

# A Critical Approach to the Use of Computers in Architectural Design

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**Abstract.** *There are two dominant approaches to architectural and urbanistic problem solving: program based approaches and paradigm based approaches. Beyond these two, this paper proposes the critical/formalist approach as a paradigm for architectural design while summarizing the epistemological foundations of it, and investigates the possible contribution of the computers to this approach. The primary aim is to set a starting point for a more comprehensive future research.*

**Keywords:** *Design theory, design methodology, computer aided design, formalism, architectural form*

## Introduction

Colin Rowe distinguishes between two main approaches to architectural and urbanistic problem solving which point to different epistemological positions: program based and paradigm based approaches. On the one hand, program based approaches put the emphasis on the “program” as the generating “material” and the legitimate “source and origin” of architectural form or solution. On the other, paradigm based approaches put the emphasis on “ideas” or “forms” as the “insuperable” starting point for the architectural problem solving, despite whether these “ideas” or “forms” were derived from the “typical and the typological,” “reserve of collective memories,” or Platonic forms. (Rowe, 1996)

Dictionary definition of “program” is given as “a plan of procedure: a schedule or system under which action may be taken toward a desired goal: a proposed project or scheme.” (Merriam-Webster Unabridged) In architecture, a “program” can be defined as a set of requirements, or blueprints

prepared for creating a solution to an architectural problem. The preparation of a program is highly dependent on objective and neutral compilation of empirical facts or data. Program based approaches propose that the set of requirements or blueprints, or program is the neutral source from which the form or solution is originated. According to Colin Rowe, these approaches rely on the presumption that “...an act of analysis will automatically result in an act of synthesis.” (1996) This view is related to the inductivist/empiricist conception of science, and its method known as analysis/synthesis or induction. (Bamford, 2002) From this point of view, states Karl Popper, “science starts from observation and proceeds, by induction, to generalizations, and ultimately to theories.” (1965)

The manifestations of inductivist/empiricist conception of science and its method can be observed in the functionalist doctrine of Modern architecture. Alan Colquhoun points out that “the essence of the functional doctrine of the Modern Movement was not that beauty or order or meaning was unnecessary, but that it could no longer be

found in the deliberate search for final forms. The path by which the artifact affected the observer aesthetically was seen as the short-circuiting the process of formalization.” (1984) Therefore “[the architectural] form was merely the result of a logical process by which the operational needs and the operational techniques were brought together. Ultimately these would fuse in a kind of biological extension of life, and function and technology would be totally transparent.” (Colquhoun, 1984)

The theory that underlies this approach is called “biotechnical determinism.” The “biotechnical determinism” of functionalism proposed that the architectural form was not achieved with “the conscious interference” of the designer but “postulated as his ultimate purpose.” (Colquhoun, 1984) This position postulates a break from tradition, and sought to replace the “authority of tradition” with authority of “science and technology.” (Anderson, 1963) Reyner Banham’s revised version of functionalism shares the same epistemological ground with the functionalist tradition in Modern architecture. By determining and criticizing “the tradition within the Modern Movement itself,” (Anderson, 1963) Banham proposed that “[a genuine scientific program] ...would take in all aspects previously left to tradition, including the aesthetics of perception, human response, (visual, psychological, biological) technologies of environment, and the like; science would simply reveal and propose the best solutions to the design of shelter.” (Vidler, 2003) He defines the “Scientific aesthetic” as the one that uses “...as the basis and guide to design, observations (made according to the normal laws of scientific evidence) of the actual effect of certain colors, forms, symbols, spaces, lighting levels, acoustic qualities, textures, perspective effects (in isolation or in total ‘gestalts’) on human viewers.” (Banham, 1960)

From this point of view, in his article titled “The Science Side: Weapons Systems, Computers, Human Sciences,” published in March 1960 issue of *Architectural Review* Banham aims to review the

emergent computer technologies. In his response to negative remarks of M.E. Drummond (Drummond, 1960) for the use of computers for aesthetic creation, he states that “aesthetics and other aspects of human psychology are no longer mysteries necessarily to be set up against ‘cold hard facts.’” He argues that “insofar as psychological matters can be assigned numerical values –and statistical techniques make it increasingly feasible to quantify them- they become susceptible to mathematical manipulation...most jealously-guarded ‘professional secrets’ of architecture are already quantifiable.” (Banham, 1960) We may observe the implications of this view of the use of computers in architectural design in many of the recent experimental studies exploring the potentialities of computer modeling and animation software.

## The problem

Anthony Vidler addresses this issue in a recent essay. He states that many architects bring together “their exploration of the formal potentials of digital media and an equally radical approach toward the program by exploiting all the possibilities of animation and rendering programs.” (2003) For him, the basic target of these experimental studies is combining and representing “...information and thus overcoming one of the fundamental blocks to modern functionalism –the ‘translation’ of data into meaningful form.” (Vidler, 2003) In somewhere else he argues that “...the flows of traffic, changes in the climate, approach, existing settlement, demographic trends, and the like,” were formerly “be considered by the designer as ‘influences’ to be taken into account while preparing a ‘solution’ to the varied problems they posed.” By the help of the computers, however, they can now “...be mapped synthetically as direct topographical information, weighted according to their hierarchical importance, literally transforming the shape of the ground.” (Vidler, 2000) The excellent capabilities of computers for producing and processing data, as

well as their graphical capabilities for translating the data directly into form make them ideal devices for such “scientific” approaches. But epistemologically there are three essential problems with the paradigm that these approaches are based.

Firstly, the preparation of a comprehensive program requires an efficient gathering of a wide range of data. Unfortunately, the range, and what is relevant, what is not relevant as data for a specific design problem cannot be determined, especially without the existence of an initial configuration or idea. In addition, all data required cannot be gathered by any rational means. Data gathering and interpretation will always be biased and affected by our expectations and prejudices.

Secondly, there can be no formula, algorithm or method that will encompass the complexity of a design problem. And there can be no guaranteed formula, algorithm or method for a direct translation of data into a successful architectural solution. The solution is not an outcome of a “deterministic process,” but always be affected by the preferences, choices and intentions of the designer.

Finally, we cannot, -and should not- free ourselves from tradition by replacing it with science as a new authority, and start from a *tabula rasa*. Popper underlines the indispensability of tradition and earlier knowledge to make progress in science. For him, we have to “pick up, and try to continue a line of inquiry which has the whole background of the earlier development of science behind it.” (Popper, 1965) As such, replacing “tradition” with “science” does not make a sense since science is also dependent upon the existence of earlier knowledge and tradition to operate.

Contrary to the program based approaches, the paradigm based approaches privilege the “forms” as the starting point for the architectural problem solving. These forms can be originated from types, collective memories, historical precedents, or Platonic forms. In architecture, a heavy concern in “work on form,” and ignorance of other aspects of architecture is often considered as “formalism.”

Formalism can have different connotations: it may be linked with historicism or traditionalism when it means mindless imitation or repetition of traditional forms, or it may propose freedom from tradition, or a *tabula rasa*, by proposing expressionistic forms.

## **Beyond program and paradigm: the critical/formalist model**

Apart from these, I will propose another approach which I call “critical/formalist” model of design to distinguish it from the “formalist” or “formalistic” approaches in architecture that primarily focus on the formal aspects of architecture and ignore its content, and its functional or programmatic aspects.

Critical/formalist approach to architecture can be illustrated in Alan Colquhoun’s discussions in “Typology and Design Method.” In Colquhoun’s words, in architecture, “the area of a pure intuition must be based on a knowledge of past solutions applied to related problems, and that creation is a process of adapting forms derived either from past needs or from past aesthetic ideologies to the needs of the present.” (1984) This approach puts the primacy on paradigm: the precedent ideas or forms to be reconsidered to adapt them to new problems.

Colquhoun points out that in the works of Kandinsky and Schoenberg “...traditional formal devices were not completely abandoned but were transformed and given a new emphasis by the exclusion of ideologically repulsive iconic elements. In the case of Kandinsky, it is the representational element which is excluded; in the case of Schoenberg it is the diatonic system of harmony.” (1984) The “process of exclusion” renews the perception and helps us to see “the potentialities of forms as if for the first time.” Colquhoun admits that “this is the justification for the radical change in the iconic system of representation, and it is a process which we have to adopt if we are to keep and renew our

awareness of the meanings which can be carried by forms.” (1984)

Colquhoun’s conception of “process of exclusion,” “formal device,” and his critical/formalist approach to the production of form is based on his borrowings of the notions of “estrangement,” “renewal of perception,” and “device” elucidated in the doctrines of a school of literary criticism called Russian Formalism established at the beginning of the 20th century. As admitted by Fredric Jameson, Russian Formalists are “ultimately concerned with the way in which the individual work of art was perceived differentially...” (Jameson, 1972) Victor Shklovsky, one of the major figures of the Russian Formalism, suggests that the “purpose of art... is to lead us to a knowledge of a thing through the organ of sight instead of recognition.” (Shklovsky, 1990) He argues that “by ‘estranging’ objects and complicating form, the device of art makes perception long and ‘laborious.’” (Shklovsky, 1990) It is art’s responsibility to make one to sense the life by “estranging” the “habitual.” Shklovsky pointed out that “the perceptual process in art has a purpose all its own and ought to be extended to the fullest. Art is a means of experiencing the process of creativity. The artifact is quite unimportant.” (1990) “Estrangement” as conceptualized by Russian Formalists involves a “reading” that requires the transformation of the habitual (transparent) to the strange (opaque). Formalism in this conception is not related with the form or composition of the object but implies an interpretative and hermeneutic dimension.

For the critical/formalist approach, rather than the work itself as it exists in the real world or world of physical objects (the first world in Popper’s terms), our understanding and interpretation of it as an “objective content of thought” as it exists in the “third world” is particularly important. In his book titled *Objective Knowledge*, Popper distinguishes three worlds or universes: “first, the world of physical objects or of physical states; second, the world of states of consciousness, or of men-

tal states, or perhaps of behavioral dispositions to act; and third, the world of objective contents of thought especially of scientific and poetic thoughts and works of art.” (1972)

Popper argues that the third world is an “autonomous world by a kind of biological and evolutionary argument.” (1972) Unlike the biological living organisms, it is the world of non-living “objective contents of thought” produced by the human mind. His evolutionary epistemology introduces three ideas borrowed from evolutionary theory: “instruction,” “selection” and “adaptation.” For him, “adaptation starts from an inherited structure...the gene structure of the organism.” (1972) These structures are transmitted to the following generations by instruction –either through the genetic code or through tradition. Any change in structure, such as mutations, variations, or errors, “arise from within the structure, rather than ...from the environment.” (Popper 1997) So, the trial (or reconfiguration & mutation) comes first and the system is then tested. This explains two things: first is the error elimination. If any change in the structure is conflicting with the environmental conditions, these are “badly adapted trials,” and they won’t survive. Popper calls this the “stage of the error elimination.” Second, if the change “fits” the conditions, this leads to a successful evolution. Popper calls this the “adaptation by ‘the method of trial and error’, or...’the method of trial and the elimination of error.” (Popper, 1997)

Popper proposes that different than the biological evolution “...scientific theories can be formulated linguistically, and that they can even be published. Thus they become objects outside of ourselves: objects open to investigation.” (Popper, 1997) In this sense, “they are now open to criticism. Thus we can get rid of badly fitting theory before the adoption of the theory makes us unfit to survive. By criticizing our theories we can let our theories die in our stead.” (Popper, 1997)

Popper’s these arguments have significance for architecture. Critical/formalist model is estab-

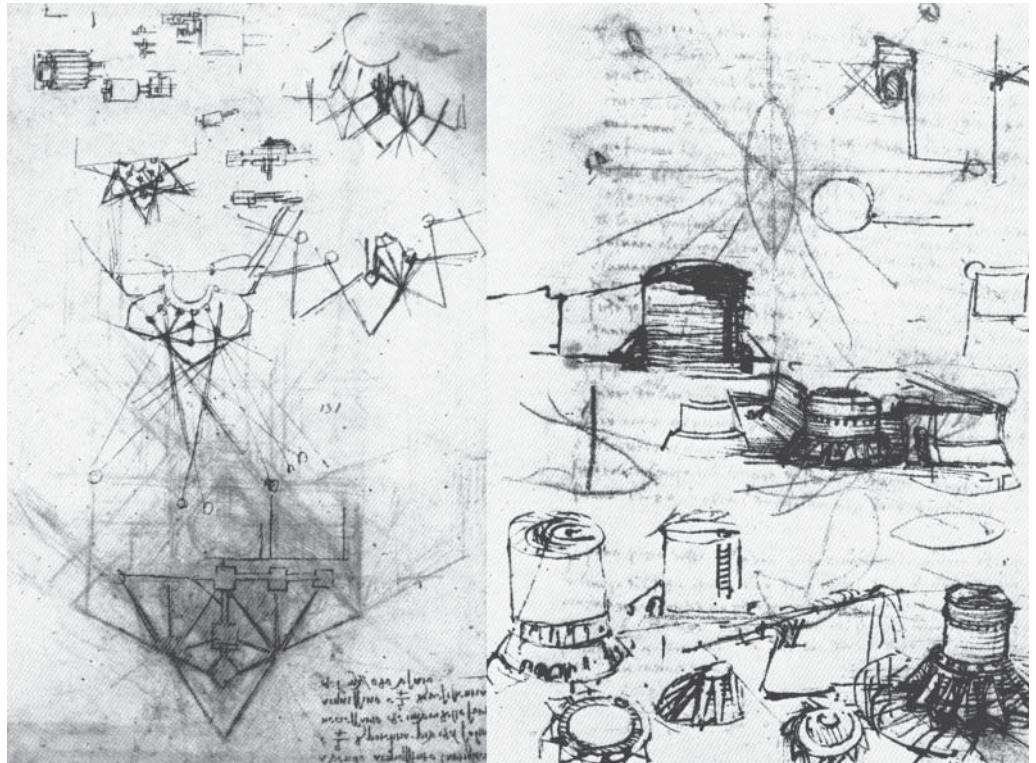
lished on the idea that every design process begins with an “idea” or “form.” Typically, sketches, drawings, models are the means of representing these ideas. They make possible the architects to represent their ideas outside their minds similar to scientific theories, and thus make these ideas open to reading, criticism and error elimination. This is the point where the designed object enters a type of an evolutionary process.

### **Towards the use of computers for the critical/formalist model**

In their essay titled “Lines of Vision Lines of Fire” Alexander Tzonis & Lianne Lefaivre explore the evolution of the Renaissance Bastion from

round to the angular form. Their investigation has a particular importance for the present study for the illustration of a critical/formalist approach to design and the possible contribution of computers to this approach.

Tzonis and Lefaivre argue that the revolutionary approach to the design of angular bastion begins with Francesco di Giorgio’s works. Francesco was the one who conceived the use of texts and drawings as indispensable elements for solving the problem of perfect fortification. Francesco anticipated “visual representation” “as a means of architectural thinking, as a way of grasping phenomena which otherwise would have remain unrepresented, thus incomprehensible.” (Tzonis & Lefaivre) But he could not find the solution to the problem



*Figure 1. Leonardo da Vinci's studies of bastions/Fortifications of Piombino (Pedretti, 1986)*

of perfect fortification. It was Leonardo da Vinci, a close friend of Francesco who invented the angular bastion. Tzonis and Lefavre argue that the basic reason behind what kept Francesco from inventing the bastion and what made Leonardo invent it, was the mode of representation that they utilized. Francesco could not find the solution to the problem, since it required an appropriate representation technique to make one to be able to deal with the problem situation. The problem was that the lines of Francesco “only describe built form,” that is far from representing all the required information layers and all the factors affecting the design of a bastion. On the other hand, Leonardo’s drawings mapped process, movement, operation in addition to built form. (Figure 1) Therefore in Leonardo’s case, two things were represented simultaneously: the “idea” or “form” of a bastion, and “overlayed upon it, the routes of missiles hurled from shooting points.” (Tzonis & Lefavre)

Leonardo’s representation is a composite one bringing together various layers of the problem together; the visible one such as the bastion and also the invisible ones such as the missile trajectories. But perhaps more important, it encompassed both the program and paradigm simultaneously.

So on the one hand, Leonardo abstracts the “idea” or “form” of a bastion from the existing bastions. On the other, he determines the conditions affecting the object that will help him to test the mutations that he made in the initial idea. The conditions affecting the design of a bastion are the thrown missiles by the siege equipment and the defensive function of a bastion. These are also subject to representation, to make them visible, and apply them to the proposed solution, for testing it.

The system employed by Leonardo can be evaluated as a kind of computation and gives some clues about the possible use of computers in a creative design process based on the critical/formalist model.

## Final remarks

Firstly, it must be noted that Leonardo’s way of computing does not follow the mathematical or logical methods of classical computation, but a visual and formal one.

Secondly, although computer-generated photo-realistic models are actually used widely as a means of preparing representations of the architectural objects, in most of the case these are the already completed objects. As it was stated by Allen, the photo-realistic techniques of “visualization ignore what has traditionally given architectural representation its particular power of conceptualization –that is to say, its necessary degree of abstraction, the distance interposed between the thing and its representation.” (Allen, 2000) Allen, argues that “design does not operate on the basis of resemblance, but on the basis of abstract codes and a complex instrumentality. Architecture presumes a transformation of reality, but an architect attempting to work directly with that reality will be paralyzed.” (Allen, 2000) Thus, computer representations in a creative design process are not valuable in the sense that they provide realism but that they provide “opacity” and “strangeness” to the representation of the designed objects.

Thirdly, creative design representations are rich in information, represented in various sub-systems or layers as in Leonardo’s case. These multiple layers of information are brought together in a complex way compared with the photo-realistic representations of the end-products that primarily aim the representation of the visual characteristics and qualities of the object.

Fourthly, although they impose quite a different approach than the conventional devices, the extensive “making” and “remaking” potentialities provided by the computer modeling seem to support a more flexible and a faster trial and error elimination process for the production of design objects. This will surely condense and accelerate the evolutionary process. Unique to the comput-

ers, they can record the evolutionary history of the designed object, which at any time any point of this history can be accessed to be read, interpreted and manipulated without losing anything and these interventions instantly affect everything that occurred afterwards. This creates infinite processes to work with, and at any time the products and knowledge created by these processes can be overlapped, intersected or brought together to generate new works.

Finally, computers give us potential to visualize what was existing and visible, such as the form of a bastion, and what was invisible such as the program, the missiles. Better than the conventional devices, for the computers any imported knowledge can be represented and brought together at any point regardless of their type, origins, scale, and meaning. In addition, they can map and represent dynamic issues.

It must be noted that it is out of scope of this paper to fully analyze and criticize the existing practices utilizing the computers in architectural design, and give a complete account of both the critical/formalist model and the possible contribution of computers to this model. This paper must be taken as a starting point for a more comprehensive research.

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