THE ROLE OF CAD IN CREATIVE ARCHITECTURAL SKETCHING

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1 Introduction

The history of computers in architectural design is very short; only a few decades; when compared to the development of methods in practical design (Gero 1983). However, the development of the user interfaces has been very fast. According to the practical observations of over one hundred architects, user interfaces are at present inflexible in sketching, although computers can make drafts and the creation of alternatives quicker and more effective in the final stages of designing (Haapasalo 1997). Based on our research in the field of practical design we would wish to stimulate a wider debate about the theory of design. More profound perusal compels us to examine human modes, pre-eminently different levels of thinking and manners of inference. What is the meaning of subconscious and conscious thinking in design? What is the role of intuition in practical design? Do the computer aided design programs apply to creative architectural sketching? To answer such questions, distinct, profound and broad understanding from different disciplines is required. Even then, in spite of such specialist knowledge we cannot hope to unambiguously and definitively answer such questions.

2 Observations from architectural sketching

The empirical material of creative architectural design is collected from nearly 40 Finnish architects (Haapasalo 1997). In the following, there are a few general points outlined from the existing literature. Architect Petäjä (Lehti & Ristola 1990) writes that the creative design is based more on art than systematics (science). Senses or feelings have a great effect on design. The capability to create is based on the designer's own life experience as well as his genetic inheritance. Petäjä (1977) establishes that architectural design is not only physical facts based in design but it also includes the demands of emotions and viewpoints. Architect Laine (Lehti & Ristola 1990) argues that an idea develops in architectural design while a set of

symbolics gather together unconsciously. She also emphasises the role of unconsciousness in solving problems. Uncertainty and incoherence in design are signs of fertile unconscious working. The ingenuity of creative design is hidden into the great efficiency of unconscious or subconscious processes. (Lehti & Ristola 1990).

A very usual phenomenon among architects is that the fundamental solution to a problem comes from the subconscious, from the unconscious dimension of thinking. Therefore it is essential to allow enough time to the subconscious in processing the problem. In other words, design requires time to incubate. Thus, solutions can be found seemingly by themselves after incubation. It is a usual experience for architects that the problem cannot be solved at once. It requires thinking, sketching, and more thinking. The solution will then appear suddenly with a ‘bang’. A usual experience for architects is that an unsolved problem is automatically solved after a night’s sleep and the idea is clear, obvious and adaptable. (Haapasalo 1997).

Imagination is an important tool for design, because spatial thinking creates opportunity to see the prospective of the body of building. Imagination is also the designer’s ability to imagine the completed edifice whilst it is still at the design stage. The final solution contains many different elements which are included in designing. For example, images of the exterior are in the back of the designer’s head all the time, even when not actively processed while working with the plan view. Images develop during the designing and are also reorganised and transformed many times in designers mind. (Haapasalo 1997).

Drawing is also a decisive tool for designing, because "in practice the architect has to be a good drawer". "Skilful ability to draw is a straight extension of imagination - direct contact to paper is quick as lightning". "Drawing is sometimes also done quite arbitrarily and apparently aimlessly resulting in a mess, but after several overlapping figures the solution or idea is taking shape". "Drawing is like unpacking the subconscious work to a visual shape". (Haapasalo 1997). Architect Scarpa says that he draws because he wants to see (Ferrare 1996). Van Dijik (1995) also points out the fact that physical act of hand-sketching helps the designer in generating new ideas. According to architect Ferrare (1996) creative architectural design is based on magical interaction between eyes, brains, hands, pencil and paper. The architect works at early design stages primarily by pencil and paper and rough card working models. After investigating preliminary ideas by sketches and physical models, a skeletal computer model can be constructed, which can contain varying degrees of details. Ferrare (1996) also believes that physical models, as well as manual drawings play an essential role in creative design.

Architect Alvar Aalto (1948) indicates that design is not a straightforward process. During the design an enormous amount of different demands and problems form an obstacle, which makes it difficult to bear out the fundamental architectural idea. The final solution is achieved by forgetting the problem temporarily, while the work continues in his subconscious. The design can be seen as abstract art, and this

illogical working is controlled by instincts. Aalto describes the intuitive work of architects in his well known article "Taimen ja tunturipuro" (Salmon and Mountain Brook). The article is a description of a salmon's birth in the mountain brook and its migration to the sea. Aalto believed that architecture and its limbs somehow pertain to biology. The fundamental ideas of the solution are not born as a fully grown salmon, not even in the same sea or in the same water where they normally live in. The small salmons are born hundreds of miles away form their living space, where rivers are narrowed down to a brook between mountains. As far from normal life as the individuals feelings and instincts are from the daily life. The growth to full-grown salmon from the corpuscle of roe demands a lot of time, so does the development of our intuitive ideas. (Aalto 1948).

Descartes aphorism "I think therefore I am" describes logic and rationality. According to Damansio (1994) rationality is based on neurological feelings in social situations: "I feel therefore I think". Feelings are interpretations for changing, experiencing and identifying emotions. Mario Bottas architecture comes form thinking and feeling. Differences between these is only theoretical and in creative work both are needed (Broner 1982). Thinking is composed of logical and rational substances, which are learnt by architects during their career. Feeling in the architecture is influenced by irrational, poetic and subjective autobiographical elements. (Haapasalo 1997).

Creativity is an essential part of architectural design. But even if creative work is a sensitive entity, we have to see designing as a completeness, which contains technical and artistic elements. Designer have to solve technical and practical problems and express him- or herself artistically. That is why logic is also needed in architectural design. Functioning, features and weaknesses of the plans can be ensured and tested by systematics. Logic is also a part of human thinking. It is a tool for thinking and organising things. Designer have to have the courage to be logical, but the fact that logic leads only to a partial truth has to be understood. (Haapasalo 1997). Aalto (1948) also bolsters the idea that the definitive solution takes shape and requires hard logical working, but it also demands forgetting the problem temporarily, neither illogic nor abstract ingredients can be forgot.

Creativity is the ability to produce new ideas and solutions (Lehti & Ristola 1990, Tuomaala 1995). It is a normal activity of the brain and indeed the whole human body. It is also a primary quality of every person. (Bergström 1984). Using intuitive methods man can solve problems, which cannot be even determined logically (Richards 1974). To research and develop ability to be creative we should first recognise the existence and the mode of action of our four basic human functions: conscious mind, subconscious, motorics and senses. These human parts are in operation with each other making our activities, thinking and doing in different tasks of life possible. Understanding the human ability to be creative and the progression of sketching has to be done particularly carefully, in order to generate novel computer aided designing programs. These elements create the possibility and basis

upon which to develop user interface, which is useful and suits sketching too. Science knows little about our mysterious subconscious. We cannot consciously leaf through our subconscious mind and neither is the detailed investigation of its operation easy. Different practical observation can be made, which are at some point fictional and detailed authentication is very difficult. In our research, however, the empirical observations are so congruent, that they can be considered reliable (partly presented above) (Tuomaala 1995, Haapasalo 1997). All architects have their on artistic nuances and methods of working and all design processes are unique, but there can be seen several clear similarities. Support for the theory has also come from various disciplines, for example mechanical engineering designers and industrial designers.

3 Evaluating CAD as a creative tool

The history of computers in designing is very short when comparing to the evolution of traditional designing (Gero 1983). It is therefore obvious that the CAD programs cannot be at the same level as drawing or sketching by pencil and paper. But the development of information technology suggests present and novel CAD programs are probably going to change the way of designing, at least partly. In Haapasalos's (1997) examination, according to Finnish architects, information technology has already partly changed designing and architecture (38%), partly hasn't changed (58%) and (5%) it hasn't yet, but it will change in the future. Some of the architects think that CAD partially improves and partially deteriorates designing. Some think that CAD doesn't affect the architecture where the CAD is used as a auxiliary means in designing. (Haapasalo 1997). Be that as it may, architecture is consequently going to evolve. In some contexts the influence of CAD in designing or architecture has been compared to the invention of a ruler. Architecture would most definitely be different from present, if the ruler hadn't been discovered.

In Finland the majority of architects consider the state of CAD and information technology good, although there will be a great amount of developmental work in the future. At present CAD is generally used in those design projects where clear benefits can be achieved. In several Finnish architectural offices the operation with CAD is incomplete: "The bike has been bought, but the chain isn't functioning". 66% of the Finnish architectural offices have purchased the CAD user interface, but approximately only one third of the work in done with computers, or approximately only one third of the architects are using computers in their work. Although the fact that only one third of the architects uses CAD in their work, 80% of them consider it as a necessary tool in the future. (Haapasalo 1997).

Typical CAD hardware consists of a central processing unit, screen, keyboard and mouse. From a design point of view the most important parts are the pointing devices and screen. As we noted in a previous chapter the interaction between brains, eyes, hands and the emerging line is essential for the best possible design results. In present CAD programs this connection is not somehow reacting as it should, at least not for

all users. There are, however, some designers who can use CAD as lightly as moving a hand.

Typical CAD user interface can be used in different ways in architectural design. Kiviniemi and Penttilä (1995) have also considered that the major differences between computer aided and traditional design are the formability of drawings and the lack of unambiguous scale. Mouse, keyboard and screen creates also a different working state than pencil and paper. This can be one of the greatest difficulty in the beginning, because there is no direct physical connection in between hands, eyes and brains (Ekelund *et al.* 1992). In CAD the lines don't emerge where they are drawn, and the important items cannot be emphasised by for example pressing the pencil stronger than normally (Haapasalo 1997). These are, however, according to Penz (1992) only questions of learning.

Especially in the initial learning stages CAD requires a lot of the designer's attention and thereby decreases concentration on the actual design which may lead to a deterioration in quality of the end result (Haapasalo 1997). It is therefore essential, that the learning is done thoroughly. On the other hand the actual design and thinking is given more time, when mechanical routine work is done faster with computer. (Clark 1988, Stevens 1991). Nevertheless it has to be noticed, that "it isn't enough that designer learns to use CAD properly. She or he have to also learn to create with them, which requires also a new way of thinking and reacting towards CAD". (Haapasalo 1997). In traditional sketching, work is done on one sheet at a time, but in CAD it is typical to control the model through views in several windows (e. g. exteriors, plan views, perspectives and sections). The results of design are usually several drawings or one CAD model of the building. Computer aided drafting and design is always done in real scale and the final scale doesn't play any role in design, so even wide drawings can be treated as a totality (Penz 1992). For designers who are used to drawing in a certain scale, lack of scale can cause problems in the beginning, but for those who incorporate design with real units, operation will be much easier (Kiviniemi & Penttilä 1995).

The results of theoretical and practical examinations indicate that current computer applications are well suited to the implementation stage of the architectural design process, but their applicability to sketching is problematic. CAD can make drafting and the creation of alternatives quicker and more effective in the final stages of designing. It also a subsidiary tool for some of the users in preliminary stages of designing. (Haapasalo 1997). In spite of the fact that CAD intensifies architectural design, the ultimate work of architectural design is not dependent on whether it is done with CAD or not. The design itself is a visionary goal, which has to be processed in the designer's mind. Common sense and the architects professional way of thinking are needed in the use of CAD, because the nature of design is changing slowly when comparing it to the built environment (Penttilä 1989).

4 Conclusion

Present user interfaces can make drafting and the creation of alternatives quicker and more effective in the final stages of designing. Nevertheless, only one third of the architects (in Finland) use computers actively in designing. However, over 80% of them consider information technology necessary. The utilisation rate of computer applications is low; 66% of the architectural offices (in Finland) have acquired a user interface, but only one third of the designing is done with computers. User interfaces are at present inflexible in sketching. Drafting and sketching are the basic methods of creative work for architects. When working with the mouse, keyboard and screen the natural communications channel is impaired, since there is only a weak connection between the hand and the line being drawn on the screen. There is no direct correspondence between hand movements and the lines that appear on the screen, and the important items can not be emphasised by for example pressing the pencil stronger than normally. In traditional sketching, the pen is a natural extension of the hand, as sketching can sometimes be controlled entirely by the unconscious. Conscious efforts in using the computer shifts the attention away from the actual design process. However, some of the architects have reached a sufficiently high level of skill in the use of computer applications in order to be able to use them effectively in designing without any harmful effect to the creative process.

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References

Aalto, A. 1948. Taimen ja tunturipuro. Arkkitehti, 1/1948, s. 7 - 10.

Bergström, M. 1984. Luovuus ja aivotoiminta. In: Haavikko, R. & Ruth, J.-E. (editor) Luovuuden ulottuvuudet. Espoo, Weilin + Göös. s. 159 - 172.

Broner, K. 1982. Arkkitehtuuri on muodon antamista historialle: Mario Bottan haastattelu. Arkkitehti, 4 - 5/1982. s. 18 - 29.

Clark, P. 1988. Design Modelling: Advances in CAD. Architecture Australia, Vol. 77, No. 4. p. 80 - 87.

Damansio, R. A. 1994. Descartes Error. Reason and the Human Brain. Grosset. 213 p.

Ekelund, W. & Kiviniemi, A. & Kotro, P. & Penttilä, H. 1992. Arkkitehdin tiedonhallinnan oppikirja. Oulu, Oulun yliopisto Arkkitehtuurin osasto. 165 s.

Ferrare, S. 1996. Back to the Drawing Board. Lund, 14th ECAADE, 12 - 14 September 1996. Lund Institute of Technology, Lund University. p. 155 - 161.

Gero, S. J. 1983. Computer-Aided Architectural Design - Past, Present and Future. Architectural Science Review, Vol 26, no. 1. p. 2 - 5.

Haapasalo, H. 1997. Creative Computer Aided Architectural Design. Lisentiate thesis. University of Oulu, Construction economics laboratory. Oulu. 88 p. (In finnish).

Kiviniemi, A. & Penttilä, H. 1995. Rakennus-CAD. Helsinki, Rakennustietosäätiö. 148 s.

Lehti, E. & Ristola, K. 1990. Suunnittelu luovaa työtä. Helsinki, Rakennuskirja Oy. 127 s.

Penttilä, H. 1989. Tietokonapuisen arkkitehtisuunnittelun perusteet. Otaniemi, Teknillinen korkeakoulu arkkitehtiosasto, rakennusuunnittelun laitos, Julkaisu B29/89. 71 s.

Penz, F. 1992. Computers and Architecture; Tools for Design. London, United Kingdom, Longman Group. 152 p.

Petäjä, K. 1977. Arkkitehtuuri - suunnittelu - luovuus. Arkkitehti, 3/77. s. 48.

Richards, T. 1974. Problem-solving through Creative Analysis. Epping, Essex, Great Britain, Cower Press Ltd. 198 p.

Stevens, G. 1991. The Impacts of Computing on Architecture. Building and Environment, Vol. 26, No. 1. p. 3 - 11.

Tuomaala, J. 1995. Luova koneensuunnittelu. Jyväskylä, Tammertekniikka ky. 287 s.

Van Dijk, C. G. C. 1995. New Insights in Computer-aided Conceptual Design. Design Studies, Vol. 16, No. 1. p. 62 - 80.