COMPUTER IN CREATION OF ARCHITECTURAL FORM

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ABSTRACT
This paper considers graphic methods of presentation of ideas and evolution of these methods, determined by the implementations of information technology. Drawings have been the main medium of expression since Leonardo da Vinci to the present-day. Graphic communication has always been treated as a main design tool, both at the ending stage of design and at the early design stage. Implementation of computers in design does not change this situation. The entire design process proceeds in a traditional way. While searching for the idea we use hand sketches and, after this, technical drawings are drafted on a plotter, which replaces a drawing pen. Using computers at the early design stages encounters serious difficulties. The main thesis of this paper is that hardware and software inadequacy is not the problem, the problem is in the inadequacy of the design methods. This problem is to be reconceived as what a person can do with a program, rather than what is the capacity of a program. Contemporary computer techniques allow us to put an equation mark between the searching for idea, visualisation and its realisation in virtual space. This paper presents “Sketching by scanning” - an experimental method of using computer hardware and software for stimulating of searching of architectural’s form.
Finally, computers go wrong.

What do we mean by “go wrong”.

One characterisation is that they behave in ways we did not anticipate.

R. Glanville, 1997

Creation

The basic conditions of creation are intuition, that is the ability to foresee without trying to understand, and imagination, that is the ability to create certain images in our mind. Therefore, the core of creation is based on creating an idea in our thoughts, which had never before been brought to life by anybody, as well as images, which are not associated with any past experiences. (Maslow A.M., 1962) Creation understood as production of form is described by S. Lem as a scheme which consists of:

1) a generator of excessfull diversity, 2) criterional filters sifting that diversity, 3) a program of the given transformation modifying the selected elements, according to the instruction included in this program (Lem S., 1988)

Those elements - generator, filters and program might be generally independent one from another. The generator may produce diversity in the strictly accidental way or according to its knowledge. The filters may sift “diversity” with regard to freely assumpted criterious. The transformational matrix may perform a defined by itself transformation over the sifted elements. However, that scheme works in a different way in the architectural creation. There is a changeable feedback - reaction of the created elements to what have created them. It means that the designed form is not only the result of an architect’s reaction to the unformed matter, but also the result of the reaction of the created form to its own creator. One should remember that owing to the experiences assumed during the further projecting activities, an architect may introduce some changes in elements that have already been designed. That correction is influenced by the feedback (object - architect - object) and also by the fact that the begun work has an endless amount of possible ways of development. Moreover, the development of the form is proportional to the reduction of invariants’ number. The influence of the earlier activities over the further ones may be double. They support the author when a development of the project corresponds to his ideas. Then we experience a feeling that the object is projecting itself. They may be also an obstacle when the development of the form is inconsistent with the authors’ ideas. Analyzing the first stages of creation we can state that its beginnings as a strange incident, repeatedly undefined. We do not know what kind of set of elements we dispose. We cannot fully control all features of the selecting filters. Moreover, we do not know the transforming matrix which we launched during the process of creation. When analysing the structure of designing, H.A. Simon assumed designing as an ill-structured problem. These problems are characterised by a poorly developed structure from the point of view of such parameters as the aim, possible alternatives and evaluation functions. (Simon H.A., 1973).
Reitmann believes that architecture practically knows no definite idea of the aims to be chosen, of the proper methods and of what is usually the starting point for a designer. (Reitman W.R., 1964).

The whole process of creation is individual, it evolves differently at each architect’s mind. But the history of architecture proves that in a creative process of design an inseparable component of this process is graphic techniques. A drawings have always been a very important communication tool, and it is still the natural and obvious medium for expressing visual thinking. With its help a visual pictures formed within the architect’s mind change and become more precise. Simultaneously, as a feedback, drawings reflect our memory, complementing spatial pictures already conceived in it. Drawings, being the catalyst of the designing process, also play the role of its organiser. For example, a plan puts in order information on circulation, structure and visual forms better than most other presentation methods. The perspective separates the visual images of the designed image in a way that no orthogonal drawings can. As Omer Akin states, the choices of the presentation method is equivalent to the choice of the problem solution method. (Akin O., 1986)

Every type of creation has constructed the proper means of expression and its own methodology, perfected with every generation. This process of perfection is in each type of art extraordinarily important as each artist seeks for a means of communication with his or her contemporaries. Each type of art has specific and unique characteristics of artistic expression, its own language. A novel leaves the reader with a synthetic impression, evoked by the read text. A film adaptation of a novel leaves totally and qualitatively different images, the similarity of which to the literary original depends on the imagination of the receiver. The sum of impressions evoked by a text and film also gives a qualitatively different image, enriched by the set of impressions which are the result of the perception of these very different types of art.

Architectural creation is also characterised by its unique method of communication. It includes a very specific lexicon, both verbal and graphic. In the process of communication, the very important items are the precision as well as the richness of the contexts of graphic images, as it is these that the full realisation of the architect’s idea depends on. Each symbol and each line carries a specific meaning. The creation of a work of art in architecture has always happened by means of lines and symbols. It would be very difficult to imagine just how many drawings had to be drawn in order to realise all the stages of the development of architecture. It is the intuitive meaning of lines that represents the idea of architectural creation.

The sketch
The sketch is a graphic means of seeking the architectural idea. The drawing has always been the basic means for expressing the thoughts of an architect, whose whole activity during the many centuries of existence has been divided into two stages. The first stage has always been designing - finding, perfecting and presenting the idea of an architectural structure. This process has been expressed by means of a drawing. The second stage has been building - the realisation of the architectural explorations in the material, corresponding to the technical drawings done in the designing process.

Until the mid 19th century, the architect was at the same time the designer and the builder. He designed and, at the same time, supervised the construction of his work. Therefore, when designing, he used graphic
representation only when he felt that the drawings could be of any use to him. They merely had a supporting role. What was not included on the drawing was supplemented by the architect himself - he explained his ideas to the workers either verbally or by means of a sketch. However, despite the sloppiness of those images of architectural objects, the architect could not work without drawing.

The necessity to perfect the idea and the fixation of all the stages of this process eventually forced the architect to use graphic representations. By the end of the 18th century, a tendency to narrow down the specialisation of the architect to the designing stage, accompanied by the preparation of sketches and technical drawings, is seen. The sketch becomes a means of making the representation of „the seen” (the reality) and then the expression and perfection of creative ideas possible. Different methods of organising the particular stages of the designing process are developed. Each stage has its unique means of expression (sketches - in the early stages of designing, technical drawing - at the stage of preparing the documentation). In the deliberations presented further, we shall focus on analysing the significance of the manual sketch for the creation of architectural form in the traditional designing process. In architectural practice the sketch played a deciding role. Most architects believed that designing is impossible without sketching. They expressed their resort by means of sketches on a piece of paper, with each stage characterised by a specific type of sketching forms. First, the idea of the sketch was developed, where the main contours of the form were searched for. The form became continuously detailed with each consecutive sketch. The image of the form was enriched with detail and information on the colour and texture.

In the creation of the architectural form, the first drawing is a blurred and imprecise image of the construction, reflecting only its main idea. On the other hand, the contents of the image are sufficient to an extent that they can be expressed by means of a simple symbol. This elementary character of the image is natural because, as it is seen throughout the many centuries of practice, making the visual images more concrete takes place gradually - from a small hieroglyph to bigger and more precise drawings.

In the latter part of the present paper, three different cases of the use of manual sketch for the purpose of searching for the architectural form are analysed.

**Case 1**

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Figure 1: Sketches of the Ronchamp chapel made by Le Corbusier.
For example, let us now take a number of Le Corbusier’s sketches made during the designing of the Ronchamp chapel. The first drawing presents the idea of the compository influence of the body (form) of the building and its surrounding landscape. The landscape is a contour of a hill with a few lines presenting the faults of the land and a path. (Fig. 1a). In the next drawings, the image of the chapel is developed. The author turns the building, making its form more detailed. The precision of the presentation is still so weak that the contours of the chapel are only clearly marked on the drawing of the southern facade (Fig. 1b). On drawing 1c and 1d, the author makes the fragments of the form more concrete, not paying much attention to the precision of the contour. The lack of a clear decision defining the contour causes a lack of precision in the presentation method. The lines marking the contour are crooked, broken, thick in the places of repetitive drawing. The sloppiness of the drawing is natural however, as it reflects the author’s real idea of the form at that particular stage of his research. The next series of drawings (1e-1h) presents four facades of the chapel. The basic contours of the body was decided. Regardless of the broken lines and careless lining, characteristic of Le Corbusier, the plasticity of the form is perceived clearly. The graphic art of this series of sketches shows just how much the author’s idea of the object has become precise. The linear drawing has become clearer, it carries more information.

The presented sketching method is characteristic for the process of searching in which the subconsciousness plays a main role. The architect makes numerous small drawings as if automatically. The many marks (representations) placed on the paper directs, in result, the author at the idea which will then be developed consciously. In effect, the subconscious images stored in the long term memory turn into fantasies that the author is still unaware of, which later become the idea of the form.

Case 2

![Figure 2: L. de Costa, sketch of the Brasilia composition.](image)

Another method of using sketches is observed when the author, from the very beginning, consciously chooses a particular direction of his search. Knowing what he wants to find, he pursues an aim, analysing critically each consecutive stage of sketching. The sketches of the Brasilia city, made by L. De Costa, can serve as an example here. When looking at them, we see the image being created with all consequence. The two intersecting lines transform into a drawing of a dragon-fly, being the essence of the assumed directions of composition.
Case 3

Figure 3: O. Nimeyer - sketches of the Brasilia cathedral.

The third form of searching takes place in the case of a long term inability to find an idea. The author is unable to overcome the material resistance and the consecutive sketches bring about nothing new. Such dry and infertile periods are more than exhausting for a creator. However, in reality, the imagination is still a witness to processes preparing further creative peregrinations. A moment eventually comes when a small impulse evokes associations and the mind begins to work in the right direction. This is what happened in the design process of the Brasilia cathedral. The first sketches did not satisfy O. Nimeyer, who drew a circle in the open area meant for the church. The circle transformed into a sun, surrounded by an aureole of rays, what suggested the central plan of the building and pylons open to the top as if sunflower leaves (Fig. 3).

New methods of searching for ideas of form

In the last 20 years, great changes with regard to processing of information related to architectural design took place. A great volume of technical documentation, without which the realisation of the design is impossible, has been more often and to a greater extent been performed by computers and graphic software. Television, photography and film are used in designing. Under the influence of the new techniques, the character of the graphic art and modelling is constantly subject to changes, which in turn determines the changes in the technical means used in architectural design. Traditionally, CAD software development has mimicked the hardware tools (pencil, paper, paint brushes) used in the practice of architecture. Many designers think, that a computer is a tool, just a piece of charcoal is. Using computer as traditional tools would be used, they feel disappointed. If they are doing conceptual work, it is more difficult to make just a hint or suggestion of something with computer than to do it by hand. A computer wants to render real things. It is extremely difficult to create a drawing that hints at a basic form or idea. A computer drawings is too finished to use at this stage. (Asanowicz A., 1997) In result, design process proceed in traditional way. While searching for the idea we use a hand sketches and, after this, technical drawings are draught on a plotter, which replaces a drawing pen. Using computers at early design stages encounters serious difficulties, what is clear to everybody who tries to make a sketch in AutoCAD or another CAD software.
Comparing computer to a pencil or technical pen, at 1st AVOCAAD Conference, I wrote “A pencil is a pencil. A computer is a computer. A computer isn’t a pencil. A pencil isn’t a computer.” (Asanowicz A., 1997) Of course, that when we make a drawing of a project, we use a computer as technical pen. We draw lines, arches, curves .... Thanks to that we are able to produce technical documentation a lot faster than before. Without any doubt it is an Added Value - created by computer in a design process. But it is not enough that one could expect from such an advanced technology.

The thesis of this paper is that it is not hardware and software inadequacy that constitute a problem but the inadequacy of design method. As B. Laura wrote - this problem must be reconceived as what a person can do with a program, rather than what is the capacity of a program. (Laurel B., 1993) This type of thinking has become the stimulus for undertaking an effort of developing experimental methods of the use of computer hardware and software for stimulating the search for the architectural form. In this method we try to use a computer as a medium. A tool becomes a medium as it is used for things that were not its original intention. When a tool becomes a medium, it gains immeasurably in potency and in its ability to help for our thinking - and thus to take a role as a partner in enhancing our creativity. (Glanville R., 1994)

Case 1
The "Squares and Spheres" design was done by means of the Imaging Imagination Workshop in 1997 at Delft University of Technology. The task was to design a scenario of using the town market square, composed of two squares connected at the corners. Having the outset situation precisely determined and absolutely no idea of how to solve the problem, we decided to use a scanner for the purpose of the project. We placed a cardboard cut-out of the square’s contour on its surface. Next, the colour pieces of paper placed on it were scanned. (Fig. 4a, b) Because the images obtained seemed too homogenous and static, we added small spheres (beads), being the metaphor of the movement taking place on that square. (Fig.4c, d) That way, a second series of scanned images was obtained. The images were achieved by coincidence, however not without the intervention of the authors, who were responsible for choosing the amount and the quality of the elements used. Few images best satisfying the imagined ideas of the authors were selected from among the images of the second series. They were later subject to computer graphic processing. After a number of transformations, bit maps corresponding to the already shaped idea of form were obtained. (Fig. 4e, f, g, h) On that basis, a visualisation in a 3D studio programme was developed. The presented process of designing can be compared to the analytical method used by Le Corbusier when designing the Ronchamp chapel. The form develops and is made more precise, parallel to the development of the digital sketches - from the abstract ones to the more and more detailed ones.
Figure 4 a-h.
Case 2

The design of the museum, just like in the case of L. De Costa's Brasilia, was created according to the consciously defined direction of searching. L. De Costa assumed the drawing of two intersecting lines as the basis of his concept of the city. Similarly to that, in the design of the museum, the main indicator was a sea-holly leaf. From the series of images obtained by means of scanning the leaf placed on the scanner in different positions, one was chosen, which was later subject to processing by means of the Trace Contour operation under the Photo Shop programme. A digital sketch of the plane of the museum was obtained. The design was made on the basis of that sketch (Fig. 5). (The design was done by a 4th year student, Tomasz Stryjewski, under the guidance of Dr Jerzy Ullman from the Faculty of Architecture, Technical University of Bialystok). The design is an example of the reduction method of designing according to Poincare’s thesis - First I have, then I find. If a 3D scanner was used, than the inspiration could become a form in itself.

Figure 4: Squares and Spheres.

Figure 5: Museum.
Case 3

6a 6b
6c 6d

Figure 6 a-d: Regular urban structure.

A design of the city is a perfect illustration of the role of the coincidence in the designing process. "The accident is an early, especially decisive factor in every evolution process where the arrangement during the creation produces its own patterns which cannot be found at the very beginning of it." (Lem S., 1988) The preliminary sketch was created by scanning a ping-pong ball and a piece of aluminium foil on a black and white scanner. It was probably the first unconventional use of the computer hardware in our Faculty. The image, called "Bacon and eggs", was a joke and was not supposed to be used for any designing purpose. (Fig. 6a) However, after a series of graphic transformations, an image called the "Aztec Circle" was created. (Fig. 6b) After exporting the sketch to Corel Trace for the purpose of its vectorisation, a 3D Mosaic procedure was initiated by chance. (Fig. 6c) On the basis of the obtained image, resembling a city from the SimCity 2000 computer game, a design of a regular urban structure was created (Fig. 6d).

Conclusion
1. A specific character of the composition activity of an architect is associated with the methods and modelling ways of spatial forms. Creativity is realised as a process of "making an ideal model real". Therefore, the creative modelling of a form, where the characteristics of the composition are shown is so important.

The analysis of the design process shows that the graphic art. has always been one of the basic designing media because it ensured the operational and flexible fixation of design ideas. Each sketch, being the expression of a defined view of the form, allows for an evaluation and formulation of the new aspects of the idea of composition. At the same time, a deeper interpretation
of the architectural image requires the development of a sufficiently long sequence of visual models. In traditional graphic art, as design experience shows, such presentation of the transformation of composition is extraordinarily difficult. The graphic computer transformation, together with the creation of the history of the undertaken activities, allows for a fuller exploration of design metaphors, for the metaphorisation of the process of form creation.

2. Designing at the early stages is becoming more and more metaphorical. Out of the chaos of forms the proper forms are selected by our mind, corresponding to our ideas. Whereas the manual sketch made it possible, with a bit of skill, to graphically represent the idea of the creator, it did not, being a tool, create an additional value in the very design process (excluding its aesthetic value that it possessed).

The use of scanner makes it possible to discover forms which are surprising, sometimes even to the author. This method proves that the computer can be useful as a "metaphorisation machine" and can serve the role of the "Superior" in the process of creation, taking upon itself the role of the generator of chances. And as Lem once said: “The accident is an early, especially decisive factor in every evolution process where the arrangement during the creation produces its own patterns which cannot be found at the very beginning of it.” (Lem S., 1988).

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