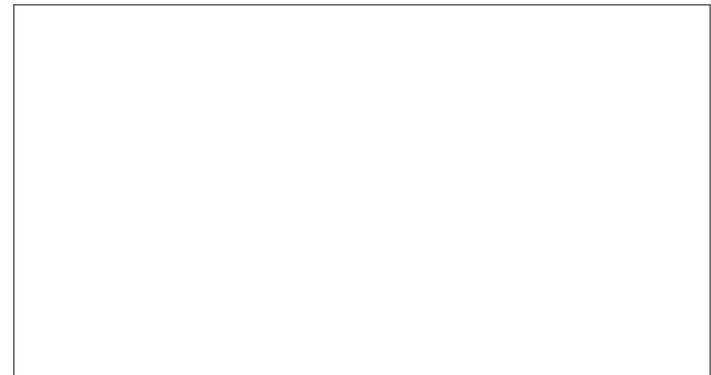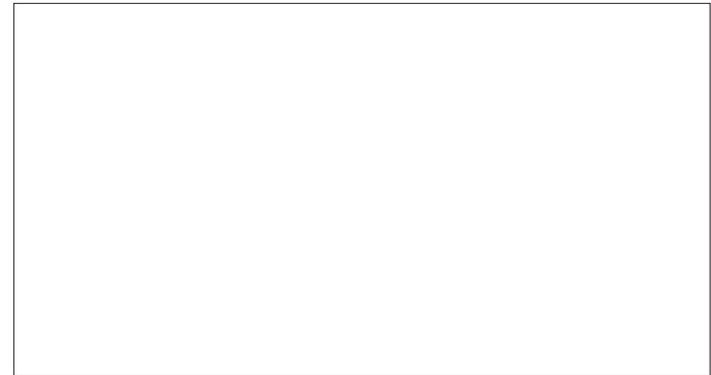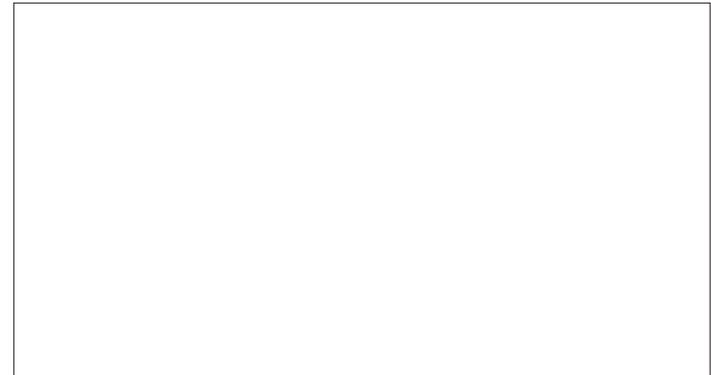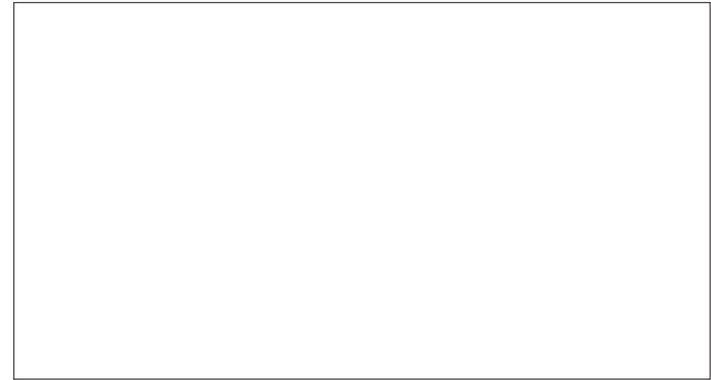# Architectural Design and Digital Paradigm:  from Renaissance Models to Digital Architecture*

Paolo Fiamma
Università di Pisa

## Abstract

Means of expression have always affected our ways of thinking. Designers, who have to interpret signs, languages, and evolution in order to translate into an organised "form" the recurring problems and values of mankind, have left thoughts, projects and wishes to the study of representational techniques. In this way, they have also disclosed a unique view of reality and at the same time a "way of being" towards the meaning of design itself. In the relationship between architecture and representational techniques, Brunelleschi said that "perspicere" was no longer just the science of optics, but also the science that contained the lines of research on geometry and shape that he was the first to exploit in design. Centuries later, in the axonometric representation advocated by De Stijl and intended for factories and industries, the object, shown in all its parts, easy to reconstruct even in the space to which it referred, revealed with extreme clarity the mass-production building and assembly materials and systems. Digital representational media make a great entrance in the heuristic process, invalidate all signs, and promote its quality. The result is an ever-changing, computerised architecture, dominated by curvilinear, wavy shapes that flow from a generative process made of the deformations, additions, and interference of different volumes.

*A Digital *Work In Progress*

## Architectural Design and Digital Paradigm:  from Renaissance Models to Digital Architecture

Paolo Fiamma
Università di Pisa

## 1  Digital Architecture

Today, the new representational technology affects the way designers work, in terms of speed, as well as promoting the use of static elements (paper, plastics), of such notions as time, motion, flow, through to the generation of simulations that can be used to work differently, to imagine space, and to relate to it in a new way.

The new technology is dramatically changing our approach to design; it also allows us to work with a vector geometry which marks the end of the rule of the Euclidean geometry. This breaking off involves our conceptual and designing potentials as much as their implementation. We could say that, somehow, this also increases our designing abstraction skills.

Increased production, reduced designing costs, improved communication of the executive building choices, and a new conception of the architectural space are just some of the major consequences of the use of new technology in architectural design.

The contribution given today by digital technology to the development of modern buildings is undeniable, as shown by the latest Venice Biennale.

The computer paradigm, that goes so far as to propose coatings that turn into screens on which pictures flicker (a blend of architecture and media), also delves into the classic, the so-called Euclidean forms: it disjoints them, runs through them with planes, and overlaps, making them iridescent and sometimes even dynamic. This change is revealed, for instance, by the change in the architectural "shells."

The dynamism of architectural space and the envelope as its expression appear to have reached a current statute of feasibility thanks to the achievements of modern instruments of computation and virtual simulation, message of a design concept and of constructive techniques that declare expressed today, following digital models, that verification which in the past was implicit in the rules of the art set by tradition.

The electronic and digital management of the design allows competing that envelops fresh and complex articulation, three-dimensional synthesis of experiments on the dynamism of space, whose processing and visual restitution is no longer consigned to traditional graphic representation systems, and on the nonlinearity of performance requirements, paradigm of a new digital message that comes to assume theoretical bases of fractal computation, beyond the concept of the Euclidean principles, towards the complexity of the nonlinear dynamics generated by the meeting of forces and resistances—inside the matter of constructive components—with the flow of climatic factors coming from the outside (Figure 1. Foster & P., Swiss Re Building, London).



**Figure 1. Foster & P., Swiss Re Building, London.**

The envelope is broken down and recomposed in three-dimensional space; it is framed by a fresh variety of viewpoints; it is dematerialised by plastic and curvilinear shapes, by the subtraction of parts, by an almost evanescent transparency that invites experimentation in crossing it; it is brought to the most contemporary fluid deformations of the architectural material until the expression of an almost vital dynamism.

The envelope can be read as a dynamic field where its constructive components push and broaden until the static and thermophysical paradox.  An extensive diagram in which

vectorial signs and systematic lines of force can be reduced to synthesis, which allows controlling the manipulation of the shapes under light, the increases in scale, the combination of viewpoints, the movement and the stagnation.

It is the metaphor of a new information landscape, magically unstable and dynamic, which proclaims in the envelope the symbolic passage from the building as machine to the building as computer. A new "science" of architecture and its vanguard must decide what cultural position to take with respect to the permanence of shapes, to the search for tradition and memory, to the spirit of place, to the value of history.

The plan "City of Culture" in Santiago de Compostela—Peter Eisenman—is an example of the relationship between topological surface and historical-cultural heritage (figure 2).
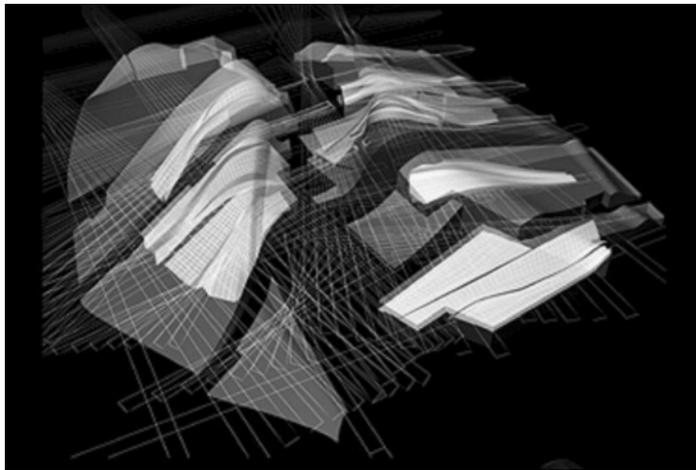


**Figure 2. P. Eisenman, City of Culture.**

The design develops from the overlapping of three sets of faces: the plan of the old city centre, the Cartesian grid of Mediaeval streets, the topography of the hill that disrupts the two plane geometries by creating a topological surface (neither figure nor land) that superimposes and mixes the old and the new. A designing and cultural transformation process: we can think of a relationship between "the software" and "the Genius of the Place" (E-topia, William J. Mitchell).

Traditionally, architecture has always been regarded as a semiotic system that expresses a well-defined expansion of the matter. Today, the saturation of communication technology contributes to create a phase of implosion and social reversal. This implosion marks the passage from a semiotic culture obsessed with representation—with an excess of information—to another post-semiotic sensitivity.

In it, weak meanings and symbols, that belong in a fading imagination, give up to traces and signals that produce an alternative condition of the figure and the land.

## 2  Dynamic representation

One can even redefine the acquired terms of representation as well as the size, the space, and the structures, or "invent" new ones, more suitable for expressing such changes. We no longer work within a limited 3D system, but within a media hyperspace (more cultural than technical) which reopens the question of space in the way we are used to perceiving and conceiving of it. Currently, the representation of the project has a new dimension (the video) that was not available in the past.

Thinking, for instance, of the potentials of virtual navigation within the designed spaces, one can see that this increases, improves the process of knowledge (knowability and creativity, and therefore also design) to such extent as to allow the cognitive processes themselves to move from a symbolic-reconstructive value to a perceptive-motor value.

This interaction between the object (the project) and the subject (the author of the project) is only believed but not made concrete. The modality of animation and introspection across virtual paths allow this. Animation techniques turn movement more into a force than into a sequence of pictures.

More than a handy tool for viewing and controlling designs, we could say that animation becomes a designing tool. It is not about designing buildings whose appearance recalls motion; this would be like referring back to what the modern movement produced when inspired by boats or other industrial products. This is about having design take place in a dynamic environment of forces, in which form and matter can even be replaced by digital information and mass communication.

In architecture, changing the environment where design takes place involves a dramatic change in the way the architectural space is conceived of and designed.

Shape becomes information, information as a set of ever-moving, ever-changing data. Information turns time into a spatial parameter. Once able to move, space and time become inseparable. While architecture has always been compared to the study of the inert, of everything "static," the coming of IT technology brings this assumption to an end.

There is a connection between representation—the approach to the real (and therefore to design)—and culture.  In the Renaissance, representation was conditional on the philosophy of anthropomorphism. The vision of reality expressed by the Renaissance box into which one looks is static (the Arnolfini family, by Van Eyck). Perspective is man-sized: the onlooker's eye is the human eye, and builds a world in which architecture is its background. Later on, the Cartesian model becomes a way to represent the architectural space, which is the symbol of a new society. The position of the object can be known: its distance from the subject becomes zero (the approach to the real is conditional on positivism).

By the late eighteenth century, the need was felt to represent a reality that was to be used for the technical reproducibility of those products that would respond to those same needs. Since the nineteenth century, representation has had to be

able to reproduce the architectural object: no longer as just a unique, unrepeatable "model," but often as a serial piece.  At the beginning of the twentieth century, the viewpoint aims at infinity; one wants to portray the whole of things, not just part of them. In its meanings, representation suits the new meanings underlying design. Nowadays, the digital tool is so successful also because it is an "answer": an answer to what a new architecture asks for, to represent itself in a society that is more and more complex, heterogeneous, dynamic and relational.

There are two main aspects: First, there is the theoretical side, about the possibility of discovering a kind of visualization of our *mental space*. Secondly, there is the technical side, about the possibility of rendering some portions of space visible that would otherwise usually lie beyond our perception.

Today, the new representational technology allows the conception of a variable architecture, capable of representing not only finished shapes but the very conditions of formalization (e.g. the design by algorithm of Marcos Novak: in fact the algorithm expresses a system of relations, an "order" which binds variable elements to each other).

And the digital tool is also an answer to the more and more complex needs of today's design. The digital tool certainly contributes to the concept of "formal complexity," but also to that of the "exhaustiveness of design" by enabling design to become more and more integrated. This contribution affects not only the design concept but also its verification and the semantics of the design specifications, targeted to all the professionals involved in the designing and building process.

## 3  3D model: the form and the technique

With regard to the development of the project, an observation should be considered: a tri-dimesional model of a building may be modelled substatially in two different ways: with a generic shape or with constructive components. In the former case, the function of generic modelling propopsed by the CAD system. Conversely, in the latter case, when the building model has to be developed by construcuve components  it is necessary to consider softwares (A.E.C.) that are dedicated to architectonic projects.

This methodology works similarly to a simulator, in a unique larger logical, physical and functional model, that is a prototype of the manufacture, then the pictures, the reports, and computations, etc.

For the techniques of creating projects in the fields of engineering and architecture, it seems that the contribution offered by the use of dedicated software solutions for the creation of three dimensional models is becoming increasingly important. The possibility of creating a complete functional-logical model of the projected structure is closely linked to the development of specific object oriented caad, which re-propose, in the construction of the three dimensional model itself, the logic which will govern the construction of the actual building. It

becomes, therefore, necessary to be able to create a virtual model using elements of construction such as pillars, beams, bricks, and fixtures, and at the same time calculate, for example, the cost, the resistance characteristics, the thermo-physical properties, etc. This will favour the on-going process of a project in independent steps, allowing the recovery of its meaning as an expression of a single and simultaneous concept of all the aspects involved (structural, economical, functional, etc.)

The contribution given by the possibility of quickly changing the solutions adopted, as provided by the introduction of digital modelling, highlights the need to regard the project as a "verified concept" through an interactive process running across different disciplines and iterative between the time of the ideational expression and the time of its verification, now based on a wide-ranging concept of numeric modelling which underlies the digital 3D models.

In this respect, it is increasingly important to focus the efforts of research on thinking about the great innovation introduced by digital 3D modelling in the housing sector, not only in the merits but also in the methods of the designing conception.

*Thinking* of an object-orientated constructive 3D model does not merely mean to represent it, but also to conceive it, by generating it within an *existing* although virtual space.

This encourages one to focus not only on the formal and compositive side, but also on the technical and technological side of the future building, whose constructive components are brought in, arranged, and above all *connected* within the virtual building, as will happen in the practice of building, according to the building rules.

Specific A.E.C.  software solutions for the building sector need the users to enter accurate constructive details for each component through dedicated graphic interfaces. The object is built in a virtual space, a preview or an extension of the real one, to which it will be given back later on, in the building to come.

## 4  Digital tools and digital method

To make the most of the possibility to develop an integrated virtual model, the design concept needs to be integrated at an early stage. The development of this virtual plastic model, which establishes relations among aesthetics, materials, costs, structural resistance, and overall energy efficiency, all *at the same time,* seems to articulate, in a topical manner, the directions given by the masters of the Renaissance on the need of constructive models for designed works. In this sense, the digital tool (A.E.C. technology), is certainly a tool but looks increasingly set to offer *a method*, an approach to design which is new, but ancient at the same time.

The relationship with traditional design seems convincingly related to integrating the ancient process based on the experimentation of design perceptions, corroborated by an empirical tradition, where the current expectations can be tested with "a priori" models before the work is developed.

The digital tri-dimensional model permits to obtain in an

unicum, not only the possibility to present a project, to study the different phases of construction, to produce explanatory graphics for the building yard, to explore the object in movement, to simulate the light and the shadow, and the thermic loss or the structures, but allows the generation of all these elements *in a combined manner*. (The Renaissance model, did not have this feature).

The data included in the electronic images of a project are not more rigid (like in the traditional computer support programs), but they are easily modified. To modify the thickness of a wall in an electronic model involves the simultaneous assessment of the cost of the thermic values regarding the light penetration on the internal or external images because the parameter thickness could be interactively linked with many others. (We should go so far as to assume that the construction of digital 3D building models may play a "regulatory" role as part of the design approval procedures, thus becoming an integral and no longer an integrable part of it).

The research, aimed at filling the gap between the design and the model and at the same time between the model and the product, can eventually provide an important contribution to the future development of digital designing techniques, that will allow this type of modelling to be more and more substantially used in building engineering.

## Digital culture across…

### 5.1  The past . . .
The need to investigate the relationship between the most innovative digital representation technology and the historical-



**Figure 3. The ancient Castle**

cultural heritage and the meaning of such relationship is extremely topical. A case-study concerns the relationship between tradition and innovation in the representation techniques: the plan of restructure of an ancient castle in one Island in Tuscany, Italy (figure 3), in two closely related phases, the reading of the built structures and the outlining of a work plan.

Paper documents on the most significant building stages in the development of the castle were very poor and partly missing; the possibility to gain an insight of the current state of the castle was partly limited by its peculiar location: the place is impassable; some ridges are inaccessible and dangerous, and often swept by strong winds; even inside, some significant areas are covered with a thick, all-invading vegetation which could not be removed. The method chosen was to synthesise both the historical reconstruction and the on-spot survey into a 3D digital model (for the moment, a geometrical one) that could also be used as a basis for outlining the potential work plan (to be therefore completed by adding constructive components).

The progress of the extensions and alterations that have taken place over the centuries and therefore the *room* occupied by the castle as it extended *over time* was examined through a 3D model which blended these two dimensions into a virtual dimension: this resulted at first in a chronological journey that was used, later on, to simulate a contemporaneity of moments that are remote in time: from the past to today and beyond, through to the future work plans. This directly affected the possibility to gain an insight into the construction, its liveability, its "ambience." The virtual decomposition and re-composition of the fortified construction highlighted constructive problems that could be open to uncertain readings.

Through the dynamic method, we could experiment with constructive conditions that are typical of the building process and which otherwise would have been purely imaginable (because of collapses or restrictions), thereby reconstructing the accessibility and usability that would have been reconsidered at the design stage. Digital simulation was key to another two aspects: the designing and the informative one. The works, based on utmost feasibility and compatibility criteria, even in the choice of materials, had to be prefigured in the way they would fit in with the context (including some provisional devices).

### 5.2   . . . and the present
The digital tool has potentials that are unexplored because it frequently reduces its expression to just images. It is a rapid, dynamic, pure, and amazing electronic image that changes continuously and disappears; therefore, it seems unable to leave a permanent trace (it is not a statue). But this is only a general definition, an apparent contribution. However, at a deeper level there is another definition that is often forgotten, in particular, regarding architecture.

Digital technology offers a new possibility to architecture. The potential of artificial tools is not only a mere artifact. You can get

an image from a picture; the image is bi-dimensional. A three-dimensional model is not an image; it is not only a representation, it is an object: it means the transformation from a "dual" reality to a reality.

One often thinks that the virtual is in contrast with the real or, vice versa, that the virtual is a continuation, an extension of the real: I think that the virtual is a dual existence, compared to the real. To understand this "dual" reality concept, just think of the dual gender of some European languages. Dual: it exists in its own right, but in a form other than the one we usually attach to the existence of things. There is a harmonic development, for exemple, between the virtual dimension and the real dimension, which now needs to become more and more fitting. An example is the "capturing-processing-plotting" process, that can be obtained through the latest 3D scanners (combining laser and optic components): the real object is captured and immediately modelled in the virtual space, where its design is altered; then it is embodied again in man's physical space by the printers, also 3D printers, used in quick prototyping.

However the idea of space is changing due to influences that stem from temporal contractions and the new dimensions of interventions produced by the media, with which architecture enters in an always intensifying dialogue. The media bring "dominants" (a concept of European formalism from the early twentieth century) into architecture: i.e. "factors borrowed from other arts, able to rewrite the interpretative codes and affect the different components of a work."

Mass communication must be straightforward, clear, simple, to put across one's message in a concise way and establish a relationship with the receiver: to create correspondence straightaway. Digital media help this form of communication. Digital architecture is often the architecture of relation: it does not keep its distance from the onlooker; it asks the onlooker to enter the building.

Architecture is no longer defined by the space it offers, but also by the number and features of the services it supplies—its ability to change as quickly as possible, to be open to anything without contradictions. The building becomes, in itself, a service whose value is related to its ability to fulfil a given number of requirements.

This is a cultural model of "relation". But one should consider that extreme communication speed and profusion of information risk making everything look like everything else, making everything relative, a loss of accurate points of reference. A shallow communication, that tends to impress at first but leaves no marks isn't deep (because it must leave the floor to the next piece of information, which is coming up). This leads to fragmentation, segmentation, and division. This may be the case of an architecture in which the form of the building stands out, prevails over its function, on the consistency of the constructive decisions—a way to design to become independent. Locally, this produces buildings that after some time are unliveable. Thus, even digital architecture can risk reducing its message to pure

form, a magnificent but empty shell. The risk could be a fashion leaning towards aestheticism, that makes the representation ("marketability") prevail over "the fact" it refers to (the correctness and operation of the architectural design).
Digital media can help shape surfaces that flow so well they fly away. They impress, they attract at first, but they leave no marks; they don't turn into experience, reflection, critical awareness. This produces a shallow architecture: the metaphor of a lack of depth as is often stated by postmodernist culture.

The opposite also applies. I think that at the bottom of the need of interrelations, which is typical of today's communication, prominence should be given to the wish to create a bond between the person and the surroundings and "within the person": among all the needs it is made of. The possibility to tend to express oneself as a unity is a culturally strong position. Perhaps this can be compared to digital media (and digital architecture) if used to prefigure an architecture "of depth" where all the sides involved are holistically looked at through a constructive 3D model: we overcome the concept of images as "mere artifacts."

## References

Baborsky M. S. (2001). XX Secolo- architettura, Milano.

Dringoli M. (1997), La frontiera, la campagna, il mare, Pacini Editore.

Eloueini A. Architettura virtuale: nuova frontiera dello spazio e Architettura e macchine astratte (Internet).

Heinsen G. L. (1995). Appunti della lezione sul disegno in Architettura, La Editrice Artistica Bassanese e la Scuola Remondini. Bassano del Grappa.

Mitchell William J. (1999) *E-topia*. The Mit Press.

Nantois F. Lo stile informazionale in architettura (Internet). Uddin M.S. (1999). *Digital architecture,* Mc Graw-Hill.

Next 8^ Mostra Internazionale di architettura (2002) Marsilio Editore.