste by coordinating dimensions and positions in stead of improvising on site by cutting to size. Applying information instead of energy. This is an important condition to re-use building parts, thus extending the lifetime of building parts, without the waste of dumping and recycling, coinciding with degradation and the use of energy.

2.2 Levels of decision making

If the notion of having to make provisions for an unknown future is the intriguing problem of Open Building, the concept of levels gives directions towards the solutions. Three levels of decision making are defined, being tissue, support and infill. They are separated, yet co-ordinated. The town fabric (tissue level) is of a higher level than the buildings, positioned within the town fabric. Buildings can be altered or replaced, while the town fabric remains the same. The buildings in turn can be divided in base building (support level) and fit-out (infill level).
The higher level (support) accommodates and limits the lower level (infill), which in turn determines its requirements towards the higher. On every level there is an 'ultimate customer': the consumer on the infill level, the housing corporation or developer on the support level, the municipality on the tissue level (Figure 1).
The levels of decision making always refer to decisions about building parts. They connect a decision making party to an object under construction or in transformation. The different levels of decision-making should be disconnected, yet coordinated. The higher level (support) accommodates and limits the lower level (infill), which in turn determines its requirements towards the higher. On every level there is an 'ultimate customer': the consumer on the infill level, the housing corporation or developer on the support level, the municipality on the tissue level.

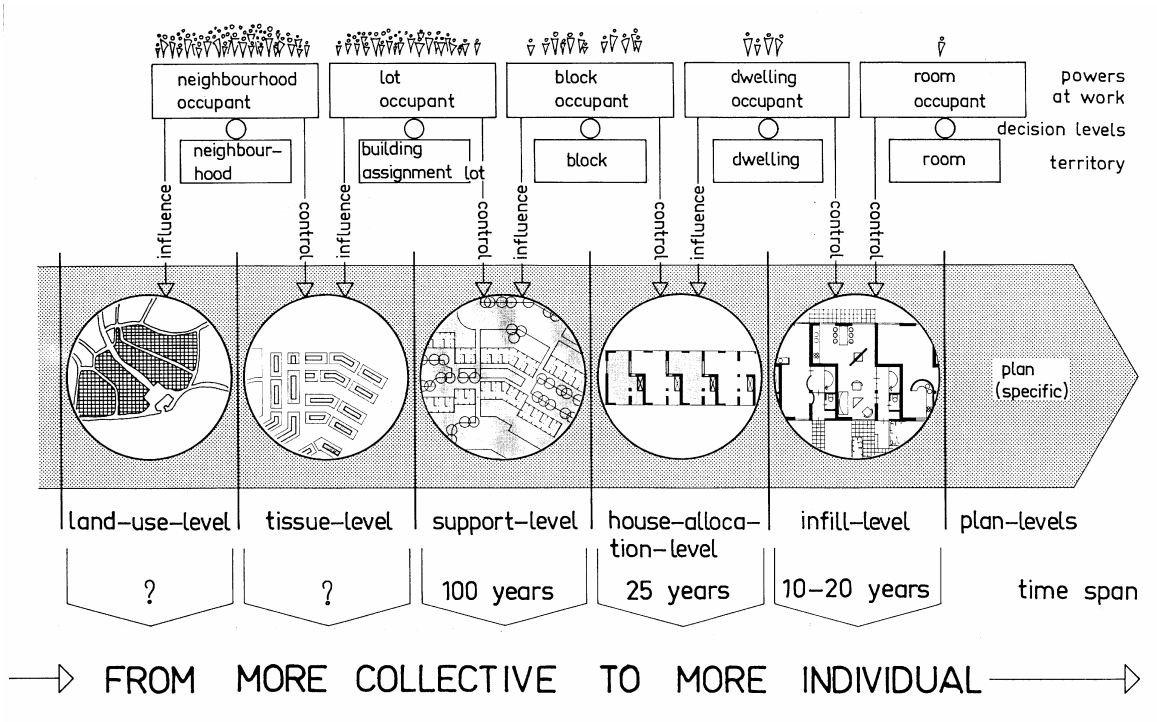

FIGURE 2: levels of decision making

In addition to the levels of decision-making, the building process is also subdivided along the lines of disciplines and different trades in the construction and building industry. This involves a different kind of coordination and belongs to the field of building management and contracting. Then there is the subdivision in technical subsystems, such as façade, roof, load bearing construction, inner partitioning, HVAC.
Another subdivision can be along the lines of financing, with a long term mortgage on the support and the infill financed with a personal loan. This opens new financing constructions such a rent-buy, with a long term lease on the support and a personally owned infill.
If building parts with a different life cycle or a different environmental impact need to be separated, new subdivisions will be introduced.
Any subdivision serves its own aim. A better understanding of these different subdivisions helps to synchronise their dividing lines, for a more efficient building process.

4. INTEGRAL DESIGN

Habraken introduced the importance op the natural relationship: ‘(…) the dwelling is first and foremost a relationship between people and environment. (…) This relationship therefore is the basis for all that has to be done in the matter of human habitation. It is the outcome of human nature, and I will call it the "natural relationship"’ (Habraken, 1961) Before the effects of the industrial revolutions took off, there was another ‘natural relationship’ between design, construction and the built environment, with the architect as the master-builder. When the effects of the industrial revolution took over, this relationship disappeared and the need to repair emerged.
Traditional building has developed into an industry with characteristics of mass production. The natural relationship between design, construction, use and maintenance of buildings has disappeared and has been replaced by a complex system of decision making, logistics, legislation, a subdivision of labour, a subdivision of a whole integrated building into subsystems and disciplines in the construction process. The disintegration of the construction industry is reflected in a disintegrated built environment. In order to restore the natural relationship, Integral Design advocates to organise the construction process along the levels of decision making and to replace the master-builder by a design team, applying the integral approach. In 2000, the Royal Institute of Netherlands Architects, BNA, the Dutch Society for Building Services TVVL and the Delft University of Technology started a research project named Integral Design. Recommendations were given with regard to the daily practice of the construction industry (commission, design and construction and management phase as well as training and education (apprenticeship, workshops, projects in practice.

4.1 Practice

The integral approach encompasses the built environment from initiative, design, construction and real estate management as a seamless whole. This seems to contradict with the subdivision of the construction industry in phases, parties with different interests, resulting in disintegration and waste. Co-ordination of these independent phases, scales, decision making and disciplines are crucial to create a built environment in which people concerned, feel comfortable. This is the core of the integral approach.
As the process goes on, it gets harder to introduce major changes. The largest steering influence is possible in the planning stage. Therefor the integral approach is based on integral design demanding mutual understanding of all parties involved. This is the basis for a clear distinction of disciplines, avoids misunderstandings, establishing liabilities and responsibilities and fees. It prevents disruption by interference and opens the road to improvement through participation.

4.2 Training

Professional pride: 'He does not need to tell me how to do my job' and cost control: 'I cannot do more than what I am contracted for' seem to contradict with the integral approach. However, the synergy of inter disciplinary consultation will be profitable for all parties concerned, as long as the their limits are clearly defined. This attitude come naturally to the one and requires adaptation for another. It concerns all individuals in all stages of the construction process as well as the organisation of the construction process.

The making of the built environment has become far too complex to be orchestrated by the master-architect. It is driven by short term economical and political considerations, resulting in a fragmented environment. In order to create conditions that assure a built environment that gets better as it ages, the position of the master-architect has to be replaced by the ingenuity of the team. The broken natural relationship needs to be restored by a building process according to the lines of decision making. Real integral design combines the quality of the team with a well considered process of decision making (Quanjel and Zeiler, 2003).

5. LEAN PRODUCTION, THINKING AND CONSTRUCTION

Lean construction is a construction management concept that originated in the late eighties of the past century. The American and European car manufacturing industry was in a deep crisis and saw their market share decreasing, while the Japanese car makers took over. Research of the IMVP (International Motor Vehicle Program) made clear that the car manufacturing in Japan had deviated from America, which had always set the example with mass production of cars. WWII had changed the word and Japan faced import as well as export restrictions. The local market was to small for mass produced cars, such as the T-Ford and the Volkswagen Beetle. The were forced to look into ways how to assemble different cars in small production runs on the same production line. Toyota was the first in successfully adapting car manufacturing American Style to the Japanese circumstances. The change-over time of the production line was considerably reduced, long term relationships with sub contractors open the way to just in time delivery and the relationship with the end users were vital in determining future car programs. This become known as TPS, the Toyota Production System, or in more general terms, ‘Lean Production’. This is very well described in ‘The Machine that Changed the World’ (Womack, Jones, Roos, 1990). These ideas caught on and there is no manufacturing industry, these days, not applying one of these ideas involved. The adoption of Lean Production was not limited to the manufacturing industry, many others, such services industries as the travel, healthcare, financial, telecom and energy industry, to mention a few, are not ‘lean’ at all. The house building industry was mentioned in the same category. Lean Production guide lines were described in more general terms as ‘Lean Thinking’ (Womack, Jones, 1996).
It can be summarised in five steps:
- Value: determine what the customer (end user) expects as the added value;

- Value Stream: deliver the wanted added value;
- Flow: Optimise the production process;
- Pull: Optimisation of the production process is directed by ‘pull’, the clients wishes, rather than ‘push’: selling products, not asked for;
- Perfection: continuous improvement.

Lean Construction is inspired by Lean Production and aims to apply lean thinking to the construction industry.
The basic principle of ‘lean’ is to reduce waste: ‘specifically any human activity which absorbs resources but create no value’. (Womack, Jones, 1996, p. 15). ‘lean construction results from the application of a new form of production management to construction. Essential features of lean construction include a clear set of objectives for the delivery process, aimed at maximising performance for the customer at the project level, concurrent design of product and process, and the application of product control throughout the life of the product from design to delivery’ (Howell 1999).

6. CONCLUSIONS

The discourse about design and research usually explores new grounds. What are the latest trends and developments? Originality is highly regarded and rewarded. The results are an expression of today’s culture in the first place. Thus the quality of the built environment is reduced to a by-product. Architectural design as a means to solve spatial problems of the built environment has become disconnected from architecture as a cultural phenomenon. Mastering the basic skills of design, knowledge of the past and making provisions for the unforeseen, instead of trying to forecast future trends can help to restore the connection. Learning to design and to plan the design process does not come naturally, it has to be learned and needs to be taught. In order to apply design as a problem solving method, its reach has to be appreciated. We can learn and teach from existing projects. Concepts such as Open Building, Integral Design and Lean Construction help us to understand interventions and transformations of the built environment.

A comparison of Open Building and Lean Construction suggests that they have much ground in common. They both originate from dissatisfaction with traditional second wave industrial production that was felt at approximately the same time. Open Building and Lean Construction can complement each other, they have their sympathy towards lean thinking in common. Open Building is concerned with the quality of the built environment and the way it is established, from initiative, via decision making, design, construction and real estate management. By applying different levels of decision making in order to de-couple parties and building parts, Open Building aims at avoiding conflicts of entanglement.
Lean Construction aims to create value by improving the flow of the process. However not the quality of the process, but the quality of the product has priority. Lean advocates

creating value by building. This is best done by creating an atmosphere of trust between parties concerned rather than making profit by hair splitting contracts, which in turn resembles the idea of integral design: mutual understanding instead of over ruling each other in a conflictuous fashion.

In the mean time these concepts are aids in teaching and subject of further research and design.

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