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CREATIVE COMPUTER AIDED ARCHITECTURAL DESIGN

Computer aided architectural design (CAAD) is considered on the basis of the newest knowledge of man's creative thinking and intuitive design. A creative architectural design method of universal application is outlined. The method is verified on account of both the empirical observations from practical architectural design as well as the presentations of architects in the literature. The policies of different CAAD programs are discussed. Lines for the development of a new creative CAAD program are also discussed.

1 Introduction

Present design science is strongly concentrating on the development of different systematic theories and methods for the utilization in practical design (see for example Hubka & Eder 1992). The trend can be perceived clearly for example in the field of mechanical engineering. In Finland different development stages can be noticed in the architectural design (Lehti & Ristola 1993). Nowadays a creative design phase is considered to be dominated having also the predecessor of a rational systematic based design phase. Each of the prevailing development phases are thought to had its own special features.

The development of architectural design computer programs and the growth of their usement have caused new needs to understand the theoretical base of creative architectural design. On the other hand, many partly conflicting views have been heard from the practical architectural design directing our attention to the applicability of CAAD programs to the essential creative design. The design with CAAD programs differs so much from the conventional manual method affecting also many difficulties for the architects. This paper examines this applicability problem from the creativity theory point of view. The examination is strongly based on the theoretical development in the domain of mechanical engineering, where we thought some new meritorious results to be achieved. These theories are compared with the perceptions from architectural design and some applications and completing theories are also developed.

2 Creativity and intuitive design

Creativity is ability to produce new ideas and solutions (Lehti & Ristola 1993, Tuomaala 1995, Drabkin 1996). To research and develop our creativity we should first recognize the existence and the mode of action of our four basic human functions: conscious mind, subconsciousness, motorics and senses (Fig. 1). These parts of human being are in operation with each other making it possible to our activities, thinking and doing in different tasks of life. Science knows the least about our mysterious subconsciousness. We can not consciously leaf through our subconscious mind neither the detailed investigation of its operation is very difficult.

A man controls consciously his action only to some extent. We use our five main senses (sight, hearing, tactile, smell and taste) to perceive events around us and in ourselves. Clearly we have also many other inner senses, for an example, sense of balance. Perception processing takes place both in the conscious mind and in the subconsciousness. The motoric comprising our hands (fingers, feel, tongue, etc.) is controlled either consciously or subconsciously.

Also simultaneous controlling is possible. Thanks to the control we are able to utilize our motoric parts for example to speaking, reading, writing and walking.

The capacity of the conscious mind is very limited. The fact compels us to use many different functions for conscious problem solving. The subconscious mind is the second part of our consciousness. In practice it has an unlimited memory and its action is faster and more accurate than conscious action. The theory of subconscious problem solving is presented by Tuomaala (1995, Figs. 2 and 3).

The information in the levels of conscious and subconsciousness is presented in the form of short elements. The elements may be connected to each other and form nets. When striving to solve a problem it is necessary to create a tension according to which the information elements tend to orientate themselves to form of a net and thus from an insighted solution.

Let us consider the model of the operation of two-level consciousness (Fig. 2). On the conscious level the information forms both connected and broken chains. The conscious objective appears as a tension between the sides of the plane. The missing connections are built by logical cause and effect relationships. The conscious rates are, however, based on the subconscious information. The necessity tension is also reflected towards the subconscious mind. In the subconscious mind relations gradually become activated and send signals to the loose chains of the conscious mind. By the aid of these signals a sensitive researcher has a presentiment of what to study and in which parts more information should be added to both the levels. (Tuomaala 1995).

In the Fig. 3 subconscious centres of knowledge are presented. When acquiring information about something we have to get an insight into it. The information penetrates laboriously through the surface boundary to the subconscious mind where it becomes attached to the existing information. The penetration is very difficult, if there is no practical motoric action, good example in familiar context or something like that (see the shaking circuit in Fig. 1). When the information increases

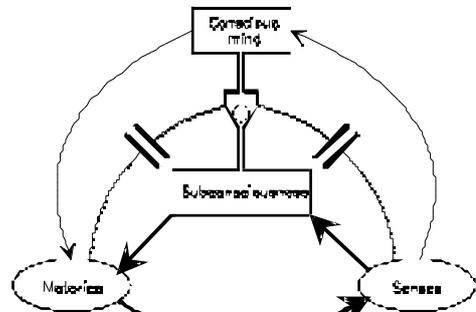


Fig. 1. A model for human information communications.

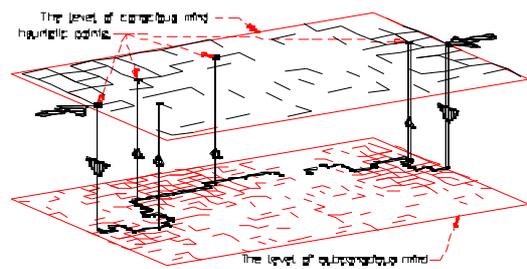


Fig. 2. The levels of conscious mind and subconsciousness and the formation of a presentiment (Tuomaala 1995).

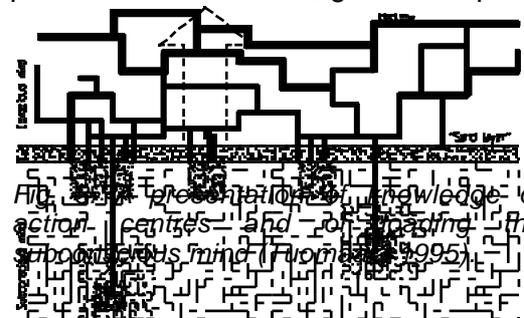


Fig. 3. A presentation of knowledge or action centres and of shaking the subconscious mind (Tuomaala 1995).

also the connections increase and gradually a new centre of knowledge, skills or actions, is formed, let it be a programming language or riding a bicycle etc. A completed and finished action centre can be used with very simple control commands and only one channel is needed for the connection. At that time the action centre starts also to slowly descend deeper down to the subconscious mind. For example, the action centers for speaking has sunk to a level where the connection to the conscious control channels is very weak. Driving a car is a different kind of action. It can be controlled in many ways eventhough it also functions perfectly as a subconscious action.

The learning of information down to the subconscious mind, subconscious processes, the sensitive listening to the ideas produced by the consciousness and the penetrative logical analysis are the fundamental methods of creative design. The learning down to the subconscious mind presupposes obviously motoric action and observing by senses. These functions "shake up" the funnel of the model (Fig. 1) making it possible the information descend down to the centres of the subconsciousness.

Although we don't exactly know the subconscious processes, we can guide and control them by the tension created by our conscious mind (Fig. 4). The tension (presented as the arrow in Fig. 4) is a consciously and subconsciously sensed will to achieve an objective or to go a certain direction. It is very important to allow enough time for the subconscious processes. In practical design this can be done even by painful copying drawing of details. This, in itself an absurd and valueless work, however, gives the subconsciousness permission to work. (Tuomaala 1995, Pallasmaa 1993, Lehti & Ristola 1993, Louhisalmi 1995).

The listening of subconscious messages demands sensitivity and humility and also the cutting down of conscious pressure. Powerful conscious logical thinking increases the pressure in the conscious mind causing that the subconscious messages can not travel through the funnel up to the conscious mind. During design work the subconscious messages form new heuristic working points, in which new information is loaded down to the subconsciousness and from which the entirety is slowly solved and constructed by the subconscious processes. (Tuomaala 1995, Lehti & Ristola 1993).

The target tension tries all the time to achieve a final solution. We must, however, hold back the tension and, if necessary, the solution formed must be able to decompose by the aid of powerful logical analysis, called penetrative analysis or decomposing (Fig. 5). In this design phase we determine the main functions of the solution. They can be materials, manufacturing methods, strengths, colours, costs, etc. A penetrative analysis is a critical process where the reasonableness of the structure is judged. This work is systematic, but a creative designer can leave the results floating and is able to catch them by varying ways. (Tuomaala 1995).

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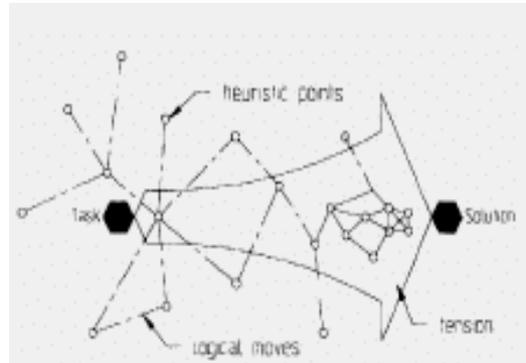


Fig. 4. The fundamental idea of intuitive problem solving). The logical transfers describe the subconscious information transferring between heuristic points (Tuomaala 1995).

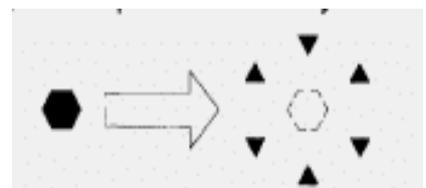


Fig. 5. Decomposing a structure (Tuomaala 1995).

3 Creative computer aided architectural design

A general creative design method is developed by Tuomaala (1995). Because of its applicability we use this model directly to describe also the course of architectural design. In the Fig. 6 the whole process of intuitive creative architectural design work is presented as a scheme. The net of heuristic points is not drawn any more but it is nevertheless it has a connected with it. In the figure there are also the surrounding decomposed ideas to be presented. They can also be other constructions whose applications are somewhat connected with the field of work. The results of penetrative analysis form heuristic points or join them. The net of heuristic points becomes deeper and making it denser and more mature is more efficient. (Tuomaala 1995).

The first phase ends in a solution. A better result is achieved if a penetrative analysis is made on the first solution. Once again we must return to the basic elements and examine different possibilities dispassionately. Now the pieces form a basis for the heuristic points net which is completed with additional ideas and information. The final result will be better and more mature than the previous one. (Tuomaala 1995).

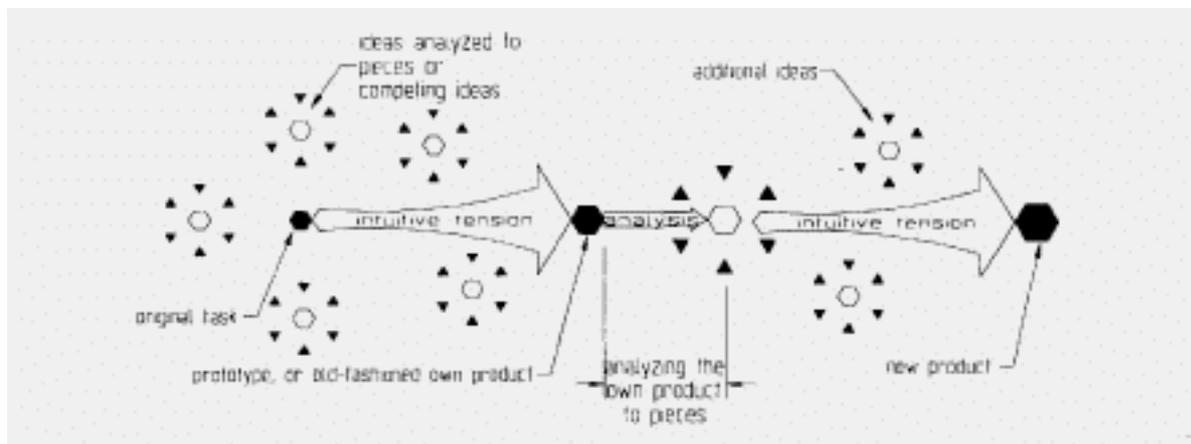


Fig. 6. A scheme of creative architectural design (developed first for mechanical engineering design by Tuomaala 1995, see also Louhisalmi 1995).

Let us consider more practically the intuitive method in architectural design. First we can separate different design levels in the architectural design. Comprehensive plans and different local plans belong to the level of urban planning. We can further differ several more detailed design levels. For example, in the design of an individual house we can differ the design levels of site functions, the main shape of building, rooms and their traffic, the details of a room, etc. Different rooms are planned to satisfy the needs of customers. When single-family house design is considered, the essential starting-point for the design is the needs of the family and the building-site available. An architect develops a tension for himself and starts to work in some heuristic points, which he can detect thanks to his experience. Typically the design process is continued by the design phases of site traffic, locations and main forms of buildings, rooms and, if wanted, even more detailed parts and details. Essential points in the design are the functions needed for the inhabitants in question. (Routio 1994, Lehti & Ristola 1993).

When considering the applicability of CAD programs to the creative design work, the following observations from the field of mechanical engineering can be presented. CAD is seen to be suitable for creative design because of its visibility illustrated feature, the facility to construct details or objects and the limitation of monitor screen. With advanced drawing editors different vector based geometric elements can be produced. We can also adjoin attribute information into the objects. In architectural

design a wide selection of different CAAD programs are available. The working with CAAD programs is mainly based on the use of demanded number of two-dimensional levels. Three types of different CAAD programs can be detected. Vector graphic oriented programs are based on the handling of vectors, i.e., lines, curves and circles. Object oriented programs process data more from the side of final elements. The most systematized type is the level of knowledge-based or data-based product model programs. In this type information is gathered during the working into the memory of computer to form of some logical system. (Mattos & Dessloch & Leick 1991, Kiviniemi & Penttilä 1995).

4 Observations from practical design

We think that the thorough scientific test and verification of the creative design theory is a very difficult and laborious task. We were not able to do this work. However, in the experimental part we interviewed five experienced Finnish architects. In these tests the base of the creativity theory was proposed for discussion with them. It was remarkable that all of the architects accepted and verified the presented features of the theory. In addition very similar part descriptions of the creative design were published by architects Lehti and Ristola (1993) as well as architect Pallasmaa (1993).

According to architect Petäjä (Lehti & Ristola 1993) the creative design is based more on art than science. Senses or feelings have a great effect on the design. The capability in creativity is based on the designer's own events of life as well as his genetic inheritance. Petäjä also establishes that architectural design is not only physical facts based design but it includes also the demands of emotions and views. Architect Laine (Lehti & Ristola 1993) express her opinion that in the architectural design an idea develops while a set of symbolics gather together in the unconscious. The role of the unconscious in problem solving is emphasized by her. Uncertainty and incoherence in design are signs of fertile working of the consciousness levels. The ingenuity of creative design is hidden into the great efficiency of unconscious or subconscious processes.

Several regulations and limits border the work of an architect. Hence, architectural can not be regarded as a type of art. The part of intuitive subconsciousness controlled work is great. Logical analysis of the part-solutions takes proportionately less time. Typically the design work takes generally plenty of time having also not effective work phases. An observation from the practical design was the use of two-dimensional drawing fairly purely in the design. Most of the architects saw three-dimensional perspective drawings only as a business or illustration way for customers.

All of the architects have also used CAAD programs in their design. The accuracy demand of the use of different CAAD programs were seen as a notable problem in architectural design. Excessive accuracy in the early phase of the work was seen to move the design into wrong details. Instead of that the CAAD programs were seen as good tools in the later phases of the work. The furnishing test was one of the most important logical analysis or test in the architects work. No special other test phases were observed.

5 Conclusion

The theory of creative design developed specially by Tuomaala (1996) suits very well to represent architectural design work. The core of the creative architectural design is the working in heuristics points, i.e., the main functions included in the result of architectural design. The creative design of final solution is situated in the subconsciousness of an architect. It is a fact that this subconscious work can not be performed in the computer tool or CAAD program used. Furthermore, the whole solution is not allowed to draw too early during the creative design work. This observation can set the credibility of knowledge-based approach to the development of design programs very questionable.

Sketching is one of the special and noticeable features we can observe in architectural design work. Its function is in all propability in the listening of subconscious messages. As a well learned ability it is controlled directly by the subconscious mind making it a very effective communication way with the subconscious mind. The most essential point of the sketching is, however and how we understand that, its concentration function to listen architect's

subconsciousness. As it was observed in the field of mechanical engineering design, it is also possible to concentrate to listen the subconsciousness without sketching by an other way (Tuomaala 1995). We should also recognize that it is very probable that the sketching by computer can never be as efficient as by manual direct pen-method. Hence, there are two alternatives for the concentration. First, an alternative method for concentration should be learned into a part of creative computer aided architectural design. Second, the concentration must be performed without any computer based tools.

The conclusion of this study can not be considered as final scientific results. Our essential objective was, first of all, raise a wide discussion about the fundamentals of the creativity theory presented. We ourselves give the theory the credit for its graphical way of presenting which, in our opinion, makes the difficult theoretical details of the creativity easy to understand and, furthermore, easier to exploit in the development of architectural design.

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