ARCHITECTURE AND THE VIRTUAL
TOWARDS A NEW MATERIALITY

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THE DEVELOPMENT OF DIGITAL DESIGN IS OFTEN PRESENTED AS A THREAT TO ONE OF ARCHITECTURE'S ESSENTIAL DIMENSIONS: THE CONCRETE ASPECTS OF CONSTRUCTION AND BUILDING TECHNOLOGIES, IN A WORD, ITS MATERIALITY. SUCH IS FOR EXAMPLE THE CONCERN EXPRESSED BY KENNETH FRAMPTON IN HIS RECENT WORK, STARTING WITH HIS STUDIES IN TECTONIC CULTURE.[1] DESPITE THE COUNTER-ARGUMENTS POSED BY WILLIAM MITCHELL AND OTHERS,[2] THIS CONCERN IS EASILY UNDERSTANDABLE, GIVEN THE HIGHLY FORMALIST NATURE OF MANY DIGITAL ARCHITECTS' PRODUCTION. COMPUTER-BASED DESIGN OFTEN APPEARS TO NEGLECT THE MATERIAL DIMENSION OF ARCHITECTURE, ITS INTIMATE RELATION WITH PROPERTIES LIKE WEIGHT, THRUST, AND RESISTANCE. ON A COMPUTER SCREEN, FORMS SEEM TO FLOAT FREELY, WITHOUT CONSTRAINT OTHER THAN THOSE IMPARTED BY THE PROGRAM AND BY THE DESIGNER'S IMAGINATION. THERE IS SOMETHING DEEPLY UNSETTLING IN THIS APPARENT FREEDOM THAT SEEMS TO QUESTION OUR MOST FUNDAMENTAL ASSUMPTIONS REGARDING THE NATURE OF THE ARCHITECTURAL DISCIPLINE.

However, should one accept the present stage of computer-based design as if it were setting definitive standards? As digital architecture remains in its infancy, one must be cautious not to draw conclusions about the temporary features it presents. Frampton and other detractors perhaps assume its current condition to be permanent, taking its temporary characteristics too seriously, while underestimating the real questions it raises. Its present tendency towards a certain immateriality, or rather its often-glib attitude towards materiality, may very well be ephemeral. Far from being jeopardized by the generalization of the computer and the development of virtual worlds, materiality will probably remain a fundamental feature of architectural production. One can furthermore speculate whether the use of the computer, with its web extensions, represents a substantial departure from the traditional features of architectural representation. In many respects, two-dimensional, hand-produced drawings are no more material than computer-based ones. The abstraction inherent in architectural representation does not necessarily imply a lack of materiality in its realization.

I would like to begin precisely with the general question of architectural representation, before turning to the changes brought about by the computer. Among the leads I will then follow is the idea that materiality, like almost every feature of our environment, is to a large extent a cultural construction. As has been argued by various proponents of social constructivism, physical experience is shaped partly by culture, technological culture in particular. We perceive the exterior world through the lenses provided, both literally and on a more symbolic level, by the technological culture that surrounds us. Beyond perception, our everyday gestures and movements are indebted to our machines and their specific requirements. In such a perspective the impact of the computer may more accurately be described as a reshaping of, rather than an estrangement from, physical experience and materiality.

The approach adopted here tries to avoid the pitfall of positing a naive enthusiasm with regard to the existing state of digital architecture, or the symmetrical bias of rejecting it without further examination. Rather than discussing the value of various contributions to digital architecture — hence the scarcity of the references made to them — I will concentrate on questions of a more epistemological nature. What does digital architecture, even in its present state of incomplete development, suggest regarding the changing categories of physical experience? If materiality is not endangered, how is its definition nevertheless evolving?

When we discuss computer productions, from images to web-based worlds, the term "virtual" almost immediately arises, along with an accusation of dematerialization that explicitly opposes virtual reality and true reality. Without entering into the usual philosophical debate evoking Henri Bergson or Gilles Deleuze, one may still observe that such opposition is hard to sustain in an architectural discourse. An architectural design is indeed a virtual object. It is all the more virtual that it anticipates not a single built realization but an entire range of them. There is no architectural design without some margin of indeterminacy that allows for different paths to be followed. Usually only one will be realized. Despite the attempts to improve the codification of design procedures in order to anticipate as closely as possible the built outcome, this relative indeterminacy is fundamental to the architectural project. It enables it to "speak," or rather to function as a matrix of possible narratives regarding the built reality it anticipates, without which the project would be a mere technical blueprint.

Returning to the question of materiality, one could summarize the situation by saying that while design pertains to the realities of the built environment, this relationship remains ambiguous. Again, drawings and specifications evoke a range of material effects rather than a precise, unequivocal, and unique material reality. The ambiguity of architectural design reflects on architectural representation. Even the most convincing techniques of representation do not correspond fully to the experience of the built reality. We never see buildings in plan and elevation, to say nothing of cross section or the modernist axonometric view that presupposes an observer situated ad infinitum. One would be tempted to affirm that representation in architecture, as in cartography, presupposes an impossibly located observer.

Architectural representation negotiates these contrary tendencies: the quest for verisimilitude and the desire to preserve margins of indeterminacy. Actually, the necessity to balance between these two conflicting ideals might very well account for an inherent paradox of architectural drawings: the more specific the physical effect intended, the more abstract the representation, as if this fundamental tension translated into an equilibrium between materiality and abstraction. From the Renaissance on, the drawings of architectural profiles illustrate this point. For the Vitruvian inspired architect, nothing was more material than the play of light on various moldings of a building. Yet, their representation in profile was often surprisingly distant from the effects desired. Even in canonical treatises like Palladio's **Four Books on Architecture** this representation is reduced to linear drawing.

Given this history, do computer representations imply a clear departure from the traditional practice of architecture? At this stage, the digitalization of design may very well appear as

BACKGROUND IMAGE: All of the background images in this article are from a photograph taken by Martyn Thompson. The photograph reveals the materiality of panelite, a translucent honeycomb panel developed by architects. The images are reproduced on each subsequent page at an decreased a scale factor of ten to reveal the different material properties at different scales.

a mere technological advance, a supplementary power offered to the designer, a power that does not affect the nature of its production. Digitalization does allow the architect to manipulate extremely complex forms and to more freely envision design modifications. However, are these extensions of vocabulary and the capacity to interact at every stage of the design truly revolutionary? Is this change quantitative rather than qualitative, as if contemporary designers were simply endowed with a more varied and flexible set of pencils and rulers?

This is of course not entirely true, for the computer breaks with the immediacy of the human gesture. Between the hand and the graphic representation, a layer of hard and software introduces itself. Inherent in the software are modes of operation and preferences that constrain the designer. The machine and its programs are synonymous with a thickness absent in traditional tools.

This thickness might eventually disappear with the development of increasingly sophisticated interfaces that almost seamlessly integrate the computer into design practices. The Media Lab at the Massachusetts Institute of Technology has invested years of research into digital gloves and tactile screens as well as camera- and laser-controlled feedback systems linking physical and digital modeling. Nevertheless, the mediation of the machine and its software will not be abolished.

The difference between hand and computer produced designs parallels the contrast between a walk and a car ride. At stake in both cases is an opposition between man and the pairing formed by man and machine—a machine which cannot be reduced to a mere accessory. Both the power of the computer, and also its thickness, make it indeed different from traditional tools. Its use could be assimilable to an encounter with a "non-human actor," to use Bruno Latour's conceptual frame.[3] In the decades following World War II, the automobile had already led to such an encounter.

Another possibility is to consider the pairing of man and machine as a new composite subject, a hybrid of flesh and machine already realized in the automobile driver. The computer user's almost visceral relation to the screen and keyboard might be interpreted in the same light so that digital architecture comes to imply a cyborg-like author. This proposition is suggested by various contemporary reflections on computer technologies and their anthropological dimension.[4] Their influence can be traced in various architectural publications.[5]

If we leave aside these broad perspectives, the automobile analogy is still revealing. The traditional opposition of the richness of walking to the impoverishment of driving implies that materiality was at stake as seen by the contrast between the plenitude of real physical experience and the abstraction fostered by a technologically determined environment. Almost a century after the car became a mainstay of contemporary culture, we know that this opposition does not fully apply to the automobile experience. Rather than dematerializing the world we inhabit, the automobile has instead transformed our notion of materiality. My intention is not to enter here into a detailed discussion of these transformations, but to insist on some major points.

When we drive, we don't perceive exactly the same objects as when we walk. Seen from a freeway, a building is different from the vision we have when we stroll by. At the speed of the automobile, objects regroup forming new perceptual entities. The scale and form of contemporary urban skyline are manifestations of the automobile age, as are the landscapes produced by the rapid succession of billboards along major highways.

The automobile provides a series of different sensations, from accelerations and decelerations to the feeling provoked

by the wind, some of which are intimately linked to the use of the engine. We have become so accustomed to acceleration that we tend to forget that the sensations it creates were almost unattainable in formerly non-mechanized societies where slow and regular movement was the rule. In a mechanized environment, between the exhilaration of speed and the prospect of accident, we have both an impression of power and a feeling of vulnerability. James Graham Ballard's famous novel, **Crash**, focuses on this new status of the human body, or rather of the hybrid of the body and its mechanical extension. This hybrid, both empowered and vulnerable, makes nothing of miles and is always on the verge of being bruised. In Ballard's perspective, the mélange of power and vulnerability carries heavy sexual connotations. For his characters, the accident, the fatal crash that gives its title to the novel, becomes a new technologically mediated form of coitus.[6]

The redefinition of perceptual entities that we experience while riding in a car alters our very notion of space, changing the existential status of our entire body. The most significant shift is perhaps the subtle changes that the use of the automobile infuses in our everyday experience of space. The automobile has altered but not diminished our physical perception of the world by displacing the content and boundaries of materiality.

It is tempting to use the automobile as an analogy to the computer, interpreting it as another vehicle that induces a new displacement of physical experience and materiality. The computer-assisted architect loosely parallels the driver or passenger embarking on a journey that generates a new type of experience. What are the salient features of this material experience?

The computer presents us with new perceptual entities and objects. Whereas the architect previously manipulated static forms, now she or he can play with geometric flows. Surface and volumetric deformations acquire a kind of evidence unavailable to traditional graphic means of representation. They can indeed be generated and followed in real time on the screen. In that respect, the use of the computer is strangely close to practices like clay modeling, and it is no coincidence that various attempts have been made to couple its use with three-dimensional shaping in places like MIT's Media Lab.

The new evidence acquired by geometric flows may account for the multiplication of projects that look like fluid surfaces. For example, Reiser + Umemoto's "West Side Convergence" appears as a geometric flow that has been frozen into architectural form.[7]

In addition to deformation and flows, the computer enables the manipulation of non-material phenomena, such as light and texture, so that they acquire the status of quasi-objects to the architect. Numerous parameters of light can be manipulated: it can be intensified or dimmed, made direct or diffuse. Similarly, surfaces can be adjusted with an almost infinite combination of factors of roughness and smoothness, of reflectivity and transparency to an extent that makes them almost tactile. These manipulations have widely different manifestations, from superficial effects like the "hypersurface" projections made possible by the digital world's capacity for any form to be textured with any image,[8] to the mathematically substantiated creations of Bernard Cache's Objectile practice.[9] What they have in common is an emphasis on surface and tactile conditions, as opposed to abstract volumetric considerations.

While some dimensions of digital architecture, like the surface condition I just mentioned, become essential, others appear more problematic. In the case of the automobile, the emergence of new pertinent objects is accompanied by the loss of the ordinary sense of distance in favor of the notion of accessibility. In a similar way, with digital architecture, scale no longer seems evident. What is the true scale of the forms that appear on computer screens? Despite the inclusion of scale figures in photomontages, it is often difficult to answer this question. The standard presentation of a project like Nox's "Beachness" is highly revealing in this respect. One first perceives a complex maze of lines, then a twisted form that looks like a crumpled piece of paper or cloth. Subsequent images reveal that one is actually looking at a huge, almost megastructural, design.[10] Computer imagery is in profound accordance with a world organized by fractal rather than traditional geometry in which information and complexity are found at every level. In such a world, there is no fixed scale at which things must be deciphered.

In addition to challenging ideas of scale, digital technologies make the relation between architectural representation and tectonics less clear than in the past. This dissociation between representation and tectonics is evident Frank Gehry's CATIA-designed complex surfaces, the forms of which owe little to structural considerations.[11] Despite the discourse of the architect, a similar distance separates Toyo Ito's transparent luminous competition model for the Sendai Mediatheque from the structural reality of the heavy steel plates used to construct the building.[12] Foreign Office Architects' Yokohama Terminal reveals a similar tension between the fluidity of the original design and the techniques mobilized to realize it. The world shaped by digital technologies is not only complex at every level; it is also full of surprises because of the gap that often separates computer modeling and tectonics.

The antagonism of critics like Kenneth Frampton is directly related to the recognition of this gap between digital represen-

FACING PAGE: A construction photograph on the left showing the installation of the wood plank finish on Foreign Office Architect's Yokohama Port Terminal. Techniques used to construct the design and in fact, the material dimension itself contrast with the smooth surfaces suggested in the competition renderings.

tation and traditional tectonics. However disturbing it may be, such a gap is not necessarily synonymous with a dematerialization of architecture. The computer redefines materiality rather than abandoning it in favor of the seduction of pure images.

This displacement demands a redefinition of design objectives and procedures. The digital world requires a new visual practice able to follow the complex maze of interactions between the global and the very local, between the general definition of the project and the sometimes minute, sometimes dramatic changes brought by parametric variations. In this world, the smallest change may affect the design as a whole, as in the well-known claim of chaos theory that the fluttering of a butterfly in one part of the world may cause a storm in another.[13] The sensibility generated by this dependence on parametric variations is again not without analogy to the heightened sensory experience of driving at full speed on an uneven surface where the tiniest obstacle can cause dramatic consequences. Marcos Novak has compared the digital and liquid states: "the operations associated with the idea of the liquid suggest that parameterization leads to radical variability within a continuum implied by a thing and its opposite."[14] Computers immerse us into a fluid, eminently variable world that gives a special intensity to some of our sensations and the decisions to which they lead us.

The automobile is only a metaphor, and as such shouldn't be taken too literally. Contrary to the automobile's linear trajectory, the digital world that unfolds under the eyes of the designer is multi-dimensional. It flows theoretically in all directions; it is also theoretically reversible. These characteristics are at odds with the necessity for the design process to follow a particular sequence from preliminary sketches to the ultimate technical specifications, and to involve various consultants, from the architect's collaborators to the engineers and builders in charge of specific technological developments. In other words, computer-aided design cannot be a labyrinthine exploration of the almost infinite possibilities offered by the machine. While form can vary endlessly, choices have to be made; decisions have to be enforced in order to break with the theoretically reversible nature of digital manipulation.

The importance of these choices fosters a new attitude based on the strategic evaluation of the potential for design evolution at critical stages of development. It has been often noted that computers imply a scenario-based kind of reflection. Besides the use of scenarios, diagrams may orient the designer among the various paths of evolution made possible by digital media. Because of their proximity to concept, and the suppression of unnecessary concrete details to which they proceed, diagrams are often perceived as pure mental schemes. This approach is inconsistent with the true nature of diagrams, namely the fact that they are inseparable from courses of action. They possess a physicality of their own, similar to the seemingly abstract notations that choreographers use to note the steps of a ballet. There is a striking parallel between the contemporary, often Dutch-inspired, architectural diagram and geopolitical diagrams produced at the beginning of this century.[15] Both are based on a schematic description of the world that tends to neglect differences in scale and geographical complexity, to say nothing of historical specificity. Geopolitics loves blocs, alliances, and other global entities. Dutch-inspired diagrams are also based on massive aggregates and global data.[16] In both cases, the world appears as a field in which forces are manifest rather than a static geography. Like geopolitics, contemporary architectural diagrams make extensive use of charts and arrows attempting to make these forces visible. They converge on nodes that can be likened to objectives or targets. In both cases, what seems at stake is the apprehension of a mobile and fluid environment, requiring continuous action.

More generally, the computer has often been understood as an extension of the mind, a super memory or an enhanced tool for logical exploration. The French anthropologist Leroi-Gourhan, for example, tracks a spectacular evocation of human progress through the use of technological tools in **Le Geste et la Parole**. This book spans the Neolithic period to the twentieth century, from the first trimmed and polished stones to early computers.[17] For Leroi-Gourhan, human progress was marked by the gradual externalization of functions, from stone knives and axes that extended the capacity of the hand to the externalization of mental functions with the computer.

The computer indubitably can be related to an extension of the mind, but it also alters our perception of objects by extending the realm of our sensations. New interfaces currently being developed will soon affect our motor skills. Already the mere use of a mouse has created new kinds of gestures. Among teenagers, the development of video games has fostered even more specific kinds of reflexes.

Our very perception of space will in its turn be affected by these physical changes. Films like **Johnny Mnemonic**, **The Matrix**, or **Minority Report**, have envisaged changes in the perception of ordinary space brought about by the development of sophisticated interfaces between ordinary and digital space. The notion of enhanced or increased reality suggests a different materiality made possible by the hybridization of the physical and the digital. While this hybridization is not fully developed, some features of the displacement of materiality are already evident.

Similarly, visual codes are changing at a surprising speed. We no longer marvel, for instance, at digital media's capacity for effects like zooming in and out. Rather, we tend to perceive our ordinary three-dimensional world in similar terms, as if ordinary reality were the result of a provisional compromise, or rather a middle-range lens accommodation, between the very small and the extremely large, between atoms, or rather pixels, and galaxies. Immediately recognizable forms and objects are suspended between closely observed surfaces and textures that evoke some kind of abstract art and the less abstract, satellite-like views that give precedence to surface and texture effects. In both cases, the perception of volume relies upon the relationship of two kinds of surfaces or skins.

One could also relate the new status of form and object to the cultural context created by globalization. Globalization can indeed be characterized as a strange short-circuit between the local and the general that destabilizes middle-range institutions and practices.[18] In our global world we see things either from very close or from an extremely distant point of view. It is certainly no coincidence that the computer has been instrumental in the process of globalization. Zooming might be a mere consequence of the crisis of the traditional notion of scale implied both by computer use and globalization, a crisis that generates a specific form of perceptive instability.

This instability blurs the distinction between abstraction and concreteness, for nothing is at the same time more abstract and concrete than a view that challenges interpretations based on the ordinary categories of form and object. More generally, in the age of the computer and with the physics of solids and DNA manipulations, materiality is increasingly defined at the intersection of two seemingly opposed categories. On the one hand is the totally abstract, based on signals and codes; on the other hand is the ultra concrete, involving an acute and almost pathological perception of material phenomena and properties such as light and texture as they are revealed by zoom-like practices. This hybridization between the abstract and the ultra-material represents the new world of sensations and movements that we are entering today.

In the architectural domain, the coexistence of reflections of a diagrammatic nature with a renewed interest in some of the most concrete aspects of materials is typical of this situation. At an urban level, the GPS also represents the immediacy between abstraction and concreteness. Using a GPS, we are both plugged into a global, abstract geodesic grid and confronted with our immediate surroundings.[19] As the computer is beginning to affect the design of buildings, the digital environment will eventually modify urban design, if only because old problems like the legibility of the urban sequences are now redefined by tools like the GPS.

But how are the intuitions of the architect or the urban designer conveyed to a public that inhabits his projects? In other words, can the new materiality desired by computer aided designers concern a larger public unaware of the various and often contradictory reflections developed by figures like Greg Lynn, Marcos Novak, Jesse Reiser, and others? Their architecture of blobs and topological geometrical forms seems distant from the common definition of architecture. At the level of the city, the same gap separates the world of computerized urban simulations from the ordinary perceptions of the people.

At least two reasons may be invoked in favor of an optimistic answer. The first one lies in the way the computer permeates everyday life, so that this alteration of materiality can be understood as a general phenomenon. We are all about to inhabit both the ordinary and the virtual worlds – hence Toyo Ito's famous statement that architects should indeed design for subjects imparted with two bodies, a real and a virtual one. "We of the modern age are provided with two types of bodies," writes Ito." The real body which is linked with the real world by means of fluids running inside, and the virtual body linked with the world by the flow of electrons." Actually, these two bodies are not separated, but rather they are part of what constitutes today's physical presence. The Sendai Mediatheque epitomizes this contemporary physical status: simultaneously densely material, reminiscent of heavy-duty naval construction with its massive steel plates, and fluid, translucent like a precious electronic gem. Thus, in this case, the gap between tectonics and architectural representation, far from being accidental, is actually rooted in the core intention of the architect.

Earlier I mentioned video games and their impact on a whole generation, the behavior of which has been shaped by bizarre figures of dwarves, princes, and ogres running and jumping on Gameboy and computer screens. This generation has developed physical and mental attitudes that call for a different kind of space, a space that can be deciphered through systems of clues and series of unfolding scenarios, instead of traditional holistic mapping. This generation's spatial expectations might very well be fulfilled only by digital-oriented architecture.

The second reason to be confident in the new architectural materiality enabled by the computer lies in the fact that, contrary to the automobile, the computer is not an isolated machine of the kind that the French philosopher George Simondon called a "technological individual," or a super prosthesis adding to man's physical capacity. The computer is only a part of a global digital universe that includes entire world-

FACING PAGE, LEFT AND CENTER: The intention of Nox's "Beachness" is a merging of skin and object, the body and space, resulting in an almost scale-less environment. One first perceives a complex maze of lines, then a twisted form. Subsequent images reveal that one is actually looking at a huge, almost megastructural, design.

FACING PAGE, RIGHT: Reiser + Umemoto's "West Side Convergence" conflates infrastructures of transportation, distribution culture and knowledge in an inflected geometrically flowing roofscape.

wide networks as well as millions of personal digital assistants. One could of course argue that the automobile was already inseparable from a world populated with roads, traffic lights, gas stations, and parking lots. The automobile world was, however, comparable to a denumerable system rather than to a seamless fabric. The density and the high degree of interconnection and redundancy that characterize the digital universe make it difficult to describe it in terms of systems. Environmental categories such as landscape seem more appropriate. We are more and more immersed in this landscape.

Regarding the question of materiality, the digital landscape provides numerous new opportunities like the possibility to design materials, to shape their properties and appearance, instead of using them in a passive manner. As various authors have pointed out, the digital revolution is contemporary with a revolution in the materials we produce and use. At the Harvard Design School, a group of professors and students led by Toshiko Mori recently has been exploring the potential for architectural expression of materials by design, a potential already mobilized by designers like Mack Scogin or Sheila Kennedy.

Computer-aided material production seems to abolish the distance between representation and materiality, provided that one defines materiality in other terms than traditional tectonics. But this collapse is actually an illusion provoked by the elimination of the complex series of interfaces necessary to bridge the distance between architectural representation and material by design. The computer doesn't abolish the distance between representation and reality, far from it. It simply creates the possibility of a continuously documented process between pure architectural representation and technical specifications. In his revolutionary descriptive geometry course, Gaspard Monge began by distinguishing between the objects that were susceptible to receive a rigorous definition and those that were not.[25] The digital age enables every object and every material, at each stage of its elaboration, to be rigorously defined. True novelty might very well lie ultimately in the generalization of design, as a practice regarding not only buildings and their various technological systems, but also materials and beyond them nature as an engineered reality. Many contemporary landscape proposals, such as the Fresh Kills landfill competition entries,[26] no longer address nature as an external resource to be drawn upon. Increasingly, it appears as something the production of which can be shaped by adequate design. The increasing use of the term "landscape urbanism" in regard to situations like Downsview or Fresh Kills appears as a consequence of this trend.[27] In this technological nature, materiality is totally permeated by design. Despite the dissociation between architectural representation and tectonics, the true novelty is not a growing gap between design and materiality, but rather their intimate interaction that might eventually challenge the traditional professional identities of the architect or the engineer. Both identities were indeed based on the assumption of a distance between the intellectual and the physical world, a distance that design was meant to bridge. If one takes seriously the hypothesis of a blurring between abstraction and concreteness, these identities must be altered. Cecil Balmond's claims to cooperate fully in the design process, instead of being confined to mere structural calculations, is representative of the new perspectives that arise from a world blurring the distinction between mathematical abstraction and spatial concreteness.[28]

This potential generalization of design procedures makes us more liable than ever for its consequences, since the world appears more and more as our creation, from nature to artifacts, from materials to building. Thus, a new political responsibility is at stake. For architects, this implies a departure from the traditional posture of the professional indifferent to the large issues raised by his realizations. To inscribe oneself in current economic and cultural trends is probably no longer enough, considering, as Sanford Kwinter once put it, that the task of architecture is to take "the flow of historical conditions as its privileged materiality."[29] As we have seen, materiality means much more today than the mere understanding of the forces that shape the global market. Toshiko Mori has said, "Architects and other citizens must actively make choices about where to build, what to build, how to build, and with what to build."[30] One should probably add to the list "when not to build" in a world where the environment and sustainable development have become crucial issues. To refrain from building is more and more often a better solution than to engage in developments that may eventually prove damaging. The real problem of today's architectural scene is, in my opinion, not so much its possible dematerialization as its lack of clearly defined political and social agenda despite the greater than ever need for it. The growing success of designers of sustainable structures like Shigeru Ban might very well lie in their articulation of both a concern for materiality and technological innovation and a more clearly articulated political and social concern.

Instead of representing an endangered dimension of architectural design, materiality will remain a pervasive concern. But this concern is now synonymous with a new responsibility. Its content is changing, and its meaning is yet undecided. One of the tasks of architecture might very well be to throw some light on its present potential. ⊖

NOTES

1. See among others Kenneth Frampton, **Studies in Tectonic Culture** (Cambridge, Massachusetts: The MIT Press, 1995).
2. William J. Mitchell, "Antitectonics: The Poetics of Virtuality," in J. Beckmann ed., **The Virtual Dimension** (New York: Princeton Architectural Press, 1998), 205-217.
3. See B. Latour, **Nous n'avons Jamais été Modernes, Essai d'Anthropologie Symétrique** (Paris: La Découverte, 1997); B. Latour, **Politiques de la Nature** (Paris: La Découverte, 1999).
4. Cf. D. Haraway, "Manifesto for Cyborgs: Science, Technology, and Socialist Feminism in the 1980s," in **Socialist Review** 15:2 (1985): 65-107; D. Haraway, Simians, **Cyborgs and Women: The Reinvention of Nature** (New-York: Routledge, 1991); P. Edwards, **The Closed World. Computers and the Politics of Discourse in Cold War America** (Cambridge, Massachusetts: The M.I.T. Press, 1996).
5. See A. Picon, **La Ville Territoire des Cyborgs** (Besançon: Editions de l'Imprimeur, 1998).
6. J. G. Ballard, **Crash** (London: Cape, 1973).
7. For a reproduction of this project, see for instance **Città: Less Aesthetics More Ethics** (La Biennale di Venezia: Marsilio, 368-369).
8. S. Perrella, "Electronic Baroque, Hypersurface II: Autopoeisis," **Architectural Design 69**: 9-10 (1999): 5-7.
9. B. Cache, **Earth Moves: The Furnishing of Territories** (Cambridge, Massachusetts: The MIT Press, 1995).
10 See for instance the presentation given in P. Zellner, **Hybrid Space, New Forms in Digital Architecture** (New York: Rizzoli, 1999), 114-117.
11. For a general discussion of the tension between surface and tectonics that epitomizes Gehry's work, see M. Burry, "Between Surface and Substance," **Architectural Design 72**:2 (2003), 8-19.
12. Cf. R. Witte ed., Toyo Ito, **Mediatheque of Sendai** (Munich: Prestel, 2002).
13. Cf. J. Gleick, **Chaos** (New York: Viking Press, 1987).
14. M. Novak, "Eversion: Brushing against Avatars, Aliens and Angels," **Architectural Design** 69:9-10 (1999): 72-76, 72 in particular.
15. On the diagrams produced by geopolitics, see for instance Cl. Raffestin, **Géopolitique et Histoire** (Lausanne: Payot, 1995).
16. Among the publications typical of this practice, see R. Koek, W. Maas and J. van Rijs, Farmax. **Excursions on Density** (Rotterdam: 010 publishers, 1994); R. Koolhaas, S. Boeri, and S. Kwinter, **Mutations** (Bordeaux, Arc en Rêve, 2001).
17. A. Leroi-Gourhan, **Le Geste et la Parole, I. Technique et Langage. II. La Mémoire et les Rythmes** (Paris: Albin Michel, 1964, 1991).
18. Cf. P. Veltz, Mondialisation, **Villes et Territoires: L'Économie d'Archipel** (Paris: P.U.F., 1996).
19. GPS art is actively exploring this short-circuit between abstraction and concreteness. See for instance **GNS Global Navigation System** (Paris: Editions Cercle d'Art, 2003).
20. T. Ito, "Tarzans in the Media Forest," **2G** 2 (1997): 121-144, 132 in particular.
21. G. Simondon, **Du Mode d'Existence des Objets Techniques** (Paris: Aubier, 1969).
22. Cf. G. Dupuy, **Les Territoires de l'Automobile** (Paris: Anthropos, 1995).
23. See for instance B. Bensaude-Vincent, **Eloge du Mixte, Matériaux Nouveaux, Philosophie Ancienne** (Paris: Hachette, 1998).
24. T. Mori ed., **Immaterial/Ultramaterial** (Harvard Design School: George Braziller, 2002).
25. **Programmes de l'Enseignement Polytechnique de l'École Centrale des Travaux Publics,** reproduced in **J. Langins, La République avait besoin de Savants. Les Débuts de l'École Polytechnique et les Cours Révolutionnaires de l'An III** (Paris: Belin, 1987), 126-198, 142 in particular.
26. See these projects **Praxis 4** (2002).
27. Ch. Waldheim, "Landscape Urbanism: A Genealogy," **Praxis 4** (2002): 10-17.
28. C. Balmond, with J. Smith, **Informal** (Munich: Prestel, 2002).
29. S. Kwinter, contribution to **Flying the Bullet, or when did the Future Begin?** (New York: Princeton Architectural Press, 1996).
30. T. Mori, xv.