Preface

Geometry, Rules and Models

The "*Digital Revolution*" is changing each side of our society. In the world of the Industrial Design, which involves as well the renovation of architecture, a deep transformation improved the representation, then the formal reference and eventually the design itself. Facilitating the creation of complex geometries, 3D modeling offered a new, powerful tool, which allowed designers to create easily organic or not regular forms of contemporary international trends. As every actual turning point, the change regarded not only the shape, which means formal features, but just the concept and then the approach to design, namely the design process. The synergy between the digital modeling and the use of prototyping machines can easily transform virtual models into actual objects, anticipating the change in production processes and industrials manufacturing. The production is changing as well. With the 3D printing, the innovation concerns specially the process, leading the way to further changes that on the one hand give new life back to old practices, on the other hand link together the designer and the maker. A new crafts age opens after the crisis that afflicted the industrial age. Actually the world's economic crisis stressed the instability of the global model of the "Western" industrial system, which built its wealth on the production of huge numbers of identical objects. The mass production gave the economic justification for manufacturing production lines to make broadly identical low-cost products, but the industrial model failed with the contemporary decline of consumption. Markets ask for adaptability and product's customization: Digital fabrication answers the requirement of a new economic model that brings back to craftwork. The industrial design was a consequence of the machine age that followed the Industrial Revolution, when Design and production have parted. The industry called a careful project to manage the whole production chain: the design process prior to the making. A common fate linked the industry to design, while it diverged from crafts. In fact, the artisan was able to create objects from a true-scale drawing, without any preliminary draft, because in handwork to

make and to design refers to the same actor. Craftsmen just made objects, machines only produce them.

The dichotomy between the creative and the manufacturing phase, which features the industrial process, relegates the contribution of design in the drafting process. The relationship between thinking and making, originally intertwined in the action of the crafts's hand, evolved in design: The drawing played its connection role from making to thinking. It became a technical language instead of being just an active tool in creative process. Today, the integration of parametric generative software with digital prototyping in 3D printing allows the low-cost manufacturing of special pieces from the same code-model and it gets the concept of a single piece married with serial production and it puts again basic design rules at the beginning of the making process. On the other hand, it opens the way for a new type of designer-craftsperson.

A new Industrial Revolution is following this new relationship between design and making, that is new and old at the same time. To manage the transformation of tools without get rid of all the heritage of design culture, we need to re-discover the root of design. It lay in Shape Grammars and in their basic rules, which refers to the growing process of living. The design process becomes the scripting of a code in order to design a product's DNA that starts a morphing process with all its possible variants. Digital technology re-discovers and applies the fundamental principles of formal structure (grammar) and manages how these principles subtend the final form. The digital code subtends the form, and designing comes into play where the first meets the latter. The design merges with the making, they are the work of same actor, they are two steps of the same work.

These developments will have far-reaching implications in design procedures and methodologies. Digital fabrication may offer new opportunities to design, but it needs the development of a different approach in making process. Starting from these awareness, the eCAADe's Regional Workshop in Milan focused on the use of digital technologies and generative software in the design of innovative textures and surface patterns, particularly those which offer high performance to the areas of industrial design, fashion and architecture. The programme involved design and experimentation by the use of algorithmic design and digital fabrication tools, cognizant of ancient principles on the one hand, yet fully aware of innovations in new technologies on the other.

The first aim of the meeting, hosted in one of the biggest design schools in the word, was to focus participants on changes in design and in fabrication, which concern the scholars' attention to the whole process and its transformation through the digital management with the representation of their closed or interlaced systems, as they were organic systems. The second aim was to promote a comparison among schools from different countries and in between Italian schools, which arrived late to digital applications and are conditioned by important architectural heritage that conditions cities developments and attracts main economic and cultural resources. At the beginning of the twentieth century, the industrialization and the consequent social changes led to the birth of design and to radical transformations in architecture. Today, the closed relationship between man and information management

makes it possible to amend the object during its production, combining the concept of the single piece with mass production. It is possible to create objects that change gradually their shape. They adapt to different needs of customization, and/or create have responsive element that react to environmental stimulus.

The product and the architecture become changeable and mutant. In the different scales design, from objects to buildings, the morphology changes in order to fit in "*real time*" with the user's needs, following a set of rules that fix the relationship between changing parameters. The parametric design is a digital structure of dynamic links in between different factors: generating events (input), the project (digital actions' processing of shape), and formal representation (output). It is a way to create responsive objects and architecture that are able to react to externals stimulus.

Parametric representation includes the variable "time", and it concerns the simulation of movement in order to check the handling of responsive elements. Digital design goes over the virtual representation and improves the interaction between the designer and the whole environment. The effect of parametric design and rapid prototyping on the development of new forms of kinematic surfaces and responsive architecture is flagrant. This digital evolution is powered by a renewed relationship between man and computer, or more generally between the human being and the digital space. The key element of the innovation is the centrality of computing in the design process, such as in new products development. Computing is the intelligent soul of design.

An articulated design process subtends the representation of this complexity. It put together on parametric modeling, on kinematic simulation of models, on digital prototyping, and on the digital acquisition of experimental mock-up models.

This book gathers several contributions to the workshop: some introductory lectures and several personal researches. Speeches are organized in three parts:

The first section focuses on design models and shape grammar, up to the management of complex forms. It begins with an analysis of the organic model and the basic theory of design.

Innovative concepts derive from organic models through the use of generative design tools and digital fabrication technologies. Shell, lattice, and grid structures can underpin patterns and surface textures. The knowledge of the Nature's harmonic relationships can be traced to Pythagorean doctrine, Vitruvian principles, and later Renaissance thinkers.

In the nineteenth and twentieth centuries, the knowledge of biological systems development provided inspiration to theoreticians like Theodore Cook, D'Arcy Wentworth Thomson, Ernst Haekel, Jay Hambidge, Matila Ghyka and Keith Ctitchlow, and practitioners like Richard Buckminister Fuller and Charles-Édouard Jeanneret-Gris (better known as Le Corbusier). In contemporary times, digital technologies allow an easy access to patterns and textures, as well as knowledge of proportion and balance, at the nano-, micro- and macro-levels; such technologies offer sources of historical inspiration in the fields of the visual arts in general and industrial design and architecture in particular. In the Nature's models, the

industrial design and the architecture find their common origin in ancient concepts of basic design.

The second part concerns the relationship between Design, Architecture, and Responsivity. The term "Responsivity" is used in relation to the changing morphologies of the architectural artifact. As early as the 1970s, visionary thinkers like Nicholas Negroponte proposed that advances in artificial intelligence and the miniaturization of components would soon give rise to buildings, capable of changes in the external and internal environment. Thanks to technological advances, today we are able to manage these changes through pre-programmed mechanism of real-time response and feedback embedded in inhabitable spaces. It is possible to consider the building as a system which adapts its behavior to information acquired about its users. Information external to the building could also be integrated into the process, so as to respond to a multitude of condition able to create new forms of experience and expression.

The third section deals with digital heritage. "*Heritage*" is a broad term that refers to the study of human activity not only through the recovery of remains, but also through tradition, art, and cultural evidences and narratives. "*Digital heritage*" is an active area of research throughout the last decade, and it is a process of research and transmission of ideas and values and a knowledge that includes the material, the intangible and the virtual.

With the advancement of technology, digital heritage projects have enhanced their capability to increase interaction and manipulation of the research object, facilitating new findings. For example, augmented reality, the integration of digital information with the user's environment in real time, seems to be of particular relevance in the fields of archaeology, architecture, art, and city planning.

Furthermore, a few recent cases demonstrate the possibilities of heritage interpretation through use of modeling generative tools. These researches indicate new frontier in study of cultural heritage, while opening up possibilities of revealing complexity levels that could not be managed only a few years ago.

That demonstrates how digital heritage interpretation can be considered as a new process and at the same time how to ensure multiplicity in understanding the past.

That focus on cultural heritage expresses a special feature of Italian schools that apply innovative technology in the development of a new approach to the management of material and immaterial values. Actually, the application of digital technology to cultural heritage is an important topic in Italy, not only concerning digital representation, augmented reality, virtual museums, and heritage conservation. It may be an useful research tool that links tradition and innovation. New technological inventions have always made it possible to investigate and improve our knowledge of the world—think of the introduction of perspective and the use of the frame as the basis for Renaissance architecture and painting or of the studies of the lens by Galileo as the basis for the telescope and microscope. These tools, made thanks to scientific research, amplify human capabilities, while increasing the capacity for investigation and analysis and thus enabling new discoveries. Similarly, the research covered in this publication can be considered as an extension of human thought, enabling the understanding of formal properties and complex

nonlinear phenomena which cannot be managed with traditional tools. In a word where computer-assisted design accompanying the designer from the generation of the form through its digital fabrication, the integration with theoretical analysis and comprehension tools able to maintain a high level of coherence is increasingly necessary. The creation of conceptual devices able to define correct methodological procedures represents the intellectual challenge of the future for the design disciplines.

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