An Innovative Model of the Building Development Process
Design as a Process of Crystallisation

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ABSTRACT

In the past, models describing the development of artefacts, including buildings, usually were of a linear nature thereby suggesting a sequential path from conception of the artefact to its completion. This has consequences for the sequence of activities in the design and programming phase. However, designing is basically a thinking activity and is as such not bound to the same laws as e.g. the construction process. This must have repercussions for the way the design process is designed and managed. The proposed conceptual model of the artefact development process – in this case a building design process – is a kind of framework which is more in accordance with the nature of thinking-activities. It should stimulate a non-sequential process. The development of a solution to a design problem thus should become a responsive search process driven by insights and creative leaps but guided by the framework the model provides. Furthermore, the model is meant to support the exploration and clarification of the problem as well as to extend the solution space by various means such as the development of scenarios and strategic values as a basis for the realisation of the building project's goals. This model is an essential element in the development of an innovative approach towards the process design of the building design process. The creation of a building (conception, design and development) is not considered a sequential process but a process of crystallisation with the potential of developing in all directions, thus growing from a conceptual centre outwards.

1 PHILOSOPHICAL CONSIDERATIONS

The development of building design whether it is represented as a linear process with feedback loops or a cyclical process is mostly seen as basically a sequential process. Whereas feedback loops are thought to be essential for enhancing the quality of design, creative and seemingly chaotic jumps from one phase to another back and forth are assiduously avoided.

In this paper it will be shown that the development of building design especially in the early stage of the process can be best understood and supported when seeing it as a non-sequential process, a process of crystallisation with the capacity to develop in all directions, thus growing from a conceptual centre outwards.

Design methodology, if approached from a practical viewpoint becomes very much a prescriptive discipline that borrows a lot from construction and production (processes). The step-by-step approach that results from such a methodology is only of limited use, as designers do not work according to the prescribed steps (scheme, plan, blueprint), which is even admitted by the exponents of this approach. On the other hand, if approached from a fundamentally academic point of departure one is

mainly interested in understanding the design process as such and design methodology does not get beyond the stage of elucidating the course of activities performed by designers [Sarlemijn, 1995].

The process in the early stages of building design is fairly elusive because research activities seem to become intertwined with design activities and efforts to keep these two actions apart do not work. The core problem lies in the supposed separation of these two activities and the supposed sequence of them i.e. first research then design. This separation however, does not exist. Research and design are closely related phenomena and even intermingled activities. (Bax et al., 2000) argue that `Observation of design and research processes clearly shows that design processes comprise both design and research activities, and vice versa: research processes not only encompass search activities, but design activities as well. The formulation of a hypothesis and the choice and set-up of experiments are examples of design activities in research processes. Similarly, in design, analysis and modelling activities of programme and situation are typical research-like activities. What these processes have in common is the alternation of generalisation and specialisation oriented activity´. Based on Peircean pragmatistic philosophy, they furthermore state that `(…) design and research should be understood in an interrelational context to which a third term has to be added: 'Cultivation'. In an academic environment reflection, learning, education, training and formation are exponents of cultivation, a process leading to a higher level of understanding, which enables us to interconnect the elements research and design´.

Invention does not just start when reality is known. If that would be an indispensable condition, proper designing could never begin. In this paper it will be argued that in order to understand reality it is necessary to start designing and in order to be able to start designing an intention and at least some relevant knowledge of reality is needed. This is based on a constructivist viewpoint of science. It is argued that the design problem as well as the design solution is designed. Creating knowledge about reality (the problem) and knowledge about the design object (the solution) is an alternating process whereby knowledge of the one influences knowledge of the other. So, to really get to know and understand the design problem it is necessary to start designing. Consequences of this observations are that - as design projects involve ever more participants - problem finding becomes an activity of constructing a mental image of reality that is understood by all persons involved in the project. Moreover, even if the solution of a design project is a technical solution, it evolves from a problematic situation that is made up of a tangled mess of interrelated problems, the so-called wicked problems [Conklin, 1997].

Thus, firstly in this paper, we will consider the experiences that result from the traditional approach to a design project. This will reveal the complex nature of problematic situations.

Secondly, a new way of thinking about the design process will be presented that should enable and stimulate a process that is more in accordance with the nature of thinking activities. The process is based on learning theory and draws from chaos theory where emergence as well as creativity plays an important role.

Thirdly, a conceptual model of the building development process will be presented that acts as a framework for the design process. This framework should make it possible to work according to the design theory that is being developed.

In the fourth place, a first prototype of an instrument, called a Design Reactor, will be presented, that will help to make the framework operational.

2 EXPERIENCES WITH THE TRADITIONAL DESIGN APPROACH

In an earlier paper the drawbacks of phase models as well as the nature of the design process were discussed [Friedl, Trum, Rutten, 2001]. There, also a number of shortcomings of the current approach were presented that in short comprises the points subsumed under 2.1. For the investigation of the design approach a framework was developed and used that consists of the following three elements:

- The object/building design.
- The process design.
- The design of the project design organisation.

2.1 **Shortcomings of the current approach**

For the building design the main shortcomings consist of:

- A separation of the development of brief and building design. This corresponds to a separation of problem and solution.
- Briefs that are both too extensive and not specific enough.
- The lack of integrated design.

For the design process shortcomings can be summarised as follows:

- A rigidly defined problem at too early a stage in the process.
- A narrow focus on a solution at too early a stage in the process.
- A reduced complexity of the design process by reducing the number of participants, as well as dividing them along discipline boundaries.
- Focus on technological issues (isolating it out of the wicked context).

And finally for the project design organisation:

- Too little attention paid to `soft´ factors in the organisation and management of the project design organisation, especially now that ever more participants are involved.

2.2 **Conclusions concerning 'the state of the art'**

Especially in the early stage of the building development process, existing models and design approaches are too confined and do not provide sufficient support to the design team. [Macmillan, Steele, Kirby et al., 2000] who compared a number of phase

models also state that `(…) none of the models succeeded in capturing ways to help a new design team overcome the stimulating but potentially chaotic period at the start of a project. ´

Thus, the need for an alternatively modelled design process results from the perceived lack of a good fit between existing phase models and the observation of actual design processes. Phase models describe the development of a building design in retrospect, that is to say, they result from recorded processes of completed design projects. Through generalizations and idealisation it is attempted to find the 'logic' behind the design process of a specific building design. However, by attempting to find logic, most of the process properties and qualities that are not logically explainable or describable, are blanked out and are not registered nor do they appear in the design process protocols.

3 PROPOSAL OF AN INNOVATIVE DESIGN APPROACH

A new approach assumes a radical change of the settled design culture in the building industry. All three the core elements of the framework will be affected by the proposed changes.

For the development of the building design this means that an alternative product development model must be worked out that has to be agreed upon by the members of the design organisation. This new model will have immediate consequences for the design process as well as for the organisational forms and the fee structure.

For the design of the project design organisation this means that the current discipline oriented way of working will be replaced with a multidisciplinary and an interdisciplinary one. In order to reach this end it is necessary that the actors from the various disciplines become familiar with the terminology, norms, values and ways of working of the other disciplines. Moreover, also participants from outside of the project design organisation will gain influence in the process.

A second aspect is the fact that more attention must be paid to team skills of the participants. In general there must be the willingness to work in an unorthodox and unfamiliar process, which asks for a high degree of flexibility and openness on part of the participants.

3.1 **Theoretical considerations**

The new approach is based on the following theoretical considerations. It has already been mentioned that the design tasks result from a mess of interrelated problems that are characterised by a high degree of complexity.

The first hypothesis of this approach is to make use of this complexity rather than to try to reduce it. The management of the design process is traditionally characterised by mechanisms of control. They subdivide the process and make it linear to reduce complexity thereby losing the sight of the whole. This approach

results in complex situations further on in the process when adaptations and changes are difficult to make. It is argued that by accepting *complexity* and *non-linearity* at the beginning emergence and adaptation are stimulated which also are mechanisms more suited for the early stages of the design process. Non-linearity is a core issue of the first hypothesis.

The second hypothesis of the new approach is that learning is an essential factor throughout the design process, but in the traditional approach it is reduced to `single loop´ learning. It is argued that to start designing in an early stage is a way of learning about a problem and also to *adjust one's view of the problem*.

The third hypothesis stems from the observation that particularly in the chaotic early stages of a design process creative leaps occur. These creative leaps should be made use of and even stimulated. It is essential however, that ideas resulting from those leaps but belong to other stages (or phases) are not discarded but given a place and are saved for subsequent use.

3.2 **Goal of the innovative approach**

The goal that should be attained with the new approach will be defined as a set of strategic values.

Firstly, it should result in better design i.e. design that satisfies not only technical criteria but also social/public and economical ones, as well as criteria on a higher level such as scientific, professional and aesthetic, and still on a higher level cultural and ecological criteria [Bax and Trum, 2002]. As the requirements to fulfil all these criteria are so divers it is virtually impossible to reach one best design. Thus, the best design becomes the one that satisfies those criteria and demands that are perceived as the most important ones.

Secondly, as it seems to be impossible to reach one best solution, the attainment of consensus becomes more important. The various participants must reach one solution that is satisfactory for all of them. This makes the process fundamentally a social process.

In the third place learning in the form of double loop learning and adaptation to dynamic issues becomes a strategic value. Learning should not just result in understanding the problem but also in creating understanding for other participants' viewpoints.

In the fourth and the fifth place, creativity as well as fun and delight will play an important role in the innovative approach. Complex problems ask for solutions that are not commonplace but unexpected and new. Both creativity as well as the element of fun is considered essential to tackle complex problems effectively.

Time (on schedule) and costs (on budget) are two strategic values that of course, do not come in sixth and seventh place but are two basic values that always must be considered. It is argued however, that in order to realise these two values it is necessary to consider the aforementioned values closely.

3.3 **Trends**

The goal also answers trends that can be identified in society and that have repercussions on design projects [Rutten, Trum and Bax, 1998]. These trends are:

- People are becoming more emancipated and demanding, changing the traditional supply market in the building industry to a demand driven market.
- Solutions are judged by their potential to realise customer value (goals) and not just to solve technical problems.
- Best solutions are becoming consensus solutions that satisfy all stakeholders´ demands and needs.
- Public support is essential for building projects.
- Constraints and demands are dynamic i.e. they will change in the course of a project owing to the growing insight in the nature of the wicked problem.

3.4 **The components of the new approach**

The five components of the innovative approach that were considered in an earlier paper [Friedl, Trum, Rutten, 2001] are supposed to help to enable the change of culture and subsequently realise the strategic values. These components will influence the three core elements that must be considered when developing a product (in this case a building) i.e. the building design, the process design and the design of the project design organisation.

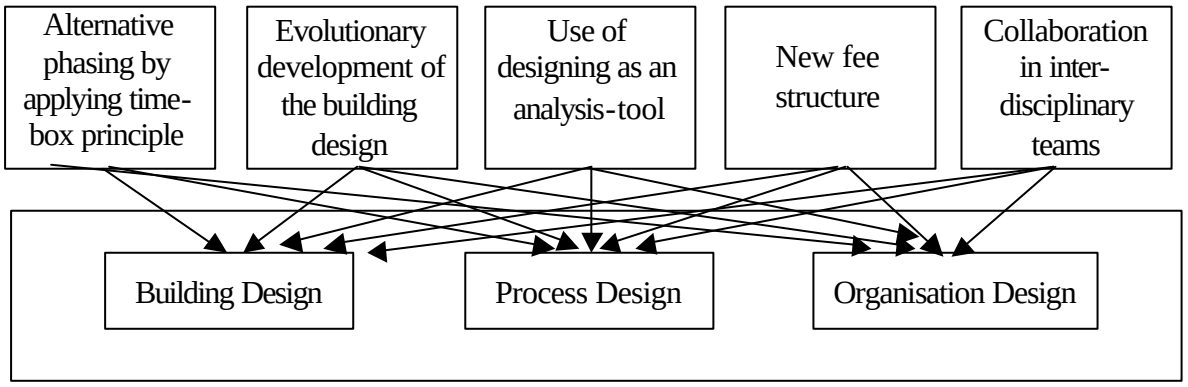

Figure 1**: Components of the innovative approach**

This paper mainly deals with the introduction of a new model of the artefact development process that is the basis for the realisation of the first two components i.e. the alternative phasing of the design as well as the evolutionary development of

the building design. This model will have repercussions on the process design as well as on the design of the project design organisation, which however lie outside the scope of this paper.

The requirements for such a model are as follows:

- It should primarily be descriptive.
- It is only prescriptive in as much as it prescribes the relevant stages and elements that must be dealt with and the relations and transformations respectively between these stages but does not prescribe any sequence of activities.
- It should follow and guide the process.
- It should be capable of capturing all relevant information during the development of the artefact design (i.e. the building).
- It should encompass the whole life cycle of the building.

4 THE INNOVATIVE MODEL OF THE BUILDING DEVELOPMENT PROCESS

The first step in the development of the innovative design approach was the development of a model of the building development process – the BDPM (Building Development Process Model). This model is represented as a circle and encompasses the whole life cycle of an artefact (in this case a building). The model draws from different existing models of the artefact development process from different domains (with special attention paid to product development models).

It is however, not rolled out to form a linear model, but represented as a circle or wheel. This circle is particularly an orientation tool that clarifies the relations between various stages of artefact development. By defining these relations and not the sequence of activities it enables the designers to work in a non-linear way and in doing so, it supports creative jumps back and forth between stages. Thereby it is expected to stimulate `growing insight´ that helps to get a better understanding of the wicked problems. Furthermore, the information and ideas resulting from jumps between stages can be stored in the adequate place of the model (the adequate segment) and thus is not lost. This information fulfils several purposes among which the quick check of an idea, concept or part of information belonging to a more abstract stage, the stimulation of other ideas belonging to another stage, and the crystallizing development of the artefact (in all directions) from a conceptual centre outwards. This is represented by arrows in figure 2 whereby the length of each arrow indicates the degree of development of this stage.

4.1 **Description of the BDPM; methodological considerations**

The circle is divided into four segments where the linking points between segments correspond to essential states in the development of the building (see figure 2). Within the segments other important elements are defined that are vital in the development of the building. New elements in this model (as compared to others) are the scenarios

and strategic values and also that it aims to represent the development of a building linking the stage of `creating experience´ i.e. buildings-in-use to the `fuzzy front end´ of the inception stage of a building project.

The four essential states mentioned above are:

- The physical building.
- Perception of events.
- Strategic values.
- Concepts.

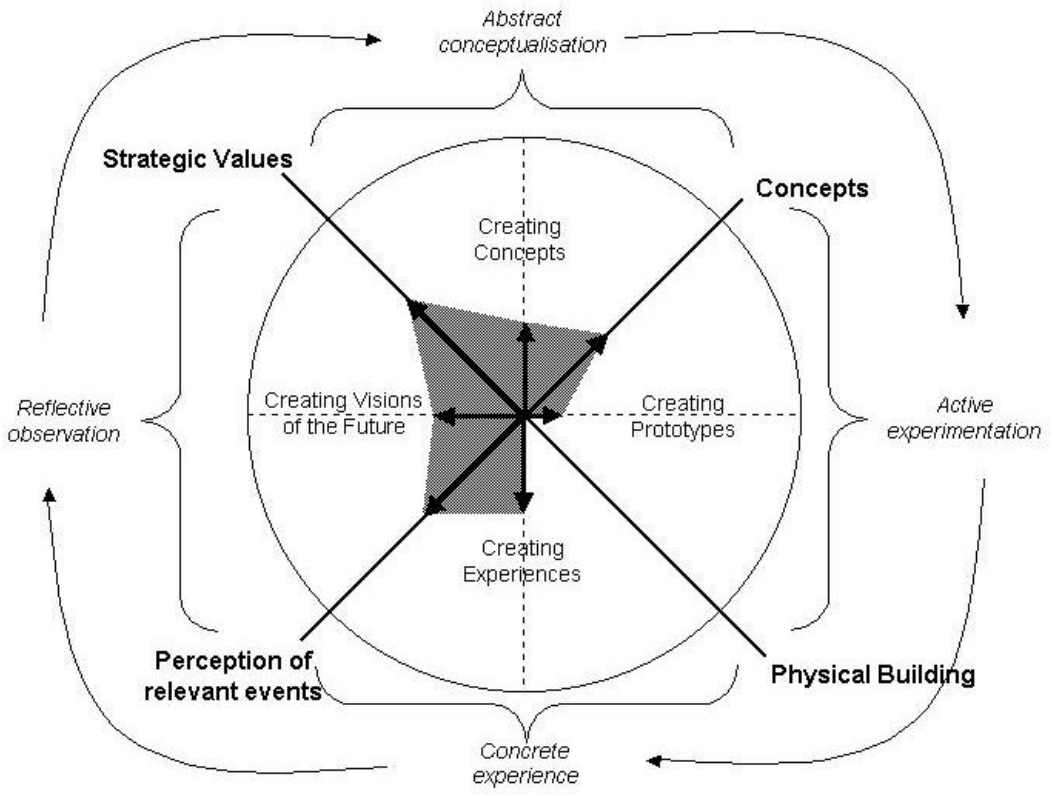

Figure 2: **The BDPM and the modes of experiential learning**

The BDPM is circular and as it should not prescribe a sequence of activities, the issue where it starts, is not so important. That is why the `physical building´ is brought forward as the first essential stage.

Anyway, it is through physical buildings and more specifically the analysis of buildings that most experience can be acquired about how a building fits its purpose. This process of gathering experience about the performance of a building in its

context but also about the factors that make up this context yields the `perception of relevant events´. The segment between `physical building´ and ´perception of relevant events´ is attributed with the term ´giving experience´. Experiences are necessary in order to become aware of the past and the present. They only can be useful to develop notions of the future, if their relevancy and relations to the overall design task is clear. These notions are requisite for intentional action i.e. attempts to influence the desired possible future development. The development of a building is one possible intentional action in order to change a present state (of mind) into an intended future one. This state (of mind) is determined by the degree of satisfaction of a set of values. To realise these values, is the purpose of a building. The `strategic values´ is the set of values that is identified as most important for a particular long-term building project. The segment in between is called `creating visions of the future´.

In order to realise the strategic values a number of transformations is necessary that subsequently must be joined into one (or several) concept(s) – an idea of how the building should work in a changing future and cause the intentioned transformations. The segment in between is characterized with the term `giving concepts´.

The concepts are worked out into detailed specifications of the building and executed to form the physical building. The BDPM segment between `concepts´ and `physical building´ is termed `creating prototypes´.

4.2 **The BDPM in relation to learning theory**

The BDPM and its four segments respectively show similarities with the process of experiential learning [Kolb, 1984]. The four adaptive learning modes can be mapped onto the four segments of the model of the building development process. Therefore, the segments of the BDPM correspond to these learning modes as shown in table 1.

It is furthermore expected that the BDPM as well as the model of experiential learning can repetitively be found in the four segments and that the models fit together to form a `nested´ pattern. Thus, the four adaptive learning modes are applied various times on different levels.

The BDPM is presently being further developed with regard to the segments, that are divided into smaller segments delivering intermediate stages and the relations between them.

Table 1: **Corresponding relations of learning model of Kolb and BDPM**

Segments of the BDPM	Adaptive learning modes of Kolb
`Creating Experience´	`Concrete Experience´
`Creating Visions of the future´	`Reflective Observation´
`Creating Concepts´	`Abstract Conceptualisation´
`Creating Prototypes´	`Active Experimentation´

4.3 **Conclusions concerning the BDPM**

An important concept is the `nested´ structure of the model. It is expected that the same model can be applied to various levels in the building development process and even that it can be found on a higher level fitting into a higher level development process such as for example environmental planning processes. How this nesting takes form however, has still to be further investigated.

5 THE DESIGN REACTOR PROTOTYPE

The conceptual model described in section 4 was used in the design of a prototype of a design tool that is supposed to enable and support the following actions:

- Provide a frame for the dynamic/chaotic design process that is characteristic for the early stage of a design project.
- Provide a space where a multi-disciplinary team can work closely together.
- Enable/stimulate creative jumps in levels and phases and simultaneously warrant that the results of these jumps all find a place in the model.
- Enhance mutual understanding of perceptions of problems and solutions.

This prototype called `Design Reactor´ is a first attempt to implement the conceptual model. Though the tool may be basically applied in all stages of the building development process it supposedly will be most helpful in the early stages i.e. for developing scenarios, determining strategic values as well as establishing functional and performance requirements, and creating concepts.

5.1 **Development of the prototype**

The BDPM was used as a hypothesis to develop the prototype. It consists of four segments and four `linking points´ as described in section 4.1.

The circular BDPM is projected onto four walls of a room - called `Design Reactor´ - attributing each segment to one wall. The four linking points are given space by chamfering the edges of the room thereby creating an octagonal room (see figure 3). The walls function as data carriers and are supposed to capture all ideas generated by a multi-disciplinary (design) team as well as stimulate a kind of cross fertilization between contributions. The team is situated in the room and works alternately on the different walls stimulated by a facilitator.

The sequence of the walls is determined by the members of the team themselves and follows a random pattern defined by the emergent necessity to deal with certain (design) tasks. It is however, following a pattern of divergence and convergence guided by the process facilitator. The process is further characterised by reflection on the achieved results. This reflection helps to choose a new focus-wall each time. The choice of a focus is helped and guided by the facilitator who will have to take action more often in an unexperienced team.

The process therefore will be quite chaotic, which is the reason why the name `reactor´ was chosen. The tool should enable this chaotic process and at the same time contain it within secure bounds.

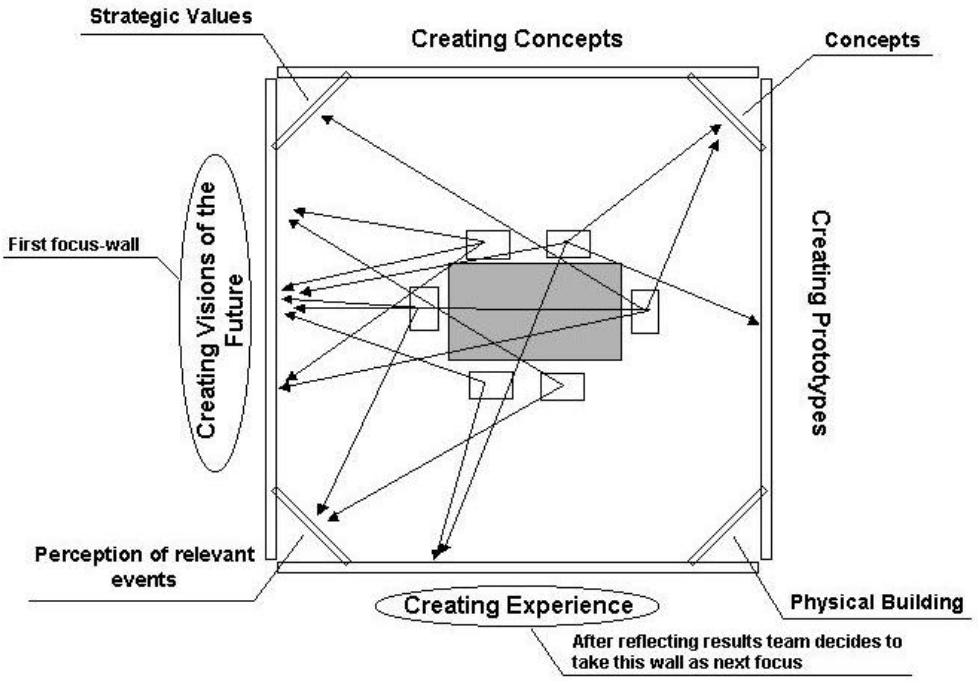

Figure 3: **The Design Reactor**

5.2 **Testing the prototype**

The goal of the test was to assess whether the prototype is capable of actually supporting a process based on self organisation and a minimum of control, enabling creative jumps and resulting in a better and deeper understanding of the problem as well as yielding more potential solutions.

5.2.1 *The test case*

As first test case served an environmental planning issue, viz. the project of restructuring the stockbreeding and dairy farming areas in the Netherlands due to a general reorganisation of that sector. This project will affect more or less 10 % of the territory of the Netherlands, particularly the sandy areas and is of very complex nature

due to the wide range of problems and people concerned. It can be said that the issues of this project represent a real textbook example of wicked problems.

Furthermore, it is a project where a lot of initial work has already been done, i.e. problems have already been mapped and goals defined as well as some concepts and partial solutions. However, it was felt that profound insight into the problems was still lacking and that the prototype of the tool should be used in a plenary session to deepen the understanding of the problem and thereby, getting better to grips with the complexity of the project. The tool was thought to be appropriate for the situation because it does not prescribe a sequence of activities and can also depart from existing concepts and work or jump `backwards´ as it were towards the problem situation.

5.2.2 *The session*

The goal of the session was to get a better understanding of and insight into the complexity of the problem situation in a short time.

The team consisted of 15 persons with different backgrounds that can roughly be categorised in three groups i.e. specialists, generalists and `wild geese´ (participants that are not affiliated with the issues at stake and can therefore offer fresh insights). A facilitator guided the session helped by an assistant who was responsible for putting the generated information on the respective walls and order and cluster it. The walls did not however, form a room, but were unfolded in such a way that all participants could see them without having to turn around. The team received a short introduction about the tool and the process that was to be followed together with the `rules of the game´ for the session. These last were similar to rules that apply for creativity techniques such as brainstorming. Information was transferred with post-it stickers and placed on the respective wall.

As far as process design is concerned a balance should be reached between the divergent and convergent thinking activities (scope – focus). The same goes for the possibility of self organisation and control (chaos – order).

5.3 **Conclusions concerning the test**

Most participants agreed that the concept of the Design Reactor with its data carrier walls is worth to be developed further. The possibilities for jumps however, were not sufficiently used. Presumably, this was to do with the unfamiliarity of the participants with this new approach. Furthermore, in the practical setting of the test situation the prototype showed certain drawbacks that can be subsumed in the following points:

- The generated information must be rendered in a different and quicker way in order to increase its usability for the participants.
- The group must not be too large to avoid blocking of contributions of participants. Group size should be between 8 and 12 persons.
- The process depended too much on the process facilitator and the guidance offered by him.
- The process must provide different modes of action; divergent activities must alternate with convergent activities.

Overall, more tests and experience are needed to further develop the prototype.

6 CONCLUSIONS

The drawbacks of the traditional approach have briefly been described resulting in the claim for an alternatively modelled design approach/process specifically for the early stages of that process. Then an innovative design approach is presented that is based on the idea that three core-elements of a building design project i.e. the building design, the process design and the design of the project design organisation must be developed in correspondence with each other and with equal attention, as they are equally important. The designs of these three elements are interdependent i.e. none can be designed solely first with the others developed as logical consequences. Changes in one element result in alterations in the other elements.

The first element to be developed and main theme of this paper is the introduction of a new model of the building development process called BDPM (Building Development Process Model). This model is represented as a circle and is particularly an orientation tool that clarifies the relations between various stages of the building development. By defining these relations and not the sequence of activities it enables the designers to work in a non-linear way and in doing so, it supports creative jumps back and forth between stages. Thereby it is expected to stimulate `growing insight´ that helps to get a better understanding of the wicked problems. Furthermore, the information and ideas resulting from jumps between stages can be stored in the adequate place of the model (the adequate segment) and thus is not lost.

Finally, a prototype of a support tool is presented that is based on the BDPM. This prototype has already undergone a first test in which it showed its potential and shall be further worked out.

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