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DESIGN TYPOLOGY AND DESIGN ORGANISATION

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1. Introduction

The idea of focusing upon the creation of a design typology was articulated by [Andreasen & Wognum 2000] and detailed by [Andreasen & Wognum 2001]. The aim was to propose a typology, which could serve as identification of design types and design research contributions.
For a long period the design research society has recognised normative procedural models of designing as being a reasonable answer to the question: How does designing proceed? The reasoning behind the models, from which the design methodology model by [Pahl & Beitz 1995], may be seen as a characteristic one, was a mix of human problem solving-, design management-, and artefact nature-reasoning. Critique has been raised to that type of models as being neither explanatory nor instructive. If we accept these models as merely being pragmatically "stepping-stone" explanations of what happens during designing, it is interesting to observe, that these models are presented as guidelines for "new to the world"-situations. They do not take into account, that in any normal design situation, the designers "have been there before", i.e. they have experiences from similar tasks, knowledge domains, procedures etc.
In order to explain our approach to the creation of a design typology, we use a metaphoric picture of the design situation: "We design on dirty blackboards". The designer has always reusable patterns, which may be used as support, if we carefully do not wipe the blackboard clean. The false assumption in the current design models is, that the blackboards are clean. By assuming this, we also lose our possibility to explain how designing is possible.
The core question concerning our typology is as follows: What is the set of views of designing, we have to establish in order to obtain a sufficient set of explanations? Or: Is there a different set of theories or models delivered from research and practice, necessary for explanation?

2. Some basic assumptions and theories

Following the terminology of [Hubka 1976], designing may be seen as a transformation system, in which an operand is being transformed into a desired state by a set of operators. The operand is primarily the artefact to be designed, based upon an intention and observation of a need and transformed into a specification of the design, which satisfies the need.
The system of operators is the "machinery" performing the design process, i.e. humans, technical means, information, goals and management systems used here. But as pointed out by [Andreasen & Wognum 2000], the basic elements of designing are, see fig. 1:

- the design strategy we formulate
- the design task we choose to solve
- the way we choose to design
- the organisation (what we are and know) we create for the task and how we use it
- the actual context and how we react upon it

which all seem to be objects, which are also designed or at least arranged (except maybe the context). This leads to the problem, that also the machinery for designing is designed.
[Hubka & Eder 1996] refer to a design situation, i.e. a set of factors that influence designing. Their factors are a mix of constraints, specifications, means and knowledge, while our set of basic elements are seen as "machineries" or operations, i.e. things which are selected, planned and executed, leading to the actual design conditions.
The physical artefact is normally not the only thing, which is designed. The artefact itself (seen as a materialised product) is operated and utilised in a service situation, and the product must be fitted to a long sequence of life situations from materialisation through sales and service to disposal. Some of the actual systems for producing, distributing or disposing the product may also be an object of designing. So the typology we are looking for is not a simple one for explaining static design situations, but a complex, dynamic and innovative typology.

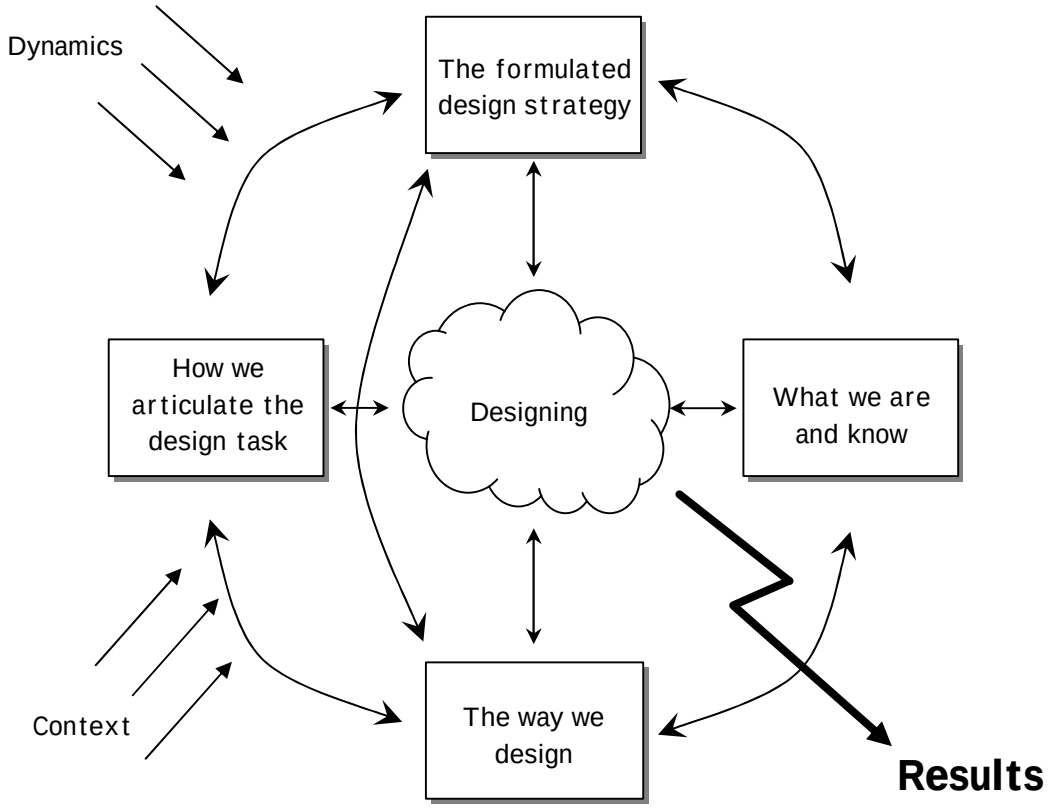

Figure 1. Basic elements of designing

3. A preliminary proposal

Based upon proposals from the literature, which more or less directly may be seen as design typology contributions, a preliminary design typology is proposed [Andreasen & Wognum 2000]. The typology consist of 4 elements:

A. *A design task typology*

By the design task we here see the purposeful, early articulation of a short- or long-range task of creating a new product and new business to the company. A design task typology is composable from the literature's proposals ([Pahl/Beitz 1995], [Frost 1994], [Ullman 1997], [Rückert 1997], [Maffin & Alderman 1994]).

B. *A design result typology*

Here the task is expanded into the necessary statements about other designed objects like the business related to the product, the product (hardware, software, delivery, service, etc.), the operation or duty of the product (value, efficiency, usability, man/machine interaction etc.), the product's service (utilisation, ownership type, the system in which it serves, etc.) and the product's life phase designs (product related specific systems like manufacturing, maintenance or recycling systems).

C. *The design chain typology*

The A and B elements of designing are not sufficient for characterising the operand of designing. There seems to be certain chain phenomena, which are found in all steps of designing and which are crucial to the result. The chain phenomena are:

- *The solution/technology chain* (the supply of solutions necessary)
- *The need/quality chain* (from interpretation of need to the need-satisfying product with proper qualities and values).
- *The navigation chain* (solution possibilities, leading to a feasible, timely route of designing).
- *The cost/economy chain* (market value/price, project economy, product costs, and overall business result).

D. *A design operation typology*

This element of the typology is in focus in this paper and therefore we will elaborate upon it in the next section.

The design operation typology may be seen as the way our knowledge, skill and design organisation operates for solving the design task. There are several different ways this may be done, therefore we can speak of typology characteristics.

What is the nature of the design chains? The chains seem to be important aspects of designing, handled by different design operations in different stages of designing and therefore critically for the integrity of the design process. The list of chains cannot be claimed to be complete. There seem to be different principles, strategies and approaches related to handling these chains, but they may belong to the design operations mentioned below. So the chains may be intrinsic design aspects, but not necessary for a design typology.

4. The design operation typology

As mentioned it is our aim to identify a set of views or projections of the total design activity, where each view is a fundamental dimension or phenomena. The literature research and our considerations [Andreasen & Wognum 2000] lead to the following proposal for views:

- **Task selection,** the way we identify and articulate tasks.
- **Design strategy operating,** the way we attack the task and use our resources.
- **Way of designing** (operative knowledge)**,** which may be divided into sub-areas:
  - *Artefact designing*, the way we utilise our experience and knowledge for designing actual artefacts (product, business, etc.).
  - *Design method utilisation*, the way we utilise models, methods and instruments for designing.
  - *Human operator designing*, the way humans, teams or organisations design, using their skill, imagination, experience, mental strategies and insight into methodics.
  - *Design procedure or plan execution*, the way we arrange a complex design project execution.
- **Insight and technology utilisation** (substantive knowledge), which may be divided into three sub-areas:
  - *Domain insight establishing and utilisation*
  - *Artefact insight establishing and utilisation*
  - *Technology development, transfer, establishing and utilisation*

- **Controlling and coordination,** the way we create appropriate and timely coordination of the activities of designing.

5. Critique and clarification

This proposal for a typology has been presented on several occasions, leading to many comments and questions. The question "why these views?" is based both on the authors' problem of articulating distinct dimensions and the basic question: "How to prove that this set of views is the most appropriate set for a productive typology?".
The complexity of designing is mirrored in the number of views and the fact that we are forced to work with (three) levels and a "development of the machinery" dimension as explained above. But how to identify each view? What are the characteristics or the action parameters in each view?
A very fundamental dimension seems forgotten in the proposal. [Eekels 2000] introduces "the realm of material reality" and points out, how designing is based upon imaginations of existing and future situations, the nature of the domain and the act of intervention. This is the area where new possibilities, need satisfaction and business are identified, and then translated into a task. [Galle 2002] identifies the dual nature of technical artefacts: There is a functional intentional view and a structural-physical view.
We must therefore add one more view, see fig.2:

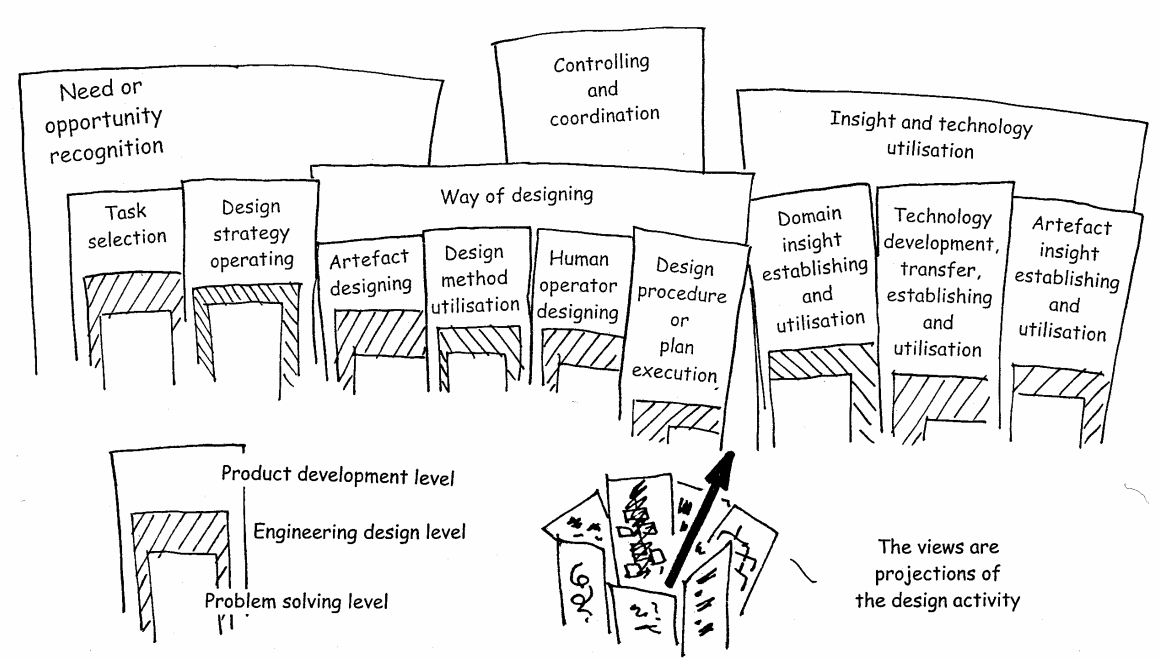

Figure 2. The design operation typology headlines

- **Need or opportunity recognition,** i.e. the way we imagine, translate and articulate an intervention with reality, i.e. establishing a new need satisfaction.

Each of these views may be seen as a machinery operating on different levels, for instance seen as three levels of synthesis (Andreasen & Hein (1987)):

- **Product Development level,** i.e. the creation of a new business
- **Engineering Design level,** i.e. the engineering design and artefact knowledge level.
- **Problem Solving level,** i.e. the human operator elementary activity level.

Each of these views may also be seen as a "design of the machinery", i.e. each of the five views is seen as a system, which is *designed* and *established* for the actual operation, and each of the systems is basically performing based upon *past experience* and *learning abilities*, i.e. they have "dirty blackboard" nature.

In conclusion we now claim, that a design operation may be understood or explained by six basic views (with a sub-division into 11 views). Each view contains basic characteristics, models, theories and instruments for designing and in all views the designer or team is part of the operators.
Each view may be seen as a design machinery sub-system, which operates on more levels and which may be designed, established and enhanced and which posses experience and learning abilities (a knowledge system).

6. Exploratory examples

Our research on design typology is arranged as an exploratory and experimental approach to establish a promising classification and then to use this typology for identifying situations and means for designing.
In this paper we will illustrate the dimensions of the design operation typology by creating some examples:

- **Quality Function Development** is basically a goal/means matrix, used as a method for linking insight into the view of *Need or opportunity recognition* to the view of *Artefact insight establishing and utilisation* i.e. a sort of product characteristic modelling. QFD is a design method, to be utilised (*Design method utilisation*) but without effect unless the human operator reasons about the evidences of the matrix (*Human operator designing*). The insight obtained is used for *Task selection and identification.* For a company introducing QFD it is important to realise its proper role and prerequisites.
- **Modularisation** is a complex approach, linking several views. It is a specific *Design strategy operation*, utilising substantial resources for establishing modular architecture, leading to an operational readiness. It contains *Artefact designing*, based upon pre-designed sub solutions (models) and rules for their configuration into products. The *Design procedure* becomes very dynamical because the execution of customer orders is now decoupled from the design activity.
  The modular architecture allows a new *Artefact insight establishment and utilisation*, because the product related knowledge might be linked to the architecture as a product model. Modularisation is based upon re-use and pre-use (preparing for future use) and the effects give benefits and rationalisation, like purchasing, production, logistics etc. Therefore modularisation needs a new type of *Human operator designing*. Seen from the time-dynamic viewpoint, introducing modularisation is a business process reengineering operation, an introduction of a new way of designing (based upon a product model) and introduction of several new problem solving-level operations.
- **Integrated Product Development [**Andreasen & Hein 1987] is also a complex approach, linking several views or demanding professional approaches in several views. The basic procedural model of IPD is a basic pattern for *Design strategy operation*, following a traditional problem-focused strategy. The model is normally transformed into a company- and project- specific procedure and plan, i.e. it relates to *Design procedure and plan execution*. Several methods like business and product specification, Design for X, costing, conceptualisation, and evaluation may be applied in the framework of IPD, and some of them are substantial carriers of integration, i.e. there is a *Design method utilisation* dimension here. The characteristics of IPD belong to the three views mentioned here. New developments of IPD take new dimensions into account, for instance product life thinking (*Domain insight establishing and utilisation*), product modelling, architectural thinking (*Artifact designing*) and computer integration (*Design method utilisation*).
  It is important to recognise, that IPD does not cover (i.e. it does not give any substantial explanation) activities related to need and task.

These examples show how the organisation of design, in the broadest sense, may be seen as a concern about the six views or dimensions of designing. Going back to the metaphor: We need an understanding of the content of the dirty blackboards in all six views for organising design properly.

7. Conclusion and outlook

The proposed design typology is at a conceptual stage and a result of a feasibility study. We judge the typology as promising and recognise preliminarily its ability to articulate important areas of design theories and insight. The typology shall be judged upon its "productivity", i.e. its ability to create comprehensive, explanatory and focused pictures of design situations, and to allow for classification of such situations.

The perspective of a design typology is to be found in practice, where a new, fundamental understanding of establishing the proper conditions for innovative design is a substantial task, - and to be found in design research, where we have a need for identifying the proper identity of research contributions i.e. linking them to design situations.

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