THE IT REVOLUTION IN ARCHITECTURE

THOUGHTS ON A PARADIGM SHIFT

by Antonino Saggio

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The IT Revolution in Architecture

Thoughts on a Paradigm Shift

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Antonino Saggio

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To Raffaele and Caterina and
all those children who study

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Forword

Our relationship with information technology is structural, cultural, and formal at the same time. *Structural* because all of society rotates around the value of information; *cultural* because orienting one's self in this new scenario is fundamental; and *formal* because the procedures put into effect by this IT way of thinking can also influence the way of conceiving architectural form.

The expression "IT Revolution" was chosen to underline a parallelism. During the 1920s, driven by the new mechanical and industrial world, avant-garde architects completely reformulated architecture. This was a revolution because architecture modified all its operational parameters.

Today we are in a different era. Architects' key words have changed. Now we think in terms of "personalization" instead of "standardization." Processes are no longer seen as "division into cycles" or "assembly lines" but "networks" and "systems." The city is no longer conceived with single function zones but as an interactive whole of uses and functions; we no longer refer to the idea of a "repeatable model" but to concepts of adaptability and individualization.

Spaces tend to be ever more multi-functional and designed using complex geometry. Construction utilizes special pieces created by cutters guided by digital models. But information above all becomes the essential component of a new architecture and a new urban environment.

Information technology is imposing itself as the central paradigm for a new phase in all of architecture; the dynamic interconnections at the heart of IT are being transferred from the world of digital models to the reality of a reactive, sensitive, interactive architecture.

In order to deal with the various aspects of this subject, we propose an organized structure in some ways sequential and essay-like, and in others a-systematic and hypertextual. From the essay point of view, we will follow a sequence starting with an *Introduction*, a quick, summarizing treatment that anticipates a series of arguments presented in the three main sections constituting the body of this volume. The *Introduction* is followed by the first part of the book concerning *Questions of Content* and organized into three chapters. The first of these is called *Substances* and deals with the relationship between content and aesthetic research in light of the closely related, major concepts of Modernity and Crisis. Then a discussion based on the theme of *Communication* gives central place to the return of the narrative moment in architecture over the past few years. This discussion continues with the theme of the *City* and finally *Landscape* and the new relationship between architecture, nature, and scientific and technological research.

The second part of the volume is dedicated to *Theoretical Aspects* and concentrates on defining three fundamental concepts. The first chapter, *Information*, structures the conventional meaning of information, clarifies the meaning in information technology and attempts to explain why the research of avant-garde architects over the past few years has revolved around this term. The second chapter, *Time*, discusses the close relationship between time and space, the coexistence of many reference systems, and the meaning assumed in today's design research by technological "prostheses," first among these the Internet. The third chapter considers the role of the *Model*; on the one hand this deals with questions of method, including general design, and on the other, exemplifies the role of the term in a more specifically digital and scientific context.

In the third section of this volume, *New Spaces of Interactivity*, the chapter *Reification* analyzes the close relationship between scientific paradigm, mental form, and architectural research; the chapter *Catalyst* illustrates in detail various ways interactivity is manifested in contemporary architecture. The closing, summary chapter, "*Informatizable*" *Architecture*, sums up the fundamental arguments of the book and presents an index of the terms used. These terms are arranged in binary pairs that underline the difference between the industrial and IT paradigms in architecture as well as other areas of thought and activity. The section *For Further Study* provides several starting points for further reading, consideration, and information, as well as a glossary.

As mentioned earlier, the book also interweaves a second, hypertextual structure alongside this linear structure and sequential progression. If so desired, the reader can leap from one discussion to another. For example, first consider a possible definition of *Information*, and then consequently be attracted to the term *Communication* to tackle reciprocal relationships, or become interested in a major theme of current research such as *Landscape*, and then move on from this to the concept of simulation and the *Model*. Or the reader may consider the theme of *Time* and see how this argument is linked with the idea of *Catalyst* and this in turn to the concept of modernity as presented in *Substances*. So even though the individual chapters are sequentially related to one another, they can also be read independently. The give and take of the operation is the presence of certain conceptual and terminological repetitions. Though they may weigh down a continuous reading somewhat, they are indispensable to a self-directed reading. In short, this book, accompanied by supporting bibliographical material, aims to be both a text and hypertext. This structure seems to me the best suited to the times and the subject.

ACKNOWLEDGMENTS

How can I give credit in one single text to research that has involved the writer in the creation of a book series with the same title as this volume and has seen around thirty-five specialized books published in various languages? A dozen specific articles, many prefaces, several conferences, and numerous university courses have originated around and alongside this series. A considerable amount of work has been produced; relationships are close-knit between the various theoretical, scientific, technological, design, constructive, and educational aspects. The structure chosen for this book was to avoid a "crib sheet" on the "IT Revolution in Architecture." The formula of the "treatise" was just as impossible to use not only because many aspects of contemporary scientific research are oriented toward a structure that remains intentionally open and serves to launch new hypotheses rather than solidify certainties, but also because this aspect is reinforced by the material that by its nature finds itself in an free, interconnected, intrinsically problematic dimension.

For their careful reading and useful opinions I wish to thanks Gianluca Mori from Carocci Editore, and Antonino Terranova from DiAR, la Sapienza Rome. I would like to thank all the authors in the book series from 1998 till today for having made frequent and important contributions to promoting a new digital culture in architecture. These authors are: Markus Bandur, Furio Barzon, Stefano Converso, Derrick De Kerckhove, Francesco De Luca, Peter Eisenman, Michele Emmer, Maia Engeli, Mirko Galli, Marco Galofaro, Luca Galofaro, Paola Gregory, Alberto Iacovoni, Ian+, Alicia Imperiale, Kari Jormakka, Eleni Kalafati, Alexandro Ladaga, Alexander Levi, Michael Leyton, Bruce Lindsey, Silvia Manteiga, Antonello Marotta, Paolo Martegani, Patrizia Mello, Riccardo Montenegro, Claudia Mühlhoff, Marco Nardini, Kas Oosterhuis, Maria Luisa Palumbo, Dimitris Papalexopoulos, Maria Rita Perbellini, Christian Pongratz, Luigi Prestinenza Puglisi, Gianni Ranaulo, Paola Ruotolo, Amanda Schachter, Gerhard Schmitt, Patrik Schumacher, Pierluigi Serraino, Valerio Travi, Makoto Sei Watanabe, Nigel Whiteley.

Over the years, several authors and friends have often emphasized the urgent need for a general, theoretical text on the theme of "The IT Revolution in Architecture." This has finally arrived.

Introduction

That is why a new theory, however special its range of application, is seldom or never just an increment to what is already known. Its assimilation requires the reconstruction of prior theory and the re-evaluation of prior fact, an intrinsically revolutionary process that is seldom completed by a single man and never overnight.
Thomas S. Kuhn

Here now is a quick, completely general summary of the main facts. I believe it was 1961 when Lego constructions started containing a light bulb-brick. Placed in the living room, in the evening it would illuminate the model of a house. This was more than we expected. After years of research at MIT laboratories in Boston, several years ago Lego began distributing a new type of brick, a *chip-brick*, a small plastic block containing a programmable integrated circuit that would allow constructed models to do new things, to move, react with the environment based on conditions occurring outside, almost think. In reality, the sociologist Alvin Toffler had already anticipated this type of event in 1980. In his *Third Wave*, he maintained that after the agrarian age, lasting several thousand years, then the industrial and electric ages, lasting around a hundred fifty years, the electronic age had now officially arrived and at its heart lay information and the treatment of information. Unfortunately, since Toffler is not an architect, he is not able to fully develop a specific discussion close to our hearts: in other words, the influences this information era will have on architecture and urban planning.

Everyone remembers the frequently abused term “The Industrial Revolution.” This took place between the 18th and 19th centuries when the labor force was for the first time artificially produced. The invention of the steam engine sparked changes of epochal significance: movements of populations, accumulation of capital, the birth of a city completely different from cities in the past, new social classes, new philosophical systems, and new organizations of scientific thought in addition to a growing acceleration in technological discoveries.

For architects and artists, industrialism was a crisis that lasted more than a century. If we look at the eclectic, revivalist, and uncertain movements during a good part of the 19th century, we see an inability to respond to the changes industry had imposed on the world. But between the 1907 of Picasso’s *Demoiselles d’Avignon* and the 1926 conclusion of the Bauhaus, this response finally took shape. In other words, art resolved problems that could not even be clearly formulated before they were resolved. The crisis was transformed into a value and created aesthetics of rupture. This will be discussed at greater length in the chapter *Substances*. Who would have thought that a response could be made to industry and its world with an architecture that no longer had preset typological outlines but a free and functional arrangement of bodies, no longer stone structures but points, no longer opaqueness but transparency, no longer pompous themes but houses, factories, schools, and neighborhoods for everyone? This new movement was so powerful and so right, and the Bauhaus building such a pregnant symbol that the response became global, international, and successful. Now let’s return to today. The only word that truly expresses what is happening before our eyes is “revolution” and more precisely an “Information Technology Revolution.” Therefore, the problem occupying forward-looking architects is one with a historic importance comparable to Gropius.

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Let’s return to the Lego brick. The world of information technology is also made of bricks; for clarity let’s call them “informational atoms.” The basic characteristic of electronics is that the support containing the information (numerical, alphabetical, pictorial, vectorial, three dimensional, etc.) is not rigid (stone, papyrus, parchment, paper, etc.) but is made up of an electric impulse. It changes at the speed of light.

The advantages to this are well known. Information varies continuously, the word is constantly refined, one number always replaces another, pillars thicken, plants lengthen, etc. Seated at our desk, we can have a teleconference over the computer that brilliantly accomplishes everything, or at least almost everything. With the Internet, we are part of the whole world. But on closer examination, this series of practical advantages derives only from the difference between an electrical support and one that is immaterial or rigid. In reality, these advantages have almost nothing to do with the truly central aspect of information technology.

One of the great popularizers of modern science, Fritjof Capra writes: "In quantum theory, you never end up with 'things': you always deal with interconnections … It shows that we cannot decompose the world into independently existing smallest units. As we penetrate into matter, nature does not show us any isolated building blocks, but rather appears as a complicated web of relations between various parts of a unified whole."

So to start with, let's not delude ourselves. The problem is not inserting a technological brick into our buildings like Lego has done. Merely technological gadgets (interactive screens, cabling, robots that automatically open and close devices, and the like) will not unravel the problem because we have failed to grasp the idea that the real center of information technology, like matter, lies in its interconnections.

The world of information technology is in fact essentially a mobile web. We can reassemble informational nuclei with each other, hierarchize them into innumerable relationships, and create models. By changing one atom, we can create a change in the entire system or form different worlds by changing the sense, order, or network of the connections.

The word "model" becomes key in this way of thinking. A computerized model of a building is potentially not just a three dimensional construction that, like a real building, gives us infinite points of view, but is actually a model in the scientific sense (e.g., a mathematical, financial, physical, or statistical). The information is interrelated and a change in one varies the other. By now all CAAD (*Computer Aided Architectural Design*) programs can create a hierarchical structure (from time to time called symbol, type, object, etc.) that represents the specific possibility of creating within a project design that dynamic web at the center of electronic design.

Within the organization of a computerized design, dynamic relations can be established among the information describing a project so that changing some of this information consequently creates changes in others connected to them. The possibility of simulation in these environments deals simultaneously with spatial and constructive, functional and formal, quantitative and economic organization. A design represented electronically is not just completely different from a plastic one (considering that three-dimensional visualization is only one component and basically relatively insignificant) in the sense it is a "model." It gives us a dynamic, open structure for simulating a reality that in our case is a possibility to investigate and design.

This way we can constantly simulate by designing and design by simulating. This has now expanded from the design phase into the construction phase. (We will more and more frequently see cutters that cut pieces based on our designs. We will more frequently see construction robots directly guided by computers. And we will more frequently see this computerized legacy, this model, expanding further beyond the construction phase into land registry, deeds, building management, and the city itself.) Now we come to another aspect of the question.

The fundamental messages of the industrial era were assertive messages. Consider advertising. This soap washes whiter, these jeans are more resistant, this toothpaste contains fluoride. We know that today advertising sends more and more metaphorical messages. It induces an association between a series of elements and the product, frequently without showing or even describing the product. First we buy the narration, the utopia the product promises, then the form, and absolutely take for granted the product works. The container wins hands down over the content. The fact is that precisely in relation to the enormous mass of information contained in the product, and therefore the know-how condensed within it, all the contents can no longer possibly be rationally and technically transmitted. Because of this, static and assertive messages must be eliminated (cause and effect, before and after, etc.) and substantially metaphorical, figurative messages must be launched, as dynamic as electronics itself. Thus "rhetorical figures" come back into play (estrangement, metonymy, and many others still, but for simplicity we will stop at metaphor).

Induced by a feeling that goes beyond industrial mechanism to open onto a more liberated and poly-directional sphere of messages, the process based on the dynamic interconnections of metaphors, invests everything in our current era. It is sufficient to look at design and the sphere of architecture, itself even more resistant to change. A building is no longer good if all it does is function, is solid, spatially rich, livable, etc., but instead because it recalls something other than itself. One architect makes a dramatic Z to recount the drama of the holocaust; a second, a dance of telluric slabs for his church; a third, a lotus flower in his auditorium; a fourth, crevasses that clash against each other in his house. We know this process of metaphorization invests a good part of today's architecture and that its fundamental field is a new interiorization of landscape and the relationship between man and environment (cf. *Landscape*). This is acquired, or almost. To continue, we must return to electronics and especially its center: interconnection.

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After the invention of the personal computer (we are speaking of 1976), another important progress in information technology occurred in 1984 with the wide-scale distribution of a revolutionary new operating system. The basis was, naturally, metaphorization.

No longer were there abstruse codes which appeared on an inanimate screen, but objects on a desktop-screen. There was a large table of instruments for design; to write, a scroll similar to a typewriter; to design, a universal drafting device. This first level of metaphorization was fundamental; since it introduced millions of people to using the computer, it was important that it become a standard on more platforms.

However, the second invention was even more important and so innovative that only after several years is its significance being effectively understood. It was in 1987 and a genius, William Atkinson, after having made a substantial contribution to the construction of the metaphor of the desk, developed another new idea. Why not give the user not only a pre-packaged metaphor, but also the possibility of creating metaphors himself? Why not work, in other words, with a metaphor “creating” tool?

So Atkinson created Hypercard, which is just that; a computer environment which creates metaphors. The user puts down information under any form (designs, writing, numbers, tables, animated sequences, three-dimensional objects and many others) and either at the same time, or later, performs two fundamental actions: creates the connections and organizes a metaphorical environment.

The most banal of these environments is the card, where the information is contained and where, clicking on each, the user can proceed in the network of relations; but along with the card, there can be millions of other metaphorical environments. The production of an artist is in his virtual studio, a virtual lesson is held on a blackboard, shopping is done at home in a real store, but more importantly the user can dream and build worlds which do not exist.

In brief, this is what is called Hypertext. The basis is the interconnection between the units of information and the creation of a metaphorical environment in which these interconnections are located. The end result is that the user has methods, which are non-compulsory, non-sequential. He can follow courses already preset or find his own new one. By now, this system is everywhere, since, while in 1987 it was only relegated to the single computer, internet today is a planetary web which connects many worlds of information to each other. Apparently, the process brings to a virtual and “second” life, but we are interested in “real” architecture.

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Let us return to architecture and ask ourselves: can we also work in architecture on this second level? Can we work on an architecture which is not only metaphorical, but also a “creator of metaphors”, which leaves its own decodification open, free, structured/non-structured and suggests and offers to the user the possibility of constructing "his own story"?

To put it briefly, the true end is not only the metaphorization of the first level, but that of the second. To manage not only to imagine an architecture which is fluid, metaphorical and open, which plays on the skin like new, immaterial sensors, which completely assimilates and values a multimediality which moves into systems of control and information, but which is above all capable of generating other metaphors and causing others to be generated, those of life and its advancement into this new dimension: the entire past and the entire future.

Can we work on this ambitious and very difficult concept as the frontier of our task? Finally, does a more adequate word exist than Hyper-Architecture to describe this challenge?

What can help us? Can it really be that this sense, this need, in a century so rich in events, personalities and geniuses, has not already been at least guessed at? Over the past few decades, several important discoveries have been made in architecture by looking at figurative art.

The latest Gehry owes much to Boccioni and his concept of trajectory, to that push beyond the plastic quality of the isolated object for an atmospheric vibration. Peter Eisenman has borrowed more than one technique from the vibration of Duchamp and Balla. Pollock's *drip technique* has flowered in experiments into new forms of landscape and the construction of nature. But who has truly perceived the innate spatiality in a Kandinsky?

Geometric worlds and atoms are inserted into his paintings in a liquid amoeba, but these figures are interconnected with lines, with overlays, with interconnections. The whole emanates energy and seems like a hypertext because it can continuously move; it has a photographic structure in a pattern, but its value is not the static moment of a Mondrian, but the possibility of becoming, of being free and open, of leaping from one state to another.

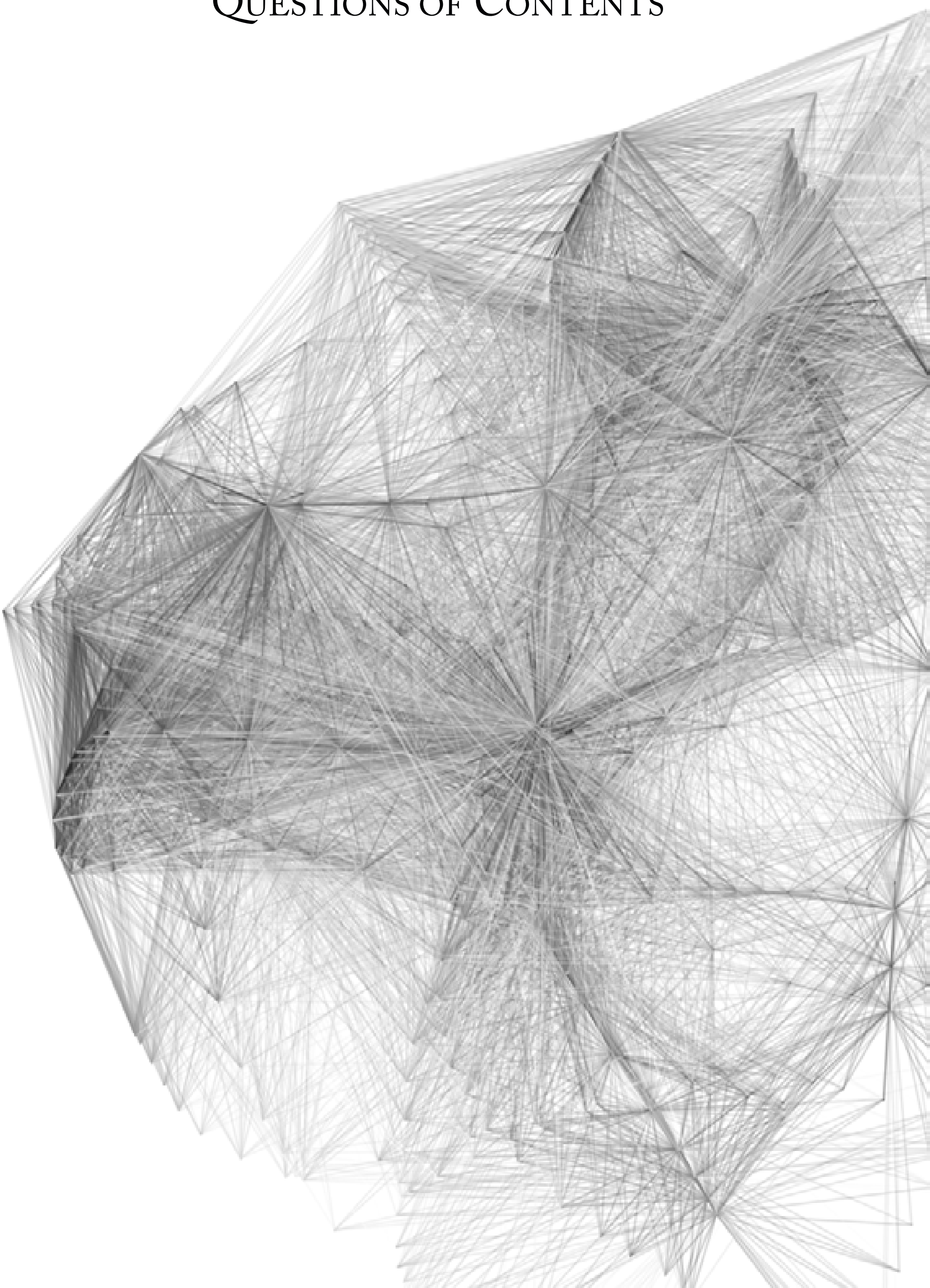
Certainly, we know that without impressionist orientalism and the breaking of the square box, there would be no Wright, that the space of Braque foreshadowed the Bauhaus, that the energy of movement and Expressionist deformation were related to Mendelsohn and Scharoun, that neo-plastic designs transmigrated almost directly into Rietveld and Mies. We know that artists have a spatiality which transmigrates into architecture.

But the fluid, liquid, submarine, metaphorical, symbolic and interconnected spatiality of Kandinsky (and Mirò and Klee) is, without information technology, impossible to conceptualize in architecture. With information technology, on the other hand, this becomes almost vaguely intuitable.

In the final section of this book, we will return to this idea in a liquid spatiality that has already existed in painting in the 20th century, linked to the key IT term "hyper." This links IT to metaphor and dynamic interconnections, and leads to a research in which we believe even more, a research into *interactivity* as carried out by the new IT architects (see *Catalyst*). But this discussion would bring up once again and remember this is just an introduction.

First we will consider the theme of new Substances, in other words the relationship between content and the ideas from Modernity implicit in the choice of the term "Revolution"; then we will move on to the other concepts anticipated here.

Part One
Questions of Contents



1. SUBSTANCES

These terms are closely connected to one another. Placed in sequence, they are: substance, crisis, modernity, aesthetics, and, in our case, the IT Revolution. Having to choose only one for this chapter's title, I believe "Substance" is precisely the word densest with meaning. The word "substance" was introduced into the contemporary architectural debate by Eduardo Persico who in turn borrowed it from Saint Paul.

In the conclusion to his 1935 conference "The Prophecy of Architecture," he said: "For a century, the history of art in Europe has not been merely a series of particular actions and reactions, but a movement of the collective consciousness. Recognizing this means finding the contribution of current architecture. And it is not important that this preliminary question is denied by those who should most defend it, or betrayed by those who vainly most fear it: this still arouses the secret faith of the era, 'the substance of things hoped for'." In Persico, as in Pagano, Terragni, Venturi, Argan, and Giolli, there was a tension toward "substance" that regarded the simplification and standardization of industrial processes, the response to the concept of public housing, services, and urban planning; the search for an abstract, elementary, sensible aesthetic. Aside from the indigenous, Mediterranean, classical, metaphysical dreams, a new culture needed to be promoted that would bring Italy closer to Europe.

This idea that architectural research has to do with "substances" (i.e., situations, problems, and necessities) can be linked with a definition of Modernity useful in the context of this work. But to clarify, let us first look at two regularly used definitions that will not be adopted here.

1.1 Modernity

The first definition considers Modernity from a chronological standpoint. According to this interpretation the "modern" world temporally follows the "ancient" world, which some historians claim began in 1492, and others in 1789.

The second interpretation is used for example by the new functionalist architecture that defines itself as "modern" in certain contexts (for example at international congresses on *Modern* Architecture, or in the phrase *Modern* Movement, or in some histories of *Modern* Architecture). This accepted meaning contains an implicit value judgment. In other words, the meaning states that *modern* was positive and progressive because it responded in various ways to the times and needs of the new industrial society. These two accepted meanings, the first temporal and chronological, the second containing a value judgment, are accompanied by a third meaning, the most useful in the context of this book and the one we will adopt.

This definition maintains that, "Modernity … is what transforms crisis into a value, a contradictory moral, says Baudrillard, for it gives rise to an aesthetics of rupture." This definition of modernity came to me during a conversation with Bruno Zevi. At a certain point he said to me: "Modernity is what turns crisis into a value and gives rise to an aesthetics of rupture." Even though he had throughout his life in various ways worked specifically on modernity, he had never developed this specific interpretation in detail. Found hidden in a parenthetical note in the last paragraph of his *Architettura della modernità*, published in 1994 in the "Mille Lire" series from Newton Compton.

Zevi was careful about quotations and also verbally emphasized that the definition came from Jean Baudrillard, in part shared by Henri Lefebvre. But from the beginning I considered its origins marginal. The important aspect of this definition in my opinion lay in being a real instrument; it created a way of thinking, verifying, and orienting. In this sense, the value of this quote lay not so much in its philological genealogy (who used it first and how?), but only if interpreted and used on its own. (Zevi himself concluded a famous conference in Modena in 1997 with the phase "*continua tu… tu… tu…*" ["carry on you… you… and you"]).

A key to understanding this instrumental aspect of the definition of modernity is contained in the word "crisis." Modernity, a modern attitude, confronts crisis, "transforms it into a value" while, on the contrary, an "ancient" attitude suffers the crisis, retreating into what it already knows. Now naturally many crises exist on a historic, social, national, and naturally also individual level. This idea of crisis refers back to Persico's idea contained in the "substance of things hoped for," the idea of anchoring work in innovative, essential concepts that architecture must cultivate and manifest in order to actually be a "substance" (of things hoped for).

1.2 Aesthetics of Rupture

One key word in our definition of modernity needs to be discussed at this point; this is the word "aesthetic." In fact, the concept of modernity not only aims at dealing with real content, but also "giving rise to an aesthetics of rupture" and change. In this context, the aesthetics of rupture and change implies the aesthetic level represents something very different from the notion of both "beautiful" as well as "style."

Without covering almost three thousand years of thought related to the idea, let's examine a definition of aesthetic still useful in this context. Above all, I would say that aesthetics, considered in this area of discussion, is a form of concise awareness that arrives not through analytical, rational processes but through some sort of short circuit, rapid yet profound at the same time. These short circuits of aesthetic awareness pertain obviously to various forms of expression (poetic, architectural, pictorial, musical, etc.). They do not function by accumulation but by leaps (Roman Jakobson would say "by combination and not selection"), in other words by "figures," using this term in a broad manner. (A figure may also be a piece of music or architecture or poetry and not just a painting or sculpture).

Having established that an aesthetic is not in fact a style (and certainly has nothing to do for us today with "the beautiful," as it did for the ancients), now the decisive sense of the quote can be understood. Through a contradictory, combinational, and non-linear process, Modernity transforms a situation of crisis, a real and substantial problem, into value, i.e., into a challenge to be faced, into crucial nourishment. This tension toward modernity tends to create aesthetics of rupture and change. From a certain point of view, the more deeply the crisis is felt and present, the stronger the aspect of rupture and change for which the new aesthetic searches, even though the path, as history teaches us, is frequently long, tortuous, difficult, and certainly never direct or predictable.

Contents (crisis) and aesthetic are thus linked in a process that is not linear, as socialist realism would have it, but proceeds by a method of leaps. The poet and mathematician Piet Hein splendidly defined this method of understanding and resolving everything through art: "Art is resolving problems that can not be formulated until they have been resolved." This is a different, ingenious manner of combining the two key concepts of crisis (here "problems") and the aesthetics of rupture (here simply "art").

1.3 Crisis

At this point, we must take a step forward. The industrial society connected to that phrase from Persico (with sensational new elements to which the architectural culture of the 1920s managed to respond aesthetically as well as ethically, functionally, and constructively) has been replaced today by a radically different society. The crisis of change is just as profound as that which saw the birth of the industrial model at the dawn of the 19th century and represents a complete revolution in many aspects of society. From a historical point of view, the crisis of our time is closely connected to the advent of the economic model tied to information technology and the enormous number of people now skilled in various ways in the creation, transmission, and formalization of information. We are experiencing a historic moment of passage from the industrial world to the information world. To help better understand this, as a parameter Alvin Toffler uses the number of employees in the sectors of the production of goods (statistically in agriculture and industry) as opposed to the production of services. In the United States, the number of employees in the service sector became greater than the other two combined as early as the mid-1950s and constantly accelerated over the next half century until surpassing 80 per cent in some metropolitan areas. But this well-known phenomenon also affects all those countries that call themselves industrialized and now should instead call themselves "informatized."

In other words, the information society is completely changing the rules of the game, all games, including those of architecture. If large industry and machines were the driving engine of the previous society, in this society these are in the service sector. Today's machine is the computer; its fuel, the systems of formalization, transmission and development of information. If the wealthiest men were once industrialists (Carnegie, Ford, and Agnelli), today they are the producers, not even of hardware, but of the software for software. William Gates was the teacher, but now we have Larry Page and Sergey Brin, the founders of Google. We could discuss this at length, but as has been clear for more than two decades now, the truth is we are in a historic phase completely different from the previous; we are in the *Third Wave* and thus must confront new crises caused by the emergence of the world of information in all its economic, political, social, and, in our case, architectural and urbanistic components.

But if, from one point of view, the progressive retirement of the industrial society has specifically determined this crisis, then from another point of view, the simultaneous rise of the information society offers immense opportunities and becomes a fundamental agent for finding solutions and answers. Is there still any doubt regarding the decisive role of information technology in a greater number of human activities (from biology to physics and medicine) that could in no way do without it? Enormous progress in these sciences is due to IT applications. Why should architecture be any different?

So here is another way of understanding the choice of the term "IT Revolution." In relation to a phase in architecture characterized by the response to the industrial world, the purpose of research in this radically different historic phase is to tackle ideas from the world of information and use these to transform the crises that have arisen into values and opportunities.

What are, very briefly, some of these crises facing the passage from the industrial to the informational world that guide today's experimentation and somehow reveal new values? The first deals with the so-called "brown" or disused areas that represent a fundamental field of opportunity and open up new investigations based on the vital characteristics of new contemporary spaces. This vitality transforms these "brown" areas, as real architecture has always done, into a new aesthetic feel that foresees and imagines a different city and calls for radically new design methods as well as activities (cf. *City*). The second revolves around the concept of landscape as the great area of contemporary architectural research that puts back into play the relationship between architecture and nature. This area includes the great relationship with sustainability and enlightened use of resources. Architecture looks at nature along with science and seeks new structures for its work in the difficult, the complex, the rough, and the apparently chaotic (cf. *Landscape*). A third has to do with the great role of communication. Elements of information and communication determine value in post-industrial society. This completely changes the assertive communication mechanisms and typical parameters of functionalist architecture (cf. *Communication*). A fourth opportunity has to do with the emergence of a systemic concept of space and the progressive abandonment of a deterministic concept. This area is complex in part because it deals with the change in the concept of Time and the use of constantly more advanced technological inventions, first among these the Internet (cf. *Time*).Finally the fifth substance that cannot be ignored, one that unites and drives everything forward, is again the aesthetic. Transparency was the catalyst for many questions, needs, and aspirations during the mechanical and industrial functionalist revolution in architecture. Today, what could the catalyst be of this era and the crisis of the IT Revolution in architecture (cf. *Catalyst*)? Before proceeding, let's start by asking: How do Communication methods change in the information society? Are we truly in a Super Symbolic society for architecture as well?

2. Communication

There is an ongoing debate on the role of communication and return of narration in today's architecture. Kenneth Frampton, in his well-known book on *Modern Architecture* (Thames& Hudson, 1982), mentions the construction of the Bauhaus building by Gropius only in passing. Instead, our book considers this building absolutely fundamental in the history of architecture. The end of the chapter will present how everything the Bauhaus proposed and exemplarily created was completely overturned. This also means changing paradigms, enormous admiration combined with the need to move ahead.

2.1 The Return of the Cathedral

The new Bauhaus headquarters was inaugurated more than eighty years ago in 1926. In Dessau all links with the construction of the past were drastically eliminated. In particular, the new building cancelled every idea of building typology, structural continuity, urban morphology, perspective framework, historic style, and finally *cathedral*, conceived as a communicational and symbolic meaning attributed to architecture; a painful elimination if we remember the image of a cathedral designed by Lyonel Feininger was present in the school's first program, edited by the new director in 1919. Among other things, Walter Gropius believed "The new construction activity of the future … will rise toward the sky like the crystalline symbol of a rising new faith."

As we begin to develop this point of view, we see the decisive aspect here is the disappearance of the cathedral. Modern movement architecture could only tautologically communicate *its own function*. The final form was determined by abstract, meaningless signs ("pilotis," two-dimensional planes, ribbon glass), assembled like mechanical pieces and based on purely syntactical rules. Accused by post-modern historiography of having an "inhibition" toward form, this method of operating had a profound logic because it simulated the way machines were conceived, designed, and built.

But when the parameters of objectifying functions, standardizing components, typifying solutions, and serializing processes, together with the entire industrial production system, entered a crisis period (that exploded during the 1970s and 1980s), it re-entered the field as quickly as it had been excluded, i.e., in the narrative, symbolic, and communicative moment of architecture.

Jørn Utzon anticipated the beginning of this process of reintroducing meaning and symbol into a language of modernist origin with his design for the Sidney Opera House in 1956. But the process took on full importance only more recently. In 1997, for the first time it became clear to everyone that architecture had completely reacquired its public communication value (if we want to use a derogatory term, it *advertising* communication value). For several reasons, let's use the Guggenheim Museum in Bilbao as a litmus test. (We could also make similar considerations about the new wing of the Jewish Museum in Berlin.) Since 1997, the world has been going to Bilbao as if on a pilgrimage, drawn by a new cathedral, a new secular cathedral of culture created with a contemporary language. Apparently, this has no relationship with information technology or the architecture of information. But doubts arise if we consider Toffler's definition of today's society as "supersymbolic."

This return in grand style of communication as the driving engine of a new phase in architecture is actually something *structurally* linked to the information society and information technology, a fact frequently misunderstood and considered secondary.

Information represents 90% of the value of the vegetables we buy at the supermarket (research, marketing, distribution, packaging, and bar codes connecting goods and consumers in a continuous flow through purchases with those famous "discount cards"); the same is even truer with appliances and automobiles (where the presence of electronics is directly injected into the product). More and more, people produce goods that are "pure" information. Information is what makes any and all goods competitive today. Information is the added value of both "traditional" goods as well as obviously, and even more so, electronic goods.

Now the passage between information and communication is very fragile. In the field of architecture and objects, information also means narration, image, and design. Consider a watch, a car, or at this point even an architectural design. First we buy the narration, the utopian lifestyle, then we buy the form, and just take for granted the product will actually work. Containers win out over content.

But obviously this first communicational, narrative and frequently metaphorical level is only the beginning and constitutes, if you wish, a very superficial relationship between architecture and the IT Revolution, far from influencing the essential substance in play at this moment. For a parallel example of where we are today, consider Bruno Taut's *Glashaus* (Glass Pavilion) at the 1914 *Werkbund Exhibition*. In that case, the use of glass and transparency was a romantic anthem, an expressive and poetic breath that had no real influence on the substance in play. In order to understand how glass and transparency could be the catalytic element in a new architectural vision, we had to wait to for the beginning of the Bauhaus.

In Dessau, transparency became the substance itself of Gropius's message, a substance that was aesthetic, formative, practical, functional, and philosophical. For Gropius, transparency was the objectification of function, the ability of architecture to annul "every communicational aspect" in order to present only itself. If not for transparency, the *Neue Sachlichkeit* would have no aesthetics, but only ethics.

One further comparison is needed here with the Bauhaus since its architectural designs could only be overwhelmingly, dramatically different than the architecture of functionalism. Gropius slew his five-headed dragon of traditionalist architecture by adopting: 1) Free bodies each conforming to function instead of *a priori* typological patterns; 2) A centripetal system of conquering space instead of blocks closed to the street; 3) Construction with structural frameworks instead of continuous walls; 4) A dynamic rather than figurative language anchored in history and Renaissance perspective; and 5) The elimination of all symbolism.

Today there is an attempt to understand how the same elements discovered by Gropius, and in various declinations by Mies, Mendelsohn and other architects, would change radically one more time. They could do nothing but change considering that technological innovation is, as we have said, unstoppable and can only have consequences for our field.

This new generation of architects is attempting to make a 180 degree turn, to *completely* replace the discoveries of Gropius; not because they do not like them (on the contrary, they continue to love them just as we love Piero, Michelangelo, or Caravaggio), but because today's world has completely changed and poses completely different challenges.

In the following pages, we will ask not how to create an architecture that superficially uses information as communication or narration – as already seen during the 1990s – but on the contrary how to do this in such a way that information becomes *the essence itself, the raw material of a new phase of architecture* (cf. *Information*).

3. City

Consideration of the role of information in the contemporary city naturally has great cultural, political, and economic implications, examined here from a very particular viewpoint. In other words, an investigation will be made into the role of the information society in general and information technology in particular in establishing a reference framework for new project scenarios. This section is organized around eight pairs of opposing terms (Display versus Clock, Network versus Chain, Anti-Zoning versus Zoning, Driving Force versus Mono-Functionality, Designs versus Projects, Rebuilding Nature versus the Far West, Complexity versus Linearity, In-between versus In-front) and aims at outlining an easy and communicational conceptual map, considered within the network of ideas and the logical consistency of this reasoning.

In this context, the debate over the role of "information as raw material" in a new phase of exploration in architecture and urban design constitutes the necessary theoretical basis and can only be treated in the following section (cf. *Information*). But as a formula, we briefly reiterate that the conventional structuring of symbols has become crucial and absolutely predominant in the production of value during this period of human history.

In order to understand how the information era also influences architecture and urban planning, we begin by asking a question that is important because it reinforces the logic of many contemporary projects. The question is: "What is our concept of time today?" We can consider the answer through an image by asking a much more banal question, "Where is the clock today?"

3.1 Display versus Clock

Once upon a time, the clock stayed in a precise place: on our wrist, in the factory siren marking different shifts, the school hall, or the office. Today the clock is ubiquitous; it is everywhere: the cell phone display, personal computers, microwaves, televisions, video players, and the Internet, as well as "also" on our wrists. If the clock has changed from mechanical and localized to digital and omnipresent, our concept of time itself has become revolutionized. The idea of time that is sometimes productive, sometimes leisure, sometimes rest – situated and regulated – has been replaced by the information era and information city with an interwoven network that superimposes times and makes everything available, always and everywhere.

Our informational umbilical cords allow us to work anywhere. We can simultaneously work and spend our free time, produce and consume, and soon learn while sleeping.

This gives rise to a brand new model of the city. The architecture of the past aimed at being itself a construction of time, perhaps *mystical* (remember the construction of the gnomon for the Mausoleum of Augustus in the Campus Martius in Rome or the oculus in the Pantheon that captured the sun), *humanistic* (the city of perspective measured space and time in a closed frame dominated by the human eye), or more recently *mechanical*. The image of the rotating factory gearwheel (recalling the image of the worker in Chaplin's *Modern Times*) was transferred into the spaces of the industrial city, into those times and different functions sequentially determined by the clock. The rotation of the gearwheel and clock was also the guiding principal of many works of sculpture, painting, and architecture. But the city of today is going through a *digital* period. Rather than constructing time, it tends to annul time through the beat of the bits that continuously recreate data and images on the screen. Contemporary city time seems more and more what we experience on a screen, existing only in its immediacy.

Now although this situation can be consciously pursued in the teeming cities of the distant Orient, historic European cities cannot accept the annulment of time without annulling their own logic and peculiarity. The challenge obviously is to include the natural, historic time of European cities in a system with today's simultaneity and constant "refresh rate." This is possible if we understand that modernity means accepting crisis, changing so as not to fade away.

3.2 Network versus Line

We must now better understand the difference between the city where we are beginning to live and the urban model used till yesterday in a great part of the Western world. The idea of the functionalist city was implicitly tied to the idea of the assembly line that organized a series of operations to be performed sequentially so as to achieve efficiency in the production cycle. Each phase was constantly perfected and optimized to then move on to subsequent phase.

But the concept of before and after, cause and effect, "if ... then," related to mechanized, serial production has now been replaced by a concept of simultaneous processes, subdivision of cycles, the presence of alternatives, in other words of "what if." The network that diffuses, interrelates, interconnects, and makes the development of processes both global and local has inevitably replaced the figure of the line.

The aim of the production system is no longer the uniformity and homogeneity of the final result (guaranteed by constantly greater improvement in the various production phases) but exactly the opposite. It is the personalization of the product based on individually activating several different connections each time in the informational network. One example comes from the comparison between the famous Model T, produced by Henry Ford in millions of units, absolutely identical even in color ("They can have a car any color they like, so long as it's black"), and the powerfully individualized choices involved in the production of a car such as today's Smart Car. Potentially, this is even greater than the "overchoice" coined by Alvin Toffler since by activating an informational network directly at the point of sale (perhaps in the waiting area of a multiplex cinema) each user can design his or her "own" personal car, made to order by activating a series of informational channels in the network.

3.3 Anti-Zoning versus Zoning

These revolutions reach architecture and urban planning much more slowly than other sectors, but the impact remains significant. Above all, one of the cardinal concepts from the previous theory of the city becomes eroded.

Both space and time were once conceived, organized, regulated, and designed using the familiar principle of zoning. Each zone was organized by specific standards, density, and building type, and arranged, as we have seen, "in a line" with other functionally distinct zones so as to optimize general productivity. A concept of space was naturally associated with one of time. You work during these hours and in these places; you are entertained during these hours and in these places; you sleep here and rest here.

But in the context just described, the idea of zoning and functional homogeneity loses its central place. In fact, exactly the opposite becomes true because the information city tends to regroup, combine, superimpose, and interweave functions.

3.4 Driving Force versus Mono-Functionality

One of the fundamental aspects of this change is the presence of the phenomenon known as *mixité*. In other words, instead of adhering to one single function – factory, school, residence – design projects (as well as sections of the city) tend to each be a combination of various activities, assigning an important role to what were once aseptic conveyor belts or nodes of exchange, i.e., infrastructure.

Thus more and more new projects tend to adhere to great nebulas of different uses. Using terminology that gives the dynamic idea of expansion, we will call these: 1) *Inhabiting*, 2) *Exchanging*, 3) *Creating*, 4) *Infrastructuring*, and 5) *Rebuilding Nature*. These are nebulas of activity. If we want an image, consider replacing a painting by Mondrian with Rauschenberg's *Persimmon* in which each layer moves freely, is filtered, veiled, and transparent, and blooms differently from the territory of the canvas. If instead of final objects ("house" or "office"), we consider activities as areas of chromatic veiling we have evoked, then we can see how to combine the various functional components "each time" in a different way. Basically, each design project in the information city presents different uses as much on the grand scale as on the micro-scale of the building (look at the level of *mixité* today in what were once called stations or airports as well as museums, shopping centers, or university campuses).

But the key to *mixité* is not so much the co-presence of various functions as the hierarchization of the components so that the result is in any case endowed with meaning, with image, with a story to tell. This is why instead of an image of only process, a jumbled presentation as if a painting-event by Pollock, we preferred the veiling of *Persimmon* as an outline of this idea of city. The concept of *driving force* is fundamental since it contains both the need for the presence of a mix of functions as well as foreshadowing a direction, a will, a driving characterization rooted in profound substantial, contextual thought. We must be specific here. In some places *mixité* is based on a campus for the study of the territory, in others it operates in new production centers that relaunch pre-existing activities in a new way, in still others it develops mainly environmental awareness or historical areas, or the ideas of culturally and socially integrating marginal populations. By now many examples can be found around the world.

3.5 Projects versus Designs

The natural consequence of these trends is the tendency to work as they say "for projects" rather than grand, frequently impractical overall designs. The logic of planning pays more and more attention to the interconnections between space and function, rather than the exclusive improvement of each in part, in order to give rise to lifestyles based on simultaneity instead of sequentiality, on a mix of functions, interests, and exchanges, rather than mono-functionality, the co-presence of interests and capital, as much public as private.

To sum up, the city divided by zones, consistently conceived with the techniques of separation into phases and areas, contrasts with an information city based "exactly" on opposing processes, since networks distribute, personalize, combine, and invoke complex, stratified and hybrid processes in life and design. In other words, they digitize reality.

3.6 Rebuilding Nature versus the Far West

The idea of the city for the Functionalist CIAM (the International Congress of Modern Architecture) evoked a city in constant centrifugal movement as if it were a flywheel that could "youthfully" and mechanically expand, absorbing pieces of the surrounding territory. We know this model has entered a crisis period over the past few decades for a whole range of reasons, not the least the awareness of the limited nature of resources and the birth of an ecological consciousness. As we have mentioned, the presence of the information era has contributed greatly to this because the change in the production model (robotization, miniaturization, the decentralization of heavy, polluting industries) creates new opportunities and frees up resources. In particular, the great industrial areas becoming available create the possibility of an epochal reclamation project. Reclamation is an essential key word here since green spaces, nature, and park facilities can now be introduced into areas frequently filled with high-density construction. At the same time, large natural areas must be conserved and respected and not eroded infinitely by the undifferentiated expansion of new suburbs even if they are supplied with wireless broadband.

More specifically, if CIAM's idea of nature was "green," i.e., something that resembled a patchwork on a plane where green zones contrasted with residential, industrial, or office areas, the modern concept is one of landscape (cf. *Landscape*); in other words, a much more complex idea that sees nature and constructed areas "together," a constant hybridization between the formative rules of the urban landscape and the architecture itself of buildings. To sum up, architecture and urban planning themselves make up today's landscape. Architecture takes what it does not have, absorbs it, transforms it, makes it its own, and reconstructs a new idea of nature.

3.7 Complexity versus Linearity

Along with the opening up of great tools for simulating complexity, a fundamental effect of research and modeling made possible by the scientific-mathematical basis of information technology, a vector has penetrated into the wealth of relationships with materials, constantly theorizing mutable, interrelated relationships, and giving center place to methods of hypothesis and simulation rather than rigid theoretical assumptions. This sort of research operates in depth, in a surface that becomes loaded with interwoven movements and active flux, in a body transformed down to its viscera, and a new concept of landscape and nature. We will discuss this further in the future.

3.8 In-between versus In-front

This great field of investigation involves the potential of architecture, urban planning, and contemporary urban design connected with the central role of the information city and information technology. At least five broad sectors should be considered.

The first is the return of imagery in the great process of figuration versus abstraction. The narrative moment of architecture (from the Jewish Museum in Berlin to the reconstruction of Ground Zero in New York) must come into play in the information and communication age, given that information is the added value in today's products, including architecture (cf. *Communication*).

The second aspect is the birth of techniques that simulate complexity used as diagrams of movement in new designs. Here information technology gives science and architecture the ability to create infinite models for investigation and formalization (cf. *Model*).

The third is the possibility of moving residually, between the existing folds, with new techniques of inserting sections of cities or buildings even into pre-existing urban fabrics, not with the old dialectical logic of the new, shining image in contrast to the remembered past but rather with techniques of insertion, of *in-between*. In this sense, the theory is born of constant interconnection between the parts, between outside and inside, between the practical and formal reasoning of an organism conceived more as a process than a result.

The fourth is one that, thanks to information technology, opens new "stereoreal" scenarios through lighting techniques that illuminate, project, and re-semanticize what exists (cf. *Catalyst*).

The fifth, and we are only at the dawn of this, sees information technology enter into the fiber itself of new buildings, designing them first with a digital logic to potentially optimize the various components, building them afterward using new construction techniques (and later new management techniques), and above all exploiting the dynamic connections of electronics to create interactive, living buildings that react to variations in flows, stimulations, and desires (cf. *"Informatizable" Architecture*).

In closing, the great change between the industrial and information eras has created many avenues for contemporary cities to no longer give a central role to type, standard, series, product, or zoning but rather to individuality, multiplicity, differentiation, the subjectivity of desires and projects, and the inclusion of hypotheses instead of set theories. Not because this is necessarily what we want, but because we cannot avoid it in order to continue to live. Let's look at how this aspect has been grafted onto the new notion of Landscape characterizing the past two decades of architectural research, in particular as related to the emergence of information technology.

4. LANDSCAPE

What are the relationships between the concept of landscape – strongly characterizing the architectural debate over the past two decades – and information technology?

Environmental and ecological awareness spread around the Western world during the 1970s. The concept of dominion over nature, typical of the industrial development model, and associated indiscriminate use of resources, was replaced with the search for a sustainable relationship, a relationship of mutual integration between man and nature, and thus between urban, architectural, and environmental systems. An "environmental awareness" was created along with increasingly widespread interest in technological innovation to create "intelligent buildings," at least through a more aware use of energy resources.

4.1 Information Technology and New Nature

Information technology entered this sector through technical advances. Many control devices, sensors, and innovative and recyclable materials helped support advancement of this research. In the wake of this, attention was given to technical as well as more completely aesthetic considerations. So-called "sensitive environments" aimed at hybridization between purely natural elements and electronic, technological elements. Images, sounds, water, vegetation, and control systems were hybridized, grafted onto one another, and mixed together.

Clearly, the change in the relationship between nature and architecture over the past decade has a connotation linked with the epochal shift from the industrial to the information era.

The man from the post-industrial, electronic civilization could actually repay his debt to nature since, if the manufacturing industry had to necessarily dominate and exploit natural resources, the information industry can valorize it.

Robotics, miniaturization, the spread of communication and transportation networks, and delocalization of many industries, all lead to the liberation of large former industrial areas across the Western world. At least in technologically advanced countries, this structural change in this direction opens up an opportunity for"reclamation" of historic importance. Vegetation, nature, and recreation areas can now be inserted into areas frequently with high-density construction, or natural areas highly exploited and industrialized but now disused and available.

The concept of the relationship between city and nature changes radically in a post-industrial society. This no longer means circumscribing and enclosing new green areas or parks in contrast to residential, service sectors, and office areas, as in the organizational logic that divided the city and industrial territories. On the contrary, this means creating new pieces of an integrated city where a strong presence of natural elements is found alongside an interactive group of activities from the information society. Although zoning may have been the way of planning the industrial city through division into distinct, homogeneous sections, now multi-functionality and integration have become standard in the new production model linked to information.

Therefore the development of environmental awareness leads to a development of environments, not just intelligent but sensitive. The concepts of an integrated relationship with nature and architecture in new ideas of the city are closely linked phenomena. In the first case, information technology is the tool of technological development; in the second, it is the cause of a generalized change that gives rise once more to questions central to this historic period. But in the IT Revolution in architecture, nature or, as we shall see. *Landscape*, plays more than just a technological, economic, and social role, but also becomes actually "instructive" and powerfully influences the research of forward-thinking architects.

4.2 Definition

. A definition of the word "landscape" would be a good start in following this progressive intersection of a new concept of nature and landscape with information technology.

The word "landscape" has a very different meaning than the word "nature," commonly used in the context of functionalist architecture.

The word "nature" was considered "external" with respect to architecture. Nature existed in and of itself, and was obviously also an object just as architecture itself was an object. The fact followed from this that those pure volumes, created by applying the industrial, mechanical logic of architecture, were set like platonic solids on a terrain already foreign to them. Nature was, on the one hand, a land conquered for a city considered in continuous expansion; on the other, it was a purely "healthy" resource (providing sun, air, and light) that "served" architecture.

The concept of landscape turns objective into subjective, the idea of exteriority into interiority. When we start to consider a possible definition of landscape, we see the one thing we cannot help but think about landscape is its "image," particularly its *representation* in painting. We can take away everything from the landscape. Think of the landscape with no sky, no nature, no green, or no water. We can even imagine an uninhabited landscape. We can think of many things missing in a landscape, but we cannot think about landscape in any way without painting. Naturally, by painting we mean a form of two-dimensional representation that started with the Lorenzetti brothers – who painted Siena and its countryside during the 14^{th} century – and has continued right up to Burri or Pollock.

But why must we think of painting (representation) when speaking of landscape? The first reason is that painting forces us into a "critical" relationship with seeing. What really exists is not the landscape, but only an aesthetic interpretation of the world we call landscape. Landscape "is" interpretation (not nature, not territory, not matter). Interpretation is a form of complex awareness that is actually first aesthetics and then (albeit subordinately) also scientific, botanical, socio-economic, geological, historical, etc.

The second reason for bringing the notion of landscape closer to representation and painting is that painting, in addition to being a critical interpretation, is also, at the same time, a design project.

In fact, could we have a painting without looking? The act of looking is a critical act (as opposed to the purely mechanical "seeing"). The exercise of looking at a painting does not suggest a passive activity, but rather an activity that constructs the image and therefore in reality proposes a real project of transformation.

Consider Canaletto (naturally André Corboz should be mentioned in this context), Turner, Cezanne, Pollock, Rauschenberg, and Rotella. Their interpretations of landscapes created (*created!)* landscapes, then buildings and towns. Cezanne never portrayed a mountain as it was. In his way of painting, Cezanne understood how the world should have been. And that world was the one Le Corbusier, Mies, and Gropius really constructed and we really inhabited. Should we mention the Pop Art Rauschenberg and Gehry? Or Klee? Are all those many landscapes studies sufficient in one way or another to actually construct the landscape Klee painted, as in the case of Hadid? Painting, representation, and notions of landscape are thus connected to the architectural project. This connection is neither easy nor immediate, but is still profoundly useful.

There is a third level. As we have seen, landscape in pictorial representation is not merely (1) critical interpretation, and (2) project; it is also *at the same time*, self-representation, (3) self-portrait. Van Gogh is crucial to understanding this aspect.

On the one hand, this aspect leads to the fact that everyone should look at, interpret, and above all represent landscape. The exercise of representation can and must be done in first person as a critical and self-critical practice, as a reading of the world in our image and likeness. But the second aspect of the notion of self-portrait as landscape (well-known in psychoanalytical literature) is connected to the relationship between subjectivity and collectivity.

As individuals know how to measure themselves in relation to others through a close-knit network of historic, social, and economic relationships, so landscape is a field of meditation between subject (and personal representation) and collectivity. The notion of landscape plays back and forth between individual personality and collective responsibility. The greats shrug off the historically established vision (Lorenzetti, Cezanne, Boccioni, and Burri, as well as Gehry, Eisenman, or Hadid) and oblige the social whole to progressively rearrange itself around a new aesthetic and new means of transforming the landscape. So here is the definition:

Landscape is the aesthetic representation, collectively and culturally shared, though still in constant evolution, of a part of the world.

4.3 Information Technology and New Complexities

In its early phases, the relationship between this definition of landscape and information technology was indirect and instrumental, but ultimately also became direct and creative. It was indirect and instrumental because Gehry's *cheapscape*, Eisenman's *palimpsests*, and Hadid's dynamic *textures* were three ways a subjective, personal idea of landscape was transformed into a "collectively and culturally shared aesthetic representation" as well as into architecture thanks to computerization. Information technology, computers, models, sophisticated calculations, and in part direct production of components, are all electronic tools that have made possible the realization of those ideas in this historic period. Otherwise, how could Gehry's large, constantly shifting masses be designed then constructed in the Los Angeles Walt Disney Concert Hall, or the deep fractures in the earth in Eisenman's Cultural Center in Santiago de Compostela, or the crevasses and interweaving of the Hadid's Museum in Rome?

However, these concepts of architecture-landscape were not actually inspired by the computer. Instead, this will occur for the next generation of architects after Gehry, Eisenman, and Hadid; the generation "Born with Computers" intimately connected to electronics. In this case, the idea is of a landscape made from raw materials that are effectively information and information technology (cf. *Information*). A relationship is born with a new idea of landscape intimately, almost inextricably, interwoven with information technology. Let's see how and why.

New architects seek to give form to a landscape born out of systems of dynamic interconnections, interrelations, mutations, and topological or parametrical geometries, typical of the world of information technology. A whole series of architects are giving shape to an IT landscape. Although this may not have the clarity of that "collectively shared" representation assumed by the works of Hadid, Gehry or Eisenman, its features have already been outlined.

This notion of a computerized landscape is closely linked with contemporary scientific methods of investigation and simulation. Structured through information technology, this idea uses the term "complexity" as a sort of key word. At various times it can show typhoons, cloud formations, the reproductive mechanisms of DNA, or sedimentation of crevasses or terrestrial masses. But the difference between this generation and the previous is that these experiments are not performed with sketches or metaphorical images, but are investigated directly through computer simulations. The genetic mechanisms of various phenomena are studied and formalized (i.e., interpreted with mathematical equations) in these simulations.

The mathematical formalization guaranteed by information technology leads to the birth of real project strategies (particle systems, attractors, modifiers, etc.) that guide and conceptualize the logic for developing the project. In this case, computer technology is not a tool for realizing a complex landscape considered independently from electronic media, like Gehry's *cheapscape*, but rather it studies phenomena taken from the world and matter, and by formalizing these phenomena identifies variations that slowly but inexorably lead to new concepts of architecture, in an inextricable weave between the object of study, computer modeling, and architecture.

4.4 IT Landscapes

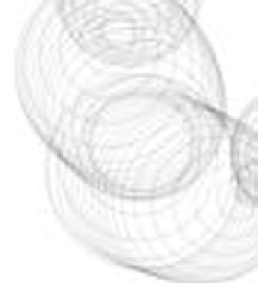
In summary, our era is giving shape to a new knowledge of landscape; information technology is the key to this for an entire group of connected reasons.

In the first place, the information era provides an overall different model of the city, and urban landscape, as well as in part the surrounding territory that has mixed uses with overlapping flows, open 24 hours a day for production, leisure, social, and residential activities, where natural and artificial elements are woven together with the combination of functions and uses.

In the second place, information technology supplies the "mathematical models" to investigate the chemical, physical, biological, and geological complexity of nature (see *Model*). These simulation models permit structuring new relationships in projects that consider reasoning and dynamics. In this process, information technology supplies the essential tools for first creating, then designing, and finally constructing designs conceived with these complex systemic approaches.

In the third place, information technology endows architecture with reactive systems capable of simulating natural behavior in their reaction to weather, flows, and usage, as well as ultimately emotional behavior, and thus offers a new phase of investigation into a concept of landscape that is not just "simulated" in architecture but actually and physically represents several aspects. This means defining an environment and architecture that not only evoke the formative rules of landscape and nature, but also propose environments capable of interacting and evolving. In this context, information technology enters directly into the fiber itself of new buildings, first by digitally designing them, and later building them using new construction techniques, but above all by exploiting dynamic electronic interconnections to create environments that react to variations in real situations and flows to form a sort of IT landscape in new buildings.

The following section deals with several theoretical-type questions. Within our problematic context, the meaning must be understood of the terms "Information," "Time", "Space", and "Model."



Part Two
Theoretical Aspects

5. Information

What is information? What is its specific significance in the area of information technology? How could information be considered the raw material in the most advanced architectural experimentation over the past few years? This chapter illustrates a series of concepts, provides arguments, suggests experiments, and most importantly formulates some definitions.

5.1 Working on a Definition

Take a white sheet of paper and a pencil with a sharp point. Place the pencil on the paper until it leaves a point, the smallest possible.

Now ask yourself "How big is it?" There will be no lack of ideas about how to measure it (magnifying glasses, microscope, etc.). The only thing you obviously will not say is: "it is not possible to measure it; it has no dimensions." Why? Because it is inside the field created by the question "measure." However, to measure it we need a basic assumption, a fundamental postulate or, in other words, that the point (let us say "that" point) has no dimensions, or better yet, as Euclid wrote, "has no parts." So here is a nice contradiction. In order to measure that point on the paper (a point clearly measurable), we must use the postulate of its immeasurability.

To resolve this contradiction, let's proceed with an initial formulation: 1. *a datum is the minimum element that modifies a previous situa-*

tion (the paper "was" white and now has a point). Now I can proceed to the second formulation: 2. *a datum is the objects of multiple conventions*. This means a datum must be associated with a well-defined convention in order to have any meaning. The basis of the convention may not necessarily be logical, but can be simply utilitarian. This is why by saying the point is "a surface," if needed I can calculate the area, but if the point is assumed conventionally "without parts," then we arrive at Euclid's first postulate which has developed into one of humanity's most powerful (and useful) constructions. Remember the second postulate: a "line (curve) is length with no width"; and the third ("the extremes of a line are two points"). Another convention I can apply to the point is related to its state of standing still or in being in motion. (This system can be adopted to help understand *vectorially* the creation of the computerized three-dimensional world.)

But we are still stuck at the crux of the problem. Applying convention to a datum begins the "formation" of a world. This word "formation" is important and leads us to the center of the problem and the third formulation: 3. *information is the application of a convention to a datum.*

Let's see if this definition functions in the common as well as electronic contexts. In the common meaning, information is a collection of data that comes to us substantially and objectively like a package, divided by critical opinion.

Our definition functions very well (perhaps better than others) in the common context. Now we come closer to the center of the problem, i.e., the profound difference between the world of paper and pencil (for clarity we will call it "traditional") and the electronic world.

Let's go back to the sheet of paper and, instead of a point, draw a small oval. Now let's change the question. Instead of "How big is it?" let's ask "What is it?"

As we stated in our third formulation, in order for it to be something, a convention must be applied to that datum. Only through this process will the datum become an atom of information, albeit the smallest.

Depending on the convention we choose to adopt, that oval could be: a group of smaller points; a letter of the alphabet; the number 0; an oval (mathematically defined); the two-dimensional projection of a volume; a whole note; a "sprite" in a montage; or even a symbol for something else. All this "depends" on the convention. Our definition functions excellently in this second meaning.

Now we come to the fundamental passage regarding the difference between the traditional world and the world of information technology.

The fundamental passage is that the world of information technology *is a world already formalized from the start!* In other words, the earlier question, "What is it?" (referring to the small drawing of the oval) is inconceivable because in information technology "we know right from the start the conventional system within which we are moving."

So here is the fourth formulation: 4. *in information technology, data do not exist, but instead only and always information.* Information technology has a well-known, close relationship with the electrical data of the computer that are in fact "data": either they are there, (*On* = 0), or they are not there, (*Off* = 1). Based on the presence or not of this electrical datum, a series of codification systems have been constructed since the Morse code.

We are slowly approaching the thought behind the statement "information is the raw material of architecture" but we still have a few more steps to take. Here is the fifth formulation, a crucial tautology. *5. if in information technology, data do not exist but only information, then in information technology everything is information.* This formulation touches on the crux of the problem and takes into account that information is truly "in formation," in constant, dynamic, inexhaustible moving and becoming! It also defines the territory where this occurs as precisely the electronic territory.

Thus information is, by definition, a *fluid* mass that must "still" take form.

At this point, it is useful to refer to the Oxford English Dictionary: "inform" means "put into form" and information is the "action" of this putting into form.

From this definition comes a new decisive proposition. If, in information technology, everything is "in formation," then 6. *the taking* *shape of information is defined as modeling and finds its expression in the creation of models,* a term we will discuss shortly (cf. *Models*).

Thus, the model is *the form assumed by information*, the form into which information becomes "modeled."

5.2 Raw Material

Many families of models exist in information technology. The simplest is represented by the spreadsheet that links pieces of information to one another via mathematical formulas, allowing constant updating of all values based on variations in only one piece of information. This invention has had consequences in a broad field of activities, from financial to construction. Above all, it represents the advent of a generalized way of thinking "What … if" or rather "What" happens in my model "if"? For some time, "spatial and architectural" models have existed that dynamically link the geometric, spatial, constructive, and even performance information of a project so that varying one datum makes it possible to verify "in a cascade" what will happen in all the interconnected areas of information in the project system.

In this context, as we will see more clearly, a design project tends to function like a group of equations representing specific sub-areas of the project. Defined forms are not designed, but instead "families of possible forms" that can vary within several parameters, substituting the geometry of Euclidean absolutes with topological families. Architectural design and thought thus moves within a network of these fluctuating, moldable bits of information like a system of interconnected equations that pass data back and forth between each other.

The new generation of architects is working to understand how these mutable, interconnected, dynamic models representing the heart of the IT Revolution could transmigrate into an architecture that would be their reification (cf. *Reification*). If this research constitutes the horizon of a new phase of architecture, its raw material, the wellspring that feeds the research and moves in waves, whirlpools, eddies, and waterfalls, is called information, the raw material of a new phase in architecture.

6. Time

Here we discuss why considering time is fundamental to considering space. How do time and space relate to the IT Revolution?

Humanity is surprisingly capable of assimilating technological progress that annuls distances and radically changes attitudes and behavior. One example is the difference between the "Who is it?" and the "Where are you?" connected to the birth of cellphones, or the fact we can see and speak to each other anywhere, or the continual hybridization with the artificial, or combining biologically to procreate, clone, etc. in a way unthinkable just a few years ago. Even though these changes have a very rapid penetration time, a *forma mentis* persists based on the teaching of Cartesian, Newtonian, and, for architects, Mongian absolutes. Consideration of the consequences of technological innovations and the significance of other scientific hypotheses is necessary even if it shakes up some of the traditions of making architecture. In this chapter in particular, I would like to challenge the mental structure that considers space and time *objective* quantities. Out of habit, architects think of shaping something that "is" and not of being able to create time and space themselves. This topic is important particularly if the investigation is connected to the more generalized change from a mechanical (objective) paradigm to an informatic and above all *subjective* paradigm (cf. *Communication*).

This chapter illustrates a series of concepts, furnishes arguments, suggests experiments, and most importantly formulates several definitions.

6.1 On the Nature of Time

We should begin with the first condition that precisely states *1. time is the first dimension of space.* Time is actually not a fourth dimension of space ("since everything moves, everything is relative" as overheard frequently in conversations on relativity), but time is the only way of describing a space. (To understand this, just set up an artificially limited condition, a dark room or a space with only one dimension as explained in the note.[1]) We should underline here the first formula-

[1] We start by placing ourselves in a limited situation, a space with only one dimension [Ex. 1]. Let's imagine living a limited life along a track, immersed in an exclusively linear dimension, never having attempted or even imagined anything else. Let's ask ourselves a key question. How can we know, describe, or represent this linear world? Evidently sight is no help because everything would appear flattened to a single point. The answer must lie in another field of experience. The way of understanding this linear space can occur only by traveling within it. I can in fact calculate the time from one point of the track to another and this precise "interval" allows me to describe this spatial condition! So time becomes the first dimension used to understand and describe this space. The line is the minimum spatial entity. In this experiment, I am using the famous example by Edwin A. Abbott from the novel *Flatland: A Romance of Many Dimensions* published in the late 19th century in England (Seeley & Co., London 1884); (Michele Emmer made this into a film in 1994, cf. www.mat.uniroma1.it/people/ emmer, in addition to discussing the book several times.) I mentioned the writer Edwin Abbott, but would like to clarify that although the definition of time as the first dimension of space does not come originally from this English writer, I mention it in an attempt to resolve what appears to be a literary artifice used by Abbott.
Flatland is a space with two dimensions (a Cartesian plane) and home of the Square, the book's protagonist. Other geometrical figures live in this space and all of them move like flatworms. They know no other world except the two-dimensional plane. Now a figure, let's say the Square, could be aware of all the other figures – triangles, circles, polygons – not because of the fact these have luminous, colored sides, as stated by Abbot, but rather by "circumnavigating them," traveling around their perimeters and thus bringing in time as the first dimension of space!

tion leads directly to a second that states 2. *space is an interval that can be traveled* (and therefore its smallest dimension is a line), and a third that regards a broader definition of the "point" than usual and states 3. *a point is something that has neither space nor time.* (This also has implications in astrophysics.)[2]

Now let's ask how this idea of time as a decisive factor for the comprehension and existence of space leads us to formulate several ideas of interest to our field. The center of a second investigation, also discussed in the notes,[3] is that time is not just the first dimension

[2] This use of time in formulating space arrives at expanding Euclid's first postulate (remember for Euclid "the point is something with parts"), and adopts several components of the astrophysical definition of a black hole that has infinite mass and curvature but neither time nor space. Space and time are generated together. ("Time began with the big-bang," states Hawking 98, p. 64.) They are also governed by a well-known relationship (one second = 300,000 kilometers, i.e., the speed of light). The famous astrophysicist also recalls that Saint Augustine answered the question "What did God do before creating the universe?" by stating, "Time is a property created by God and so therefore before the beginning of the universe time did not exist," (Hawking 1998, p. 21).

[3] Let's try asking ourselves: How can I perceive a three-dimensional figure if I live in a world with only two? To answer this, let's try a second experiment [Ex. 2]. Imagine pushing a sphere into a plane. If I only know the two dimensions of the plane, and travel around the section where the sphere is joined, I would naturally think the sphere is a circle. But let's bring the factor of time to bear on the sphere. In other words, let's move the sphere down in such a way that the section intersecting the plane becomes progressively larger. In this case, in circumnavigating the intersected section a second time, I would discover that the circle has become larger and in doing so a third time I would find this circumnavigation has tripled. Naturally, this would be an "almost" unexplainable phenomenon in a world with two dimensions. Conjectures could be made on the event and bizarre hypotheses developed. But it is also possible to logically hypothesize a sort of progression: considering that knowledge is possible in the two-dimensional world of worlds with only one dimension (i.e., lines), it would be possible to imagine this progression could also move upwards. In other words, after a world with two dimensions, another one could exist with three! A brilliant scientist in the two-dimensional world could hypothesize that, since three-dimensional space exists, then three-dimensional figures exist, and therefore that the continually changing circumferences on the plane were actually intersecting sections caused by the movement of a sphere in a three-dimensional space! This series of discoveries would be terrifying, almost impossible to explain to anyone who only knew the two-dimensional world. But this discovery would be self-

of space, but is also the fundamental tool in comprehending worlds with fewer dimensions than ours and, in the same way, logically imagining worlds with more dimensions.

In particular, it should be stated that *4. every lower reference system is contained in a higher one, 5. a lower system can receive a projection of a higher level and above all 6. every reference system is valid within itself and has an autonomous space and time.*

These formulations imply a decisive point: time is "different" in the various reference systems with one, two, or three dimensions. This point is central and actually shakes up the idea of the objectivity of time (and consequently space) that is a common, reassuring fact in our work.

In order to better understand this, let's perform this experiment. Take a sheet of paper, draw a straight line between A and B, and call this line "T." Now imagine being in a world with only two dimensions; others do not exist; nothing else can possibly be known except the two-dimensional world of the page. Imagine being a sort of flatworm capable of understanding and frequenting only the dimension of the plane. As we have stated, "T" is considered a temporal interval, and therefore simultaneously a potential space that also has the characteristic of being the most efficient space possible to unite A and B.

Now start curving the page, first slightly, then more pronounced. Notice that length T, even though curved, does not vary. The method of going from A to B always remains marked by the same line (even though this has become a curved line). Now continue curving the page until points A and B are "almost" touching. Again, since still confined to two dimensions, that "continuous" curved line is the shortest way of connecting A and B. But here is the great step: imag-

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evident if one could leap from the two-dimensional world to the world with three-dimensions and so see the scene of the sphere intersecting the plane from another point of view, literally "from another system of reference." The reason for this long digression is to show that in this case the key factor is also time. (Here the movement of the sphere is the element that shows the existence of a world with more dimensions than those actually experienced.) While the idea of an analogy for considering worlds with more dimensions and the concept of a leap from one dimension to another are themes derived from Abbott, the time factor is foreign to the English writer's reasoning and is what characterizes this entire analysis.

ine leaping outside that two-dimensional world and looking at the curved page from a three-dimensional world. From the outside, we see immediately, that the shortest route from A to B is not along curved line "T," but along a new line "t" that connects points A and B in space and actually moves within another *reference system* (i.e., space with three dimensions xyz) with respect to the two-dimensional system of the page (xy)!.

By seeing everything from another dimension, not only is the problem of connecting A and B resolved differently, *but it becomes obvious that the times* are specifically different ("t" is much shorter than "T"). And since the times are different, so are the spaces (let's say at least the logic of the spaces) considering that "t" is different from "T" and a new, more efficient way of uniting A and B. So this demonstrates that time and space are not absolute, but rather that each system is a temporally autonomous space, dependent on the system of reference used.[4]

This difference in space and time in different reference systems is proven here in the absence of reciprocal motion, a characteristic that distinguishes this demonstration from the one related to Einstein's special theory of relativity.

[4] Furthermore, even in everyday experience, not to mention data networks, this precise interweaving between time and space is commonly used to make choices. We all know that sometimes, because of traffic reasons, instead of a direct route, we take a longer way that is in reality shorter. This is a simple application of the necessary change in a system of reference; in this case, the change is simply from a spatial system of reference to one that combines space and time. IT networks, as well as low-cost airline networks, frequently teach us that a packet of information takes a tortuous route to arrive at its destination. This route is physically longer but in reality much shorter. Information technology continuously makes these calculations in data networks (here these are actually "data" since they have been decomposed into pure electrical facts and recomposed on their arrival) even though we never directly realize this. Concerning low cost airlines, several friends explained to me that to get to Alghero from Milan, it was faster and cheaper to go through London!

6.2 The Leap

On my computer desktop, I have an image by Benoit Sokal of a whale leaping out of the water's surface. This image can be associated with thoughts about "how" to perceive another dimension when it is somehow "forced" into a lower one. In this specific case, how can a fish confined "only" underwater "perceive" and understand what is outside that liquid, and describe and actually imagine coasts, gulfs, and beaches? Naturally, we understand fish can do this with a leap outside their own dimension. The image of the leap is fundamental to perceiving another dimension as well as understanding and at the same time actually seeing our own. But the result of the leap is not merely perceptive, not just a broadening, however incredible, of vision and thought; it is most importantly the beginning of understanding the rules of other systems of reference, other spaces, other times and especially other systems; here architecture comes back into play. We are moving slowly thorough this difficult territory, through this atmosphere with little oxygen. This is the search for the aesthetic knowledge of the information technology dimension. I believe there is enough here to make the movement to four dimensions.

6.3 Four Dimensions

Naturally the fourth dimension (we took this path in order to make things clearer) is actually not time, but a fourth geometric dimension that extends the geometry "xyz" in the progression we have described.

We can consider creating a four dimensional space with a similar process of transference theorized in the 19th century by the mathematician Bernhard Riemann. If the three-dimensional space from which we begin is a cubic space, in transferring a cube we would have a space ideally enclosed in a hypercube that ends and begins with a cube and will have sixteen vertices instead of the eight in the original cube.

According to our logic, the space thus defined will have a series of characteristics in common with others:

1. time is the first dimension of space;
2. space is an interval that can be traveled;

3. a point is something with neither space nor time;
4. every lower system of reference is contained in a higher one;
5. a lower system can have a projection of a higher level;
6. every system of reference is valid within itself and has an autonomous space and time;

But to truly understand what a four-dimensional space is, we must now add a seventh formulation:

7. in every higher-level system, infinite lower-level systems of reference co-exist.

Now let's ask how this four-dimensional space is made. What happens inside it? Naturally all the points describe functions even though extended by a fundamental characteristic summarized specifically in the seventh formulation: within a four-dimensional space, other systems of reference exist with three dimensions! So if infinite lines exist in a space with two dimensions, then infinite planes exist in a space with three-dimensions, and infinite cubes exist in a space with four dimensions! Each can have a different orientation on its axis, and naturally they do not necessarily have to be cubic, but can also be ovals, spirals, or spheres. (The cubic, or rather hypercubic, form was only chosen for simplicity.) As seen in previous cases, each of these systems of reference (not necessarily with axes perpendicular to each other) can describe different worlds from the viewpoint of space and time. Furthermore, the different worlds can move quickly over one another, generating the phenomena, only apparently paradoxical, of Einsteinian relativity.

If the innate characteristic of four-dimensional space is the presence of entire three-dimensional worlds, we should then pose a fairly crucial question in closing. What is the prevalent navigability of a four-dimensional space? In linear space, only the line can be navigated; two-dimensional space is evidently flat; three-dimensional space is also vertical; but the four-dimensional world can actually be navigated *with the leap!* If in a two-dimensional world, I can continually change line and in three dimensions continually change plane, in four-dimensions I can continually change volume; I can change three-dimensional reference systems.

The basic navigability of a four-dimensional world allows a leap from a three-dimensional world to another three-dimensional world and this "leap" is not (as we have seen) only spatial, it is temporal space. Four dimensions can be navigated via the "leap."

Let's stop here for a moment.

6.4 Technological Prosthesis

Now an element should be added regarding the perceiving body, i.e., the subject of vision.

During this discussion, we have established that passages from one spatial-temporal system to another are not absolute; each has its own internal system with its own laws that can be broken only by a higher level. Now all this is in some way "also" dependent on the perceiving body. In various examples, we have imagined being an insect that can walk only along a thread, or a flat worm that only knows a two-dimensional space, or a human being able to move and perceive in three dimensions. We can deduce from these examples that three-dimensional space is not objectively tied to an essence of things, but rather to a "physical" characteristic of men and animals, i.e., perceiving and moving within three dimensions.

So we seem to have arrived at an "objective" limit, that man by nature is a system of three dimensions and not four. Leaving out other arguments regarding time and thinking only pragmatically, we know (and have seen over thousands of years) man has the ability to construct technological (or biological) "prostheses" that serve in various ways to extend his objective limits. From this standpoint, we can also see the cognitive aspects of the development of technology. The great theme here deals with more than just continually supplying new technological prostheses, but raising crises, asking questions regarding the perceptive, cognitive and (this is the most difficult) aesthetic nature allowed by these technological prostheses.

In short, we feel these technological prostheses could also act to expand the dimensions of this new architectural spatiality. Naturally, we cannot fully cover this debate, but will briefly mention three points.

The first regards the fundamental link between the dynamic interconnections typical of the world of information technology, the idea of model in the scientific sense, and the deeper meaning of interactivity that leads to variations in the physical mutability of architecture based on exterior conditions as well as the desires of users.

The second point regards the existence of the Internet. The Internet is one of the most revolutionary prostheses created by man. Coupled with windows interface systems, real time navigation systems, long-distance representation via sensitive and interactive hologram systems (achievable in the near future), the great world of the Internet can multiply and make denser various spaces and times. We can have windows simultaneously open on worlds far apart from one another and literally leap from one world to the next, live inside them, experiment with spaces in acceleration or movement, represent and be represented, and all in real time, constantly passing between the various worlds by "leaps." The Internet is a necessary tool for architecture in this phase of research because of its pragmatic and more importantly cognitive aspects. Understanding this will show us how the Internet and interactivity can activate a formulation we have set aside until now: *5. a lower system can contain a projection of a higher level.*

This formulation means the concept of a four-dimensional space is possible, even though physically inserted into three-dimensional spatial-temporal limits. And why could not this four dimensional space be used, imagined, understood somewhat, designed, and shaped?

Regarding the great transition from object to subject that invests all spheres of art, science, and thought, this discussion has underlined that time and space are no longer objective, but subjective. They are shaped by our dimension, our will, our time, our creative comprehension of technology. Our time is the first dimension of our space.

7. Space

We have stated that *information* is the raw material of contemporary architectural research that considers electronics a field of investigation, and that *time* is the first dimension of space. These statements aim at emphasizing respectively that information belongs to the sphere of language and thus has first and foremost a *conventional* value. The electronic world contains no data, but only information since this world originates *already formalized* (cf. *Information*).

As regards time as a way of seeing and understanding space, the crux of the problem is *that one single objective space does not exist*, but instead a relationship between space and the cognitive dimensions we control as living beings. However, since man has invented and constantly perfected prostheses that extend his physical limits (from the 17th century telescope to today's nanotechnology and molecular reactors), it is possible to conceive a world with "more dimensions" than those our physical limits permit (cf. *Time*).

In reality, neither of these statements is simply speculative. Instead, they help illuminate research areas just now being investigated by new architects from the IT Revolution. Theoretical considerations represent the necessary nourishment and sources for applied architectural research.

After the nature of information and the role of time, we now approach the definition of the concept of space. Our main assertion is that "space is information" and moves in the same spirit and with the same methods as the previous environments. The spirit is to help understand how new thought on space opens up new fields of architectural research in relation to information technology. In terms of method, we will again proceed with a series of logically linked assertions and facts we also hope are, in the end, convincing.

7.1 On the Nature of Color and Transparency

To understand how space is effectively information, we must undertake an apparently tortuous logical path that starts with color, comes back to the concept of transparency, and finally arrives at the thesis that space belongs to a group of cognitive, conventional entities and thus is finally information. Two specific fields of study give some help on the theme of color, both of them certain within the limits of their scientific structures.

The first is the broad sector of the psychology of perception. Several points in this field have been established in the work of Hermann von Helmholtz in the second half of the 19^{th} century, Rudolf Arnheim in the mid-20^{th} century, and more recently Fabio Metelli and his fundamental studies in transparency. Personally, I owe much to the studies of Osvando Da Pos from the University of Padua. In a series of publications, Da Pos recalled, and in some cases demonstrated *ex novo*, two highly important concepts I will summarize from his writings and conferences. The first is that *the perception of color is contextual*. What does it mean that color is contextual? It means we human beings do not see a determined color in an absolute manner but a relative manner. For example, we more or less read a certain shade of color depending on its proximity with others or our custom to more or less notice its presence.

The second absolutely crucial understanding is that like color *transparency is also contextual*. Our recognition of a situation or material as transparent is not absolute but again depends on the relationship with context.

Therefore the basic importance of this investigation is that color (as well as transparency) is not at all absolute but actually contextual, derived from our habits and customs of seeing a context in a determined way.

To better understand this, try this experiment. (Originally from Metelli, I found it in articles by Da Pos.) Draw a cross with one color on the vertical axis and another different color on the horizontal axis. You could also do the same by drawing both axes with a gray pencil. The color will appear darker in the square corresponding to the superimposition of the two axes. Anyone looking at this drawing will see the area of superimposition as transparent (veiled) and yet will have no doubt about the process.

Now if we cut the drawing around the central square, moving the lateral arms of the cross a few centimeters away from the central square, the latter will no longer be seen as transparent, but as simply another color or a different shade of gray!

7.2 Hyper-contextual Transparency

Here we will digress somewhat to explain from the beginning how this concept of transparency as "contextual" and not objective has repercussions in today's architectural research.

We have seen (cf. *Communication*) how transparency has acted as a sort of reagent and transformed the elements, although innovative, of German functionalism, particularly the Bauhaus Building in Dessau, into a new aesthetic. The notion of transparency crossed and reinforced functionality, the anti-perspective abstraction, health and safety regulations, punctiform construction, and innovative material technologies to move the conquests of the new industrial, functional, and mechanical architecture into a dimension that was not only practical and utilitarian, but also completely aesthetic. The New Objectivity had found its aesthetic in the idea of transparency.

This summary also serves as the needed premise to a new step forward. The studies cited from the psychology of perception have shown us transparency is in reality "contextual" and therefore, like color itself, something other than objectivity! This discovery has profound implications for our studies. Although this consequence has only now become widespread, it has been understood, felt, and comprehended by contemporary architects ever since Jean Nouvel (who humbles us in his simplicity and stature). At his Cartier Foundation in Paris, Jean Nouvel bases his projects on a new "anti-objectivity" idea of transparency. In his hands, transparency in the information era becomes a cognitive phenomenon profoundly different than objective revelation in the world of Gropius. For Nouvel, transparency actually becomes a contextual and subjective element precisely in the play of fluctuating screens and various effects, at times decorative, at times planar, at times illusionistic, he attributes to his designs. His work returns to the great theme of surfaces and the "apparent" epidermal transformation of the project's spaces and elements.

If transparency has changed from an objective to a subjective element, this is also "hyper" contextual, so to speak. In fact, electronic screens with different levels of transparency may contain many types of information that can be personalized and even interactive, as we will see later analytically (cf. *Catalyst*). Everyone remembers the actor who moves through an information space transformed into spatial, transparent holograms. (We refer here to Tom Cruise who shifts, reassembles, and organizes information-images by moving them through space in the 2002 Steven Spielberg film, *Minority Report.*) These brief notes describing the theoretical framework should help us intuit how this concept of hyper-transparency is connected to the idea of context, interactivity, and electronic information. What may appear to be pure theoretical speculation in reality opens the way for many new considerations in architectural research that attempts to make use of them. This is possible because today our construction materials not only include the stones used by the Egyptians, or reinforced concrete and steel, but also electronics. Now let's return to our theoretical and speculative analysis.

7.3 Elements of Physiology

After the first area of study on the psychology of perception, we now come to a second that regards physiology and will again deal with the subject of color.

Some scientists, like Timothy Goldsmith of Yale, have spent their lives attempting to understand how animals see color and have discovered and scientifically proven that some elements in the eyes, called "cones," are different in birds and mammals.

Birds actually have four cones while most mammals have only two. So birds have a "physical" characteristic different from other animals and a different "physical" perception of color directly linked to their eyes. In particular, they see an extremely broader spectrum of radiation than ours; they see more; they see another world!

The reason for this fact is completely understandable and naturally environmental. It has to do with the vital need of these species to recognize more shades of color to better see food and insects among the plants in order to more quickly and certainly identify their target and consequently gather information about space. Clearly, this latter statement is central to our discussion.

When this information is not necessary, the body eliminates the information, for obvious reasons of economy and specialization, as well as the physical mechanisms used to collect it. Many mammals see only black and white and not color. The reason is since mammals evolved from nocturnal animals, naturally color has little importance at night. Meanwhile other characteristics became essential such as the sense of smell and sense of sight "expanded" to infrared that actually allows them to see much more at night. Goldsmith explains these mammals have lost four cones and kept only two, even though some of them, like man, have over the millennia developed a new third cone that allows them to see "certain" shades of color.

To summarize, studies in the psychology of perception have shown us that color is contextual. We have also seen this depends on specific physical characteristics (some animals see more, others see less) and the theory of evolution would indicate these characteristics have an interconnected relationship with the environment. These elements lead to the statement: *the perception of color depends on the context and physical characteristics of the observer*.

Thus color simultaneously "exists" and "does not exist." In other words, electromagnetic radiation exists that creates color effects by bouncing off various surfaces (thus becoming reflected). But these color effects are perceived in very different ways. They do not exist in themselves but only contextually and are perceived differently by different species. Because of our evolution, we humans move our arms or walk in about the same way and for the same reasons also see colors in about the same way.

7.4 A Cognitive Dimension

Let's take a crucial step and discuss the cognitive level. If color does not exist in reality but only contextually and physically, then we should attempt to specifically understand that color is a form of information. Real information has already been defined as "an application of a convention to datum!" The scientific fact is electromagnetic radiation. Color is nothing more than the application of information to a datum! This application moves simultaneously on all three levels: contextual, physical, and, the one we are discussing now, cognitive-conventional! Red means danger and green means go, but only in some situations and some conventions.

To understand the cognitive level in relation to color's characteristics of information, consider the fact that Eskimos have dozens of words describing the white of ice related to the different components of hardness, fragility, transparency, danger, etc. Naturally no one would doubt the fact these various abilities to "see" and consequently "describe" the color of ice have vital importance, just as seeing the different colors of food is important for birds. But even here in Italy, land of "O sole mio," many words exist in Italian to describe the color of the sky (blu, azzurro, turchino celeste, etc.) while historically the only one that exists in gray London is blue!

So using more terms for different colors, linking color in different cultures with a more or less elevated cognitive value, is closely connected to other contextual and physical levels. This leads us to the assertion that color is information, i.e., the application of a convention to a datum. The mechanism for realizing this application of electromagnetic radiation to the datum is simultaneously contextual, physiological, and cognitive. The same reasoning can be done naturally with other sensory information. Does odor really exist? Thousands of times we have seen pets perceive an infinite series of odors that escapes us. Clearly this sort of information is vital and the examples are too obvious to be mentioned.

Consider sound. Sound also naturally exists and does not exist. Sound waves exist; but once again sound depends contextually and physically on each individual receiver.

Language in particular is among the most complex types of information. Over millennia of our history, we human beings have conventionally created a completely sensory information tool based on applying a conventional, cognitive value to certain, specifically modulated, sound waves.

Now if color, sound, and odor, as well as obviously touch, all share the same nature from the physical, contextual, and cognitive standpoints, these senses are clearly all "information." They are not in any way "data." I repeat, data are electromagnetic radiation, sound waves, or scents, but when these various sorts of data are received, they effectively become information. They are carriers of information at different levels of complexity!

7.5 Finally, Space

Now we come to space. Does space really exist? The answer at this point is obvious; it may exist or not exist. Matter exists, not space. Space is absolutely dependent on the context and physical characteristics of the receiver, as well as indissolubly dependent on the cognitive characteristics.

You may think the space a bat knows and experiences is "equal" to ours. As is commonly known, a bat cannot see but sends out sound waves like radar. Does the bat experience a space like ours or is this space effectively different? Consider a small worm crawling around our room. The worm knows and experiences only two dimensions. It "crawls two-dimensionally." Is the worm's space equal to the space we see from a third dimension? What about the space of a vulture that can see an object 50 kilometers away? We could also consider fish that only live in an aquatic space. What idea could they possibly have of mountains, peaks rising above their seas, perhaps expanding below the sea for kilometers but also with snow-covered peaks "above" the sea?

What about microbes? What do they experience? Yet all these beings contextually, and independent of their physical beings, inhabit space, taking from it what they need. What do they need if not information? But this information is quite different in the various cases; so different we do not see, do not capture, and do not understand the information other beings use and need when they perform their main activity.

Put another way, although Copernicus showed us the earth was not actually the center of the universe, just by looking at things this seems precisely the case. We also need to understand that these three dimensions are not what actually characterize mankind, the center of nothing. We do not in fact live in a sort of three-dimensional bubble where everything is located, a bubble we and our bodies watch and control. Other dimensions exist, other spaces, other informational baggage! A series of parallel worlds co-exist and as we have seen allow some passages, some wormholes, some "projections," some leaps between these different worlds (cf. *Time*).

In addition, one man placed in different conditions also "sees" and experiences space in a completely different manner. Recently I spoke with our Italian astronaut, Colonel Roberto Vittori. Vittori described space in zero gravity conditions as completely different from usual space. A space in which one floats is a space full of possibilities, twists and turns, and above all a different way of being experienced physically (in zero-gravity conditions) and therefore cognitively. The information contained is different for the man in zero gravity space compared to our space. I was struck by a recent visit to the Hagia Sophia in Istanbul. The great Roman volume under the main dome was divided exactly in half; one half was as it had been designed in 537 AD while other half was occupied by enormous scaffolding. The scaffolding could be considered a vast matrix, in this case physical; but imagine it for a moment as electronic, virtual. A group of sensors describes the various points of the scaffolding-matrix and activating these hidden yet existing points on the space gives access to different information (a bit like Tom Cruise did in "Minority Report" or Marcus Novak in his installation "the invisible space" at the 2000 Venice Biennale). Imagine being able to use this space while floating like an astronaut. Or consider the simpler case of how a pigeon on accidentally entering that basilica would recognize hidden corners and hiding places; how this space is once again an information-space absolutely dependent on the three previously described principles (contextual, physical, and cognitive); and how this space exists and does not exist at the same time. It exists only to the extent these three levels are effectively accessible by the receiver.

So, considering, as Einstein said, in order to say something about space from the point of view of physics the only sensible thing to say is time. If we must say something about space from the cognitive point of view, it is that space *is* information. Space does not exist as such. It is the application of a convention to the datum of matter. Besides, the historic and scientific mutations of the concepts of space considered here are nothing but the confirmation.

We will stop at this point because we feel we have reached a resting place. Obvious consequences follow for architects who deal with information technology. If information is the raw material of architecture during this historic phase and if space is information, then how do we design for this new consciousness?

The first crucial characteristic is by increasing the *cognitive and contextual* aspect, as if technology were used as a sort of *augmented reality*. So how can we more perceptibly render perceptive and physical dimensions that pass beyond our normal dimensions and normal limits? As we have discussed, the entire history of technology also runs in this direction by creating prostheses that expand our awareness and physical limits. As we know, the latest physical experiments with micro-particles and molecular reactors show time runs backwards. Architecture absolutely makes up part of this process. All today's powerful prostheses are moving in this direction, from the Internet to nano-technologies that allow materials to change their color and density as well as characteristics of respiration and water-repellence. Then as always there is the great theme of interactive dynamic interconnections. We will return to this in conclusion.

In this context, interactivity is the natural catalyst. Because if space is information, then this consciousness can expand well beyond known dimensions and limits to go even further via dynamic electronic interconnections.

8. Model

Here we discuss the methodological and operative meaning in architecture and information technology that gravitates around the term "model." The mere use of this word immediately makes architects tremble, so many and so great were the ramifications centered on the term "model" in the past.

8.1 Decisional Models

One of the major ramifications developed between the 18^{th} and 19^{th} centuries, "when "model" was given the meaning of the "perfect example" to imitate (therefore itself static and academic) and contrasted with the term "type." In the years of Enlightenment, "type" had a progressive role since it was rational and helped in classification. "Type" stood to indicate – for J.N. Durand and the teaching of architecture in French Polytechnics for example – a basic plan that contained a group of structural, distributive, and geometrical indications. The basic plans were not to be copied but "adapted" to specific cases. The type was therefore a sort of indicative model, a model to help make choices, a *decisional model* useful as a support for design.

Over the course of the 20^{th} century, and in particular after the success of the methodological revolution of functionalist architecture, various types of decisional models existed. Four of these will be mentioned here.

The first was of a clearly objective nature. Postulate objective needs and find objective solutions. For example, look at the work of Alexander Klein and other German functionalist architects that followed in his wake during the 1920s. Man had set dimensions, occupied a given space, and had precise needs. A definite, minimum functional configuration could be reached for each situation. The decisional model was clearly expressed theoretically in manuals (like the famous one by Ernest Neuter, first edition 1936) and on a slightly more complex decisional level in the collection of building examples.

During the 1960s, rather than denying this approach, the mathematician and architect Christopher Alexander broadened and deepened it. Alexander investigated much deeper into functional requirements, "making them explicit" in the greatest detail possible. Consequently, a lattice structure was designed, with a network of possibilities and reciprocal give and take, within which educated choices could be developed, in part with the help of the earliest computers. The model thus changed from objective to performance.

Another type of decisional model is Structural or rather Structuralist. Obviously, we refer here to the philosophical thought originating with Claude Levi-Strauss and not with the constructive sphere (included simply as a sub-category). In this case, we refer in particular to John Habraken, and the Dutch SAR (*Stichting Architecten Research*) in Eindhoven, Holland, who for the first time consciously proposed a "hierarchy of choices." Some of these formed "fixed structures" (as structural anthropology had taught in behavioral contexts) and others "variations" of the forms and organizations "within" those fixed structures.

As we know, the objective-decisional model, the performance-decisional model, and the structuralist model are being replaced by others based on proximity with the scientific idea of the term "model," and thus characterized by a dynamic interconnection with information and the possibility of simulating as well as designing a project in an evolutionary manner. In all these cases, information technology becomes the main tool. But we should continue in order and discuss first of all a problem of method.

8.2 Deductive vs. Inductive

The world we have left behind, from the point of view of architectural production, political thought, and social commitment, was based on strong structures, on "theorems" of relationships with reality, created by philosophical, political, and artistic movements. Not coincidentally, for most of the first half of the 20th century, belonging to an "-ism," a system that could be political-ideological (socialism, communism, fascism, or liberalism) or cultural and literary (futurism, cubism, surrealism, etc.) was absolutely fundamental.

In architecture, functionalism (and therefore the aforementioned decisional-objective model) had indicated how to operate in design. It was a linear way of operating and consequentially borrowed from the operational model of industrial production. It operated from *bottom to top*; i.e., it proceeded by collecting facts and needs, arranging these elements in relation to one another, and operating by levels; strongly interrelated choices were formulated. Drawings organized this way still exist – called "trees" or *block* diagrams – from Le Corbusier and other architects of that generation. As mentioned, the logic ran from bottom to top and responded to an *If … Then* approach. In other words, having clarified a condition, a logical consequence followed in linear succession. As mentioned earlier, this way of operating could naturally occur because an extremely powerful conceptual and theoretical framework existed that could be followed. The parts of a project functioned when arranged in optimal sequence and correct reciprocal measurement as if the project were actually a machine. In so many words, this was an *inductive* method of operating.

Today we live in a completely different world. We live in a world of hypotheses that drives much contemporary thought and therefore has a substantially *deductive* method. Proof of this comes from speaking with great engineers and scientists. The more complex the intellectual activity, the more the mechanism generating this activity involves launching "hypotheses" into reality and placing these hypotheses in contrast with a group of elements and tools for verification. This is the way of thinking of contemporaneity; no more preset ideological and theoretical systems, but a series of questions and hypotheses first projected then verified in reality. Extremely interesting as a simplification of this process is the story of one of the leading structures in IT innovation, Apple Computers, that manages to create innovation by operating specifically with a clearly deductive approach.

So in technological and naturally architectural design, we also encounter the paradigm of contemporary science after Einstein. Like the scientist, the designer is a creator who bases himself on spatial intuitions he then submits to verification with his own scientific knowledge; he "creates" his own vision of the world and then proves it with science. Faced with a design (or scientific theory as Karl Popper would say), the fundamental question is no longer to which theory it corresponds (see Functionalism) but rather "what controls does it exceed."

Therefore the inductive method (from a summary of facts and individual needs, governed by a general ideology, precisely like functionalism) evolves into the deductive method. The process here is "from the top down," organized around "What … If" type questions. In other words, a deductive process is based on a hypothesis and a possible solution progressively verified and refined through "a process" with the aid of the proper tools.

Here we have arrived at our point. The hypothesis method is based on "a process" and needs appropriate technological, formal, and conceptual tools. This new type of decisional model must now be closely watched.

8.3 IT Models

Anyone who approaches information technology is generally interested in gaining a series of practical advantages (duplication and ease of manipulating graphics, access to data banks, three-dimensional visualization, long-distance transmission, and countless others). Data contained in the electronic representation of a design are no longer rigid but easily modifiable. While this aspect is easily understood, more difficult to comprehend is the fact this new aspect does not consist so much in the ease of "changing" as in the fact information assumes a "dynamic" connotation; i.e., electronic data can be manipulated not only in their singular parts, but above all in their relationships as a group. To give an example, changing the thickness of a wall in an appropriate electronic representation of a project also includes simultaneous verification of cost, thermal values, light penetration, and interior and exterior images, precisely because the parameter “thickness” can be linked with many others.

Processed data describing a project tend to be organized into a “model.” Verification of the results can be calculated over and over again, attributing specific values (the hypotheses of the project) to unknown areas. This potential pushes planners to master a “simulation philosophy” also in design and a deductive method based on hypotheses: i.e., using the project not only to represent, decide, and describe, but as a structure that “simulates” the behavior of the building system at various times.

The following brief discussion will be organized around this philosophy of simulation. For reasons of simplicity, we will divide this discussion into the areas of Quantitative, Semantic, and Spatial-Constructive. While we will only briefly mention the first two and will discuss the latter in greater detail.

8.4 Quantity and Spreadsheets

The quantitative area (originally the prerogative only of computers) was given a great push with the invention of the *spreadsheet* in the late 1970s. In this IT environment, numerical data contained in the cells of a table can be linked through complex mathematical relationships, making it possible to constantly update all the values in the table just by changing one information. This invention brought consequences in a broad range of fields, from financial to construction. Above all, it represented the advent of a generalized way of thinking *What … If*. (“What” happens to my model “If” I vary cost X or quantity Z in all those sections dependent on these?) This potential for simulation affects the work of designers in the fields of programming, calculations, cost benefits, and naturally computations for estimates.

For example, a spreadsheet can be created with a mathematical model of a cost-benefit table for a building to be restored. In this case, the table will explicitly (and schematically) render not just the costs of potential building operations (as is customary) but also presumable benefits from the direct as well as induced points of view. This process is important since it "gives a sense of proportion" to opinions, requiring those involved in the operation (municipalities, superintendents, designers, clients, etc.) to quantify the parameters of their judgment.

This type model becomes a tool for guiding choices. For example, we can see how adopting a frame with a border of one type or another affects the cost itself as well as the benefits (thermal, functional, and image) since, in fact, each of the actors involved formalizes a value for alternative solutions. When there are many choices and a limited budget, compromises must be made between the individual operations in order to reach the best overall solution. But it is one thing to have the entire dynamic and interactive group of choices under control, and another to see each one individually. This model can be used again and again in order to find the overall best solution. Although creating a model like this is technically very simple (perhaps with a few hours of study), the potential is enormous.

Rather than containing graphic information (the kind that would describe a plane for example), a pure spreadsheet contains only quantities, making possible what we discussed above. Naturally, an electronic cost-benefit model becomes even more interesting when the quantities are linked directly to graphic information. This potential allows us to extend the simulation of the structure, installations, lighting, acoustics, etc. These possibilities are linked to programs in the GIS (*Geographical Information System*) sector (originated by the revolutionary *Filevision* program that ran on the graphically integrated environment of the newly invented Macintosh Computer). The various types of GIS programs connect graphics and numbers in such a way as to store quite a lot of information (dimensions, characteristics, and costs), giving access from time to time to environments or relevant parts of the building. Originally, graphic and textual information was not dynamically linked and the dimensions of an environment had to be inserted manually. But now many CAAD programs make real interactivity possible with an integrated *spreadsheet*. In this case, graphic information (the dimensions of an environment for example) are read and inserted automatically into a *spreadsheet* that could for example describe a complex cost-benefits model. At this point, the logic of simulation clearly makes a decisive leap. (A modification in graphics reverberates throughout the mathematical model and all its interconnections.)

8.5 Opinions and the Expert Systems

Now we will just as briefly discuss the second area of simulation, the semantic. The idea in this case is to condense into one program the same varied and complex collection of awareness and knowledge an "expert" professional might have and thus provide suggestions and indications on how to resolve determined problems with the project by interrogating this "expert system." First introduced in the medical sector (from a series of symptoms and questions, the computer program produces new diagnoses and therapy via deductive systems called "interference engines"), this field was subsequently also adapted to construction projects.

In the field of architecture, various families of *expert systems* should be mentioned.

The first has a substantially deterministic approach and tends to represent architectural problems (although in reality these are more frequently structural or distributional issues) and has the computer find the best solution possible. The second school is of the generative type. (It defines rules to create forms with fractal algorithms, for example, or defines them via *shape grammar*.) Projects are born out of this. The third, a specialist, performance-type school, tends to create expert systems for sectorial consultancy. This specific path was later developed commercially. Based on a maximum project, the artificial intelligence program evaluates and makes recommendations for specific environments (seismic, environmental, structural, techno-illumination, acoustic, etc.). Large international engineering companies regularly use these.

We are dealing specifically here with design support systems related to simulation philosophy. These systems allow operating with complex choices, diversified and governed by the specific needs of the operator through the accumulation of new knowledge. But while the previously described cost-benefit case (whether developed in a spreadsheet or electronically linked with a CAAD program) can be easily developed by a designer, an *expert system* (requiring professional skill for its effective creation) is simply "used" in a way not much different from speaking with an expert.

8.6 Hierarchical Structures

Now we come to the central area of architectural modeling. This should be discussed at length given its importance in developing a project as well as immediate use in developing a project once the potential is understood.

We are particularly interested in so-called "Hierarchical Structures" (HS). Borrowed from programs that once operated only on expensive computers, these now characterize many CAAD programs (with terminology based on the various application programs: *block, symbol, component*, etc.).

Hierarchical structures are important because they helped create dynamic relationships within the information described in the three dimensions of a project. The possibility of simulation in these environments consequentially describes not just the quantitative or semantic but the special and constructive, functional and formal organization of the project.

The use of hierarchical structures requires deconstructing the parts of a project in order to represent it. The first idea we must keep in mind when working in this environment is the difference between *primitive*, *instance*, *object*, and *class*. A primitive is nothing more than three-dimensional information that is "normally" created in a CAAD program and corresponds to the entire model in a non-hierarchical environment. Let's imagine instead that, in a hierarchical structure, a primitive is a prism we will call "pillar"; a second primitive is a "sheet of glass," a third a "marble panel," and so on for the outline of a frame, floor, or covering element. Every primitive is modeled in its own environment, distinct from others, and can be given a conventional name. The fundamental aspect of a hierarchical system is that primitives can be combined with each other to determine "objects." In the simplest case, the "glass" primitive and "outline" primitive, when inserted into the "window" object, become *instances*: i.e., examples, symbols, and reoccurrences of the primitive. While *instances* can be duplicated and parametrically manipulated, modifications of their geometric properties, like additions to a volume or the change from a parallelepiped to a cylinder, can occur only at the level of the primitive. Furthermore, when the "window" object is inserted into the "first floor" object (corresponding to a higher hierarchical level and therefore to a different "class"), this will in turn be treated as an *instance* and the reciprocal spatial relations between outline and glass can be manipulated only at the level of their first combination. Although this may seem limiting at first sight, this hides the innovative strength of hierarchical structures.

Designing a building through the use of a hierarchically organized CAAD program makes many important activities possible. Let's look at two examples. Take the change in thickness of a frame. In this case, the operation is not computed by manually modifying (though perhaps in an electronic environment) the hundreds of windows present in the model, but by modifying only one at the level of the primitive "outline." (This operation can easily and simply be repeated many times so different options can be investigated.) Given the graphic information on frame thickness can be read directly (and dynamically) in a *spreadsheet*, corresponding variations can also be verified in all the costs (or any other foreseen relationship).

The second important aspect regards the area of realistic simulation. A three-dimensional model can naturally provide images with a quality of definition near reality through sophisticated effects of shade, refraction, or light absorption by different materials. But *instantiation* (i.e., the automatic transmission of changes applied to a primitive) makes it possible to have more alternative views of the same environment just by changing the parameters of the primitives. This method can be used to verify various paint colors, the grain of the plaster, the transparency level of glass, etc. So all project participants can verify together the effects of one design solution over another while considering all visual and quantitative components. Although these are only two of many possible examples, they clearly express why a hierarchically organized model advances the level of simulation so much it becomes similar to a deductive and hypothetical way of reasoning in architecture, the *What … If* typical of the spreadsheet environment.

8.8 Simulation Model

At this point, it should be clear why a model created with a hierarchical structure is completely different from traditional as well as other electronic products. From the point of view of the analysis, documentation and reconstruction of architecture (a field of study we have developed quite a bit over the past few years and applied particularly to the architecture of Giuseppe Terragni), this encapsulates the knowledge and interpretation that have guided construction. But from the operational and design point of view, hierarchically constructed models allow us to clearly, and in basically a simple manner, approach the logic of simulation and the deductive method described in the opening.

This hierarchical structure creates a "Living Model," inconceivable with traditional tools, which simultaneously allows much fundamental architectural research activity. A project represented in a CAAD program with a hierarchical system becomes not only completely different from a traditional plastic model (given that three dimensional visualization is only one, relatively negligible component) but also becomes a "model" with a dynamic, open structure that makes simulation of reality an actual possibility that can be followed and designed.

The meaning of the term "model" as used at the beginning of this chapter, in terms of the perfect example for imitation, has now been completely overturned and assumes a more scientific meaning: *a theoretical diagram developed in various sciences and disciplines to represent the fundamental elements of one or more phenomena* (statistical model, economic model, etc.)

At first glance, this meaning may seem foreign to architecture. Instead it has become extremely important for architects precisely because of information technology. Thanks to the computer, today one single electronic model can perform all the tasks done by architects in the past (convincing the client, studying construction phases, producing explanatory graphics for the worksite, exploring the object in movement, and simulating light and shade, thermal losses or structures). But we can also have what the ancients could never have imagined. The information contained in an electronic representation of a project is no longer rigid (as in traditional supports) but easily modifiable, not just as individual pieces of information but also as they relate to the whole. This ability comes precisely from the dynamic interconnections made possible only by electronics and mentioned above with the example of the spreadsheet.

8.9 Clouds or Diagrams

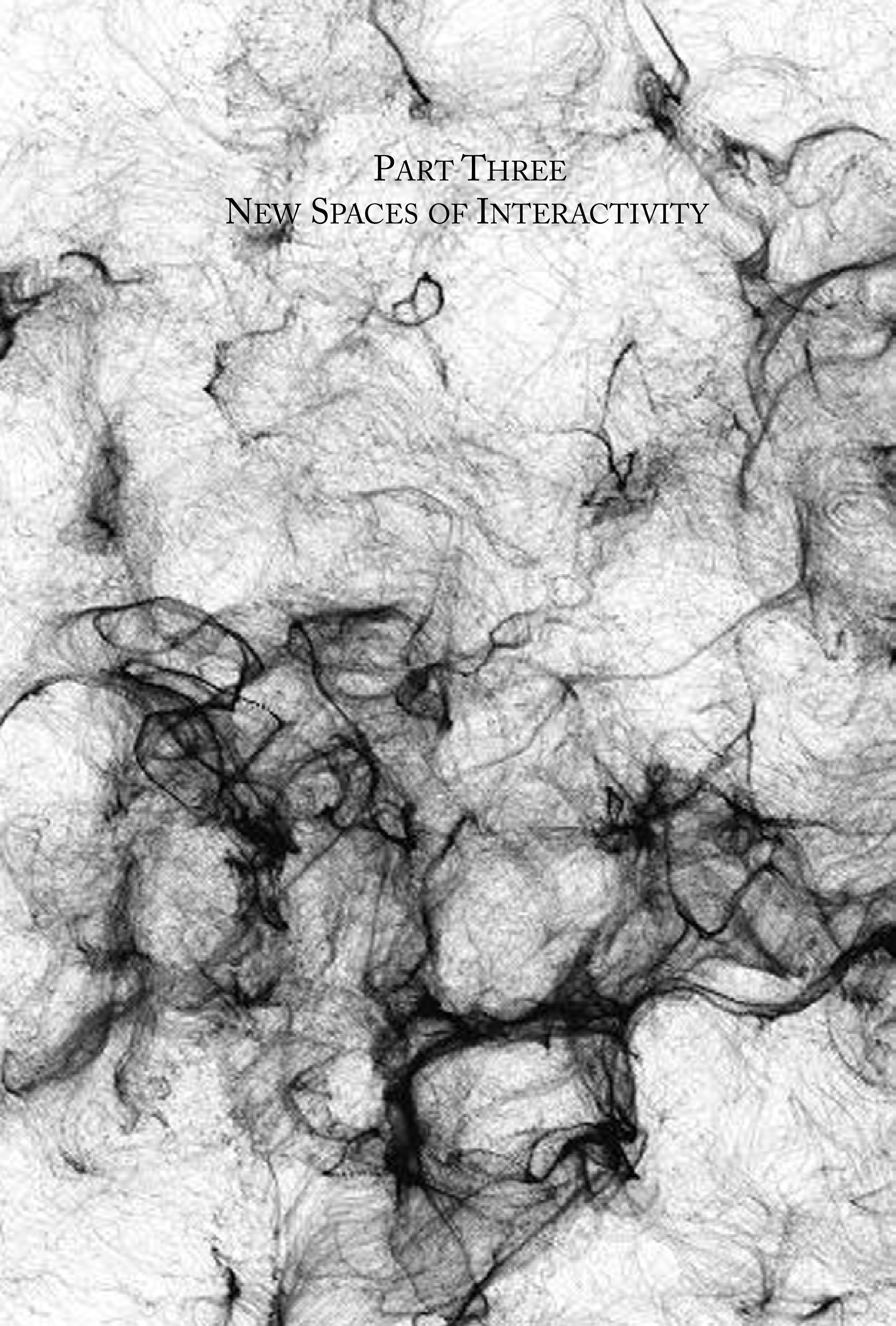
In conclusion, at this point we should remember the word "model" is "inseparably" linked with the world of mathematical relationships, with the mutability of conditions, and thus with electronics. This idea of a model is key to guaranteeing many features found in the practical world of creating contemporary design: the presence of various specialized technological and engineering areas, long distance communication, management of component databases, collaboration between different experts, and prototype production, as well as the actual creation of components through what is called CAM (*Computer Aided Manufacturing*).

From the point of view of the specific project method, this opens up at least two large families of possibility.

The first is simulation, which we have discussed at length. In particular, this makes use of hierarchical models and the activation of a series of specialized sub-programs that refer to the same three-dimensional data base and serve to simulate and verify different states and parts of the project. An overall information technology model at this level of complexity now effectively governs the most advanced projects. This type of methodological approach places "information" and its management at the center of the process, but plugs the development process into a formal, pre-existing hypothesis. This specific approach finds its highest expression in Frank Owen Gehry. Gehry starts with a drawing that is intentionally a sort of overall hypothesis, a "possible" idea of the project. This hypothesis progressively takes shape and is continually perfected through a series of verifications. The final building is governed by an overall model that already incorporates a large number of control elements. A sort of "cloud," the initial drawing takes shape through the management and development of a computerized model.

A procedural approach is different. The main tool in this case is the prefiguration of a series of relationships between the parts. This series of relations are by nature "topological" and frequently expressed through diagrams. From this point of view, the model tends not to simulate and then verify the efficiency and optimization of a whole series of sub-components of the project, but becomes a methodological guide, a diagram, a design *in progress*. (Much discussed in philosophy, the reference for this interpretation is Gilles Deleuze.). We are not necessarily dealing here with the progressive concretization of a formal idea, but the *prefiguration of the relationships that exist* in architecture starting from a DNA code that generates and regulates its development. The results depend on a series of accidents that intervene as variables to push that diagram-code to evolve toward one form instead of another. One of the essential figures in this type of approach, Peter Eisenman has repeatedly written about it, but a conspicuous part of contemporary architectural research also passes through his work. Consider the UN Studio research by Ben Van Berkel and Caroline Bos. Now that we have seen how the "Model," alongside *Information* and *Time*, constructs a new reference system, we must go further into this new spatial research and see how these theoretical ideas also structure the work of contemporary, cutting-edge architects.

Part Three
New Spaces of Interactivity



9. Reification

How do spatial concepts change? What is mental space? How can an information space be considered, conceived, or realized? The word "reification" ("reduction to something material") is used here in an unusual context. This concept is key to understanding a series of fundamental aspects of our treatment and must be examined. We will do this by considering in sequence the ideas of the "non-objectivity" of space and "mental landscape." Both these are instrumental for identifying several characteristics of architectural research that look "inside" electronics.

9.1 Informatizable Space

Obviously, our first consideration emphasizes the fact the *concept of space is different in different eras.*

Space does not exist as an objective fact, but as a mental form, frequently with scientific characteristics, although at times only a symbolic form. Erwin Panofsky teaches that frequently it is both things. The way of representing and understanding space varies from era to era, for example: flat Euclidean space, three-dimensional Cartesian space, the curvilinear geometry of Gauss, Riemann's space with "*n*" dimensions, Poincaré's topological geometry, etc. The mental and scientific ways of representing space have a utilitarian value. We use them if they work; we set them aside if they do not. Euclidean geometry is more than accurate for dividing farmland. But we need another sort of geometry for measuring the curvature of solar rays. Naturally these different spatial concepts do not cancel each other out but, like photographs taken from different angles, instead give different interpretations of reality.

Today we live in a multidimensional space, especially because we use many lenses to look at reality. We can use an objective with a focal point created many years ago or one from today and then return to one from the past (or, as we will see in this section, imagine one from tomorrow). Each image is true to a certain extent, even if the power and the ability of being significant today is very different.

The point I want to make is that (like color, sound, and language) space itself exists and does not exist. Electromagnetic radiation exists (color), sound waves exist (sound), *matter exists, but not space*. Electromagnetic radiation, sound waves, and matter are all "data" that, through a process that is *intellectual* (developing conventional meaning) and at the same time a process of *physical* perfection and adaptation (refinement and the development of organs in different beings), are transformed each time into color, sound (or verbal language), and space.

We should emphasize that space, color, sound, and verbal language are, therefore the result of conventional constructions that transform data, in "information." *So space is first of all information.* Space carries a complex (very complex) collection of information within its particular system of relationships[5]. When we are inside an

[5] In other words, a space not only communicates information, something obvious, but information is the nature of space itself. Space is not a "fact" but actually information (i.e., remember the definition "the application of a convention to a datum"). In this specific case, the datum is the existence of matter, but space is conventionally and physically transformed into information depending on the conventional, physical facts of each being. To see this, consider the same example we made in the chapter on Time. Imagine the room we inhabit and think of how a flatworm would experience this same room. This being would gather "certain" information, all part of its own physical and conventional system (in this case very limited). But a human being is not in fact in the same space as the flatworm! Since humans experience a completely different reference system and possess information

architectural space, and not simply a natural space, this conventional and cognitive construction reaches an even higher level because it constantly interconnects with concepts that are scientific as well as constructive, aesthetic, and technological. Being inside a type of architecture means being inside a highly designed organization of matter that absorbs and relaunches all those aspects and, in particular, *reifies* those concepts, makes them evident and tangible.

9.2 Examples

We have just seen that spatial concepts vary from era to era and that space itself is information. We have seen that architecture turns concepts of space into something concrete. We will now use some examples to help better understand this idea.

Look at the Egyptian pyramids. Is not the pyramid the concrete construction of certain ideas of geometry and trigonometry? In fact, without those ideas, without those mental forms, the pyramids could not even be conceived. If the mental form of the triangle did not exist, how could a pyramid be created? Is the Pantheon not the result of advanced geometrical calculations, a way of thinking about space and calculations using the form of "geometry" evidently used by the Romans (who would have never been able to construct that type of building with their abstruse numbers)? Let's use the example of all examples with the achievements of the new architecture at the beginning of the 15th century. Was not the invention of perspective at the basis of Humanistic architecture? Perspective was precisely the scientific concept that finally rendered space perceptively "measurable" and pushed toward creating an architecture made in its likeness and image. The architecture of Humanism was modular, proportioned, composed of repeatable and understandable elements. In other words, it was intentionally made that way to be *perspectiveable.* Finally, did not the "mechanical," abstract, analytical, and objective

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on space that is absolutely superior to the worm's information, our information-space is something else entirely!

concept that presided over industrial society find its reification and clarification in the new rules of architectural space from functionalist architecture around the mid-1920s?

Let's recall the premises just discussed.

1. Space is the result of the application of scientific, physical, and symbolic conventions to the pure datum of matter.
2. Space is information, like color, sound, and verbal language.
3. Different concepts of space are mental forms that vary over different eras.
4. Different mental forms of space find their reification in architecture.

9.3 Mental landscape

Naturally this relational process between mutable concepts of science and architectural research combines and interweaves the two together. A relationship of mutual influence lies between scientific instrument or material and spatial concept. In particular, architects frequently find their ideas of change in the spatial concept by looking "within" the instrument, "within" the same scientific paradigm.

Consider Brunelleschi who constructed the perspective framework. This framework is a scientific instrument that allows seeing things differently; i.e., it brings depth to the plane according to new rules. These rules are verified in two directions (by the actual dimensions of the perspective view and vice versa!), scientifically re-applicable each time. Perspective for example can create a door panel where people, instead of being mobile or hanging, seem to occupy a real, physical, determined, measured space. Now would it be hazardous to consider that looking "within" the scientific model of perspective and "within" that framework itself triggered a series of revolutionary changes in architecture accomplished by Brunelleschi, i.e., the creation of a modular system, recognizable and enhanced perspectively, so that architecture becomes transformed after that look within the framework. The scientific concept is *reified* in the Humanistic architectural revolution precisely by looking "within" the instrument of the perspective framework.

While there is a well established field of theses on the above (see for example Leonardo Benevolo. who built his *History of Renaissance Architecture* on the perspective-architecture relationship, and Erwin Panofsky, who has written an unforgettable article on this topic), it is interesting to consider that concave and convex lenses combined with Galileo (and his completely human efforts at measuring the sky, thus bringing it down to man instead of leaving it up to the divine mystic) to influence the concavity and convexity of Borromini, gazing at the vault of the covering like a test of strength that began for the first time from below. As if for Borromini looking "within" that new, miraculous lens had contributed to a new way of imagining space, thus reifying it again in architecture. We have no proof of this, but it is clear that linear analytical logic, the rational force that moved the industrial organization of production and positivist thought, powerfully organized all functionalist architecture.

Is it not remarkable at this point that the IT paradigm, with all the aspects we have considered so far (dynamic interconnection, mutability, modeling, network relationships, and changes in the notions of time), would come to constitute for the new generation of architects that same look "within" the new scientific paradigm to search for aspects that must be reified in a new concept of architecture? The idea of a hyper-informatizable space is born. If it is true that all space is in any case information and all concepts of space owe much to scientific and technological concepts and tools, then contemporary cutting-edge research searches for a "hyper-information space" because this concept is precisely what drives IT. Dynamic interconnections and the idea of model as a mental landscape experienced daily on computers are beginning to shape a new idea of architecture.

In summary, we are moving toward a concept that, like Brunelleschi's perspective framework, Borromini's lens, or Gropius's linear industrial processes, may be mutating into a new form of architecture precisely through the dynamic interconnections and systemic logic of information technology.

We will give the label *mental landscape* to the nebulous vision of these new possibilities, these "look within" scientific concepts.

9.4 Born with the Computer

Now let's take a new step forward. We have seen that at the center of the formative process of architecture lies "our mental model of space," i.e., the mental representations of space that have followed each other during various historic period. This mental model of space tends to be reified in a type of architecture that corresponds to it.

Architects from the new generation have been attempting over the past few years to understand exactly how these changeable, interconnected, dynamic models at the heart of the IT Revolution can migrate into an architecture that then becomes their reification and constitutes their concretization (cf. *Models*). If the basis of the spatial idea of 1920s functionalist architecture was the concept of mechanization (in its various aspects of analytics, objectivity, abstractness, seriality, and consistency), then the concept of information is, and could only be, the horizon of this architectural research phase. Architects like Marcos Novak or Kas Oosterhuis or François Roche, (to make just some examples) live *inside* the computer; in a certain sense, they are "Born with the Computer." Returning to the word "landscape," a new landscape has been taking shape for years in the minds of this new generation of architects, a landscape native to this new era, a real landscape of information.

What are the fundamental components of this new landscape? First of all, an initial element of this mental landscape takes form in the minds of new architects and artists, the element of a reconquered world and environment, again actively participating in the contemporary world. The use of the term "landscape" also alludes to this reconquered nature, is part of the research into complexity made possible by electronic models, experiences our body's mutations and hybridizations, and is presented as an active and intelligent world alongside architecture.

The second element of this new mental IT landscape is its similarity with what we experience more and more on a daily basis. Today's landscape is not just the contemporary metropolis and its variations in various corners of the globe, but also and most of all what we experience every minute through our computer screens and technological prostheses. This is a landscape made of leaps, a landscape of superimpositions, a landscape above all of dynamic interconnections between pieces of information, and therefore the landscape of interactivity. Once this was called *Weltanschauung* (the vision of the world or spirit of the time).

But the fundamental characteristic of this generation is to look "within" the same IT model. First of all, information takes on great value in this world and, as we said earlier, makes up the real raw material. These bits of information fluctuate, are reconfigured and modeled into significant, productive forms, then shift and recombine again in a different way. The fluid of information constitutes the raw material of this research and takes form through the dynamic and interconnected structures of electronic scientific models. A great distance from the past is felt, understood, and intuited within this mental landscape. If gears, connecting rods, and conveyor belts were the first bricks (and sources of inspiration) in an industrial and mechanical landscape later constructed by functionalist architects, if relationships with pop art, conceptual art, Russian constructivism and Klee are crucial for Gehry, Eisenman, or Hadid, or Toyo Ito (cf. *Landscape*), then today, and even more so tomorrow, these bits of information are precisely what constitute the indispensable value of a contemporary world struggling to take form in architecture.

These architects are attempting to give form to a subjective landscape that originates through systems of dynamic interconnections and interrelations, the changeability and parametric or topological dynamics typical of the world of information technology. These individuals are slowly but now clearly giving shape to their computerized mental landscape, already reifying a new and completely revolutionary architecture.

So we miss the mark if we think this research leads only to the creation of a parallel virtual world (internet sites, electronic games, or installations). The real objective is the materialization of a new phase of architecture, where using information technology becomes something concrete. The virtual dimension "must live in materiality" as Daniel Libeskind understood in his 1997 proposal for "Virtual House".

10. Catalyst

How and why is the concept of interactivity central to architectural research in this historic phase? Let's start by clarifying the meaning given to the word that characterizes this chapter. 1. *by catalyst we mean an agent that allows a reaction to occur*. Now we can ask, on what does the mental landscape of the new generation of architects converge? What is the catalyst?

The manner in which we use this term evidently refers to the aesthetic dimension, and therefore to a cognitive dimension that contains and summarizes many elements and represents synthetically a group of reasons and, as you may recall, crises (cf. *Substance*).

Not only does a catalyst allow a reaction to occur, but it also 2. *acts in the combination, direction, and meaning assumed by many substances placed in its presence*. There is no doubt perspective was the catalyst for a series of elements (cognitive, philosophical, historic, technical, and figurative, as well as constructive). Perspective not only represented them synthetically all at once, but also "directed" them. For example, proportional systems were developed precisely in relation to the birth of perspective that reinforced the normalization and modularization of elements in classical language. Construction was organized according to congruous, specific principles and a rational idea was born of seeing and measuring the world.

Not only does a catalyst spark a reaction (in this case the birth of the new, revolutionary Renaissance architecture) but it also organizes and guides the various elements. In other words, perspective is cause and effect at the same time in a weave that cannot be eliminated.

10.1 Transparency Once Again

We have frequently written that transparency was the catalyzing element of functionalism. Once again cause and effect, result and direction, are combined. Transparency abstracts and renders the world (apparently) objective, responds to sensible, rational theories, and corresponds to a free organization of functions yet at the same time punctiform construction. If there had not been transparency, if Gropius and the Bauhaus had not given full significance to these multiple levels of transparency, *functionalism would only have had an ethic and not an aesthetic*. The modernity of transparency responds to the crisis of the birth of the industrial world that only when it arrived at this point, a dozen decades or so after its manifestation, also became a driving element in the world of architecture.

At this point, we should ask ourselves this: What is the catalyzing element in the emergence of the new IT paradigm, the element that should be a model of scientific investigation and interpretation of the world, aesthetic and ethical, as well as a direction for future research?

As you know, we have given this catalyst of the IT Revolution the name "interactivity."

10.2 Interactivity

We should ask how and why the concept of interactivity is central for architectural research in this historic phase that looks to information technology.

To answer this question, we must approach the theme from several points of view; first of all, the historic point of view. The key word in this context is exactly "catalyst." In the second place, we must face this problem from the viewpoint of communication theory; the key word here is "hypertext." In the third place, we must explain why the concept of interactivity is central to architectural research from the point of view of the logic of information technology; the key word here is "model." Finally, and this is difficult, we must deal with the search for new spatial concepts based on the rapid change of the relevant systems; the key word here is "time." Finally, what we mean is: 1, interactivity is the catalyzing element of this architectural research phase because it contains the contemporary communication system based on the "possibility of creating metaphors" and thus first navigating then constructing hypertext systems; 2. interactivity puts the Subject center place (variability, reconfigurability, personalization) instead of the absolute Object (seriality, standardization, duplication); 3. interactivity incorporates the fundamental characteristic of information systems, i.e., the possibility of creating interconnected and changeable models of information that can be continuously reconfigured; and finally 4. interactivity structurally plays with time and indicates an idea of continuous "spatial reconfiguration" that changes the previously established borders of time and space.

10.3 Hypertexts and the Creation of Metaphors

Those who like me were educated during the 1970s will still remember the way we were taught architecture. The key word for a long time was "objectivity." We always had to demonstrate analytically the relationship between a cause and a specific solution; good architecture was born from this connection. But this way of thinking has been abandoned for some time now along with the great industrial model. Today, narration takes first place. It follows that "first" comes the story to communicate and only "after" and "within" this narration is the project developed. Examples of this are there for everyone to see.

A second factor should be added to this narrative component, and here interactivity comes into play. More and more contemporary communication is also metaphorical. The metaphor replaces one-way, cause-and-effect reasoning with multi-dimensionality and the discontinuity of rhetorical figures. Thus a linear way of proceeding is replaced by a way of proceeding by leaps.

But is not hypertext the communication environment of leaps? Does not hypertext, through HTML (*Hypertext Markup Language*), the Internet, and its *links*, represent an indispensable component in our current way of thinking?

The most fitting definition of hypertext systems is as environments that are *creators of metaphors*. So the challenge in this sector is not only to create predefined metaphors (for example an artist's work exhibited in his virtual studio), but also the ability to create "mobile metaphors" the user can interactively reconfigure every time. Ever more numerous systems exist capable of creating metaphors that can actually be personalized. (For example, consider the creation of scenarios that can be played out or visited using artificial intelligence, personalized database research, or virtual simulations.)

What do we want to say here? We want to say that interactivity shifts the sphere of contemporary communication to a more complex level. Already defined metaphors and images are being replaced with the idea that *we can create our own metaphors.* This is the great gamble of the world of hypertext communication, an open battle, political and social since it involves developing a more and more mature critical sense.

10. 4 Interactivity and the World of IT

Information technology is the standard "mental landscape" in today's architecture. What does this mean? First of all, we use "mental landscape" to say that architectural research (always) prefigures a sort of ideal context in which it arranges itself. Architecture prefigures this mental landscape, following certain elements already active in reality, developing other elements, and above all incorporating into itself scientific or symbolic models that have been created over time. Architecture transforms these models into specific spatial interpretations (cf. *Reification*).

Information technology is based on the characteristic of constructing "mobile" and "interconnected" models of information. These models are mobile since altering just one piece of information or one relation can change results. This intrinsically dynamic, intrinsically interconnected mental landscape shows reality in the form of mathematical processes and relationships. This mental landscape also creates revolutionary changes for the architecture of today and tomorrow.

Just as Renaissance architecture was transformed to become *humanizable*, and Functionalist architecture was completely restructured to be *industrializable* (meaning not "only" produced in series but also becoming objective, serial, abstract, and mechanical), so today's architecture struggles to become *informatizable*, to absorb the dynamic, interconnected, and above all interactive essence of the IT paradigm.

In this context, interactivity means architecture must tend toward being continuously modifiable, in the likeness and image of information technology itself, and become a sensitive environment in constant transformation; an environment able to react and adapt even in changing to fit the desires of users through the creation of scenarios as feasible as if they were hypertexts.

10.5 Interactivity and Time

Now we come to the last series for consideration, in some ways the most complex.

Interactivity is linked with time and, as Einstein wrote, time is the only way of saying something logical about space. Let's mention several fundamental concepts. As we have seen, space is not an objective reality (as we frequently believe) but is viewed culturally, historically, and scientifically in ways very different from each other. If we use time as a system for comprehending space, we discover something important. The rule of the leap applies from one reference system to another; we find that same leap at the base of hypertext systems.

Interactivity in buildings is not only able to vary configurations and spaces with variations in user desires or external input, but can also *create different spatial-temporal reference systems*. If an interactive system for modifying architecture is connected to navigation systems based on the Internet, the image of the leap could permeate all of architecture, a leap from one spatial configuration to another, a leap between different information systems, or finally a leap between different temporal conditions.

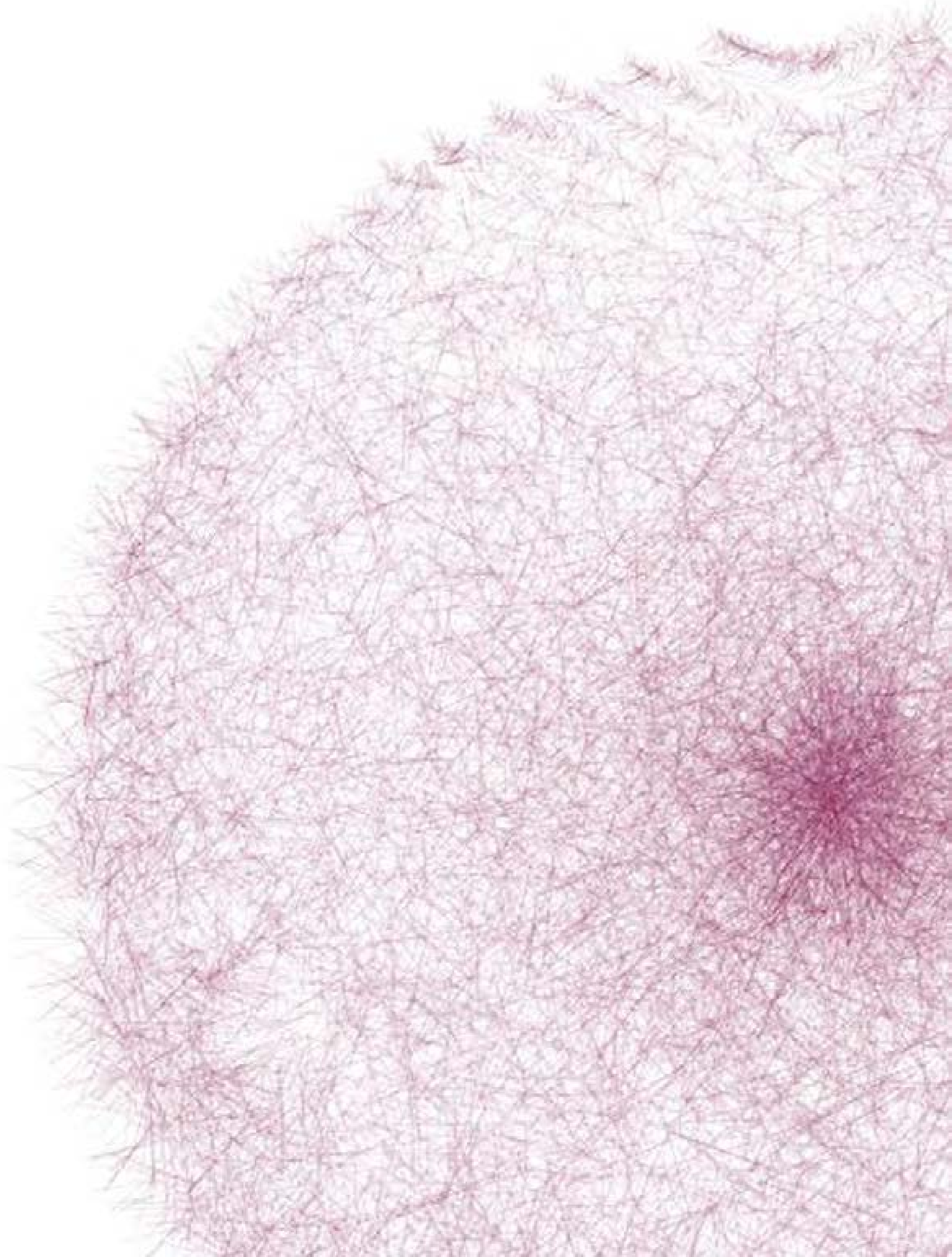
Coupled with windows-based interface systems, real time navigation systems, or long distance representation systems with sensitive and naturally interactive holographic systems (a small step in the near future), the great world of the Internet can multiply and compact space and time. We can have windows simultaneously open on worlds far apart from each other and leap from one to the other, experience and experiment with spaces in acceleration or movement, represent and be represented, and all in real time in one continuous leap from one world to the next. Repeating what was written in *Time*, the Internet is a necessary tool for architecture in this phase of research because of its programmatic as well as cognitive aspects. If we understand this, we can see how a fundamental formulation is activated via the Internet and interactivity. *A lower system can receive projections from a higher level.* So although physically contained within the spatial-temporal limits of three dimensions, an idea is still possible of a space with more dimensions than ours, as well as using, imagining, partially understanding, and designing this space with more dimensions.

At this point, I hope it is understood how the concept of interactivity runs through three key questions, mostly through the relationship with the world of contemporary communication and a greater subjectivity of choices. (Both these components present obvious political implications concerning the central place of the individual.) Interactivity is also a central factor in the mental landscape of new architectural research (through the absorption of dynamic models from information technology). Finally, through the method of the leap and discontinuity, interactivity allows designing and considering spaces and architectures that do not move within the three customary dimensions but rather project onto themselves the possibility of more dimensions.

Interactivity incorporated "within" the physicality of buildings means working at a new level of architectural complexity. The highest level of this challenge is neither scientific (creating more and more mature mathematical models), nor technological (creating physical and electronic systems that create levels of interactivity and sensitivity in buildings and environments), nor functional (understanding how to make interactivity an element of research into the “crises” and difficulties of contemporary society, instead of a game in the houses of the very rich). As always, the greatest challenge is aesthetic; to seek an aesthetic (i.e., a way of seeing, interpreting, and building the world of architecture) that is intimately and necessarily interactive. Here the role returns of the catalyst.

Interactivity is the chemical reagent, the catalyst, of all these substances. Interactivity has at the same time an ethical and political component, a technical and technological component, and a fundamental aesthetic component because it requires a revolution in feeling that pushes toward a new consciousness of contemporaneity. Looking briefly at the change in the framework of contemporary architecture, we could say that if the Modern Movement’s formula was, rightly so, *Neue Sachlichkeit* (New Objectivity), then today’s formula can only be New Subjectivity; and interactivity is the key to this New Subjectivity.

Part Four
Summary



11. “Informatizable” Architecture

Formulary for a new urbanism.
Architecture is the simplest means of *articulating* time and space, of *modulating* reality and engendering dreams. It is a matter not only of plastic articulation and modulation expressing an ephemeral beauty, but of a modulation producing influences in accordance with the eternal spectrum of human desires and the progress in fulfilling them.
The architecture of tomorrow will be a means of modifying present conceptions of time and space. It will be both a *means of knowledge* and a *means of action.* … Architectural complexes will be modifiable. Their appearance will change totally or partially in accordance with the will of their inhabitants. On the bases of this mobile civilization, architecture will, at least initially, be a means of experimenting with a thousand ways of modifying life, with a view to an ultimate mythic synthesis …
Gilles Ivain 1953

This quote gives me the words necessary for creating a sort of summary for the entire book. The quoted text speaks of a “mythic” synthesis of an architecture for “experimenting with a thousand ways of modifying life” and above all an architecture that changes “totally or partially in accordance with the will of the inhabitants” (not to mention architecture as an *articulation* of space and time!). This quote from Ivan Chtcheglov (Ivain’s real name), published only in 1958 in the first edition of the journal *IS*, *Internationale Situationniste*, is an incredibly lucid premise for what is about to happen to architecture thanks to information technology. This quote may at the same time be the best way to complete this lecture and begin the "IT Revolution in Architecture."

11.1 System Space

First of all, we should remember the IT Revolution in Architecture has only marginally to do with the facts of virtual and plastic manipulation, and more to do with the indispensable substances of today's society.

Remember the word "substance" from Persico. Within that "substance of things hope for" lies the tension toward modernity, toward the transformation of the world's crises into aesthetic and ethical values that architecture could cultivate and manifest at the same time.

The renewal in architecture experienced over the past few years is not a superficial, fashionable, linguistic episode. New substances are actually asserting themselves and with these new crises and opportunities.

When we hear attacks on the advertising, playful, communicational, spectacular, or fragmentary aspects of contemporary architectural research, this seems like the return of same misunderstandings and paradoxes of the *Art nouveau* generation against representatives from the *Neue Sachlichkeit*. Apparently, a style is attacked; in reality, this is opposition to a tension toward renewal, change, or achieving the consciousness of a different vision of the world.

The Information Revolution triggers powerful transformations across the entire social framework and requires a new direction for architects to be effective. Look at the emergence of great phenomena and issues over the past few years like abandoned areas, new concepts of metropolitan landscape, and ecological awareness, not to mention the technical potential of electronics in the construction sector.

Architecture insinuates itself into the fabric of the constructed city, uses and reintroduces pre-existing objects as "ready-mades," with its organization creates interstitial spaces "between" new and old, gives form to a new idea of contemporary landscape, of *urbanscape*, and with this a rethinking of city, its intersections, its dynamic flows, its intricate links.

At least in technologically advanced countries, the opportunity arises for a historic *reclamation*. New green areas, nature, and sports facilities can be inserted into disused areas, frequently constructed with high population densities, in order to create new integrated, multi-functional parts of the city. Today, we can work anywhere, since places for commerce or leisure or intellectual production tend to mingle and hybridize in a general connectivity.

Though the combination of these modifications leads to many substantial differences, we will discuss for a moment only the idea of space. Briefly, we could say we are shifting from an idea of *organ space*, typical of most of the last century, to a concept of *system space*. Organ space meant space conformed with respect to the function (!) it was required to perform. Wright's helicoidal ramp in the Guggenheim Museum was actually generated by an idea of function (albeit innovative). The building conforms space based on this organ-function, and based on this method it organizes, directs, and hierarchizes all the other choices (formal, functional, plastic, constructive, etc.).

In contrast to organ-space, today's idea of system space means, on the simplest and most immediately understandable level, that the creation of a building is not based on its internal operation in terms of priority, but on a much more complex weave of considerations related systematically within a network. Today buildings are created as actual conformations of landscape, interconnecting open spaces and interior hollow spaces of buildings that make fragmentation of the parts a vital element in relation to the city and surrounding environments, but above all through a network of relationships that link form and function, material and construction, urban scene and building articulation, in a way that is anything but mechanical.

The fundamental difference is that the various components that create architecture, and thus the relationship with the context, construction, spatiality, expressivity, and functionality, instead of being conceived as an absolutely consistent whole, rigidly linked together hierarchically, function like a system of "independent equations" related to each other. Each equation is optimized and passes on a legacy (a result, a condition) to the subsequent equation that in turn is optimized within its "own" parameters. This enormous revolution has not originated accidentally but as part of a great complexity closely linked to the IT paradigm.

Today's architecture is actually not the result of "structures" (spatial, constructive, functional, formal) that reinforce each other linearly and consequently, but the co-presence of "systems" with a high level of reciprocal independence.

In this new way of thinking and doing, everything changes in meaning. For example, the old ethicality of form/construction correspondence has been completely shattered. By now a project can be built in many different ways. Functional research is expanded to a broad series of considerations. Image has for some time acquired outstanding autonomy, as well as technological and engineering systems that follow their own reasoning and at times also their own expressions.

The old need for the synthesis of an architecture that would adhere to the drive toward serialization, typification, rationalization, and industrial production, corresponds to an opposite process of "liberation," of release from any hierarchically preordered system.

Today's architecture follows a process far from the assembly line and actually resembles a network where each sub-system seeks out its own optimization linking up with others only in certain "nodes."

With respect to the past, one clear result of this process of liberation is extremely more efficient buildings from the exquisitely functional point of view. At times these buildings are also much more intriguing, certainly more capable of dialoging with the different contexts in which they are inserted and, despite how incomprehensible they may appear in the beginning given their apparent formal richness, basically just as realizable. This is partially because the computer and electronics in one sense play a causal role and later become very powerful tools of geometric design and calculation, even playing a part in the ad hoc fabrication of pieces.

Instead of being at the peak of a pyramid of choices to control and prioritize, the architect searches for a course (if we want to shift the field toward avant-garde architects we could use the word "process") within inter-related choices that are also partially independent and causal with respect to the architect's desires. This occurs on all levels, from object to territorial systems.

So now we are experiencing a type of productivity no longer tied to duplicating an object in a series but the opposite process of personalization, individualization, constant mutation of information, instantaneous response, and recognition of individual creativity. As in hypertext, the path for architecture must be traced again each time. This may also be frightening, distressing, and dramatic, as always happens when new freedoms arise, but the computer and information technology at the basis of these great crises also create the horizon within which new ideas and new solutions emerge.

11.2 Surplus Value Is Information

One of the fundamental questions regards values, or rather how to establish what is valid and what is not within the general change of the architectural framework over the past few years. How do we know when a type of architecture is valid and high quality within this framework? "How does one assess value?" (Peter Eisenman constantly poses this question.)

From the viewpoint expressed in this book, the heart of the question, and one possible answer, lies in understanding the breadth of the crises of transformation connected to information technology and the search for new paths (social, functional, constructive, and naturally aesthetic) as a response to the crises of the *Third Wave*.

For many decades, architecture was considered good if it was well constructed, economic, and logical, and if its form objectively expressed as much as possible its own mechanical rationality.

The absolute freezing of the semantic dimension (according to a nice expression by Mario Gandelsonas) at the beginning of the 1970s led to an extreme point, almost of no return. Architecture was understood as language and text, and therefore had become a sort of extremely self-referential machine that ground up everything foreign to it. But in the early 1990s, works started to be designed in which communication, narration (and in some cases even the symbol) returned to the forefront in the architectural dialogue. These architectural designs took absolutely for granted they would function well. The indispensable added value is for architecture to manage to communicate and be included into the great world of information today.

Now this aspect is definitely not, as might be believed at first sight, a superficial fact of fashion or spectacle. It is instead a response to a decisive change that has completely invested the past few years (cf. *Communication*).

If for the architecture of the 1920s value meant attempting to copy the machine in its functioning, processes, aesthetic, and the same exposition in its syntactical mechanisms, architecture from our era clearly shifts its center of interest into having a form that actually *informs*. But if information represents an unavoidable substance by which today's architectural research is measured, then it is also true the key to the problem regards, as always, the "how."

In his closing comments at the 1930 Werkbund congress in Vienna, Mies Van Der Rohe said: "The new time is a reality; it exists independently from the fact that we accept or refute it. It is neither better nor worse than any other time; it is simply a given fact and in itself indifferent to values. What is important is not the 'what' but solely and only the 'how.'" The "how" is ours.

11.3 On Interconnections

The heart of the IT Revolution lies not so much in bits of information, their immense number or constant mutability, as much as in the ability of these atoms of information to be interconnected, interrelated so as to form a network and system. Here at the beginning of this century, we are navigating through a moment of passage from an earlier phase of IT application in its most evident and superficial aspects (i.e. the ease of processing complex geometries, the control of assembling and managing information and the presence of the communicative load in architecture we have just seen) toward a much more mature phase in which information technology enters directly into the essence itself of architecture. The challenge facing us is not only one of creating an architecture that is narrative and metaphorical, as is part of all today's architecture, but how to create an architecture that can incorporate this complex, interrelated, changing and extremely dynamic level that characterizes the fulcrum of the IT paradigm. As always the real problem is not technical, which is something easy and almost banal, but aesthetic. How do we work with an architecture that is "aware" of being part of information technology? What is the aesthetic sense of the IT Revolution?

11.4 Dynamic Models

Now if the fuel of change is information (its cataloguing, distribution, transmission and especially formalization cf. *Information*) and if it is true that the engine driving new development is made up of the electronic digitalization of data (in all fields and all sectors), then it is also true that these two levels, though of such enormous impact, would be nothing without the thinking soul that is the true substance of the information technology revolution. The basis is *mathematics*, but the real substance is the *dynamic interconnection of information* (cf. *Model*). We have the ability to create extremely mobile models governed by one or more functions, able to generate different worlds by varying one single informational input. From equations and linear systems, we have moved on to non-linear systems; from the defined, finite systems of Euclidean geometry to the "becoming" systems of topology. Our systems are governed by complex equations and thus by dynamic interconnections between data. This not only occurs in economic or statistical models but also in spatial and architectural models.

We have indicated the way to translate these mutating, dynamic characteristics from the world of information technology into architecture over the past few years and have discussed it in this book. It is called interactivity.

11.5 On Interactivity once again

Interactivity in architecture means, and now is the time to explain it even better here in conclusion, at least three different things in growing levels of complexity. First of all, there is the interactivity inside the architectural design process; let's say it is an interactivity of *processes*.

Today, even if few have yet to make effective use of this, it is possible to quickly and easily move within the network of interconnected information to decide the form we wish to give that group of relations. We are nearing the scenarios foreseen during the 1970s; having *one single database* of information on a dynamically organized building, as if it represented an actual mathematical equation. This knowledge is dynamically connected to external catalogues, price lists, or three-dimensional data connected to expert systems for specialized verification. This model of a future reality begins with a design, develops during construction, and continues in management. This is not a dream. Look at how the offices operate of Foster, Piano, Gehry, and Arup, as well as many others. Naturally, we are not dealing here merely with increased efficiency. Having available a network of interconnected and modifiable information means having the instrument to attempt to create the best architecture possible in relation to many ever more involved social and technical actors.

Naturally, interactive processes also have to do with another front we have named *diagrammatical*. In this case, information technology helps define a sort of beginning code through geometrical, parametrical, topological, logical, or analogical relations (in this case that simulate the behavior of other systems). We deal not with forms but relationships, and this sort of code can interactively evolve and drive the creation of the project.

Alongside this interactivity of processes, a higher level emerges we could define as *illusionistic* interactivity (or, as Paul Virilio calls it, *stereo-real*), the fact that today the real and virtual can be combined in ways once unthinkable. A sort of new, media-based illusionism intervenes by inserting projection systems almost inside a building's skin itself (now we have arrived at skin screens). These technologies can give vitality to degraded situations or places where it is impossible to intervene (from archeological sites to the degraded peripheries of cities) and turn our cities into pulsating, changing, beautiful centers in a sort of Baroque information technology. What up until a few years ago was only a hypothesis, today governs the creation of large works, for example stadiums, media centers, or buildings, in particular urban hubs. This "mediatization" clearly does not mean hanging screens like in New York's Times Square, but can replace a "hard" restyling of a building (substituting the old recovery systems) with a "soft" form frequently economically more expedient and at times richer and more interesting as an aesthetic contribution to the city. A new type of aesthetic performance (with lights, sounds, and colors) can take place in these environments, a solution that the Italian architect Cesare Cattaneo could never have imagined in 1938 when he wrote and theorized "multi-sensoriality," i.e., a way of connecting architecture and other arts that was inspired by Neoplasticism.

But the most complex form of interactivity naturally is related neither to processes nor illusions, but is in fact physical, real.

11.6 Second Level Metaphors

We repeat: information is electronically structured in models that have a continuously modifiable and re-shapeable form. These are real information trees with parts that can also be interconnected through a network of live and changeable relationships. This means that when a lower part of the tree of relations is modified, repercussions spread throughout the entire structure. Architecture is also called upon to look deeply "within" this IT model to understand it, to utilize the most profound rules and most peculiar characteristics, to recount with its own means a chapter in the transformation of these past few decades, but above all to understand how this mental landscape produced daily on computers *migrates outside computers and itself becomes architecture*.

Besides, there is nothing new under the sun. Looking "within" scientific paradigms and one's own work has always furnished decisive keys for architecture (cf. *Reification*). Was not perspective the main instrument in returning the central place in the world to man? Is it not true Brunelleschi and Alberti understood how to "completely" transform gothic architecture into something that was perspectivized and perspectivizeable? That new architecture was based on classic orders, proportion, and symmetry, on the absolute recognizability of the parts "to be congruous" with the new scientific and perspective paradigm.

Do we need an image to explain this interlinking between architecture, scientific paradigms, and the construction of the world and space? Perhaps the Klein bottle – and its non-linear equation describing a surface that turns on itself and therefore has no true interior or exterior – may be useful. Architecture has always been a Klein bottle. It conforms to the scientific paradigms from its own era and with its movements gives those paradigms form, makes them visible and concrete at the same time. There is neither exterior (no given fact or principle) nor interior (content, spatial choice) but rather a continuous weave. One gives form to the other; the scientific instrument used as an informing concept becomes a livable, physical entity and, turning back again onto itself, gives form to space, values, and the aesthetic of its own era.

When Walter Gropius discovered through an exciting process that the new mechanical, industrial, objective, functional, well-reasoned world could find a catalyst in transparency that multiplied, fragmented, and abstracted planes and above all seem to reveal "in itself" the functions of the world, he found at the same time a vision, a technique, a materialization of the new non-perspective feeling and above all established what became the aesthetic of the new objectivity.

Now we are in an era of new subjectivity where the old words of standard, type, constant quality, assembly line, and zoning have been replaced with those of personalization, individualization, anti-zoning, and network. How can we create an "informatized" architecture? How can we transfer into architecture the characteristics of an interconnected, dynamic world that is malleable and personalizable?

The answer is through "second level metaphors"; metaphors that are open, intelligent, personalizable, and therefore necessarily interactive.

At the base of hypertext systems, as well as HTML (*HyperText Markup Language*, Tim Berners-Lee, CERN 1990) and the Internet, lies the idea of giving users the possibility of being "creators of metaphors"; not merely to supply a prepackaged metaphor, but the possibility of creating metaphors on their own. Not the image of a museum vessel, a crumbling wall or contemporary cathedral, but the idea that one's own story can be created through architecture.

The second level metaphor aims to open the way for the "subjectivity of desires," obviously a historic idea when set against the "objectivity of needs" that was the absolute line for the Modern Movement. (We recall the prophecies of the Situationists quoted in the opening: “an architecture … a means of experimenting with a thousand ways of modifying life … that will change totally or partially in accordance with the will of their inhabitants … in the eternal curve of human desires.”)

In the field of these second level metaphors, as well as interfacing in the presence of powerful metaphors, the possibility also lies of rethinking the idea of time. Interactivity actually has to do with time (cf. *Time*).

As in this book, if time is used as a system for understanding space, something very useful is discovered. From one reference system to another, the rule of the leap is in effect, this same leap found at the basis of hypertext systems.

Interactivity in buildings not only can change configuration and spaces with changes in desires or external input, but also *create different space-time reference systems*. If an interactive system for modifying architecture is connected to Internet navigation systems, the figure of the leap could pervade the entire architecture, a leap between one spatial configuration and another, a leap between different information systems, and finally a leap between different temporal systems.

The great world of the Internet can multiply and compact spaces and time. We can have windows simultaneously open on worlds far away from each other and literally leap from one to the next: experience, experiment with spaces in acceleration or in movement, represent and be represented and all in real time and in one constant leap from one world to another.

11.7 Technological Prostheses

Let’s take one more step. Man has a developed mind and has created a series of instruments that have broadened his concept of time and space (consider for example Galileo’s telescope). Over the past few decades, acceleration has been prodigious and man today has real technological “prostheses” at his disposal.

We know the Internet is one of the most powerful of these prostheses. The space of the Internet breaks the conventions of a three-dimensional space because it connects, rejoins, renders contemporary, and opens up more worlds.

Many are working, and I hope will continue to work, on the idea of an "intimate" electronic space, a space of information conceived as the raw material of this phase of architectural research through the conscious, critical, and creative use of our technological prostheses. This space will have more dimensions than the space we are accustomed to because time "plays" a different role compared to three-dimensional space. This is a world where the figure of the "leap" from one world to another will be determining. This is a world of co-present systems, autonomous but also permeable, a world where (1) a new mental landscape, (2) an "informatizable" space, (3) a central role for information, (4) interactivity and time, and (5) the new technological prostheses will all play a crucial role.

So let's ask ourselves: By working in this light can we finally understand how to formulate a space of information, a space that is continually re-shapeable, naturally negotiable, naturally hypertextual and interactive, navigated by leaps?

The challenge is how architecture, "as a form of reification" of this mental landscape we already know, must completely transform in order to be *informatizable.* In other words, how can architecture consciously absorb this new dimension of information? How can this new consciousness embrace the greatest crisis, the aesthetic crisis? Here, facing the final issue, i.e., the physical concreteness of architecture, aesthetic and physical interactivity come back into play.

11.8 Physical (and Emotional) Interactivity

Physical interactivity (the third level after processual and illusionistic) means that architecture itself mutates, allowing the expression of variations in situations and desires. Considering the current state of things, this possibility is not remote.

For some years now, studies have been made into how architecture can move mechanically, for example, the Sunflower House built in 1933 in Marcellise by the perhaps forgotten Angelo Invernizzi or the Water Villas by Herman Hertzberger (Jormakka 2002). Santiago Calatrava more recently showed how structures not only can move but do so in a harmonious and frequently poetic manner. We can furthermore make architecture transform intelligently in response to changes in climate or environment. Jean Nouvel first demonstrated this in the Arab World Institute in Paris. We can also make it change with changes in usage scenarios, as already occurs in some houses for the very rich. (The designer Ron Arad conceived and constructed many environments like this in a dwelling in Saudi Arabia.) Not only can a series of electronically linked mechanisms be interactively modified (lights, appliances, music, and control systems) but materials themselves can also mutate, with microfibers in coverings, glass, and new sorts of marble, and change in grain, porousness, sound-absorbing ability, or color. In short, architecture not only can react, but can also inter-react and thus adapt itself to changes in the desires of the user through feasible scenarios as if it were hypertext. What is more, this aspect is now entering into an advanced concept of electronic systems called *domotics* where several Italian companies are also on the cutting edge.

By now work is also beginning on *emotional interactivity*. Through the use of sensors, not only does physical data interact with architecture, but also several characteristics of the psychological state and perception of humans. Proof of this is seen in what is happening with neural networks and the creation of the Ada pavilion at the Swiss Expo 02 by the multi-disciplinary group Neuroinformatik at ETH in Zurich.

Researchers, architects, and naturally many artists (from theater to cinema to various forms of the aesthetic experience, for example Edoardo Kac, Décosterd&Rahm, Studio Azzurro, and Miguel Chevalier) have begun to work consciously with these ideas and created pieces of interactive architecture in buildings and expositions. These include, among others: Mark Goulthorpe-Decoi, Marcos Novak, Kas Oosterhuis, Lars Spuybroek-Nox, Diller&Scofidio and the Neuroinformatik group, not to mention the work of two great precursors, the already cited Jean Nouvel and the sensitive master Toyo Ito. But managing to operate with these techniques is one thing, understanding the importance in the scenario of transformation and the centrality of the world of information is another. Even more important is understanding how to create a new architecture that immediately makes these new techniques evident and necessary; in other words, how to work on an aesthetic level.

11.9 A Real Cloud

It is difficult to close this book without mentioning a work that condenses this thought and, with its exemplary power, presents itself as evidence of a new way, feasible even to others.

The great historic power of Elizabeth Diller and Richard Scofidio lies in having created this work and thus synthesized much of this thought in constructed architecture.

Many will know we are speaking here of the *Blur Building* in Yverdon-les-Bains, created for the Swiss Expo 2002. This building breaks all previous conventions and introduces itself as a brand new paradigm for the architecture of information.

In Yverdon-les Bains, the building (naturally also a “normal” building built on a cantilevered metal framework on central load bearing systems that somewhat recall Buckminster Fuller) is never equal to itself. The great oval lake house “is” first and foremost information. Through a complex technological and electronic system, the building mutates constantly with variations in several parameters from external data. Humidity, temperature, and wind levels are collected by a group of sensors that, through transformation programs, control thousands of nozzles that spray nebulized water. The cloud of water produced enters into constant mutation with the building, continuously changing it, sometimes creating a prow, sometimes a terrace or a bridge, sometimes nothing. Without reading and transforming environmental information, only the pure metal framework of a panoramic platform would exist. The story of *The Blur Building* is not an extreme vision of industrialization, but was completely launched in the 21st century, in the history still to be written of the “informatization” of architecture.

Should we say a few words about the new presence of nature? Whoever has had the good fortune to see *The Blur Building* transform at night, show itself then hide itself, change lake water into fog, or transform starlight, can have no doubt this marks a new alliance between architecture and nature. This alliance travels through an electronic paradigms and here literally creates an atmosphere in the real and not only metaphorical sense of the word.

The building by Diler&Scofidio moves within the world of dynamic interconnections so present in our world of information. The idea itself of a building as a static, closed, autonomous entity has been eliminated. *The Blur Building* is an element of transformation, varying with changes in exterior conditions and changes in the program. The building is presented as an element of transformation, a mediator between situations, conditions, and potential scenarios, a convincing example of how the concept of interactivity can modify our idea of architecture itself.

11.10 On/Off

The writing of this book was sparked by the fact that the powerful, massive presence of information and information technology, and a means of production completely distinct from industrial and manufacturing, had imposed the creation "of a revolutionary science" (as Thomas Kuhn would say) in architecture; a science that reformulates its assumptions, context, and methods, because the changes around us are too powerful to understand as part of a model born in a completely different context and for totally different reasons. Besides, it has been more than twenty years since the expressions "post-industrial society," "information civilization," and "third wave" assumed a central role in contemporary thought. In this final section (with all the risks involved), we will recall the key words of the two different "paradigms": on the one hand, the objective, mechanical, abstract and functional trend confirmed in the mid-1920s and, on the other, the research that marks the current phase at the beginning of the new millennium. Today the idea is explored of an architecture based on the central presence of subjectivity, personalization, communication, and complexity. The methods themselves of dealing with design have been overturned since we tend to replace axiomatic, ideological systems and an inductive approach with deductive approaches that exploit the potential of our tools for simulation.

So to summarize and index the issues tackled in this *The IT Revolution in Architecture*, here is a series of polarities fundamental for understanding the idea touched upon in this book. Below we will furnish only a list and will summarize the general sense in *For Further Study.*

object/subject
new objectivity/new subjectivity
data/information
theory/model
nature/landscape
zoning/anti-zoning
linearity/leap
inductive/deductive
plan/diagram
punctiform/continuous
organic space/systemic space
abstraction/figure
transparency/interactivity
modularity/remixibility

11.11 Industrial Revolution/Information Revolution

In the text, we discussed the Klein bottle as a form that effectively summarizes the indissoluble bond between architecture and the scientific paradigm. The parts cannot be disentangled in this idea, since by intermingling with each other they give form to the world we construct. Perhaps, in conclusion, it would help to understand how the great dichotomy, historically ever present in the history of conscious man, between matter and representation has continued to dissolve in an awareness of the interwoven relationship, absolutely not dichotomous, between substance and information. The substances of the world (matter but also at the same time reality, at times dramatically present) assume power through our ability to understand them as part of our conventional system, through our ability to transform substance into information. Substance and information, at the end of this reading, should appear not as a dichotomy, but as an unavoidable weave wrapped inside the bottle that creates the vortex within which the mental landscape moves on which we are all working together.

We no longer speak of *Existenz Minimum* for an architecture that satisfies needs, but if anything of *Existenz Maximum* for an architecture that expands possibilities and desires. We no longer work for punctiform and discontinuous structures but more and more frequently for continuous, enveloping structures. We no longer have an idea of the city as a machine on its way to conquering the world, but work more and more between the folds of existence in new interstitial spaces, new crossings, new emergences, new derivations. We no longer consider purely syntactic forms, analytical and abstract, but seek to also convey messages and meanings; we no longer think of the fixed adherence between a form and function because we have come to value individualization and variation and are going beyond the great aesthetic of transparency, the aesthetic catalyst of modernism, in order to work toward second level metaphors, toward an architecture capable of narrating open stories, toward interactivity as a crucial value. We are in the IT Revolution, swept up in a paradigm shift.

FOR FURTHER STUDY

Books from the "The IT Revolution" series, conceived in 1996 and published from 1998 to 2004 by Testo&Immagine (Torino), since 2005 by Edilstampa (Rome), since 2001 in Chinese by Prominence (Taipei, Taiwan), and from 1999 to 2006 in English by Birkhäuser (Basel, Boston, Berlin), along with several other general studies, are all indicated in the following list of abbreviations. More specific studies are found in the related paragraphs that also contain further considerations. Unless otherwise specified, prefaces, just as quotations from articles or books with no mention of the author, should be attributed to this writer.

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Introduction

Citation of Thomas Kuhn is at p. 7 of his fundamental *The Structure of Scientific Revolution* (Kuhn 62). Fritjof Capra has a vast, interesting bibliography. Citation is from p. 70 *The Turning Point,* Science Society and the Rising Culture, Simon and Schuster, New York 1982, cf. also his *The Web of Life: A New Scientific Understanding of Living Systems,* Anchor Books, New York 1996.

Many of the arguments in this chapter are outlined in "Hyper Architecture," the afterward to Prestinenza (1998) and CB. This first article represents a real working plan that, more than ten years after its writing, has been confirmed and continued in this book. Readers interested in conceptual developments concerning Kandinsky may refer to the preface "*Le forme dell'acqua*" (The Shapes of Water) in Mello (2008). This preface is dedicated to the contemporary architect who, in the author's opinion, is the closest to achieving a liquid spatiality that recalls Kandinsky.

On CAAD terminology see the historic volume: William Mitchell, *Computer-Aided Architectural Design,* Van Nostrand Reinhold, New York 1977, and Gerhard Schmitt, *Microcomputer Aided Design,* John Wiley and Sons, New York 1988.

1. Substances

1.1. Modernity. Regarding the figure of Terragni, but extended to the architectural debate in Italy between the two world wars, see *Giuseppe Terragni Vita e Opere*, Editori Laterza, Rome-Bari 1995. The writer introduced the phrase from Persico regarding substance in "Sette parole per domani," a conference at InArch in Rome, 15 March 1999 that, along with some of the themes presented in the text, subsequently appeared in "New Substances. Information Technology and the Renewal of Architecture. A Manifesto for an Architecture of Information," *Il Progetto* no. 6, January 2000. This text has been widely distributed via Internet among students who oversaw the translations into many languages, cf. AS.
On the various interpretations of modernity in architectural thought, see Heynen (1999) and, for a fascinating history of modern thought, Watson (2001). On Zevi and modernity, see "Architettura concetti di una controstoria. Architettura della modernita," *Domus*, no. 771, May 1995 that discusses Zevi's definition of Modernity and the broadly illustrated edition in three volumes, Bruno Zevi, *Controstoria e storia dell'architettura*, Newton&Compton, Rome 1998.

1.2. The Aesthetics of Rupture. A nice survey of the meaning of "Aesthetic" by Gianni Vattimo is found in the entry in: various authors*, Enciclopedia Garzanti di Filosofia*, Garzanti, Milan 1981.
On the great Danish philosopher, designer, poet, and mathematician Piet Hein (1905-1966), we refer to the website http://www.piethein. com/usr/piethein/HomepagUK.nsf and the always useful Wikipedia. The valuable quote is found in Paul Heyer, *American Architecture. Ideas and Ideologies in the Late Twentieth Century*, Van Nostrand, New York, 1993, an occasion to remember the author of this book who passed away too soon, see also CB.

1.3 Crisis. Naturally, the theme of crisis permeates much critical literature in Italy from Giulio Carlo Argan (2002) to Manfredo Tafuri (cf. by this author *Architecture and Utopia. Design and Capitalist Development*, MIT Press, Cambridge 1976). On several sociological themes related to the growth of the information society, aside from the two books by Alvin Toffler (Toffler 1980 and Toffler 1991), books by Domenico De Masi, *La fantasia e la concretezza. Creatività individuale e di gruppo,* Rizzoli*,* Milan 2003, and Richard Florida, *The Rise of the Creative Class: And how It's Transforming Work, Leisure, Community and Everyday Life*, Basic Books, New York 2003 are both useful.

2. Communication

2.1. The Cathedral Returns. This idea was discussed for the first time in "La via dei simboli. Il ritorno del monumento," *Costruire*, no. 182, July-August 1998, and CB. On the close relationship between communication and information see "New Subjectivity: Architecture between Communication and Information", in: *Digital | Real Blobmeister First Built Projects*, P. Schmal ed., Deutsches Architetur Museum Frankfurt, Birkhäuser, Basel, on the relationship between the new media and communication, cf. Lev Manovich, *The Language of New Media,* MIT Press, Cambridge 2001.

3. City

This chapter was partially anticipated in the article "Città Informazione. Dalla catena alle reti il cambiamento della città europea sulle onde dell'era dell'informazione" in ExNext, *Città in gara. Lake square la + grande piscina d'Europa*, Centro Studi Einaudi, Cesarerani, Como 2003. A series of design ideas for the Como area are illustrated in this book. In fact, the original spirit of the chapter is operational, intending to guide the design proposals of those who gave center place to the relationship between urban design and the city of information. A useful field for understanding this relationship can be seen in many degree theses based precisely on this premise, cf. www.arc1.uniroma1.it/saggio/didattica/.

4. Landscape

4.1 Information technology and new nature. An interesting moment in the debate on the relationship between landscape and architecture occurred at the conference held by Bruno Zevi in Modena in 1997, see Bruno Zevi, *Landscape and the zero degree of architectural language*, Canal&Stamperia editrice, Venice 1999. The writer's presentation ("Landscape, new paradigm for") is also found in *L'Architettura,* no. 503-506, and in CB. On the subject of landscape, the series should be mentioned edited by Daniela Colafranceschi, "Land&ScapesSeries" published by Gustavo Gili, Barcelona. From this series, we mention *Walkscapes* by Francesco Careri from 2002 (in Italian, Einaudi 2006), *Artscapes* by Luca Galofaro from 2003, and *Waterscapes* by Hélène Izembart and Bertnad Le Boudec from 2003. A summary with bibliography of the work of Andrè Corboz is in *Ordine Sparso. Saggi sull'arte, il metodo, la città e il territorio*, Paola Viganò (ed.) foreword by B. Secchi, Franco Angeli, Milan 1998.

4.2 Definition. Franco Zagari, one of the best architects and scholars on the Italian landscape, invited me to attempt a personal definition of landscape. The text containing this, along with those of other scholars and designers, is Franco Zagari, *Questo è paesaggio. 48 definizioni*, Mancosu editore, Rome 2006.

4.3 Information technology and new complexity. See *Frank O. Gehry, Architetture residuali*, Testo&Immagine, Torino 1997, and *Peter Eisenman, Trivellazioni nel futuro*, Testo&Immagine, Torino 1996, on the Yokohama Terminal by FOA see Tomoko Sakamoto, *The Yokohama Project*, Actar, Barcelona 2002.

4.4 IT landscapes. The idea of mixitè, marginally mentioned in the text, is handled more thoroughly in: "Mixitè a Pittsburgh" in *Riflessioni sull'abitazione Contemporanea*, Marta Calzolaretti (ed.), Gangemi editore, Rome 2003, and CB.

5. Information

5.1 At work on a definition. Thought regarding the term "information" originated from an exchange of letters and a series of conversations with the director of *Op. Cit.* Renato De Fusco regarding the publication in *Op. Cit.* no. 112 of his article "Internet non si addice all'architettura" and my "New Subjectivity" (cit.). In that article, and other more extensive and explanatory essays like the last chapter of his *Storia del design* (Laterza 2002), Renato De Fusco rejected the statement that information was or could be considered the raw material of this phase of architectural research. This writer instead supported this assertion. The entire text, here broadly reworked with respect with the first publication – "Informazione materia prima dell'architettura," *Op. Cit.*, no. 118, September 2003 – serves to better argue why.
As an element of comparison, other definitions of information might be useful: "un elemento di conoscenza recato con un messaggio che ne è il supporto e di cui essa costituisce il significato" ("an element of knowledge carried via a message that is its support and of which this constitutes the meaning"), André Lalande, *Dizionario critico di Filosofia,* Isedi, Milan 1971, quoted by De Fusco in *Storia del design* (cit.). The MSN Encarta English dictionary defines information as "The collected facts and data about a particular subject." Definitions from the De Mauro Italian dictionary (Paravia) are more interesting: *"qualsiasi messaggio inviato secondo un determinato codice da un dispositivo trasmettitore a uno ricevente"* (any message sent according to a determined code by a transmitting device to a receiver); information is defined as *"dato o insieme di dati codificati e immessi in un sistema informatico"* (a datum or collection of data codified and inserted into an IT system).

6. Time

6.1 On the nature of time. This chapter is part of an idea broadly discussed in Emmer (2003) in which the mathematician outlines an interesting reading of the change in spatial concepts. The substantial difference here is that the reasoning is not confined to the geometrical-mathematical aspect of space, but in fact interweaves the concepts of time and space. We also mention the books edited by

Emmer in the series "Matematica e Cultura", Springer Verlag Italia, Milan 1998-2003, that contain the annual records of the conference of the same name. The other book that influenced several sections of this text is *Shape as memory. New Foundations of Architecture*, by Michael Leyton (Leyton 2006), a scholar known for his formalisms that connect time to the creation and understanding of form. By Leyton, we also mention *A Generative Theory of Shape*, Springer-Verlag, Berlin 2001. Useful for several sections of the text were Stephen Hawking, *A Brief History of Time: From the Big Bang to Black Holes,* Bantam Book, New York 1990 and Cornelius Lanczos, *Che cosa ha veramente detto Einstein*, Ubaldini, Rome 1967. We should also mention Sanford Kwinter, *The Architecture of Time*, MIT press, Cambridge 2002, for a series of connections between philosophical thought and the artistic avant-garde. Regarding time, the Internet, and new media, cf. various authors, *La conquista del tempo Società e democrazia nell'era della rete* Derrick De Kerckhove (ed.), Editori Riuniti, Rome 2003. The book by Luciana Finelli and Cesare De Sessa, *Conversazioni sul contemporaneo,* Officina, Rome 2001, was particularly useful in the section that reworks studies by De Sessa and deals with the relationship between scientific and spatial concepts. Page 142 recalls it was Einstein who in 1916 wrote: "We completely avoid the vague term 'space' for which, we must honestly recognize, we cannot form the slightest concept, and replace it with 'motion relative to a practically rigid body of reference.'" This could be the beginning of this text instead of a conclusion.

6.2. On the Leap. Benoit Sokal is the author of illustrated comic books as well as a series of beautiful virtual voyages. The first of these, "The Amerzone" (Casterman, Microids 1999), remains for this writer an unforgettable source of much thought on the relationship between real and virtual reality (on this theme see Oosterhuis 06 and Iacovoni 06). I have used passages from it on various occasions, for example in "Other challenges" in Kolarevic 2003. Naturally the idea of the leap finds its main moment in the critical literature from the Prague school, see for example Roman Jakobson, *Selected writings. Word and Language,* vol. 2 of a collection edited by Stephen Rudy Mouton, The Hague 1971. The theme of the leap was anticipated in the preface "Ddek" in De Kerckhove 2001. For several reasons, this writer was among the first to work on an architectural application of hypertext systems ("Extrusion, Assemblage, Joint and Connection in the Workshop of G. Terragni" in various authors, 1989 *Ecaade Conference*, Aarhus 1989). Only after several years and much research did it become clear the key to hypertext systems was not the "representation" of architecture but rather a mental landscape that seeks a path from the computer to real architecture. The quoted afterward "Hyperachitecture" in Prestinenza 98 creates this landscape. Hypertext constitutes a major element in a new mental landscape that must be reified in a new idea of architecture.

6.3. Four dimensions A series of interesting studies on this theme are contained in this web page www.arc1.uniroma1.it/saggio/didattica/Cad/2006/LEZ/14/

6.4. Technological prostheses. Naturally innumerable research centers are involved specifically in this aspect; some of the most important are: MIT in Cambridge, Columbia University in New York, the AA in London, the University of Delf, the ETH in Zurich, Carnegie-Mellon in Pittsburgh, UCLA and SCI-ARCH in Los Angeles. A more complete survey can be found in the catalogues edited by Paola Giaconia of beautiful exhibitions held in Leopolda Station, Florence: *Intimacy. Spot on Schools* Mandragora, Florence 2003 and *Script. Spot on Schools*, Editrice Compositori, Bologna 2005.
Some innovative research has also been in my courses from 1999 to the present. These can be accessed on the web at via this link www.arc1.uniroma1.it/saggio/Didattica/ as well as at the NITRO group (New Information Technology Research Office) founded in 2004 (www.nitrosaggio.net/). Regarding the Internet, I mention a recent article useful in this context, written at the request of Franco Purini in the Biennale di Architettura 2006 catalogue dedicated to the Italian pavilion (*La città muova Italia-y-26 invito a Vema*, F. Purini, N. Marzot, and L. Sacchi (eds), Editrice compositori, Bologna 2006.
The Internet has created the closest thing to God effectively invented by humanity till now. Go(ogle) is almost like Go(d): omniscient, omnipresent, and omnipotent. Google is actually everywhere at the same time; it knows everything or almost everything; it answers our abstruse questions and requests, and controls us and directs us with its spiders (like the doves of the holy trinity). Google is above all infinite, like consciousness and the constantly expanding universe itself.
"In the post-industrial era, the sense of finiteness that has always oppressed us and imposed its laws on us has been shattered. The only infinite resource has finally been made available to man: information, consciousness, intelligence." (translated from Jean Jacques Servan-Schreiber, *La defi mondial,* Fayard, Paris 1980.)
By now almost everyone knows what the Internet is. The story of its arrival in the world in the mid-1990s is a happy one.
A group of scientists utilizing military communication technologies manages to create a communication protocol between computers based on a "personal" identification number. On the basis of this identification, each computer can be "seen" by others and share its own content with others. The second invention was the application of the method of the "leap" in accessing information. This idea had already been intuited at the dawn of the new graphic interface systems during the 1970s (consider the overlapping of various "windows" on the screen) and later developed in the hypertext languages in the second half of the 1980s. In the mid-1990s, the IP system (i.e., protocols used by computers to see each other independently from their respective operating systems) is coupled with Hypertext (and the specific language of the leap called HTML) and via the web browser Mosaic, in 1994 Netscape, the embryo was established of what we now know as the Internet. When many computers are connected to each other, many more nodes are connected to each other, many more leaps through hypertext are possible from one computer to the next, from one IP to the next, from one world to the next.

Diverse, multi-media content travels at a high speed with respect to a few years ago. As we said earlier, the birth of this was fortunate and rare in the history of humanity because a mix of different technologies was assembled to expand the consciousness and abilities "also" of single individuals.
Now however we are interested in understanding how the world of the Internet has had an impact on architecture. We are interested at a profound, cognitive level of authentic research because we take for granted that the immediate practical effects of the Internet are well known (the creation of on-line magazines, the spread of information, shared access with subgroups of important information, access to databases of materials, and interaction and simulations in real time of products and usable spaces), obviously without forgetting one aspect that follows from the way we have described this technology, in other words that horizontal and anti-hierarchical organization means every individual computer can be as much a reader as author. This aspect also powerfully characterizes a philosophy of the "presence of the subject" in the network that is naturally also educational and personal.
Let's move on to the potential meaning of the Internet for architecture. To tackle this theme, we must take a small step and reflect on one of the fundamental characteristics of architecture. In other words, the fact architecture "creates" space, transforming a mental and scientific construction into something concrete.
Naturally, space is not an objective fact, but rather a mental form that varies from era to era. Architecture gives form to these concepts, "reifies" them, makes them into something concrete. We will not dwell on this. But was not the architecture of Humanism the transformation into physical space of the idea of perspective?
So we ask ourselves, "Considering there is no doubt the world of the Internet exists along with its scientific and technological specificity, what influence can this concept have on architectural research?"
The new generation of architects, those we have elsewhere called "Born with the Computer," have been working over the past few years to understand how dynamic, interconnected, changeable models, representing the heart of the IT Revolution that beats across the Internet, can migrate into an architecture that is its reification and constitutes its concretization.
The Internet, coupled with long-distance representation systems with sensitive and naturally interactive holographic systems (a brief step in the near future), or coupled with the possibility of landing almost physically in far away and different situations, can compact and multiply spaces and times.
Perhaps thanks to the Internet, the old industrial paradigm of speed is transforming into simultaneity. Today, a direction is sought in which the building itself is time, architecture as a machine that simultaneously "narrates" the future, present, and past, as well as playing structurally with the problem of simultaneity. How? What conceptual leaps must we still make to accomplish this? Does this mean including systems of automatic transformation of buildings with variations in lighting or the number of people or the weather or the need for safety and control?
Or should we incorporate systems of literal simultaneity from the Internet (with immediate access to people, data, and knowledge around the world and beyond)?

These instruments must find their intrinsic, necessary, aesthetic response. If the building is no longer just space but above all time (in its many, infinite aspects) then what are the spatial dimensions of time?
So the Internet belongs to the great world of prostheses (the telescope of Galileo, the microscope, radar, etc.) created by man to extend the senses, time, measurements, intelligence, and the concepts themselves of time and space.
The space of the Internet breaks the conventions of a three-dimensional space because it reconnects, joins, and makes contemporary and accessible many more worlds. When we understand its power, this will also have a profound impact on architecture as well, even though these leaps into new worlds naturally terrorize us.

7. Space

Looking is not seeing / the gaze is not nature / it is human construction / like speaking and every form of art, Maria Lai, graffiti on the walls of Ullasai (Sardinia), 2004. An extraordinary description of the term "space" is found in Umberto Galimberti, *Psicologia*, entry "Spazio," Garzanti, Torino 1999. We can deduce from this reading that the multi-disciplinary condition of psychology (long connected with human and philosophical sciences on the one hand, and scientific and medical sciences on the other) is among the human activities closest to architecture. Aside from the hybrid nature that also belongs to architecture, like architecture psychology has a specific operational purpose. If we architects must understand space to design new ones, psychologists must also understand starting from space a series of pathologies revealed precisely in the deviated manner of seeing spatial relationships. One category I have frequently used in the past is "therapeutic architecture" (for example cf. "Paesaggi Terapeutici," preface in Rudolf Kein, *Zvi Hecker,* Testo&Immagine, Torino 2002). The term "therapeutic architecture" refers to the possibility given architects, and in this context also psychologists, to heal with space. On the relationship between architecture and psychology, I edited the volume: Eugenio Tescione, *Architettura della mente. Brani scelti di letteratura psicoanalitica,* Testo&imagine, Torino 2003, that contains a long chapter entitled "Costruire lo spazio" (Building Space).

7.1. On the nature of color and transparency. Gregory Bateson's thought freely moves across anthropology, science, philosophy, mathematics, and information technology He reaches an opinion on the informational nature of space. See for example Gregory Bateson, *Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution and Epistemology,* Paladin, Boulder 1973. The large field of color in relation to the psychology of perception contains many studies: cf., with a broad, specific bibliography, Osvaldo Da Pos, *Trasparenze*, Icone editore, Padua 1989, and Osvaldo Da Pos "Fenomenologia dei colori trasparenti", in *Effetto trasparenza*, (edited by L. Bortolatto and O. Da Pos), Le Venezie, Treviso 1996.

7.2. Hyper-contextual transparency. Cf. various authors, "Jean Nouvel 1987-1998", *El Croquis,* no. 65/66, 1999.

7.3. Elements of physiology. Timothy Goldsmith, The Biological Roots of Human Nature: Forging Links Between Evolution & Behavior, Oxford Univ. Press, 1994.

7.4. A Cognitive Dimension. Timothy Goldsmith, "What Birds See", *Scientific America*, July 2006.

7.5 Finally, space. Cf. "The Search for an Information Space," in Oosterhuis (2006). The installation by Marcos Novak, "The Invisible Space" at the Venice Biennale in 2000 can be seen at this address: www.arc1.uniroma1.it/saggio/Filmati/AnimazioniVarie/novak.mov. The theme posed by Marcos Novak is similar to ours. What characteristics does the notion of space have? Does space exist or not? What is the relationship between new concepts of space and electronics? This installation is based on the creation of a portion of space completely different from the surrounding space, invisible yet, at the same time, existing. When the hands of the visitor penetrate a portion of the space described by the sensors, the movements of the hand are transcribed into different media. Most importantly, the movements of the fingers create a musical composition through specific algorithms. The hands that move in this space "literally" play an instrument. Thus the invisible space exists above all from the sonic point of view. Furthermore, the same movements of the hand are always transformed algorithmically into volumes projected in real time on a screen above it. So by penetrating the apparently invisible space the visitor actually creates three-dimensional shapes in turn. Some of these forms have been actually constructed and hang above the area described by the sensors. The question "does space exist or not" in this case has a clear answer. Space from a traditional point of view does not exist, but since space is information, as we have stated, this does exist and is absolutely capable of in turn generating more information.

8. Model

8.1. Decisional models. This is a field of much study, also by this writer, for example in "Die Logik der Simulation. Wiederaufbau, kritische Analyse und Renovation von Bauten der Architekturmoderne mit Hilfe des Computers," *Architese*, January 1994, and expanded upon in "Decisional models, diagrammatic, scientific, for architecture in form of model" in *Drawing as model*, Riccardo Migliari (ed.) Kappa, Rome 2004. This volume deals particularly with the concept of model in the context of representation.

8.2. Deductive vs. Inductive. For those who do not want to enter directly into epistemological literature, an excellent introduction to this subject is Bruno Zevi, "Procedimenti induttivi e scientificità inventiva" in B. Zevi, *Leggere, scrivere,* *parlare architettura*, *Marsilio*, Venice 1997, also published in webzine *Antithesi* cf. http://www.antithesi.info/.

8.3. IT models. For updated information on the subject from the fields of construction, management, and parametrical and topological design (with a broad bibliography and glossary) cf. Francesco De Luca, *Modelli architettonici. Dagli strumenti della progettazione alla progettazione degli strumenti*, doctoral thesis with A. advisor, XVI cycle, U. "La Sapienza," Facoltà Quaroni-Dipartimento DiAr, Rome 2006.
For Frank Gehry's operational experiences with IT models see Lindsey (2002) and the text by Frank Gehry's partner Jim Glymph, "Evolution of the digital design process" in Kolarevic (2003).
The concept of the model in the field of computer formalism was first advanced by Chuck Eastman who in 1969 founded the PhD program on this subject at Carnegie-Mellon (see C. Eastman, *Building Product Models: Computer Environments Supporting Design and Construction*, CRC Press, Boca Raton 1999). Robert Aish from Bentley Systems is another well-known scholar in this field; see for example R. Aish, "Extensible computational design tools for exploratory architecture" in Kolarevic 2003.

8.4. Quantity and spreadsheets. Dan Bricklin is the inventor of the spreadsheet. ViSi calc in 1978 was the first revolutionary program that implemented this idea in the Apple II, and Lotus 1, 2, 3 the popular software that spread its use in the DOS environment. The detailed website www.bricklin.com/ describes its history. The revolutionary program Filevision was created at Telos by a team led by H. Metcalfe and was commercially available in 1984. I feel this program has never been given proper credit as the pioneer of the currently popular Geographical Information System. In any case, work produced by my students in 1985 and other graduate students at Carnegie-Mellon was published in Schmitt, *Microcomputer Aided Design* (cit.).

8.4. Opinions and expert systems. I recently wrote a brief history of expert systems. See "Intelligenza artificiale" in: *La città nuova Italia-y-26 invito a Vema*, cit.). I will repeat this brief text below because it shows the relationships between Artificial Intelligence and other aspects and concepts (*Model, Reification*) contained in this book better than was possible in the main text.
Today, with the help of a computer, a city or house can be constructed not just physically but also by assigning physical and psychological characteristics to its inhabitants. When the construction of this world is complete, by now living in the post-functionalist "new subjectivity," we can verify how each inhabitant reacts to the various spaces. Artificial life and intelligence combine, as millions of players know around the world. In terms of actually constructed environments, the reference is to Ada built at the 2002 Swiss Expo. Ada is a type of architecture capable of interpreting visitors' feelings and subsequently modifying itself. It was created by a team of psychiatrists, computer scientists, architects, doctors and

artists, and based on extensive study of the brain and neural networks, once again, one of the uses of Artificial Intelligence.

In 1983, when I began studying in America, robots roamed the streets of the campus with groups of students and young researchers who apparently played with them.

Considering architecture a serious and responsible practice, I believed it had nothing to do with those playing games. Gradually, I began instead to know and later understand certain relationships between artificial intelligence and architecture.

First of all, what is artificial intelligence? The idea is to cause an electrical machine not only to calculate the range of missiles, but to approach the way of thinking and intelligence of a human being.

In an early phase after the Second World War, computers were taught to play first checkers then chess. These systems of primitive artificial intelligence today not only beat us regularly, but also surpass the best human players.

Artificial intelligence becomes even more useful when the concept arises of an expert system. In this case, the program behaves by simulating the consultancy of a human expert. For example in the case of medicine, the relationship between symptoms and diagnosis moves toward the interrogation of the expert and subsequent answers from the patient. This process of searching creates a progressively smaller field until the final diagnosis is produced by the system and the definition of suitable therapy.

On this subject, IT mechanisms have been developed with the ability to learn from errors committed by the program. In the past few years, artificial intelligence systems have worked on difficult problems such as recognizing faces or expressions or interpreting modifications in the form of organs. But they still have noticeable difficulties resolving problems of a specifically contextual nature; consider the difficulties that persist in automatically translating languages.

Again at Carnegie-Mellon, Pittsburgh, PA, in the same period as the robots around campus, there was a large group of architects/computer scientists. In other words, people with an architectural education who had embraced the world of information technology and completely accepted its methods and disciplinary rules.

Helped in part by a science popular during that period called Cognitive Psychology, these academics attempted to develop expert systems specifically for architecture. We will not tell the whole history here, but these were substantially divided into three large categories. The first had a deterministic approach. In other words, they thought they could represent an architectural problem (in reality these were structural and distribution issues) and make the computer find a solution. The second school was a generative type that formulated certain rules for creating shapes, for example using fractal algorithms, or syntactically defined through "shape grammar," creating designs from this. A third school was based on performance and tended to consider how to create an expert system for sectorial consulting. This method was later developed commercially. Based on a preliminary outline, the artificial intelligence program evaluates and makes recommendations in specific areas (seismic, environmental, structural, etc.). Large international engineering firms use this regularly.

But intelligence in architecture means not just consulting by experts in various sectors but something that should intersect with design research.
One group of architects, present at the biennials over the past few years, do not see information technology as a stylistic research for topological, parametric, or plastic torsion, but on the contrary seek to employ artificial intelligence and the specific characteristics of information technology. The computer actually has the intrinsic possibility of relating to information in a constantly changing network. This not only means a method of creating the design based on the use of mathematical models that interconnect variations in a project, but also that architecture itself tends to become dynamic, mutable, and interactive, as if it absorbs methods and possibilities from information technology.
Artificial intelligence is used to establish connections, design limits, to generate alternative hypotheses, and help find solutions.
This process is not automatic, nor does it aim to be. Even though in a few years having a computer create, plan, and build a building using a group of rules from artificial intelligence will definitely be possible, would we really want this to happen any more than we would want our own clone?
In this development process, information technology and artificial intelligence serve above all to create a new mental landscape. This mental landscape, within which an early generation of architecture is developing, is profoundly different from the landscape born out of the industrial and mechanical paradigm, but not because of this made without the critical intervention of man. No one looks at a screen saver more than a few seconds; neither would anyone want to live inside it if it were turned into architecture. But if future architects look "inside" the computer and work together with it, they will understand how to transform, somewhat in "image and likeness," information itself, the next architecture. Looking at his perspective framework, Brunelleschi understood how to create revolutionary architecture. But to really do this, the magic spark was and still is called human intelligence.

8.6. Hierarchical structures. This writer has dedicated various studies to this theme; for example, "Hypertext, Solid Modeling and Hierarchical structures in architectural formal analysis", *Caad Futures 1993*, U. Flemming, S. Van Wyck (eds) North-Holland, New York 1993. The preface "An intelligent model" to *Virtual Terragni*, Galli (1998) brings together many of these experiences and discusses them analytically.

8.8. Simulation model. See "Un modello intelligente per la ricostruzione e l'analisi dell'architettura" in: *I.CO.Graphics, Atti del convegno,* Elena Mortola (eds.), Mondadori, Milan 1993. On the use of models, also from the design point of view, see "Makoto Sei Watanabe. Script Stations-stazioni programmabili," *Rassegna*, no. 81, December 2005.

8.9. Clouds or diagrams. This subject has been greatly developed in architecture over the past twenty years, in particular in French thought beginning with Michel

Foucault and continuing with Gilles Deleuze and Jacques Derrida for example. See a broad examination of this in John Rajchman, *Constructions*, MIT Press, Cambridge 1997. A useful summary of the use in architecture of the term is found in Gianni Corbellini, "Diagramma" in *Arch'it* from 24 February 2004 (architettura.supereva.com/parole/20040224/) with an extensive bibliography. Central to this is the thought of Peter Eisenman, who has dealt with this subject many times (the most recent is *Diagram Diaries,* Thames and Hudson, London 1999), and UnStudio, who have applied it convincingly to their designs. Regarding this see Antonello Marotta, *Ben Van Berkel, la prospettiva rovesciata di UN studi*o, Testo&Immagine, Torino 2003.

9. Reification

9.1 "Informatizable" space. See Erwin Panofsky, *Perspective as Symbolic Form*, MIT, Cambridge 2001 First edition 1927. One example of the contextual and conventional aspect of color is supported by Osvaldo Da Pos in the field of the psychology of perception (Osvaldo Da Pos, "La percezione del colore", in *La percezione visiva*, F. Purghè, T. Costa, N. Stucchi (eds), Utet, Torino 1999). This type of study reasonably makes several analogies with sound and space that on closer look share contextual and informative characteristics with color.

9.2. Examples. I have worked frequently on the concept of the instrument. In particular, the entire 2005 course was dedicated to this subject and included eleven important contributions on the theme by engineers, scientists, musicians, architects, and artists. These conferences can all be heard here: www.arc1.uniroma1.it/saggio/Colti/vatori.html. A summary article on the entire subject is "Give me a cord and I will Build… Construction, Ethics, Geometry and Information Technology" in (*Re)searching and Redefining the Content and Methods of Construction Teaching in the New Digital Era*, Maria Voyatzaki (ed.) , Eaae–Enhsa, Athens 2005.

9.3. Mental landscape. We use the word "landscape" and not "mental form," as is common in the thought of Erwin Panofsky (*Perspective as Symbolic Form* cit.*)*, because the term "landscape" carries at least three meanings: Landscape on the one hand a condition that is at the same time subjective as well as in some way progressively shared with architectural research (cf *Landscape*). This also gives credit to the aesthetic dimension and explains that architects in this context are moved by non-linear reasoning. Finally, it alludes to a general architectural condition over the past few years in the face of a total return to the field of the relationships between architecture and nature. See "Il Paesaggio Mentale" in Marotta 2005. On perspective in architecture, see Leonardo Benevolo, *The Architecture of the Renaissance*, Routledge, Oxford 2002 (First edition in Italian 1968), and naturally Panofsky, *Perspective …*, cit.. On the evolution of the concept of space, see Pierre Francastel, *Peinture et société: Naissance et destruction d'un espace* *plastique, de la Renaissance au cubisme*, Denoël (Editions), Parigi 1984 (first edition 1951). On Borromini, considered from this point of view cf. "Il Motivo di Sant'Ivo", *Arch'It*, 2 March 2005, CB and in English in "Disegnare" no 39, 12/2010.

9.4. Born with The computer. Today countless volumes are dedicated to new architects from the IT Revolution. One of the first was Perbellini 00 (*Natural Born CAAD Designers, Young American Architects*). Following this came the book on the scene in Holland, Jormakka (2002) (*Flying Dutchmen, Motion in Architecture*) and research in the Mediterranean basin Ian+ (2003) (*Digital Odyssey, A New Voyage in the Mediterranean*) and in Italy Ruotolo (*Arie Italiane*) (2006). Important sources are the catalogs major exibits for example: Schmall (2001) (*Digital / Real*), Migayrou (2003) *Non standard Architectures*, and *Latent Utopias: Experiments Within Contemporary Architecture,* Zaha Hadid, Patrik Schumacher (eds) Springer, Berlin 2003: very good source are also the six catalogues produced on the occasion of the Far Eastern International Digital Architectural Award (FEIDAD) since 2002 and all edited by Yu-Tung Liu (AleppoZONE), the last one is: *Distinguishing Digital Architecture,* Birkhäuser, Basel, 2007. One of the periodicals with greatest depth and continuity, *Architectural Design* deals with various aspects of the development of information technology in architecture in single subject, monograph editions. Among more recent monograph editions, cf. Michael Hensel, Achim Menges, and Michael Weinstock, "Emergence: Morphogenetic Design Strategies," *Architectural Design*, July 2004; Chris Perry and Christopher Hight, "Collective Intelligence in Design," *Architectural Design*, December 2006; Ali Rahim, "Contemporary Techniques in Architecture," *Architectural Design*, January 2002, and Bullyvant (2005) "4dSpace: Interactive architecture" cit..
Several architects of the new generation have authored monographs. Major ones include: Lise Anne Couture, Hani Rashid, *Asymptote: Works and Projects*, Skira, Geneve 2004. S. Kwinter, M. Wigley, D. Mertins, J. Kipnis, *Phylogenesis Foa's ark: Foreign office architects*, Actar, Barcelona 2003. Ben van Berkel, Caroline Bos, *Move. UN,* Goose press, Amsterdam 1999. Greg Lynn, *Animate Form,* Princeton Architectural Press, New York 1999. Kas Oosterhuis, *Hyper bodies* (Oosterhuis 2003). Nox, *Machining Architecture*, Thames & Hudson, London 2004. Makoto Watanabe, *Induction Design* (Watanabe 2003). Mark Goulthorpe, *Decoi Architects*, HYX, Editions Frac Center, Orleans 2008. Diller + Scofidio, *Eyebeam Atelier of New Media & Technology. The Charles and Ray Eames Lecture*, University of Michigan Press, Ann Arbor, 2004. Jesse Reiser, *Atlas of Novel Tectonics,* Princeton Architectural Press, New York 2006. Francois Roche, *R&Sie(n),* AADCU, Beijing 2007.
The text makes reference to the proposal of a "Virtual House" by Daniel Libeskind in 1997, a project discussed in depth in in Antonello Marotta, *Daniel Libeskind*, Edilstampa, Roma 2007.

10. Catalyst

10.1. Once more on transparency. The first reference text on this theme is naturally Colin Rowe and Robert Slutzki, *Transparence, Réelle et Virtuelle*, (French edition, edited by W. Oechslin, of a famous essay written during the 1950s and 1960s), Les Edition du Demi-cercle, Paris 1992. The idea of transparency as a catalyst for architectural functionalism is found in "New Subjectivity: architecture between Communication and Information" also in German in Schmal (2001), and in "Other Challenges" in Kolarevic (2003).

10.2. Interactivity. Scholar Lucy Bullivant organized a conference and edited an edition of *Architecture Design* on the theme of interactivity, "4dspace: Interactive Architecture" see Bullivant (2005). This edition is an indispensable reference on the subject and contains articles by the main theoreticians and experimenters in this field. Some ideas expressed in the main text come from "Interactivity at the Center of Avant-Garde Architectural Research" in Bullivant (2005) as well as in CB.

10.3. Hypertexts and the creation of metaphors Great credit must be properly given to the HyperCard software created by Bill Atkinson for the Macintosh in 1987. This program presented for the first time a series of hypertext concepts that would be distributed on a large scale only many years later. What is more, the program also was programmable "by objects" based on the HyperTalk language created by Dan Winkler. This pioneering language shared some characteristics with the multi-platform description that is HTML (HyperText Markup Language) developed by Tim Berners-Lee at CERN in Geneva in the late 1980s. Berners created a "worldwide" system of connections (that would later become the World Wide Web) based on the hypertext already present, but only locally, in HyperCard. The basic idea is that the method of the "leap" could represent a new method for general communication. We all know what happened. The Internet and its "links" represent an absolutely essential component in our way of thinking today.

10.4. Interactivity and the IT world. A discussion of Ada, an emotive environment capable of interacting with visitors and based on the application of neural networks, was published among the articles in Barzon (2003). See among others the preface by Gerhard Schmitt who, as vice-president of the ETH in Zurich, contributed to its creation. There is a detailed text on Ada by Lucy Bullivant, "Ada: The Intelligent Room" in Bullivant 2005. On the entire Swiss Expo, see the catalogue that also contains the description of many other installations and interactive creations, various authors, *Imagination*, il libro ufficiale di Expo 02, Casagrande, Lugano 2002 a recent book that presents several interactive spaces and architecture is: Lucy Bullivant, *Responsive Environments. Architecture, Art and Design,* VdA Contemporary, London 2006.

10.5. Interactivity and time. Because of its innate evocative ability, the cinema is naturally especially useful in understanding how the concept of time and change in reference systems can influence space. On this see the film "Cube" directed by Vincenzo Natali, producer Trimark Pictures, 1997 and the sequel "Cube 2: Hypercube" directed by Andrzej Sekula, producer Ernie Barbarash, 2002

11. Informatizable architecture

11.1. System space. After years of oblivion, many new contributions have been released on Situationism. See among others Heynen 99. A useful book in Italian is the anthology edited by Leonardo Lippolis, *Urbanismo Unitario, Antologia situazionista,* Testo&immagine, Torino 2002.

11.2. Surplus value is information. This subject was widely discussed in a symposium dedicated to the book series and held in Zurich in 2000, see AS on the Internet. Part of this was reprinted in Barzon (2003) (*The Chartres of Zurich*). Mario Gandelsonaspublished essays on "NY Five" in *Progressive Architectur*e march 1973 and in *Casabella* February 1974 ("Linguistics in Architecture" and "Due opere di Peter Eisenman" The expression "freezing of the semantic dimension" is at pag. 22 ("Paralizzando la dimensione semantica, la dimensione sintattica assume un peso inusitato"). The speech of Mies van der Rohe is in Die Form, 1st August 1930 and in other book, for example in Hans Wingler, *Das Bauhaus: 1919-1933. Weimar, Dessau, Berlin,* Rasch, Bramsche 1962.

11.3. Second level metaphors. I am sorry I cannot remember who defined the HyperCard, discussed earlier, as an environment, "creator of metaphors." For me, this definition is ingenious.

11.4. Once more on interactivity. From the constructive point of view, for example as developed at the Foster studio, cf. Hugh Whitehead, "Laws of Form"; on the Arup studio see Chris Luebkeman, "Performance-Based Design," both in Kolarevic 2003. As regards illusionist interactivity, aside from the volume dedicated specifically to this theme, Ranaulo (2001), and the edition entitled "Media buildings" from François Burkhardt's review *Crossing*, February 2001, the innovative work should also be mentioned of the Edler brothers who are blazing new paths in this area in part with simple, economical technologies. See Jan Edler and Tim Edler, "Message vs. Architecture, Dynamic media as a continuation of architecture" in Oosterhuis 06. Naturally interactivity shares many characteristics with games, electronic games in particular. On this see Kate Selen "They must first be imagined," and Kas Oosterhuis and Ilona Lenàrd, "Swarm architecture II," both in Oosterhis (2006).

11.5. Physical (and emotional) interactivity. The work of Ron Arad in the field of interactivity is also presented in Lucy Bullivant "Ron Arad on Interactivity and

Low-res Design" in Bullivant (2005). The house mentioned here, with many interactive environments, is Millenium House, Doha, Qatar, 2002 for which Arata Isozaki involved various architects, artists, and designers. The house was presented at the 2002 Biennale, "Next."
On the artists cited in the text, cf. Eduardo Kac, *Telepresence and Bio Art. Networking Humans, Rabbits and Robots,* University of Michigan press, Madison 2005; Philippe Rahm, *Décosterd&Rahm Distortions*, editions HYX Frac Center, Orleans 2005; Paolo Rosa, Fabio Cirifino, *Immagini vive. Studio Azzurro*, Electa Mondadori, Milan 2005; Pierre Restany, Laurence Bertrand Dorléac, Patrick Imbard, *Miguel Chevalier*, Flammarion 2005. The work of Lorenzo Brusci is also interesting, particularly his sonic garden that combines research into plants and sounds, cf. Giovannni Bartolozzi, "Il giardino sonoro,", *L'Architetto italiano*, "On&Off" supplement, no. 16 october 2006.

11.9. A Real Cloud. A particularly complete, in-depth analysis of the work of Diller&Scofidio is found in Marotta 2005.

11.10. On/Off. The title here alludes to a new publishing project called "On&Off," a supplement to the review *L'Architetto italiano* published by Carlo Mancosu and completely dedicated to new forms of architecture and information technology. Produced by the Nitro group and A., it can also be consulted on line at this address: www.nitrosaggio.net/On&Off.htm.
At least some mention should go to the relationship this volume establishes with education. The writer taught the first course on "Architecture and the Computer" at Carnegie-Mellon University in 1985, followed by a second course in 1986 (cf. "Multi-Media Analysis of Seven Houses", *Span*, vol.5 may 1988). From 1991 to 1993 two courses were held at the Gerhard Schmitt chair at Zurich Polytechnic University. From 1999 till today, seven courses have been taught at the University of Rome, "La Sapienza." Since 2001, these courses have seen the collaboration of the architect Francesco De Luca, particularly for a series of application tutorials. These courses involved more than 500 students, many of whom have maintained correspondence. The names of the students, websites, final projects, special exhibitions – such as those held in "Spot on Schools" in Florence in 2003 and 2005 as part of the Festival Beyond Media, conceived and directed by Marco Brizzi (cf. the two volumes, *Script* and *Intimacy*, edited by Paola Giaconia cit.) – together with notes and images from the lessons can all be examined here: www.arc1.uniroma1.it/saggio/didattica/).
At the blog antoninosaggio.blogspot.com/, access is available to audio from the entire 2006 course. Naturally, ideas in this volume have been presented and progressively refined through teaching. The possibility has also been considered and discussed of creating a "big book" of the entire educational experience with the architect Italia Rossi in 2003 and more recently with the architects Rosetta Angelini and Antonino Di Raimo. The idea was to bring out the complex intermingling between theoretical arguments and students' projects and to help

understand how a sort of general connectivity is developed through student web pages, collaborators, and myself. This book does not in any way deal with this aspect. However, to at least help intuit the world that gravitates in direct relation with education, two sections of correspondence should be included that, in their informality, capture the spirit of research that has been extended to many.

"Tonight I finished your book, but I will give it a second reading (my method). These are my first considerations: the book really does work by leaps, nevertheless there is a powerful ethical, at times political, and globally operational tension. For me, this is more than just an absolutely classic textbook. The statements it makes at certain points are great. This is a theorematic-Zevian book. I am speaking of Zevi from the party of action, liberal, and radical (from a noble Italian radical culture).

I find several chapters excellent and very successful, in particular those on the model, on reification, and interactivity, but I would invite you to expand (the book) even more, to add something. This is what I would like from an ex-student, graduate, and assistant:

1) A chapter on *instruments*, I feel is required in this configuration by leaps. I remind you that you taught a course entitled 'The Tool: Relationships of artistic non-neutrality … etc.' I know you talk about information technology in the entire book, but certain phrases from the book such as: 'this tool is basically a palette for liberating dreams'; (CAAD 2004) should be developed. Or 'architecture is in a crisis and what does it do? It is an adolescent who looks at himself in the mirror'; this enormous rhetorical image should be reiterated. It is the figure of the crisis of Dostoevsky, Musil, Egon Schiele, etc. and Holden Caulfield (CAAD 2006, first lesson of this year). These things must be! In part CAAD they open the section on the 'gaze inside the tool' that I find very interesting. (This is a movement, isn't it?) I don't have my notebook with me now but if other ideas come to mind I'll send them to you. Why am I telling you this? Because the lecture activities of a teacher who gives lessons must not be wasted! I understand that as you say this book has in part been "recycled," but I believe that in writing it you spent much effort in synthesizing, that at least I noticed, and that you can give even more. In other words, I don't want to miss a thing. If you can, expand the ethical section of this reification: remember the photo of the deaf-mute from this year. Yes, there is a point where you clearly state we are not discussing the very rich who can afford certain things; you are very clear. But remember you come from a generation that promised change, and this book for me must say something about this. Because I know that Saggio has thought this, because I was also in the course when you showed *Rural Studio*. This just to say that the global challenge exists of bringing all this to exactly where there are crises … The continuous Kantian references are great, the aesthetic dimension, synthetic consciousness, through short-circuits … After Gehry, Eisenman, this has to be a real jewel. We are all with you." (Antonino Di Raimo, Geneve, 19 November 2006).

"In reading this book, the first thing I noticed was the simplicity with which such complex concepts (concepts I first encountered as a student and later an assistant)

were so masterfully analyzed and explained that they read very clearly. Now everything becomes really clear!
Despite the richness of content, I read the book almost in one sitting; I was attracted by the constant stimulation, the opening up of windows, passages, and … trampolines.
It was as if I had before me many closed boxes I wanted to open, to make that leap, to understand and understand again.
In reading this, I realized the entire book is one continuous leap, a continuous desire to go further and understand more and more, to achieve more and more awareness.
This book is valuable and fundamental for more than just students since it sparks a desire for consciousness and knowledge." (Rosetta Angelini, Rome, 10 November 2006).
The world "tool" (and even "tooling") is popular in English, particularly in computer jargon. But the right word here in the context of this book is not "tool" (a word that even in English keeps some level of "passive, automatic" connotations) but "instrument." Instrument refers back to a key expression from Alexander Koyré (in *Etudes d'histoire de la pensée philosophique*, Max Leclerc, Paris 1961, see in particular the chapter "Les philosophes et la machine") and means materialization of the spirit! The tool (*outil* in French) is an extension of the body; the instrument is the materialization of the spirit! It drives and implies a new way of thinking and generates new visions. This is why the key instrument is the Galileo Telescope and to use the world *outil* for the telescope would be simply blasphemous! This concept was presented in the text "Instrument vs. Tool," preface to the book *Re-Interpreting the Baroque*, Andrew Sanders (ed.) Rensselaer, Troy 2008. The great idea in the book is to study the Baroque within a crucial emerging IT field: knowledge related to the formal mathematical basis of computer representation or, in other words, the ability to program a series of routines that generate mathematically defined shapes. This process is called "scripting" in computer parlance and is now becoming widely available. Scripting is performed not as a separate programming world but "within" the 3D environment normally used for designing, developing, drafting and eventually manufacturing elements, either in a small scale model or actual size, ready for assembly in construction. *Scripting* is becoming as common as using a thesaurus or writing a macro in word processing program. Scripting could become a key part of design over the next few years.
As regards the series of polarities presented in the text, in all these years of attending conferences, congresses, symposiums, and seminars, I have only met one other person who shares this writer's passion. This was Roy Ascott and his extraordinary multi-disciplinary group (artists, dramaturges, designers, philosophers, scientists, and architects) dedicated to research into the theme of interactivity (cf. one of the latest contributions, various authors, *Engineering Nature*, edited by R. Ascott Intellect Books, Bristol 2006, and the website http://www.caiia-star.net/). The dichotomies proposed by Ascott are interesting although something else entirely from mine. For example, in a conference at the

Fitzcarraldo Foundation in Torino in March 2001, Ascott proposed the polarities: "*Content/Context, Object/Process, Perspective/Immersion, Paranoia/Telenoia, Reception/Negotiation, Representation/ Construction, Autonomous Brain/Distributed Mind, Nature/Artificial life, Certainty/Contingency, Resolution/Emergence, Behaviors of Forms/ Forms of Behavior.*" The important aspect of this way of approaching the question is obviously the method, as I illustrate insistently in lessons by asking everyone to create their own chart. In any case, the summary discussion of my dichotomies, as proposed in the main text, is stated here below. The only one that derives from a consideration I borrowed directly deals with the concept of "remixability," cf. Lev Manovich "Remixability and Modularity" in various authors, *Dual Realities*, Media Art Biennale, Museum of Art Press, Seoul 2006. In this text, Manovich cites in turn Barb Dybwad in the "Social Software Web Log" from 8 October 2005.

Object/Subject. This polarity synthesizes the presence of a completely different point of view with respect to the mechanistic object. The affirmation of the "subject" in our era characterizes a radical change in perspective and affects every field in today's society.

New Objectivity/New Subjectivity. As you may recall, *Neue Sachlichkeit* (New Objectivity) was a term much used in the 1920s, a real manifesto that directed many cultural, political, and artistic activities.

Datum/Information. The first term again indicates an objective fact, while the second has at least a duel meaning: first of all conventional structure, thus belonging to the sphere of language, and second an intimate dynamic characteristic (in-formation).

Theory/Model. The first term derives from the distribution of an established ideological belief that must be spread and applied (frequently an "ism" during the 20th century). The second term, in the mathematical sense linked with information technology, represents a series of variables to be tested and verified on variations in the activating context.

Nature/Landscape. The first term recalls a "separate" (objective) presence of the natural world with respect to architecture; the second term recalls the idea of an interweaving between the subject that sees or designs and the object that is seen. This interweaving also extends to formative processes borrowed by architecture from the world of nature, simulated through the formalisms of information technology.

Zoning/Anti-zoning. This recalls the polarity between a potentially mono-functional method of organizing the various parts of the city and one that recognizes the idea of *mixitè* ingrained in the information society and the subsequent combination of residential, work, cultural, commercial, infrastructure use, and leisure time activities.

Linearity/Leap. From an alphabetical method (sequential and on a grid) to a hypertext method based on discontinuity, this polarity implies not only the difference between the cinematographic sequence (the principal communications method of the 20th century industrial paradigm) and hypertext (the method of the

Internet), but also the notable differences in the idea itself of time and the coexistence of different reference systems.

Inductive/Deductive. This deals with the prevalence of the hypothesis and verification method compared to the analytic and linear method. "If … then" is replaced with "What … if," the idea of the *line* (including the assembly line) is replace with the idea of the *network* (including *Netscape*, the landscape of the network as well as the first widely used internet browser).

Plan/Diagram. The inductive/deductive difference in the world of architecture strictly speaking emerges in the difference between plan and diagram, and thus between a deterministic and geometrical reference and one that is relational and topological.

Punctiform/Continuous. From the construction point of view, the first method is summarized in the Domino plan by Le Corbusier and his celebrated "five points," the second in the Guggenheim by Gehry in Bilbao and in reticular construction itself.

Organ space/System space. From an idea of creating architectural space connected directly to a list of interior functions, and a linked, hierarchical mode of operation, to one that renders independent the various areas and needs of an architectural design and combines them in a network using systemic logic.

Abstraction/Figure. The shift is away from pure, abstract lexical elements, with no precise meaning for an architecture that "functions" analogously to a machine, and toward the search for meanings, partly metaphorical, in the architectural work, rhetorical figures to insert into the world of mass media and communication in a "super-symbolic" society.

Transparency/Interactivity. Transparency was the catalyzing element of functionalism and contained a concentrated collection of functional, logical, constructive, ideological, and synthetically aesthetic motifs; in the same way, the catalyst of the information technology paradigm gravitates around the concept of interactivity that again carries and concentrates communicative, informational, and personalizing aspects as well as those new relationships between the building and what is no longer the "other" in itself but something that interacts more and more with the various subjects, as if it were an IT model constructed within the material reality of the new architecture.

Modularity/Remixability. The idea of the module is one of the great advances in thought connected to industrialization. Enormous progress was made by applying this principal. In the information era, the concept of modularity has not been abandoned but rather reinforced and brought to a new subjectivized dimension. The key concept is remixability. In music, block programming, fashion, and component production, more and more modular "pieces" are utilized that can be reassembled into a new, ever more personalized product.

Industrial Revolution/IT Revolution. The term "IT Revolution" originated out of an incessant "ping-pong" of faxes between Professor Bruno Zevi and the writer in November 2006 when the section with the same name was about to be released in the Universale di Architettura series founded and directed by Zevi first with Dedalo

(1978-1985) then Testo&Immagine (1996-2000). My customary duty, as well as a constant homage to the master, was to summarize the new volumes by letter. In his last fax, after the publication of only five volumes out of the current 35, and four days before his sudden passing, he wrote: "YES YES YES to all three proposals. I appreciate your propriety but by now it seems to me there is no longer any need for my supervision. The small volumes in the IT Revolution are excellent, a solid cultural contribution, all to your credit. With affection, Bruno Zevi." Naturally this is not true. Nothing would have been created without him.

DEFINITIONS*

AESTHETIC – A form of synthetic knowledge developed through processes that are neither analytical nor linear but discontinuous, made possible by the use of figures.

ARCHITECTURE – The substance of things hoped for (Edoardo Persico)

ART – The solution to a problem that cannot be expressed explicitly until it is solved (Piet Hein)

CATALYST – An agent that allows a reaction to occur and determines the combination, direction, and meaning taking on by multiple substances when they are placed in its presence

CONNOTATIVE – A form of communication, as well as an approach to design thought, that gives prevalence to analytical and, as much as possible, objective relationships.

DATUM – Minimum element that modifies a previous situation. In Latin "something given".

DEDUCTIVE – An approach to design and scientific thought that begins with the formulation of general hypotheses submitted to verification by collecting information and the direct testing of results.

DENOTATIVE – A form of communication that gives precedence to the moment of subjective synthesis and finds expression in the use of figures.

* These definitions, where not specific, are the responsibility of A.S.

DIAGRAM – A series of relations that prefigure certain properties of the finished work and contribute to guiding the development of a project.

FIGURE – A representation (literary, musical, pictorial, or belonging to other forms of expression) in which denotative values prevail over connotative values, for example a rhetorical figure (metaphor, or metonymy).

INDUCTIVE – An approach to design and scientific thought that begins with the analytical collection of information and either applies a theory to this or creates one from the beginning.

INFORMATION TECHNOLOGY (IT) – Automatic information management using the computer (Philippe Dreyfus) or a science in which no data exist, but always and only information.

INFORMATION – The application of a convention to a datum.

LANDSCAPE – An aesthetic representation of a part of the world, shared collectively and culturally but in constant evolution.

MODEL – A theoretical design developed in various sciences and disciplines to represent the fundamental elements of one or more phenomena (Zingarelli 1970); in the IT field, the form assumed by information.

MODERNITY – Transformation of a crisis into a value, in a contradictory moral that gives rise to an aesthetics of rupture (Jean Baudrillard with Bruno Zevi, Antonino Saggio and you you you).

REIFICATION – The process by which scientific or symbolic concepts become something material, for example architectural space.

SUBSTANCE – The tension toward the transformation of the world through the critical awareness of one's own time and its crises.

SPACE – An interval that can be traveled dependent on a physical system of reference (with one, two, three, or "n" dimensions) conventionally structured in information.

TIME – A property created by God together with the universe (Saint Augustine).

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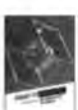

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How can I give credit in one single text to research that has involved the writer in the creation of a book series with the same title as this volume and has seen around thirty-five specialized books published in various languages? A dozen specific articles, many prefaces, several conferences, and numerous university courses have originated around and alongside this series. A considerable amount of work has been produced; relationship are close-knit between the various theoretical, scientific, technological, design, constructive, and educational aspects. The structure chosen for this book was to avoid a «crib sheet» on the «It Revolution in Architecture». The formula of the «treatise» was just as impossible to use not only because many aspects of the contemporary scientific research are oriented toward a structure that remains intentionally open and serves to launch new hypotheses rather the solidify certainties, but also because this aspect is reinforced by the material that by its nature finds itself in an free, interconnected, intrinsically problematic dimension.

The author is the founder of the international book series It Revolution in Architecture (published in English by Birkhäuser, Italian by Testo&Immagine and Edilstampa, and Chinese by Prominence), which aims at further advancing the creation of new digital culture in Architecture.
This book provides the theoretical framework for past achievements as well as an eye to future developments.

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