The Architecture of Continuity

Lars Spuybroek

Essays and Conversations

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Foreword

by Detlef Mertins

Time and again, we have been surprised and astonished as Lars Spuybroek has broken new paths for making architecture and pioneered new theoretical constructs for thinking about it. In a decade of synthetic experimental projects, he has amassed formidable new expertise, not for its own sake nor for that of the free play of imagination, but in order to address problems and limitations of the discipline. These problems, he points out, are generally not new to architecture, although their reemergence in the context of new technologies and new media gives them a sense of urgency that often makes them *seem* new. The essays assembled here make that abundantly clear, for they have been selected, augmented and thoroughly rewritten into an informal treatise as well as a resounding manifesto. In dialogue with theorists from different disciplines and eras – Deleuze and Virilio, Varela and Arnheim, Semper and Otto, Ruskin and Worringer all populate these pages – he addresses issues of technology, experience, methodology and aesthetics in turn. He draws distinctions – self-engineered rather than engineered, variation rather than randomness, active rather than passive – which result in nothing less than a new ethos of design.

For generations, one of the classic problems of architecture has been the translation from drawing to building – from what the imagination can produce in representations on paper, canvas and computer screens to what craftsmen and laborers can fashion with their materials, assembly lines and machines. But for designers of complex topologies, as Spuybroek observes, this problem has been stubbornly demanding, as they have labored to architecturalize digital tools as well as digital discourse. His response, in turn, has been radical and radically effective, for he sidesteps the issue of representation altogether to redefine the problem in other terms. In his hands, the computer has always been a *constructive* medium, not a representational one. It enables complex geometries that can also be enacted in other media or materials and at other scales, either before or after their life in the computer. Critical of "translation" for its residual neo-

Platonism – ideas first, materializations second – Spuybroek has developed a rigorously materialist practice in which there is continuity between design and fabrication. Continuity, as his book's title suggests, is his fundamental tactic for addressing the schism between form and tectonics, which continues to plague contemporary design. It is, moreover, a principle that permeates his entire ethos, oriented toward the activation of potential through what he calls vagueness.

One of the most powerful agents of continuity for Spuybroek is the paradigm of organization, for it underpins not only computing but all phenomena in nature – of life as well as matter, including human life, its societies and their material cultures. Spuybroek has never treated the computer as simply a tool but rather as a model of organization, and hence of mind and matter as well. He recasts construction as the ongoing process of change in organizations and seeks to learn from analogous organizations in different material regimes and at different scales. For his first projects, he turned to the geometry of splines – developed for designing and building ships – to achieve continuity between the construction of computer models and the steel frames of his pavilions. Later, he adapted Frei Otto's use of analogical models, which reiterate form-finding processes found in nature by hanging chains, wetting wool threads or making soap bubbles and later stretching fabrics or weaving lattices at the scale of buildings.

Leapfrogging backward over the 20th century, Spuybroek has more recently discovered a similar yet different form of continuity in Gottfried Semper's theory that architecture began with textile techniques that then came to "inhabit stone." He takes up the idea that material organizations can inhabit other materials to develop structures whose form and rigidity emerge by weaving together flexible strips of soft material. Spuybroek solves the problem of form with techniques that are not formal but rather material. He resolves the old opposition between structure and ornament by developing continuities of organization. For him, structures should

emerge through bottom-up processes rather than ones in which the results are determined in advance and then engineered for construction. Wary, however, of the naïve utopianism of the desire for pure presence, Spuybroek directs his experiments toward attaining ever greater control with which to achieve desired qualities and capacities, be they aesthetic or performative.

Problems of continuity across scales, the integration of parts and wholes, and variation and variability are all longstanding concerns of the discipline of architecture that have resurfaced among the digerati working with continuously varied and complex topologies. Here, too, Spuybroek swerves, this time away from the classical tradition, which has dominated these problems, even among the younger generation. To be as explicit about this as possible, he has embarked on an alternative history, mining the Gothic and its numerous anti-classical progeny, including the Picturesque and Art Nouveau. This history contains a rich body of expertise in curved lines – from Hogarth to Horta, from attached to loose – interwoven with structural analyses of bundled ribs, and passages from Ruskin and Worringer that seem remarkably contemporary.

Generations of avant-gardes have cut their teeth on another set of problems: the division between artifice and nature, technology and art, art and life. These are classic problems of modernity whose discontinuities were engendered by the process of modernization, with its translation of experience into new media and its reductive reifications and alienation, be it the alienation of labor, of audiences or even of designers. In response to these historical issues, Spuybroek employs another, conceptual kind of continuity: a habit of mind that favors bound dualities over binary oppositions. Through both/and rather than either/or thinking, he discovers new vitalities in the evolving machine and new immediacies in the body refigured by new technologies. But why should continuity in architecture be so important today in the multiple ways that Spuybroek suggests? Almost twenty years ago, Deleuze observed that the forces of information technology had

combined with those of genetics and biotechnology to restructure knowledge and social relations, displacing the paradigm of power through division, compartmentalization and discipline that had characterized modernity in favor of one apparently more open, but governed through control and modulation. Spuybroek – now a citizen of this society of control – rehearses in the field of architecture techniques that enact a "certain openness of mind." He produces continuities and vagueness to engender moments of play within the networks of continuous control that govern life today. As an architect, he cultivates control over generative processes so that their results may in turn open new horizons of experience and action.

Continuity is at issue as well in the interaction between people and buildings, for Spuybroek considers the body too as a kind of wet computer, continually practicing, coping and adapting within a continuum of uncertainty. Critical of the modernist open plan as too passive in its neutrality, he pursues an architecture of vagueness imbued with active potential, indeterminate yet charged with tendencies toward determination. He cites Varela, who understands cognition as a form of embodied action in which body and world are structurally coupled and interactively transform each other. If reality is the effect produced by synchronizing the rhythms of our bodies with those of the world, Spuybroek suggests that buildings could embody greater potential for action, not in a rigid functionalism, but to afford opportunities for exercising the capacities of the body through which we experience freedom.

In this context, the shift from classical to Gothic assumes another significance. Where the classical object closes in on itself – holds itself tightly together – the Gothic, Picturesque and Art Nouveau are extensive, barely objects at all but rather loose assemblies whose limits are unclear. Where self-sameness is the goal of classical form, the serpentine line is continually self-estranging, becoming other. For Henri van de Velde, the line is a force, possessing life and animating the perceptions of observers. Similarly,

for Spuybroek, the inherently empathetic nature of materiality is the basis for a politics of the object, enacted through the material logics of architecture, which are understood as continuous with those of the world. It is the "burning surfaces" of space, he concludes, that "make us catch fire. That is true continuity."

Experience, Tectonics and Continuity

Introduction

The Twilight of the Gods

Whatever happened to architecture? Any observation of the current goings-on in architecture, even for the shortest of moments, by the shallowest of minds, the critic most disoriented, cannot result in anything but the acknowledgment that architecture is in the most confused state it has been in decades. Architecture is in its slumber phase: there are no thoughts, no styles, no debates, no stakes, nothing but vast global success. We live in a global era of cuteness. We have cute architecture, cute critics, cute magazines, cute books. Cute colors, cute forms, cute materials. We seem to have arrived at the same point where we were almost 200 years ago, when we had to figure out what style to build in[1], not because we didn't have a style but because we had too many of them. It was Gothic on Monday morning, classical on Tuesday, and Wednesday was reserved for the rural picturesque. Thursday there might be an eclectic experiment, and Fridays ended in desperation. Most contemporary architects probably experience all this in a single day. To bypass such unnerving situations, the average large office today, similarly to large fashion houses like Prada and DKNY, has a principal flying all over the world with projects by the directors (all between 25 and 30 years old) that precisely cover this five-day range. There's one director for minimalism, one for high-tech, one for traditionalism, one for formalist streamlining, one for desperation (which they call the R&D department). And even this view is probably too rosy, because such a setup would still allow for some kind of positive tension, for a potentially fertile neurosis. The truth, of course, is that we have analyzed all the tension away, negotiated all the different positions: we can mix in enough traditionalism with high-tech to make it a railway station in a historic city center, or mix in enough streamlining with high-tech to make it an airport, or mix in enough minimalism to put it in Germany, add in enough signature to make it a museum, or enough desperation to take it to China. And all the critics give it the nod.

So what has actually happened to architecture?

I think the best way of understanding our current position

is through aesthetics, since it covers all aspects of architecture – not just how we make it or how we design it, but also how we get others to agree with it and to discuss it. Aesthetics is the widest scope one can take for looking at design. What is an aesthetic experience today? It is not the revelation of the century to say that there has been a major shift in the platform for aesthetic appreciation – the magazine – which has moved from being mainly language-based to being fully image-based. We are in the final stages of what I call the "Kantian trap": aesthetic experience leading to a cognitive moment of critical judgment. Now, Kant has been accused of many things, and often unjustly so, but with him aesthetic experience did give way to critical judgment and taste – the intermission when everybody gets up to discuss the play became as important as the play itself, and this led directly to reviews. This moment of critique led inevitably, fatally, to an architecture of criticality, where architecture in its turn discusses its own reviews, and all design features become illustrations for a previous or later debate. At this point, architecture considers everything as language – its history, its ordering system, its aesthetics – and all there is left to do is analyze it, comment on it and deconstruct it. Every fading architectural movement is one of language: whether from the 2nd century, the 16th or the 20th, everything ends in rhetorical mannerism. It always ends in language. And where has this architecture of criticality led us? Straight into "visual culture." There are still critics – and architects – who believe criticality resists visual culture, but in fact it precedes it and is incorporated by it. What exactly does it mean to be, as Koolhaas proposes, critical to ¥€$? Is that NO ¥€$ or YES ¥€$? Either one will do; it doesn't matter. In semiotics there can be nothing outside the global empire of signs themselves, whatever their content: signs function on their own, thanks to or in spite of their content. Who cares about content? Certainly not the signs that are supposed to embody it. And now, to return to our main question: what constitutes an aesthetic experience in the realm of semiotics? An unraveling of the subtext, a decoding of messages and a reclaiming of them? That is not an experience; that is read-

ing, interpretation, judgment. It all turned out the wrong way around: Kant's judgment was supposed to come at the end, and now it comes beforehand. But we are already far beyond interpretation or decoding, and all we can offer things today is the briefest glance, the faintest smile – the flimsiest acknowledgment of a sign's existence. We look at signs as they look at each other. And today the glossy magazines' editorial pages have moved onto ubiquitous designer websites, and the magazines have become even more visual, like websites on paper. A deader dead end can hardly be imagined – and architecture blindly follows.

Architecture and the Lamp of Life

This book, written over the course of many years, argues for exactly the opposite; not wholly unexpectedly. It proposes a radically materialist view, but one so radical that it becomes strange, indeterminate and even vitalist. It is not so much a scientific vitalism (which would not be very scientific) but one that is committed to the aesthetic, where the perception of matter resonates with matter itself, where the sensed, the seen and the structured share the same continuum. Such a materialist view means nothing more or less than that when looking at the body, *experience counts as the main form of involvement*, and when looking at architecture, *tectonics counts as the main form of articulation*. In this view, life pervades everything – experiencing bodies and structured matter, the organic and the inorganic – a view that is particularly convenient when theorizing about architecture, since it exists at the crossroads of both. Of course it requires quite some imagination to view not only people and trees but also cracked mud, foam and clouds – let alone buildings – as alive, and one shouldn't really, unless one defines life not so much as breathing and reproducing forms of matter but more fundamentally as "sensitive" and "irritable" matter, as Diderot and his contemporaries did[2]. In the early stages of the 18th century, when science was slowly moving away from Descartes' mechanistic physics toward, for instance, a chemistry dealing with the problem of fermentation and a biology deal-

ing with the problem of regeneration, early Enlightenment philosophers began to view matter as something active rather than passive, as substance with intrinsic movement, rather than movement being external to matter. In their view, one could no longer draw a clear line between matter and life. And we can't, we shouldn't, and that is as far back as we have to go to tackle the problem of contemporary aesthetics and architecture. From that point on, we have to create our own new path through history, rethinking aesthetic experience, rethinking tectonics, to finally come out on the other side of the problem.

We must simply rethink the whole process of aesthetic experience and how it relates to an architecture generated from active matter. In the second half of this book, I make many references to previous moments involving a vitalist aesthetics. One is the rise of the Picturesque movement, which emphatically positioned itself between beauty and the sublime and led up to people like John Ruskin, who so heroically stated that architecture had reached its definitive low point in the Renaissance[3], when structure and ornament became forever separated. His best chapter in *The Stones of Venice*, "The Nature of Gothic," and that in *The Seven Lamps of Architecture*, "The Lamp of Life," are quoted here over and over. Moving away from universalist classicism, Ruskin tried to advocate an architecture of life, which was by necessity Gothic because of its "changefulness and savageness"[4]. Another such moment came with Wilhelm Worringer, the German art historian who startled the art community with his thesis *Abstraction and Empathy*, and even more with *Form in Gothic* three years later, which advocated an expressionist reading of the Gothic, in which geometry itself came alive. Worringer was one of the first to map a way out of the dilemma between structure (abstraction) and empathy (ornament), which is still one of the deepest rifts in architecture, in the form of high-tech Polytechnique vs. sculpturist Beaux-Arts (see the chapter entitled "Steel and Freedom"). What I have found completely liberating is to be deeply involved with historical figures like these without at any point feeling the need to become historicist. It has to do not with history being a

supplier of architectural form but simply with tracking down kindred thought. For Coleridge, Ruskin and Hogarth, taking life as an aesthetic subject was occasion to become not speculative but accurate. I find there to be no comparison in rating them against our contemporaries, or against what we have come to know, in our 20th-century idiom, as the avant-garde, which is simply a military view of mediated taste. In tracing this historical path of life in forms, it is evident that, as I have stated above, "life" must split itself into two modalities, one concerning human corporeality and experience and the other the materiality of structures and forms. These two materialities again meet and interact in life itself, which of course raises the main question of how they affect each other and how such mutual influence reunites them.

Roughly stated, half the essays and conversations reason from experience to structure (these include "Motor Geometry" and "Sensograms at Work"), and the other half from structure to experience ("Steel and Freedom," "Machining Architecture").

Sensation, Perception, Action and Construction

The aesthetic experience we pursue is of a radically different nature from critical judgment, in Kant's time as well as our own. Now, before elaborating the aesthetics, we must focus on experience itself. According to John Dewey[5], who built an important segment of his philosophy on the notion of experience, like his contemporary William James, nothing can be more noncognitive and nonlinguistic. Experience, for Dewey, starts with pure sensation or feeling and leads more to a knowing-how – a bodily, skillful form of reflection, a motor memory – than to a knowing-what, i.e. knowledge or judgment. But all theories of experience seem to work directly as aesthetic theories, since corporeality involves an agency of the senses. The fact that our lives seem to revolve around aesthetics more than ethics is discussed at length in this volume in my conversation with Arjen Mulder, entitled "The Lives

That Are Hidden." This means we are immediately outside the reach of Kant's critique, since experience beginning with sensation directly leads to a very specific relationship between perception and action, in which one is embedded in the other. It forms one of the central arguments in this book: that there is no action without perception, and no perception without action (see, for example, "The Primacy of Experience"). Perception is not something that happens to us, or in us, but something we do, as Alva Noë[6], the latest exponent of such thinking in cognitive philosophy, says. This way of looking at experience, as an inherently aesthetic modality of human nature, then inescapably points in a direction where seen and sensed forms constitute activities. In the book's development of these ideas, many scholars and aestheticians are discussed, such as Susanne Langer, with her concept of living form; one of the earliest is William Hogarth, who as far as I know was the first person to use the word "picturesque"[7]. In "The Aesthetics of Variation," I discuss his concept of the serpentine line – the line of variation – as applied in the hairstyles of his day as well in his paintings and drawings. Hogarth found a path between the world of beauty, a world of ideal static forms, and that of the sublime, one of only forces and dynamics. He found a way to deal with forces before they become forms, as neither pure forces any longer nor forms just yet. In modern terms, he dealt with process, but without serving up pure force, as in action painting. He wanted his art to "work" and developed his aesthetics accordingly. Here, we can already discern a parallelism between perception on the one hand and the perceived object on the other. What makes one work also makes the other work. The making of an artwork somehow runs parallel with the seeing of that artwork. This is something that doesn't happen with the sublime or with beauty, or in 20th-century terms, with either abstraction or realism. The fact of the matter is that both perception and object are *constructed* during a process, which is of course the final pillar under the all-encompassing concept of life's materiality: next to sensation, action and perception, we find construction as the final dimension of experience. This specifies our aforementioned vitalism as a kind of con-

structivism. Life constructs. Agency builds. There is no other way of understanding our sense impressions than as constructs, as blocks or rhythms, or as assemblies. So, when a theory of experience evokes an aesthetic theory, and that theory can accordingly be applied to any work of art or built structure, they automatically start to short-circuit and loop. Life is shared. This aesthetic of agency is theorized at several points in the book as *sensuous*, a concept which comes very close to Worringer's concept of empathy. Sensuousness is not about the pure collecting of atomic sense data, but nor is it judgmental contemplation. It is *corporeal reflection*, so to speak, a resonating of the body, with a wide range of actions implied. It is a shift from emotion to feeling and from lived experience to life experience. Empathy is generally explained as a "feeling into,"[8] involving not so much a sharing of the same feeling between a person and an object (which would be close to animism), but a much more general and impersonal sharing of life itself.

Earthwork, Wooden Frame, Textile Wall and Fireplace

As stated before, a materialist theory of perception and sensation must run parallel with a materialist theory of architecture. On first thought, one would expect that such a theory would simply lead us to engineering, more of a theory *without* architecture. But of course, a theorized materiality doesn't need to be applied to building as such but more to the organization of the built – and organization means architecture, not building. This is why Gottfried Semper's tectonic theory of the four elements[9] (earth, wood, textile, fire) is not a concept of architectural elements, of components that need to be jointed, though it is often understood as such. His four elements are much more states of aggregation, of density or rigidity, than actual building materials. Semper was well aware that architecture, in his time at least, was monolithic. He argued that the four elements didn't inform building so much as

architecture, which was made of stone anyway. Tectonics consists of a materiality that informs the organization of things as much as their physical structure. Many scholars have struggled with this, but Semper's theory explicitly steers between what he called mere engineering and speculative aesthetics, the latter of which would mean to simply cast ideas in stone. He refuted both blind materialism and blind idealism; or, in terms of architecture schools, he refuted the Polytechnique as much as he did the Beaux-Arts. Tectonics is exactly that: an aesthetic, not poetic[10], use of structure, and in our terms this means a structure that is made sensuous. I have always paralleled Semper's four elements to the four experiential dimensions discussed above. The earthwork is the first surface; it creates the plan. The plan is the surface of action. The wooden frame is the structure, the realm of construction. The textile *Bekleidung* creates the wall, the surface of perception. The hearth, the fire, constitutes the realm of sensation. But, as with experience, these four categories cannot be simply added up; rather, they multiply, intertwine and bring forth each other. This is why in chapters like "The Structure of Vagueness" and "Machining Architecture" I have tried to rethink Semper's materialism in a more processual, active form. I was happy to find this in the original and long-ranging research of Frei Otto, who, however close to engineering (and therefore to the frame part of Semper's categorization), developed ways for active matter to "find form"[11], as he so strikingly puts it. Frei Otto, following Gaudí in this sense, created material, empirical computers to generate architectural forms, in what is known as analog computing. In the conversation with Ludovica Tramontin in this book, entitled "Textile Tectonics," I call this the "Semperian reversal": the reversal of the *order* of the four elements. Instead of starting with earth and a wooden frame to support the weaker textile fibers, I reason the other way around: weak threads move, find each other, and lock into each other, building structure and rigidity. So instead of adding the soft to the rigid, as Semper did, we see *a transformation of soft into rigid*. This is nothing more or less than the application of the concepts of constructivism to archi-

tecture, meaning that the mobility of agency is transferred into structure. While form is being generated, it necessarily becomes structured, because if it didn't, it wouldn't hold. It is all (a process of) constructivism.

When we look at this twin materialism, of the body's corporeality on the one hand and the building's tectonics on the other, we see a theory of architectural form emerge that can safely concentrate on the object of the building itself, since the other part deals with experience, which involves as much routine and habit as "program" normally would. Program and form are still complementary; they are extensities, with one filling the space left by the other. Experience and tectonics are congruent; they are intensities, both filling the same space (that's why their relation is sensuous and why there is so much empathy between them). So there is no need to go back to Vitruvius. If we consider architectural form, we immediately note the three scales of design: not *utilitas, firmitas and venustas* but *massing, structure and texture*, the three physical scales of architecture. A reworking of Semper's four elements into three scales would suffice to have life live in its full complexity both as the realm of action and as the realm of sensation and perception. Tectonics works in all directions, horizontally as much as vertically, and across all scales, on that of massing as much as that of texture. It creates a continuity we haven't enjoyed in architecture since Alberti broke it up into separate realms. Since his theory of architecture, structure has been equated with abstract, mechanical geometry, and ornament with organic beauty. And because geometry lacks empathy, it needed to be corrected with ornament that operated on the smallest scale (that of texture), while massing was governed by proportion, harmony and what he called *concinnitas*, the way a building is organically put together[12]. So architectural aesthetics is evidently an aesthetics of the whole and the parts, like any other aesthetics. But for Alberti, the parts are totally subordinated to the power of a preexisting whole, to purposiveness, not all that differently from Kant's sense impressions being subordinated to an apriority of concepts. In our world it all works immanently; the parts "find" a

whole; it doesn't preexist. We see, we apprehend, the parts through sensation and construct the whole, which corresponds with massing, which is in the realm of tectonics understood as configurational, rhythmic and patterned (see "The Architecture of Continuity" and "The Aesthetics of Variation") – and such description fits human experience as much as architectural form.

With Worringer, we see a radical shift when he theorizes the Gothic as healing that separation of structure and ornament, or in his words, abstraction and empathy – or, in Kant's words, the mechanical and the organic. The Gothic merges both positions; it is what Worringer calls "vitalized geometry"[13]. It doesn't have to decorate the structure with organic elements, since movement and life itself have become part of the structure. The Gothic is nonorganic; it is repetitive and not symmetrical, restless and not balanced. It is *the structure that has itself become sensuous and the ornament that has become material*. We see a continuity of scales, of dimensions, occurring in the Gothic. To clarify this notion, I discuss some of the ideas of the famous metallurgist Cyril Stanley Smith in the last conversation in this book, "Steel and Freedom." For Smith, who distinguished between three scales of material aggregation – "Structure, Substructure, Superstructure," corresponding with our order of structure, texture and massing – looking at aluminum alloys wasn't so different from looking at paintings. He was particularly interested in the mixture of regularity and irregularity in metal structures. He saw not a lattice of atoms that simply added up into a block of metal but lattices organized by aggregates. When a metal structure grows by itself, it does so not by addition but by aggregation: it breaks into singularities ("dislocations"[14], what I call transformations throughout the book) that make the structure expressive and empathetic in itself. The scales of structure generate one another from continuity, like the Gothic column that moves up from the floor as a bundle of ribs, subsequently disentangles into a fan-shaped top and reentangles into a reticulated vault where all four column-fans start to interweave. Continuously varying states of aggregation operate on singularities ("column," "fan," "vault"). So singularities

aren't elements (which always exist beforehand), but emerge from relations, from continuity. Going from line to surface necessitates a transformation, a shift, but without breaking continuity. Continuity in architecture does *not* mean organically smoothed-out forms but an architecture of singularities – sudden changes in a system that organizes the previous state by a matter of shifting scale, like column-line to vault-surface. In short, tectonics is not the subordination of all articulation to structure; an architecture of continuity is one of tectonic articulation where empathy (on the smallest scale) and massing (on the largest scale) are *implied in structure*, but only a structure that transforms on its own to cross scales.

Finality, Ambiguity, Continuity and Generality

Here we have arrived at the final argument: that of continuity. All the aforementioned constructivism, all the sensuousness, all the material agency spring from only one thing: sharing, or better, continuity. When Charles Sanders Peirce wrote *The Logic of Continuity*, he was convinced it would create a revolutionary change in mathematics and logic (and it did, but much later than he had hoped). Peirce is present in many discussions and arguments in these essays, especially the one that deals more directly with his ideas, "The Structure of Vagueness." Philosophically speaking, Peirce's concept of continuity is not too different from Deleuze's plane of immanence (the plane of life, of undivided consistency) or Spinoza's monist substance: all germinates from one. Or, as Peirce says, "all things so swim in continua"[15]. Continuity is part of real things, and therefore things are necessarily vague, since they are one and many at the same time. If you look at a bird, for example, obviously it is a finalized form with clear contours, but that doesn't help you to understand what a bird is; you have to see it fly first, which makes it less clear, and then you can only understand its flight when you take the air into account,

which makes it completely vague. So vagueness is not a lack of logic (though it is a lack of determinacy); on the contrary, the logic of vagueness is exactly what constitutes relations. All logic concerns relationality, that which we generally indicate by "rules" or "rule-based systems" (see "Machining Architecture"). When that same bird flies into the forest to pick up a twig to build its nest, everything that makes the twig a component is in such a relational logic itself. If there can be no continuity between elements, there can be no material agency for forms to find themselves; if there can be no continuity of natural forms, there can be no evolution; if there can be no continuity of tectonics, there can be no jumping of dimensions; if there can be no continuity of empathy, there can be no aesthetics. And this is particularly important to architects, since we tend to think in an elementarist way.

Elements are the simplest state of being; they are defined by an internal code, an identity or purpose, that which makes a screw a screw and a column a column. This form of determinism is generally denoted as finalism; each object is a finality. A column is a finality, as is a beam, or a room. Most architecture we know of operates on this level: classicism and most of modernism work with predefined elements.

When on one side of the formal spectrum we have the abovementioned determinism, then logically on the opposite side we should have an indeterminism – what is called generality. In architecture, we know this from architects like Mies van der Rohe, who mostly tries to generalize differences into a single state of being, a neutral average. A space frame is another generality architects are familiar with, since all the members are abstracted into the same state. All minimalists strive for such a form of generality, to reduce all form back into a single form.

Now that we have defined the two extremes of our formal modalities as finality and generality, we can more clearly see the two in between: ambiguity and continuity. Ambiguity is a dual state of being, like two determined states overlapping or working simultaneously. In the conversation entitled "The Aesthetics of

Variation," I name Robert Venturi as the strongest advocate of this form of architecture, but I also think of Pirro Ligorio, who bent a façade into a ceiling (Mannerism offers dozens of examples). A gallery in any typical baroque palace also counts as an ambiguity, being a corridor and a room at the same time. And I remember a wall by Adolf Loos, just behind the entrance of Haus Müller, in which there is an opening so large that it can be interpreted as either two columns or a wall with an opening in it.

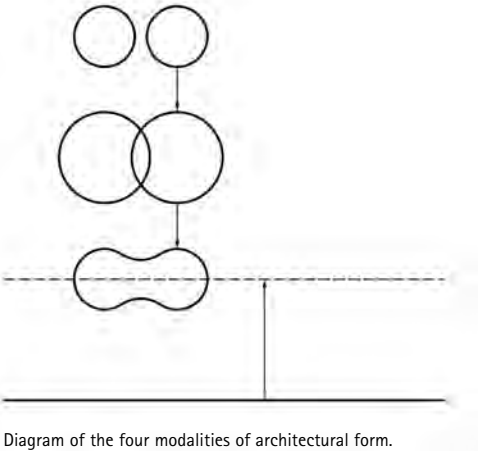


Diagram of the four modalities of architectural form.

Finally, after finality and ambiguity, we have continuity as the last mode of existence before generality. Continuity includes both sides: singularities, i.e. discrete states, and fully merged and generalized states. In continuity, all is materialized, the objects as much as the relations between them. So it tends toward generality, but things can still articulate and express themselves, on the condition that they never leave the continuity. I hold finality and ambiguity to be typical linguistic states (and therefore defunct), while continuity in all its characteristics is material. Generality I hold to be the most abstract, mathematical state of being, which

is unstructured and therefore a misconception of continuity, like the statement that when all is one, all is the same. Unity is not uniformity. Materializing the generic without differentiation is simply a misunderstanding of continuity. In the Gothic, which is the architecture of continuity *per se*, all elements are in a constant state of transition, column becoming vault, vault becoming window, window tracery becoming wall, and on and on: all movement is passed on, without ever dissipating. The relations have become external; it is the relations that create the whole, not the parts.

Concluding that buildings are made up of parts, of elements, doesn't mean that architecture should be based on elementarism; on the contrary, an architecture of continuity fuses the hard with the soft, tectonics with textile, abstraction with empathy, and matter with expressivity.

Technologies and Techniques

If we broaden the definition of technology for a moment and state that it consists of a constant handling and processing of matter, than we can apply this definition to both the materialities – the body's and the building's – that we had so carefully differentiated before into a realm of experience and one of tectonics. If there is a life of forms, technology is certainly its accelerator. Matter already moves of its own accord, but technology speeds it up. There is in technology always a great force of convergence at work, a channeling of potentials, which then diverge into millions of objects. A simple ruler seems to specify only the narrowest and simplest set of forms, but how large that set is! It is the same with a keyboard, a knife or a hammer. Of course, my own roots lie in technology, as the earlier writings in the first half of this book clearly show. On the other hand, an essay like "The Motorization of Reality," which short-circuits matter and mind completely via the technological, I could have written yesterday. "All concepts are motor-concepts," I write in that essay, meaning not only that all thought is action, a view Dewey would have subscribed to, but that the continuous production of the real is inherently and

immanently "motorized," and as much a product of time as of technologies. Machines and technology pervade the book, from human experience ("Motor Geometry") to design methodology ("Machining Architecture") and fabrication techniques ("Steel and Freedom"). Technologies have a tendency to become techniques; since their realm of existence is that of operationality and work, they can potentially work upon any object. Their specificity tends to become generalized. Computers are a final step in this abstraction of work. They can work on anything. Therefore, it must be stated explicitly at this point that the realm of the sensuous, of empathy, can be revived in architecture only because we are shifting more and more from (a) manual design techniques to process-driven computing techniques and (b) manual labor to computer-aided manufacturing. Let's recall for a moment that all the examples derived from Ruskin, Hogarth and Worringer concern handcrafted elaboration, often of a pre-industrial, and sometimes even an anti-industrial, nature. If we take Semper's notion of art as more praxis than poesis, of an art emerging from weaving and from craftsmanlike precision and delicacy, as a proposal for our times, it can only be supported by a decisive shift in craft itself. When we propose that ornament become structural (and structure become sensuous), this must be supported by (a) the industrial capacity to actually provide such complexity of variation and (b) the transference of the typical intricacy of handicraft to design and computer modeling. Craftsmanship becomes digital skill; the proposed shift concerns a technological upscaling as much as a material one. Now, this in no way means the materiality of craft is replaced by a digital immateriality (whatever that may be), that craft is transferred completely to the design studio and our designs are cut, milled and coated by five-axis robots that never sleep or strike. On the contrary, as we move from *preformed products to informed half-products*, this will necessarily mean architects will have to spend more time in factories rather than less, conduct more experiments and make more prototypes. When architects suddenly stop having to choose from a catalog, it means they need much more knowhow, or what Polyani calls

"tacit knowledge"[16], a form of implicit knowledge that involves direct experience of how things are made and done.

It also means architects need a much higher level of education in order to master digital tools, which started with simple CAD applications in the 1980s and moved on to the high-end modeling software of the 1990s and then to the generative component systems we use now. It is obvious today that educating architects to use these at a skillful level is not as simple as we thought it would be 10 years ago; the software programs of the airplane and automobile industries are far above the level of our typical CAD systems, especially since they involve fabrication, its processes and its economy. It is also clear by now that mastering the tools is a job for the architects themselves and not their draftsmen. And we should also keep in mind that these tools can only be taught when conceptualized within architecture itself, i.e., as design techniques and not as technologies, first of all because the programs are far too wide-ranging to teach in a course (a typical 3D modeling package comes with a manual of a few thousand pages), and second because functions like "copy," "paste," "lathe," "loft," "blend" and "smooth" are by no means innocent, either for architectural theory and methodology or for fabrication. In general, architecture resists such a complete immersion in technology, as the Beaux-Arts was by default opposed to the Polytechnique, but it is evident that digital technologies are of a far more abstract nature than pure engineering. I think the necessary reunion of the Beaux-Arts and the Polytechnique is a question not only of closing the gap between structure and empathy but also that between technology and methodology.

Conclusion

What will happen to architecture? Some who have written off digital architecture have probably mistaken it for yet another style in the ever-widening estuary of multiplying and branching languages we were so used to in postwar western architecture. Meanwhile, digital architecture has been getting an education; it

has slowly learned to "architecturalize" its tools[17], but it has also refused to associate itself with (or as) a group, indicating its wider scope and deeper significance. The digital turn has proved a much larger one than we thought at first, mainly because it involves a much deeper, more encompassing change at all levels of architecture: its experience, its methodologies, its history, its structure, its fabrication process, its aesthetics, its clients, its critics, its teachers, everything. I don't think singling out one or two components allows us to sufficiently grasp its complexity. Nor do I think we do it justice by applying it only to form, or structure, or decoration. We should resist easy solutions and refuse to take shortcuts. I think digitization is as inevitable as the Renaissance was after the tools of perspective, as modernism was after movies and trains, as postmodernism was after cars and television – but we must theorize digitization at the most fundamental levels of architecture, at the levels where we can start to repair the rift between the materiality of tectonic structure and the sensuousness of human experience.

Rotterdam/Atlanta, June 2008

1. Heinrich Hübsch, "Im welchem Style sollen wir bauen?" (1828).
2. Denis Diderot. *Rameau's Nephew and D'Alembert's Dream* (Penguin, 1976) and *Principes philosophiques sur la matière et le mouvement* (1770). The principle of irritability was already earlier conceptualized by Albrecht von Haller and the concept of movement being inherent to matter by John Toland in his *Letters to Serena* (1704).
3. John Ruskin. *The Stones of Venice* (Pallas, 2005): 207. On the topic of the Renaissance: "its main mistake [...] was the unwholesome demand of perfection."
4. Ibid. Book Two, Chapter IV, "The Nature of Gothic": 142. Separately edited by William Morris as *The Nature of Gothic* (republished with Garland, 1977).
5. John Dewey. *Art and Experience*. (Perigee, 2005): 21–3. And also: William James. *Essays in Radical Empiricism*, especially chapters II and VI (University of Nebraska Press, 1996).
6. Alva Noë. *Action in Perception*. (MIT Press, 2004): 1
7. William Hogarth. *The Analysis of Beauty*. (Yale University Press, 1997): 50. More than forty years later, in 1796, Uvedale Price published his *On the Picturesque* (Woodstock, 2000), defining it explicitly as "a station between beauty and sublime."
8. For a thorough discussion of the concept of *Einfühlung*, see H. Mallgrave and E. Ikonomou, eds. *Empathy, Form, and Space: Problems in German Aesthetics 1873–1893* (Getty Center, 2003). Worringer's use of the notion of empathy ends a 35-year history that started with Robert Vischer and was carried forward by Heinrich Wölfflin. *Einfühlung* (with variations like *Zufühlung* and *Ausfühlung*) was a directly sensed con-

nection of the body to built form, as experienced in dreams where, for instance, a headache is visualized as ants crawling over the ceiling of a room. This later became known as Symbolism, which we understand today as linguistic and archetypical, but in the late 19th century the connection was expressly nonlinguistic.

9. Gottfried Semper. *Die Vier Elemente der Baukunst* (Braunschweig, 1851). Later translated by Harry Mallgrave as *The Four Elements of Architecture* (Cambridge, 1989).
10. This refers to Kenneth Frampton's *Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture* (MIT Press, 1995). In the last chapter of this volume, "Steel and Freedom," I praise Frampton for his strong and ongoing defense of tectonics, but on the other hand move away from his position because it is fully based on structure as creating a (Heideggerian) place in the world, with empathy and sensuousness subordinated to metaphysics or poesis. To again make the praxis of the sensuous a *language* to express something external to it does not conceive the relationship between experience and tectonics as existing of itself. To use tectonics to experience the world is something radically different from experiencing tectonics itself.
11. Frei Otto and Bodo Rasch. *Finding Form: Towards an Architecture of the Minimal.* (Menges, 1995).
12. For a thorough discussion of Alberti's organicism see: Caroline van Eck, *Organicism in Nineteenth-Century Architecture* (Architectura & Natura Press, 1994): 45–56. We must draw a clear line between such organicism (including the more naturalist versions by architects like Frank Lloyd Wright) and the approach we are proposing. Organicism does not use properties such as agency, complexity or mobility to produce architecture, it *mimics* life by either using "natural" proportions, "natural" variety or "natural" materials.
13. Wilhelm Worringer. *Form in Gothic* (Schocken, 1964): 41. As quoted on many occasions by Gilles Deleuze, for instance in: *Francis Bacon: The Logic of Sensation* (Continuum, 2004): 46 and 129.
14. Cyril Stanley Smith. "Structure, Substructure, Superstructure," in: *In Search of Structure*. (MIT 1981): 54–68. Also in: Gyorgy Kepes. *Structure in Art and Science* (Braziller, 1965): 29–41. Dislocations are not simple cracks in a coherent lattice of packed atoms. They are films or interfaces that allow metal to be ductile instead of brittle and deal with a variety of loads. In this view, a dislocation should not be understood as a disconnection but as a complex, sliding form of connectivity.
15. Charles S. Peirce. *Collected Papers of Charles Sanders Peirce, Volume 1, Principles of Philosophy* (Cambridge, 1932): 1.171
16. Michael Polyani. *The Tacit Dimension* (Anchor, 1967). Also of interest: Richard Sennet. *The Craftsman* (Yale University Press, 2008).
17. In the early years of digital architecture all such design (including my own) seemed to concentrate on hall-like, single-story buildings, often without any windows. A lot of digital design still favors dome-like ("blob") roofs or sculpturist massing. This will cause it to become increasingly trapped in the realm of exceptional typologies and inevitably die out. Only a process of persistent reevaluation will enable it to deal with windows (without puncturing them out), structure (without inserting columns afterwards), multistory systems (without filling in the section), entrances people can find (without adding an awning), façades that align with historical environments (without cutting the building off), public spaces that deal with the urban fabric (without subtracting them as antiforms), and all the other inherent architectural issues. Major progress has been made by shifting topological thinking from the world of *forms* to that of *systems*, and shifting along the way from animation to variation. Since systems are inherently articulated they can much more easily than forms absorb the layering of floors, the spacing of columns or windows, et cetera. Systems operate on variation, from lower-scale, gradual deformations to higher-scale transformations. My stance is that such a move can only be accom-

plished by a fully tectonic understanding of scale issues, in opposition to formal or programmatic approaches, which immediately wind up in an either/or position. While the formal and programmatic do not automatically result in structure and aesthetics, tectonics does lead to form and program. Again, the architecture of continuity is not one of smoothness but of articulation. For more thorough discussions of these topics, see the essays "The Structure of Vagueness" and "Machining Architecture" in addition to the conversations in the second half of this book.

Motor Geometry

"There's this thing, this ghost-foot," said one of Oliver Sacks' patients. "Sometimes it hurts like hell. This is worst at night, or with the prosthesis off, or when I'm not doing anything. It goes away when I strap the prosthesis on and walk. I still feel the leg then, vividly, but it's a good phantom, different – it animates the prosthesis, and allows me to walk."[1]

What is it that animates a mere mechanical extension? How is it that the body is so good at incorporating this lifeless component into its motor system that it recovers its former fluency and grace? The body does not seem to care if a leg is made of flesh or of wood, as long as it fits: that is to say, fits into the unconscious body model or body image created by all the different possible movements. This constitutes the body's unconscious self-perception, or proprioception, as neurologists term it. Our legs are a "comfortable fit" by their very nature, but only because a leg coincides exactly with the ghostly image invoked by the automatism of walking.

Once a leg is frozen in immobility, however, it quickly ceases to "fit." Sacks reports one such instance: "When, after a few weeks, the leg was freed from its prison of plaster, it had lost the power to make all kinds of movements that were formerly automatic and which now had to be learned all over again. She felt that her comprehension of these movements had gone. (...) If you stop making complex movements, if *you don't practice them internally*, they will be forgotten within a few weeks and become impossible."[2] With practice and training, the movement of the prosthesis can become second nature, regardless of whether it is made of flesh, wood, or – a little more complex – metal, like a car. This is the secret of the animation principle: the body's inner phantom has an irrepressible tendency to expand, to integrate every sufficiently responsive prosthesis into its motor system, its repertoire of movements, and make it run smoothly. This is why a car is not an instrument or piece of equipment that you simply sit in but *something you merge with*. Anyone who does a lot of driving knows the dreamlike sensation of gliding along the highway or through traffic, barely conscious of what one is doing. This does

not mean that our cars turn us into soulless robots but that the human body is capable of inspiriting the car and making its chassis the driver's skin. And this must be so: otherwise we would bump into everything. If one did not merge with the car, change one's body into a 12-by-5-foot thing, it would be impossible to park, turn a corner or pass another vehicle. Movement can be fluent only if the skin extends as far as possible over the prosthesis and into the surrounding space, so that every action takes place within the interior of the body, which no longer acts consciously but relies completely on "feeling."

The Haptic

Such a method of feeling is usually categorized not as tactile but as haptic: it is touch in a more abstract, nonliteral sense. The distinction is similar to the classic neurological one between *greifen* and *zeigen*. The haptic is closer to a *potential* of touch, an activated zone surrounding the body like a sphere of action, continuously scanning the immediate environment. This is different from tactility, which always indicates direct physical contact. In the late 1980s, the Dutch celebrity physician Ted Troost, who aptly titled himself a "haptonomist," clearly illustrated this process using the case of an athlete: "... if he or she learns to make the equipment (such as a ball or bicycle) part of his feelings, he becomes one with that equipment. (...) The same applies to the opponent. Once you start seeing your opponent as a resistance, it takes an enormous amount of energy to beat him. If, on the other hand, you involve him in your feelings, you can suck him towards you as it were. You can then turn your opponent's strength to your own advantage and can move more lightly and easily. (...) If you take a touching, feeling attitude towards your equipment you become more sensitive and receptive towards your surroundings. You become softer and thus less tense at critical moments."[3] When this haptic sense of extension is taken seriously – which takes some effort – the result is that all action begins, and in a sense even takes place, in the interior of the body. And it will probably never leave the body's

sphere, either, since its relationships with objects are all felt and internalized. The body has no outer reference point to direct its actions to, no horizon to relate to nor any depth of vision to create a space for itself. It relates only to itself. In that sense there is not even an outside, no world in which one's actions take place. The body forms itself through action; through action, it constantly organizes and reorganizes itself motorically and cognitively to keep its shape. Humberto Maturana and Francisco Varela would call this "in-formation." According to them there is no structured information on the outside; of course, there is an exterior world, but it's a world of unspecified forces, which only become information by passing through the body, transforming it structurally while in action.[4] So this does not mean there is no outside (as in radical constructivism, for instance, in which the whole world is a persistent illusion); it simply means the world's relationship to the body is continuous, which is radical enough in itself.

Here is another telling quote, from McLuhan's successor Derrick de Kerckhove, concerning the acting body viewed as oriented to itself: "'Hey, we're lost!' Michael said to his [Indian – LS] guide. The guide gave him a withering glance and answered, 'We're not lost. The camp is lost!' In a flash, Michael realized a very important aspect of what separated his vision of the world from that of his guide: for Michael, space was fixed and had free agents moving around in it, like actors on a stage; it was a vast space in which you could lose your way. The guide, however, saw space as something within rather than outside the body, a fluid and changing medium in which one could never lose one's way, where the only fixed point in the universe consisted of himself, and in which, although he might be putting one foot in front of the other, he never actually moved."[5] This, of course, is a nomad's view of the world, the view of somebody on the move, because only in the prosthetic act of walking does the whole space become one's own skin. And the tent a nomad carries is part of that walking, and never interrupts space, as a house does. In this sense, every prosthesis has the nature of a vehicle, something that adds movement to the body, adds a new repertoire of actions to it. Of

course, the car, or the pair of ice skates belonging to the haptonomist's athlete-client, changes the skin into an interface, able to turn the outside into the interior of the body itself. The ice makes no sense at all to my body without skates: without changing my skin into metal, I could not be moved by the smoothness of the ice. Moreover, the openness of the world would make no sense if it were not absorbed by my body-car. The body simply creates a haptic field completely centered on itself, in which every outer event becomes related to this bodily network of virtual movements, becoming actualized in posture and action.

The Haptic and the Optic

"Where there is close vision, space is not visual, or rather the eye itself has a haptic, non-optical function: no line separates earth from sky, which are of the same substance, there is neither horizon nor background, nor perspective nor limit nor outline of form nor centre; there is no intermediary distance, or all distance is intermediary. Like Eskimo space." And: "The first aspect of the haptic smooth space of close vision is that its orientations, landmarks, and linkages are in continuous variation: it operates step by step. Examples are the desert, steppe, ice, and sea, local spaces of pure connection."[6] This means that the eye acts as if it were a hand, not as a receptive organ but as an active one, and what is at hand is always close, without any sense of depth or perspective and without background or horizon. Every action becomes prosthetic, because it extends the feeling reach of the skin, and conversely, every prosthesis (and that probably means every technological device) becomes potential action, a sort of vector object, a warp in the environmental geometry. In the haptic view, there is no distinction between body and environment, action and geometry, or inside and outside. Every change of muscle tone in the motor system has a topological effect, where the outside and the body are networked into one object with its own particular coherence, in which seeing, walking and acting are interconnected in a single, proprioceptively feeling system, with no top or bottom and

an all-around orientation. Instead of the orthogonality of the vertical, gravitational axis of the body's posture in relation to frontal, horizontal perception, there is a three-dimensionality in which images and actions relate to the same spherical geometry of the body.

Let us look at another very interesting example that brings this notion of haptic orientation closer to the actual design of spaces. In Tamás Waliczky's 1992 short film *The Garden*, made with video manipulation and computer animation, we see a little girl running around a garden, reaching out to catch a dragonfly, sitting down under a big tree, climbing the ladder of a slide and then sliding down. We see all this and, at the same time, nothing like it. In fact, during the seven minutes of the film, the little girl does not move at all – or, rather, she moves her hands and feet, but *her head never leaves the center of the screen*. We see the tree collapsing under her legs, the rungs of the ladder shrinking and bulging under her feet, the slide deforming under her body. Nothing moves, but everything changes shape. We see the dragonfly, as the girl's hand reaches for it, grow disproportionately large, then shrink and disappear the moment she shifts her attention. Clearly, in Waliczky's film, the girl is not moving around in a perspectival world where things lie between the eye and the horizon; rather, through her actions she stays in perfect balance, fixed on the vertical axis: she has become the vertiginous horizon of things, the vanishing point of the world. Things become part of her body by topological deformation, not perspectival distortion. She has become the gravitational center of a gradient field, a motor field, almost as if she were her own planet. This is not perception but proprioception: everything becomes immediately networked within the body, where the seen is also the touched and the felt, and no distinction can be made between the near and the far, between the hand of manipulation and the sphere of the global.

After contemplating these many examples from art and theory, we can start thinking about how to design a space itself. The sole mathematical depiction of sense-space by topological means (as

with Waliczky's malleable geometry, which deforms the environment) doesn't necessarily imply space needs to be actually designed with such tools – at least, not in all cases, or perhaps only in very special ones, in which feeling and experience become the sole content of the program. But if it were, what would it mean? First of all, typical architectural categories such as wall and floor, and floor and volume, would smoothly merge, since perspectival depth depends completely on their separation. What if the foreground and background were continuous? What if above and below were continuous? The eye certainly wouldn't be able to grab onto handles like contours or corners. Secondly, and maybe more ambitiously, there would be a smooth merging of action and form. It is in the nature of architecture to discipline, i.e., to select preexisting actions from an archive as habits and cast them in concrete. But what if action were continuously to feed into the form as a variable – and, vice versa, the form were to feed back into action as a variable? This would naturally be called interaction, because the origin of action would lie exactly between – inter – object and subject, and this "between" is where skin, environment and interface come together. In that case, it logically follows from the origin of action being *neurological* that there must be an *electronic* variability in the environment. We generally know this wiring of space as an "intelligent environment," but let us bear in mind that this form of intelligence (or "smartness") is primarily associated with comfort, fully in line with earlier inventions like the cushion and the escalator, for instance. In its contemporary, radical electronic version, comfort becomes wholly compliant to human needs and their real-time fulfillment, such as curtains closing themselves or lights switching themselves off. The question, though, is whether this is really intelligent. Strangely enough, comfort always seems to lead to its opposite: vehicular mobility creates obesity, home security creates fear, financial freedom creates total dependency. Such a smart *technology of desire* in intelligent environments can only result in the body becoming a remnant, in the most radical reversal between master and slave imaginable. Therefore, what we are contemplating here must be

another kind of technology, not so much one of satisfaction but one of stimulus: a *desire of technology* that seems a far greater and more destabilizing force, since our need for the accidental is far deeper than our need for comfort. Such a technology would be haptic, since it would open up the body to circumstances and situations and create a feeling reach of the body, while the technology of comfort is more tactile in nature, with everything brought under remote control.

To sum up, the architecture we are looking for at this point involves both the construction of a topological, smooth geometry and an electronic sphere that makes actions relate to images. This implies an architecture which tries to connect one act to another, putting a virus in the program itself, so that every object and every event can have unforeseen and unprogrammed effects. Nothing – no function, no object – can remain isolated; everything is involved in a continuous process of transformation; everything is necessarily opened up and leaking away. Such "liquid" architecture is not about nice, pleasing or sculptural forms; since form is action and action is form, there is always a certain risk involved. This includes the risk of form being swallowed up in the abyss of the formless, and without this risk, the act of architecture seems utterly pointless.

HtwoOexpo, the Water Pavilion

In the design of the so-called water pavilion[7], a building dedicated solely to experiencing the beauty and importance of water, we have carefully considered all the implications of the "motor geometry" concept developed above, not only with respect to the implied fluidity and interactivity but also to the corporeality, the intertwining of body, movement, perception and geometry.

Let us start by examining the formal, volumetric geometry of the building itself. It starts at the entrance with a small ellipse, with its long axis vertical, and ends some 200 feet further on with a larger ellipse on a perfectly horizontal axis. In this sense, the building is nothing more than the twisted extrusion or metamor-

phosis of a door into a complex tunnel or corridor. Over the length of the building, we have 14 instances of this geometrical figure, of which only the first and the last are undeformed. These 14 instances directly inform the steel structure that spans the width of the building. The software program we used for the design makes its ellipses – wrongly – out of circle segments, which accidentally enables a very precise process of topological, interrelated deformations. Every quarter of an ellipse in this program, symmetrical on both the x- and the y-axis, consists of four circle segments with successively increasing radii, and every segment connects to the next with the same tangent. Now the initially twisted tube is warped and stretched even more, to adapt it to the environment. Imagine the lines that connect all the midpoints of the circles being bent and twisted by outside forces, such as wind, dunes and water, as meanwhile, internal forces try to maintain the ellipses, that is, try to go smoothly from one circle segment to the other. The ellipses are stretched but not dented or cracked. So force and flexible coherence operate simultaneously. The basis of the geometry is the flexible relationship between the sets of circles, since after deformation the lines are no longer mathematical ellipses but still follow the rules of smooth tangency between the various circle segments. In short, topology precedes geometry. In this way, line and force become connected in that geometry; therefore, every twist and turn is an expression of force. The line is not separated from the point where the force attaches itself to the line, since every such vertex point is the base of a vector, capable of being displaced by outside forces and related to the other control points in the wireframe network. If the position or direction of one vector is changed, the others change with it, in accordance with their mutual dependency as defined by the circle grouping. This is the essence of a topological system. In this case, the line becomes an action itself, and not the trace of an action. We know this haptic sense of the line all too well from drawing by hand, since the line is generated by the complex biomechanics of wrist, elbow and shoulder. You don't trace the line via the eye (that's only a feedback control mechanism) – no, there is an

almost kinesthetic image of the line that feeds into the drawing. Now try to imagine dozens of arms drawing simultaneously but interdependently, because this is what computing is, arms in unison, with local, digital manipulations having immediate global effects spreading out over the whole system.

Though beginning a design with such topological logic might seem an innocent act, one must understand that it implicitly negates the floor as an *a priori* horizontal datum (and the wall as an *a priori* vertical elevation). Thus, not one part of the building is horizontal. And since the connection between wall and floor is now continuous, it also implies that the floor slopes and bends, and because of its variation, slopes do not stay within the same gradient. Conceptually, the building has not been not so much placed on the ground as dug out of it. Fundamental instability is achieved through the idea that the ground is all around. The floor becomes hyperdimensional: it *becomes* a volume by twisting and bending, instead of wall and floor surfaces *adding up* into a volume. When dealing with a haptic, three-dimensional body, a body without the conceptual distinction between feet and eyes (since feet sense and eyes touch), the difference between floor and wall becomes irrelevant. With this kind of topological perception, we lose the idea that action is on the ground and that our eyes are transported blindly and concerned only with the walls. Buildings are generally based on this dichotomy of motor and sensory, of transport and vision, where the programmatic is on the floor and the formal is in the elevation. But in this building, the information on the floor is blended with the deformation of the volume.

The water pavilion lacks even a window looking out, any horizon, any horizontality, a floor underlining the basis of perspective, any x-, y- or z-axis. Of course, this introduces the possibility of vertigo, because walking and falling become confused. On the other hand, such confusion is the basis of human movement. Or, as the 3ds MAX manual's chapter on animation has it: "Walking and running are special cases of falling." This imbalance is the very basis of this building, as it is the basis of every action, because no position is without a vector – not even the resting

position. This is why, instead of a window, there is a well that amounts to a huge diagonally placed hole in the middle of the building, visible from all directions. There is a formal relationship between the size, shape and position of the well and the overall deformation of the series of ellipses, which makes it one of the sources of the absence of pure horizontality or verticality. The well creates another kind of horizon, more like a window to the center of the earth – a hidden horizon, not horizontal but vertical, on the axis of vertigo, of falling.

A haptic body, one in which everything is networked to its motor system, is an open system, fluid, far from equilibrium, for which feedback loops can become either positive or negative. That is, through movement it can gain coherence, but it can also lose everything and fall. Three bodily systems contribute to the sense of balance: the eyes; the balance organs behind the ears; and proprioception, the body's self-perception, its own haptic sphere of possible muscular movements. This last is the basis of movement, because it creates a *gestalt*, a posture construct, out of its own actions: by moving, by correcting every small imbalance step by step, the body "gains form" and drags as much as it possibly can from the environment into its sphere (in essence, we are talking about something spherical, as in Waliczky's film). A haptic body is a closed organization and is constantly organizing itself.

Let me recall here an event that occurred just after the building had opened. About halfway through the building, an elderly man was standing still, away from the flow of visitors, carefully observing everything. Then suddenly, he ran up the slope – not the wider one where everybody was walking but another, much steeper one. I was surprised, because I hadn't designed that part for accessibility but for projections. But since this slope, though steeper, was as smoothly connected as the others to the main floor (which slopes and bends in every direction anyway), there was no reason he should have assumed that this surface wasn't also accessible. What happened? There must have been a communication between architecture and body that transcended function. The walls' smooth transformation into floors, obviously

an abstract movement, directly provokes real, bodily movement, not by prescribing it but by stimulating it. Instead of prescribing behavioral routines, as a stairway or ramp would, this variable landscape-floor *affords* a wider range of behaviors. It operates on a *lack* of definition, because there are no clear indications of where one element stops and another begins. And these actions are selected via a feeling relationship. It wasn't only that the man felt like it (that haptic sense is always present); it was more that the architecture was responding to his feelings. An architecture of functions doesn't care how a person feels; an architecture of affordances[8] does, since without feeling, the potential of an act presented by affordance would never make it to actuality.

Where, then, is the origin of action, the source of will? Here, the body is placed on a vector and can't resist reacting to that outer force. Yet the body is not being forced – a subtle but important distinction – it can change direction or goal at any time. The architecture charges the body because its geometry is one in which points become vectors. In an architecture that has become mobilized, where geometry has become a prosthetic vehicle, initiative lies exactly between body and environment. The situation is not subject versus object but an interactive blend. Part of the action lies in the object, and when the object is animated, the body is too.

Vectorization of the geometry occurs not only in the interactivity of the built form but just as much in the electronic augmentation of the environment. We built a very complex interactive installation into the pavilion, combining different electronic sound, light and projection systems to extend the concept of deformation into action. The continuous surface of the interior is covered with numerous sensing devices of three different types. Light sensors are activated whenever someone walks past them; touch sensors must be pushed with the hand or stepped on with the foot; and stick-shaped sensors must be pulled with two hands. Each group of sensors, in turn, operates on three levels of interaction. The first level consists of the topological deformation of projected wire-

frame grids, in real time. At every moment of visitor interaction with the sensors, invisible computers calculate a liquid, waterlike transformation in real time and project it in the space, in the form of longitudinal waves, circular ripples, and the stretching of a bloblike drop of water. Appropriately, the longitudinal waves are triggered by the light sensors, the ripples by touch, and the stretching of the blob by the pulling sensors. At the second level, these "special effects" change the overall lighting of the interior, in a larger-scale effect, since it occurs on a spinelike linear element that runs along the building's entire length from beginning to end. Hundreds of bulbs in a row create waves of blue light (by going on and off very quickly), which develop very complex patterns, since all the sensors are connected to the system. And finally, at the third level, there is sound interaction: all the sensor manipulations create various sound effects, like distortion and pitch and volume changes. The local, manual interactions are always simple, but they subsequently interfere with other effects on the larger scale to become more and more complex, depending on the number of visitors at that moment.

Naturally, every effect creates some kind of feedback with actions. Interaction doesn't only mean that a system responds to you; you, in turn, respond to its response, in a process that is nonlinear and difficult to predict. For instance, as you walk, you activate light sensors, one after the other, that cause waves to start moving through the projected mesh. Then, inevitably, you start to run with the waves, activating more sensors and creating more waves. Every group of sensors is covered with its own wireframe projection. For instance, when you step on a touch sensor, projected ripples suddenly shoot out from your feet, circular decaying waves in the wireframe mesh, as when a stone is dropped in water. When someone else activates another sensor at the same time, ripples shoot out from his or her feet too and interfere with yours halfway, behaving in exactly the same way as real water. And as both of you activate these local ripple effects, you also activate the lights running down the center of the ceiling.

One can hardly distinguish which element constitutes the

situation: is it the topological geometry with its lack of perspectival depth, or the electronic interaction with its unusual effects? Or the visitors and their excitement, or their number and age, or how they group and ungroup? Everything just seems to blend. How can we still distinguish the active, variable geometry of a built structure from the active, variable geometry projected in real time in that same environment? Or – perhaps a better question – why would we try? Surprisingly, interactivity is not the sole preserve of wired electronic systems. A complex, smooth topological surface can be as interactive, variable and transformable as any electronic system with its sensors and real-time responsiveness.

Why speak any longer of real and virtual, material and immaterial? Here, these categories are not in opposition, nor in some kind of metaphysical disagreement, but in a kind of electroliquid aggregation, reinforcing each other exponentially and constantly exposing their metastability in order to induce animation. The building is lit from the inside out, by the endogenous sun of the computer (that must be why the light is so blue), doing hundreds of thousands of real-time calculations, rendering all action visible.

1. Oliver Sacks. *The Man Who Mistook his Wife for a Hat* (Picador, 1986): 66.
2. Oliver Sacks. *A Leg To Stand On* (Picador, 1991): Afterword, note 2.
3. Ted Troost. *Het lichaam liegt nooit* (Centerbook, 1988): 168. Only in Dutch.
4. H. Maturana and F. Varela. *The Tree of Knowledge* (Shambala, 1984): Chapter 7.
5. Derrick de Kerckhove. *The Skin of Our Culture* (Somerville House Books, 1995): 29.
6. G. Deleuze and F. Guattari. *A Thousand Plateaus* (The Athlone Press, 1988): 382, 492 and 494.
7. The water pavilion (or HtwoOexpo) was commissioned at the end of 1993 by the Dutch Ministry of Water Management and Delta Expo, a public-private partnership. The commission was split into two parts, with the freshwater part going to my office, NOX, and the saltwater part to Kas Oosterhuis. HtwoOexpo opened to the public in May 1997.
8. The concept of affordances has been developed by J.J. Gibson in *The Ecological Approach to Visual Perception* (Lawrence Erlbaum, 1986): 127–43. An architecture of functions defines actions, while an architecture of affordance enables actions, which in general means a vaguer definition so as to afford a wider range of actions depending on who approaches the architecture and what mood that person is in. This vaguer definition is derived from landscapes, which are of course not designed for animal behavior (Gibson's book mainly discusses animal perception), though they are forms and surfaces that afford behaviors such as foraging, walking or nesting. A certain kind of terrain might afford different behavior to different animals.

Substance and Accident

In Conversation with Andreas Ruby

AR: A mechanistic system of thought like modernism could only deal with accidents by isolating and repressing them as undesirable occurrences interrupting the well-planned course of events. Paul Virilio, however, qualifies the accident as merely the other face of substance, following the Aristotelian distinction between substans and accidens. If you translate these two constituent elements of the accident into architectural terms, you get a remarkable equivalence: the built mass becomes almost literally the substance (from the Latin substans, that which stands from below), whereas people act as the accident (from the Latin accidens, that which falls into something). It is a very conventional definition, obviously, in which only the fixed counts as substantial, while everything that moves is disqualified as accidental. Could you imagine a definition of architecture that inverts this condition, an architecture in which stability is accidental and movement substantial?

LS: It's the old opposition of necessity and chance, which includes the belief that actual form can only be understood as chance breaking in on necessary, purposeful forms. The whole 20th century thrived on this opposition between the Mieses and the Cages, between the fully crystallized and the fully gaseous. One gets either a pure gridded order or a pure accidental chaos. Necessity doesn't explain anything, and chance doesn't explain anything either, especially because the two are thought of as mutually exclusive – it's either/or. We have two lines of thought and realize they should become interrelated. First, we should observe that in the postwar era our whole conception of form has been turned upside down. Physical form, biological form, the mathematics of form, how order emerges, how stability emerges – these have now all been structured in time; form has become part of time. Complexity in dynamic systems, self-organization, catastrophe theory: finally, concepts of geometry have emerged in which time has become the driving agent, the accident has become substantial, and form and order have become pattern, interference, itera-

tion, rhythm, something created in time and only to be understood in terms of time.

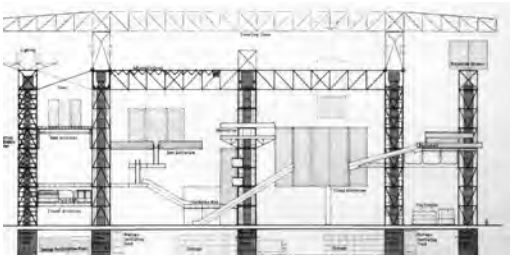
To invert this condition in architecture, as you propose, we would have to follow a similar path: we would have to understand time and form as collaborating. Obviously, this is not a question of building, because structure must be stable and "stand from below." We only know of two forms of architecture in our era that have tried to incorporate movement, one called streamlining, the other called deconstruction. The former relates movement, as you suggest, to bodily motion, and uses flow to shape the architectural form. It works on a sort of parallel between the exterior flow of wind around an airplane and the flow of people in and around a building. It doesn't relate to the issue of substance in that sense, only to its shape. The latter, deconstruction, which operates on shifts, rotations and diagonals, is even more problematic, since it goes from real movement to an accident in language, in semantics. Here, you encounter the paradox of a building that looks like it has been shaped by accident but has been constructed to be stable. I don't think it makes any sense to take diagrams from complexity or catastrophe theory and just drop them onto buildings. Our task lies in applying a deeper understanding of the interdependency of movement and stability to architecture. Stability is totally different from stasis. Stability is like homeostasis, the body's complex, dynamic temperature equilibrium. Movement should be set up to create order, not break away from it. But clearly, that is another type of order than we knew previously from axiality or symmetry. It's not one of form but of pattern, of formation. What I am saying is that it cannot be solely a formal issue; it has to be a programmatic and structural one at the same time.

> *The French word for real estate is "immobilier," the opposite of "mobilier," which means furniture. These two notions seem to indicate architecture's maximum radius of action: from absolute immobility (the building mass defining the invariable envelope) to total mobility (the furniture, which can be placed anywhere inside). In other words, architec-*

ture can actually choose from a whole set of options to "situate" itself in the variable relationship of form to movement. Nevertheless, throughout its (Occidental) history, architecture has displayed a clear tendency to opt for the immobile element as its definition. The challenging potential of furniture as the imminently destabilizing force of architecture is left aside, if not also embraced by the disciplining regime of order. In his plans of single-family houses, Mies van der Rohe used to place the furniture elements as precisely as the truly unmovable elements like walls and columns. There is an anecdote about the Tugendhat House: a couple of months after its completion, Mies came back to Brno unannounced to check if everything was in order. And Mrs. Tugendhat had indeed dared to arrange the chairs in a slightly different way. So Mies emphatically asked her to put them back in their proper position, pointing to the plan of the house he had discreetly brought along. What would an architecture be like that went the opposite way – an architecture that approached real estate with furniture logic?

I think we should resist Mies, but not for the reasons you mention. He truly believed in programmatic freedom, but his universalist solution fully fits the philosophical framework you outlined before, with substance being opposed to accident. He believed in creating as much freedom, i.e., movement, as possible, but to achieve that, architecture must – in his mind – actually back away from action and movement. His answer is an architecture that moves up in scale, so to speak, toward urbanism, to the broad span, to "bigness" – as Koolhaas has titled his agenda. I think the problem is more one of how to integrate movement and structure, to find a structure of movement. One option is to have furniture follow architecture: when architecture moves into urbanism, furniture can move into architecture. That would involve large elements that could be shifted and moved around, like in Cedric Price's or Yona Friedman's proposals. This is not so difficult to

imagine: structures growing and changing, constantly creating different patterns, even without megastructural frames. But I am more interested in these complex patterns themselves, and seeing if we can use them in design. So I think the movement should be abstract and real at the same time – complex patterns, like dunes, water, even foam or cracked mud, creating various patterns of connectivity between people, creating a variety of activities and movement.



Left Cedric Price, Front view of the Fun Palace (1964). *Right* Driessens & Verstappen, Breed #98, 2000 (courtesy VOUS ETES ICI, Amsterdam).

We should never mix up architecture and building. Just because our buildings can't move doesn't mean our architecture can't. As our buildings are hard and intransigent, our architecture could be active and liquid. This moves away from the Miesian and Koolhaasian retreat into neutrality, into the universal hall, the empty envelope. It's an old misunderstanding in architecture that when you create the greatest common denominator of all possible movements, an architecture that gets out of the way, it will induce movement and vitality in the actual building. I opt for a *geometry* of the mobile, where the geometry has become part of the furniture, of the movable – nothing neutral or passive.

Generally, Siegfried Giedion is seen as the theoretical advocate for a new conception of space based on the notion of time. But if he did indeed point to the new importance of

> *the dynamic user moving freely through the building, he never got beyond the opposition of a static space and a mobile subject. In fact, he kept the hierarchical distinction between space as substans and body as accidens, never realizing the transfer of movement from the subject onto the space. Curiously enough, this transfer of movement was a major theme in early experimental cinema and was also poignantly analyzed at the time by various scholars. In a seminal essay, the German art historian Erwin Panofsky concluded that "as movable as the spectator is, as movable is, for the same reason, the space presented to him. Not only bodies move in space, but space itself does, approaching, receding, turning, dissolving and recrystallizing as it appears through the controlled locomotion and focusing of the camera and through the cutting and editing of the various shots."*

Panofsky is right – well, he comes close, since he relates the movement of space to the movement of the body. It is no accident, though, that he turns the body into a moving camera. The whole shift from static space to the modernist concept of dynamic space is completely based on the idea of the moving camera. If we look at Adolf Loos' architecture, especially for the houses, you can see how movement takes a bite out of the rooms, even in a stepped, stairlike fashion, especially at the corners, changing the orientation from axial to diagonal. Loos also leaves the floor as a datum, much more so than Corbusier, because all events take place at different levels. I myself am convinced that finding an architecture of movement must involve perception, though I think Panofsky's words are too metaphorical still, since it's not really clear in what actual form space can "turn and dissolve," as he puts it. I think when he sees space as camera movement, it still occurs *in between* the walls, not in the order and form of the walls themselves. I am probably closer to Rudolf Arnheim, not only because of his *Dynamics of Architectural Form* but especially his *Entropy and Art*. Movement is psychological for Arnheim, which again

affects the physical movement of human beings. Arnheim is a Gestaltist, which means he is interested in form as pattern, as *prägnanz*, as an ordering potential. He argues for a switch to understanding form in terms of information, meaning a spatial configuration is immediately perceived, because perception can only understand order. So information is another way of understanding not just space and form but also image – exit the camera.

Obviously, our whole idea of perception and action as unrelated bodily functions, the whole Cartesian distinction between eyes and feet, is incarnated in architecture as the dichotomy between walls and floors, aesthetics and program, elevation and plan. It's as simple as that. This also means the relation of space, movement and body has always been misunderstood, or at least put in the wrong order. There simply is no movement apart from image, no image apart from movement. The way we construct images within our bodies is a million times more complicated than the cognitive concept of printing reality on light-sensitive gray matter would have it. The sensory charges the motor and vice versa: they are intertwined and connected. In this sense, we should resist even thinking in terms of "space"; as an architect, I actually never mention space. We have to conceptualize the body first – not the proportional Vitruvian body as the architectural center of the constructed world, but the experiential body, the living, vital body, where millions of processes go on at the same time. Therefore, we should always realize the body is a manifold patterning trying to gain stability through action. We act and see against entropy. Bodies try to transgress themselves in time through action, throwing themselves into time, that is, connecting to other bodies, other rhythms, other actions. You can only really speak of space in this sense, after you've considered the experiential body of timing actions, but never as a given. There can be space in time, but not the other way around.

But even if you refuse to use the word "space," you do seem to have a concept of it, one derived from radical construc-

tivism. According to this theory, space does not exist per se, or in other words, everything around us is mere unstructured information that becomes structured only once we interfere and interact with it. This idea implies the dissolution of the inside/outside opposition: conceptually, body and architecture merge into one synthetic action space. But doesn't this opposition reappear in the real experience of a building?

Well, I am against viewing space as the other side of movement, as in the solid/void model – solid-matter, space-void. Space is the *structure* of space, not the air in between the walls. That, first of all. Second, this structure of space should be viewed as a product of time; structure has a history, various iterations, movements multiplied with other movements. So space, the extensive space architects take as real, is at the end of the equation, it is a sediment. I see space as congruent with matter; that's why I can compare a pattern of sand dunes to foam, because they are foremost products of pattern and order. So our perception of space is much more a perception of *time structure* than one of air between the walls.

Let us now turn to the body-space relationship. You're right to refer to radical constructivism, which is Heinz von Foerster's concept, or even Varela's notion of *enaction*, which is even more radical. This idea of embodied action goes absolutely against cognitivist representation, where the so-called outer world is only recorded by the brain – and simultaneously absolutely against idealism, where this outer world is only a subjective projection of an inner one. He and Maturana refer only to "structural coupling," in which body and world are interrelated and interactively transform each other. "True" experience doesn't take place in a specific location, either in the body or in the world, only in the coupling. This is the point at which the distinction between inner knowledge and the outer world ceases to exist. What we call reality, or our sense of reality, is nothing but an effect of synchronization, the synchronization of our own bodily

rhythms with processes going on in the world around us. And in this synchronization, your dualism disappears. Our sense of reality is created by our sense of timing, our attempt to be "in phase" with the world, to live with the rhythm of the light. I don't mean this metaphorically: "in phase" is a direct, physical connection. To cut the answer short, I would say that our perception-action cycles deal with the synchronization of inner and outer lives. Of course, space is extensive, consisting of square feet, but that is not the "reality" of it; it is equally intensive, with our psychology, our rhythms and moods. What we experience as real, we can ultimately say, is the resonance between these intensive and extensive systems.

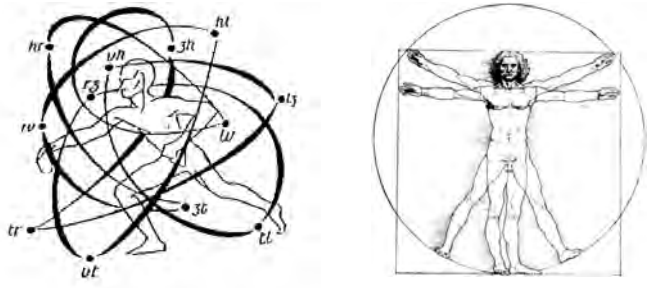
> *Every classical definition of architecture contains the idea of fixing the movement that vibrates in the world outside architecture – in Vitruvius' famous definition, this is called "firmitas." Any concerns about dynamics and fluidity are avoided like the plague. It seems as if architecture feels strangely threatened by movement, perhaps simply because it does not know how to handle it. To a certain degree, this could be caused by the "timeless" quality of the drawing systems architecture has traditionally used: plan, section, elevation – all static modes of graphic inscription that can comprise three dimensions at most, and certainly not time as the dimension of unfolding and change. Architecture has never developed a notation system for movement, as dance did choreography.*

First, we have to understand what an experiencing body is, how the body shifts between acquired habit and free action. Of course, in architecture, there have very often been attempts to combine them, but it proved difficult, and they mostly ended up with either/or concepts. The standard architectural program consists of habits, routines and work. This is viewed as the mechanistic repetition of certain acts: the program only takes account of actions that are considered repeatable. On the other hand, there is the

desire for free action, play, experiment, as in Constant's New Babylon. For me, it is not a question of either/or, work or play. Life is just the complication of these. The one is always hidden in the other. Sure, we habituate, we develop cycles of behavior. Why? Because it is hardly possible for humans to carry the whole act, to steer themselves continuously into intentions as Cartesian machines. We create our own rhythms and make them stronger than we are; we create an internal music that gets us going. Our rhythms create us: we are an actual product of them. On the other hand, we do not program ourselves. Human software is much softer than computer software. We do not repeat the same actions over and over again; they change, they differ, they vary, enabling us to change, renew or move smoothly into other acts.

Does this bring us closer to your suggestion that looking at choreographic models could help us design architectural space? I don't know; maybe partially. When we take a closer look at choreographer Rudolf von Laban's diagrams of the vectors surrounding a dancer's body, we immediately recognize the expressionist interpretation of the Vitruvian Man. Vitruvius' circle becomes a sphere, Laban's *kinesphere*. He makes the body into something three-dimensional. Vitruvius' body standing or lying dead is replaced by a living, multioriented, moving body. The question, though, is how to plot these dynamic variables in an architectural system. I think when the body model is ultimately considered a sphere, it should be able to access everywhere, rather than just rolling over the floor, which would imply a precedence of the feet over the eyes. Still, I would hesitate to oppose an architecture of *firmitas*, of standing upright, with dance, play or experiment. I would hesitate to simply twist this posture fixed by gravity. I am much more interested in standing being related to all the other postures. We know from dancers that standing still is hardest – clearly, it is difficult for Laban's gyroscopic man to mimic the Vitruvian Man. I don't want to make the same mistakes as in the 1960s. We should find a way in architecture to complicate habit, to implicate action in routines. It is about synchronizing the soft clock of the body with motor geometry. Obviously, this geometry

is not one of section, elevation and plan, but one that tries to envisage these three – construction, perception and action – within a single continuum.



Left Rudolf von Laban, Labanotation, "Neigungen der B-Skala," *Choreutik, Grundlagen der Raum-Harmonielehre des Tanzes* (1991). *Right* Leonardo da Vinci, Drawing of the Vitruvian Man (1487).

> *Do you think the new notation systems provided by computer animation modeling techniques like the ones you use finally account for the body as an active part of architecture?*

I do, though there are serious problems involved. I think what it can do is actually relate Laban's dancing body – which is like any moving body, so it can be applied in architecture as well – to the creation of architectural form. But we have to move slowly and carefully. What I try to oppose is the a priori dichotomy between floors and walls, i.e., action and perception. I think we need to create one from the other. So I don't animate the floor and then cover it in a structural envelope later, nor do I animate the volume and then stack it with floors. Like Virilio and Parent 40 years ago with their *fonction oblique*, I think we have to find ways of correlating the structural and the programmatic within a continuum of action. So, how should we operate? It might be a good idea to animate the programmatic fluxes to animate the building. But after

a while, you would notice that this hadn't gotten you anywhere either, except for smoothing the already planned movement within the program – it only leads to a new, more complex form of streamlining. Instead of form being shaped by a single vector, as with Mendelssohn, you would end up with forms shaped by multiple vectors. Nor is the aim to replace the program with free choreographies of movement and then superimpose them, as if the program is dance, which it clearly is not. *It is not the fixing of movement in the program, nor is it the fixing of movement in form.* You would end up with the so-called "stopping problem," the question of where to freeze the animation, but the real question is *how to pass the movement on*, from the machine to the architecture, from the architecture to the body, and from the body back to the machine. It should be an abstract movement shared by all participants – columns as much as human bodies.

First of all, the movement should go from floor to wall, or between walls, or between columns, or between wall and ceiling – it doesn't necessarily have to be everywhere. But the most important thing is: the movement goes into the architecture, i.e., the structure of space, as I called it before, itself. The movement generates a three-dimensionality, what Kiesler would have called the endless, which is very similar to Laban's concepts. This liberates architecture from the frame, and the looping of perception and action is never interrupted. So it's about creating tension and suspense in the program. This is very important. On the one hand, we're dealing with the desire to cool down behavior, to structure and separate actions – in short, with the instrumentality of the program – and on the other hand, we're vitalizing action through animation, by replacing fixed points and fixed geometries with moving geometries, and vitalizing action through suspense, through shifting from space to time, through the multiplication of action.

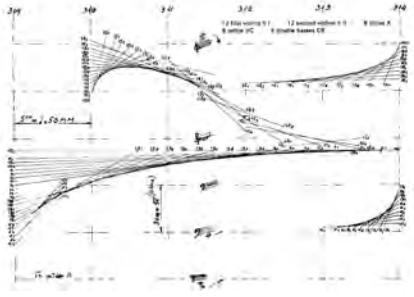
> *In dance, space does not exist as a given entity (except for the physical space of the stage, but that exists only as a precondition for the performance of the dance). Dance creates*

> *space out of movement. The shape of a form exists only in time: you can never grasp it in one moment but must commit its forms to memory. In all these aspects, dance seems to be the art form furthest removed from architecture. Nevertheless, I have the impression that it best captures exactly what interests you in architecture.*

At least dance allows the body a far wider range of postures than architecture. I have tried very often with students to use Laban's notational system or William Forsythe's choreographies to create architecture. But you would need to consider the fact that in architecture we aren't speaking only of single bodies, individuals, but also groups, crowds and such. There are quite a few crystallizations going on in architecture, and I think this could be viewed more like dance, i.e., as a dynamics of grouping and regrouping. Architecture and dance are often separated by this notion of being either in time or in space, but we have to remember they are also often connected by music. So though dance and architecture are separate, music and architecture are not. Just think of Palladio's harmonies. Now, architecture is often called "frozen music" – by Goethe and many after him – but I think that is a serious error. There is nothing frozen about architecture; that's a complete misconception. Again, it's like mixing up architecture with building. We know music exists in the score first, before it gets played, so does that mean that music is "frozen" in the score? No, of course not. Separating a state of frozenness from mobility in architecture is the same as stating that a musical score is frozen and only the performance is alive and moving. In that sense the relationship between architecture and music is much closer to, for instance, Henri Lefebvre's rhythmanalysis: "He [the rhythmanalyst - LS] is capable of listening to a house, a street, a town as one listens to a symphony."

I recently finished designing the V2_Lab, an office space here in Rotterdam. According to Bart Lootsma, its architecture comes very close to Xenakis' *Metastasis*, which I thought was a great observation. *Metastasis* doesn't have a score with notes but

a schema, a diagram. Yet it is not a diagram like the typical ones architects or composers are familiar with; it is a drawing of a geometric surface, a so-called "ruled surface." For the architecture of the water pavilion I also used geometries of ruled surfaces, i.e., curves with straight lines connecting them. Simply put, they are twisted planes with a so-called single curvature, as opposed to the double curvature of a balloon or a saddle. Xenakis' diagram is meant for a "glissandi" of strings, but it doesn't tell the violinists



Left Naum Gabo, *Torsion, Variation* (1962–3). *Right* Yannis Xenakis, *Metastasis*, String Glissandi bars 309–314 (1954).

what notes to play when. The violinists "play" the diagram, and every time they play, the performance turns out different. So in a way, the violin players are your dancers. Here, using music as a diagram, we come much closer to connecting dance and architecture. Such a surface, when built, doesn't lose that power of schematization, though it's fully materialized – it can still be "played" or used differently. Ruled surfaces are the most classical geometries in architecture for creating movement, since they are both curved and straight. Up until now, they have proved to be the most buildable of complex surfaces. Gaudí used them, Eladio Dieste used them, and Candela too, but also Corbusier, in his Ronchamp Chapel – which Robin Evans described so well in his wonderful book *The Projective Cast* – and of course also in the Philips Pavilion of 1958. The young Yannis Xenakis was working at

Corbusier's office at that time, before making his final move into music. Some beautiful sketches exist in which Xenakis interprets Corbusier's more simplistic drawings and gives them a much more sophisticated geometry.

Obviously, both Corbusier examples concern roofs, not the three-dimensional structures connecting floor and roof I described before. I just want to see people's movement feed into an all-around architectural system that, in turn, feeds back to the people. But to do that, movement has to become structural; you cannot connect action and perception without passing construction.

The best historic example I know of is Naum Gabo's ruled surfaces. What he did was completely different from, let's say, Theo van Doesburg, who dreamt of complex topological geometries but was never able to make them; to him, movement was what made cubes explode into shifting planes. Van Doesburg was a cubist, and cubism is a typical form of thinking in terms of substance as opposed to accident. Gabo, on the other hand, connects kinetics to the tracing of ruled surfaces, which is completely correct, because that's what a dimension is, the realm of movement. Then what he does is make these movements connect up, which is essential for structure, or else they would just be separate trails in space. With him, they form three-dimensionally interconnecting twisting and turning traces, connected by wires, ruled surfaces. It is no accident that Naum Gabo calls himself a constructivist. He actually *builds* from movement; there is an actual transfer of accident to substance.

> *So, if I understand correctly, the dance is not in the actual movement but in the relationship between an abstraction and its realization.*

Yes. Let's not forget that the ruled surfaces aren't clear geometries anymore. They are not surfaces that enable only a single movement. Of course, they are mathematically precise, but architecturally they are quite indeterminate. Somewhere between wall and floor, sometimes more floor, sometimes more furniture, they

become like landscapes. So the movement in architecture is much more in the indetermination, then in the fact that it is a trace of a real movement. The movement they provoke is variable, like the violin players enacting Xenakis' diagram. It actually relies fully on perception to guide action; it requires this continuous back-and-forth between the two, which would never be the case with a simple wall or floor. It's Laban's gyroscopic man relating to an architecture of glissandi, of accelerating and decelerating surfaces.

The Motorization of Reality

The history of machines is the history of thought. Down the ages, the conceptual content of tools has always been borrowed, incorporated and appropriated in architecture. And these were always – to cite Virilio[1] – technologies of seeing and measurement, every technology of seeing being, by logical extension, one of measurement. And so instruments that were built to reconstruct or record reality became tools for constructing reality in architecture. In a recurring pattern, tools that were first designed as passive, receptive instruments for recording external reality become active and productive in architectural practice. Hence, *throughout history, instruments for recording images have become instruments for creating architecture.*

Before we proceed, we must make this statement more general: instruments for recording (reality) are always instruments of creation (of reality), because they are conceptual devices. One might assume an instrument to be developed for a passive function, as a medium, a tool, an intermediary between the body and reality, for the sole purpose of recording or seeing that reality (if you could describe seeing as passive, which it clearly is not). But one might also imagine how such an instrument slowly nestles in the body: how a lever becomes part of our radius of action, how these instruments progressively become part of our visions, dreams and hallucinations, and how every instrument virtualizes within the body, to then produce and act there. Every instrumentalism is futile: no instrument of any kind has ever been a servile or neutral mediator between us and reality. Indeed, instruments have only ever transformed and deformed. A body is always presumed, with a will hovering over it – in step with the Cartesian liturgy – a will with a purpose in this world, an intention, and the accompanying instrument is subsequently invented to satisfy that desire. This is also the phenomenologist's view, that the world is always out there, untouched, but in fact the reverse is true: we live in technology. Or, more than that, we *want* to live in technology and *can* only live technologically, because a separation between us and the world is unbearable. We devise machines to accelerate and recharge reality, *to stimulate our desires* rather than satisfy them.

We share every initiative with a machine, so that every action implies interaction.

Perspective and Theater

The old wooden perspective instrument of Dürer and Brunelleschi, for instance, was not only designed to render the human body and the built environment visible, it immediately became *a tool for structuring visibility* itself. There is no innocence in tools; the latter is the reverse of the former. All the architectural instruments of visibility – the façade, the axis, the square, the monument – are instruments for constructing a polis, which is, as we know, etymologically related to policing. Though the disciplining aspect is not central to this argument, it is important to understand that, in the perspectival world, the public realm is understood as a theater per se. This is the conceptual core of the Renaissance's central figure, Machiavelli, who is often dismissed as the inventor of shady politics – something only partially true, since he is the inventor of politics as theater, which is a machine of visibility and subsequently of invisibility and behind-the-scenes machinations. Of course, the polis as such is a much older, Greek invention, but the Greeks didn't follow the black-and-white scheme of Gianbattista Nolli's maps of Rome, in which black ink depicts the impenetrable space of private homes and the white space left over indicates the open, public realm. In the theatrical urbanism of Rome control was divided between the church, which was in charge of the psychological, private space of the house, and the state, which was in charge of the collective, public realm. In the Greek polis, on the contrary, space was not black and white: everywhere was accessible, private courtyards as well as public colonnades. Institutional buildings were wrapped with colonnades and not blocked off by façades. But public life and its formalized street behavior in baroque Rome were all about acting in the theatre of sunlight: a sunlight precisely constructed by a mechanics of axes hinging on everlasting monuments and strategically positioned façades.

Or, alternatively, we can look at Haussmann's Paris for a moment, where politics, polis and policing merge into a world structured to make army ballistics coincide with "exciting" lines of sight along endless boulevards. On these boulevards, a crowd of citizens can immediately be replaced by a crowd of soldiers. Fortunately, Paris' system of visibility is constantly challenged by its dark, hidden networks of sewers and arcades, and this has always been part of its powerful dreams and mythologies. It's no accident that Situationism found its origin in the surrealist arcades. All human movement, however, was designed to culminate in a suspension of that movement (the façade, the monument) in an architecture literally only intelligible from *standpoints,* where time was made to stand still, without any dimension, whereby architecture was defined and constructed as stage sets.

Trains and Film

When we now consider two other, parallel instruments that emerged much later, *the train and the moving picture,* and contemplate how sharply they broke with perspective and hence with the urbanism based thereon, we see that this was not just a conceptual break but also a perceptual accident, a huge mental train wreck. Suddenly, the perspectival continuum, so painstakingly carved out of sunlight, failed to produce a unity of event, experience and perception. The marvelous nausea Victor Hugo experienced on the train by looking out of the window and seeing only blurred lines instead of pastoral landscapes, the difficulty people had in comprehending montage and speed in the early days of film – all this was to become the engine that propelled the cubists and Joyce. Montage is not so much an invention as it is the transfer of a technology from one field to another. It's not an "idea" but a technology becoming a technique, totally in keeping with the nature of technology, though not from an engineer's point of view but more from a biotechnologist's. The evolution of technological objects is precisely of a biological nature, because

"ideas" live only in the form of praxes. *All concepts are motor-concepts*. In addition, all machines are abstract machines. If this is true, that abstractions are machines themselves, then a deeper understanding of technology as a history of thought becomes evident. The fact that praxes are "done" or machines "work" separates them from their objective, because what can be done can potentially be done to all things – operationality precedes utility. In short, such a transfer is never metaphorical or critical but purely operational. Therefore, technological evolution or "invention" simply doesn't occur in language, though it can be described there and commented on.

Think of Adolf Loos and his *Raumplan*, or perhaps better, Le Corbusier: we would never understand how the room is replaced with a larger sense of spatiality without film and mechanical movement in general. Of course, his ramps have been compared to conveyor belts before, but again, that's not the point: it's the variable speeds, the gearing, that generates space. We would never be able to understand the way floors cut through a new spatial continuum, the way Corbusier alternated long lines with sudden curves, his pervasive penetration of the volume, the horizontal windows he called voids, and his superimposition of circulatory space on rooms – we would never have understood any of this had it not been for the cinema. In a perspective-based structure, memory is distinct from perception (that's why it needs monuments); what goes on at the back of the eye is entirely separate from what goes on before it, but in the faster kinetic and kinesthetic stream of experience generated by film, it is impossible to separate the two. Corbusier did his designing with the camera. Commentators always stress his observation of steamships and cars, but this merely implies an aesthetic cross-pollination, from exterior to exterior, of images swirling around in the *zeitgeist*. No, *Corbu was a cyborg:* the machine, the moving camera, was part of him, his body and his spatiomotor functions when he plotted the lines of Maison à Garches and Villa Savoye. He used the camera as a drawing machine instead of a seeing machine.

Cars and Television

Similarly, I can never think of Robert Venturi, or postmodernism more specifically, without thinking of *cars and television.* His book *Learning from Las Vegas* represents a complete rethinking of architectural theory based on the perspective from the car. Las Vegas was designed by an automobile. And, in contrast with baroque Rome, which can only be appreciated on foot due to the constant need to pause, Las Vegas can only be truly understood by driving around at low speed (it's important to cruise and not drive too fast). You gain little insight by walking around the city; walking, you find it impossible to imagine how driving loosened the façades from the interiors and transformed them into billboards. Walking around, one would never understand how the interiors became wrapped in a simple hall and how the exteriors – the billboards – ended up at the side of the road, with the ecstatic vacuum of the parking lot in between the two. This is no small thing, and it's the main reason why politics has left the polis and moved to television. But in television, the light that sculpts events is totally opposite to the theatrical sunlight of the polis. While the light of the polis renders events sharp and clear, the endogenous light of television renders them fuzzy and blurred, as Marshall McLuhan observed when he was explaining why John F. Kennedy had won the 1960 election. Whereas in the city all behavior is necessarily formalized, on television it is – also necessarily – informalized. On television, there are no fixed patterns of conduct; all interaction takes place on a first-name basis, all conversation is purely confessional, and all political tension either immediately drains away or escalates. On television – I'd almost say *in* television – there is never development, only crises and breaking news; no change or transformation, only stations and channels. Postmodernism has never come closer to thinking *image and speed* in one continuum; it has shied away from the agglomeration, the formless city sprawl – even Virilio did so – and ended in dark fantasies like *Blade Runner.* Nor will it get any closer now that this has been supplanted by *image and language,* complexity and contradiction. The whole postmodern

colonization by gated communities, quasi-historical shopping malls and New Urbanism floating on tarmac lakes is directly linked to the separation of image and speed. If you cut architecture off from the only perceptual engine it has, the only alternative left is to bury it in an open-air museum. We should in fact add that it was a major blunder to deny the motorway, and most importantly the television, an architectural analysis of the kind Reyner Banham attempted in *Los Angeles: The Architecture of Four Ecologies* (of which the freeways formed the fourth ecology, "Autopia") – nothing is as blissful as driving your car in Los Angeles, where driving takes place in a state devoid of aggression. The specific form of modernism in 1930s Los Angeles, so-called Streamline Moderne, with its articulated horizontal curves guiding corners and entries, was clearly trying to create an architecture that integrated speed and image, much more so than post-modernism later with its chasm between image and language. The wholesale passion of driving, the way the world condenses on the windscreen (before reaching the mind), or the absolute passion of the talk show, where the masses collectively inhabit the body, assembling in the intimate body of the confession. In an architectural analysis of the light of the television and how it drives home reality, whether it's O.J. Simpson's Ford Bronco, Diana's Mercedes-Benz, or Bill Clinton's Via Dolorosa, it is the body that has now become public domain, in a dazzling fascination with its metabolism. Instead of faces in a landscape, it now seems as though space begins with the face.

Diana. When did we last see such an implosion of center and periphery, private and public, here and there (more so even than with Vietnam or the fall of the Berlin Wall), but most significantly of face and landscape, of the vertical and the horizontal, of figure and ground? Everything is face, everything is recognition, particularly after her divorce: the bulimia, Dodi, her violent death, the entire planet consisted of her profile. Without a horizon, everything became her interior, like a furnished room.

Since the ancient Greeks, we have distinguished the substantial from the accidental, the essential from the incidental,

the general from the specific. We also distinguish use from misuse, naturally; each technical instrument can be reversed and admits its own accident: train, ship, plane, car. But this ends with the television, which does not admit accident, or rather admits only accidents – and links them up, too. We all know from live television that, in a certain sense, nothing can go wrong. The accidental is the very thing that gives a program its relief, its substance. For example, I remember a live broadcast in which two interviewees starting slugging each other. Of course, everybody got agitated – the interviewer, even the producer – yet in fact nothing had gone wrong, because it was *real,* and how can anything go wrong once you've handed over control to reality? And that is precisely the irony of television: the extra light shed on events opens them up to the catastrophic, and now no Jerry Springer broadcast has this profile of the real anymore, and people start beating each other up before there has even been an argument. Instead of regarding the substantial and the accidental as diametric opposites, we can consider the accidental to be part of the substantial, everything of which substantiality is comprised.

Computing and Networks

Clearly, computing is as much a technology of viewing as a technology of making. Any image can be digitally recorded as well as made. The computed image is radically different from the depicted image of painting or the technologically recorded image of photography or film. On the one hand, it shares television's ubiquity, which distinguishes both from painted, staged or filmed images in their isolated spaces. In this sense, computing is an evolution of the televisual, which runs parallel to life and the synchronization of events. On the other hand, this is also the last thing television and computing have in common, and though all images on television are digital, digital images are only a minor part of computing. In postmodern criticism, the digital has been described as the realm of simulation, of the model, the hyperreal – but these descriptions only cover the televisual aspects of the

digital, its screens and images. Moreover, they are a critique and not a philosophy of technology, and therefore inconsequential. Most of what is computed is hidden in the world, not only in the technology of pacemakers and airplane cockpits but in science itself. A century ago, the intertwining of process and reality was mostly a matter of philosophy (Whitehead, James, Bergson), but now growth, erosion, development, turbulence, periodicity, feedback, nonlinearity, all such properties of the processual have become calculable, and produce household images. The trees on our computer screens are generated by algorithmic parameters, as are the wind that blows through them and the water that reflects them. And I can throw a stone into that water, too. Is this simulation? Obviously it is not a real tree, but it is generated and grown, and the fact that it is grown in milliseconds instead of years doesn't make it less of a tree. The scientists who years ago set up the Tierra project, which involves millions of interactions between digital agents and has evolved into a complex habitat of unprogrammed creatures and activities like a digital beehive, state that stopping the project would mean ending life and therefore be a criminal offense.

I need only change a few parameters and my generative software produces not trees but shapes that look a lot like buildings – and I am phrasing this sentence as carefully as I can.

With computing, we can at last perceive substance and accident, image and movement, form and time in a single continuum. We first thought of form as distinct from time, as an essential ideality unaffected by the course of time. Now we have moved away from this and see form, coherence, as pure actuality. Today, we think of form as the product of time, as an ever-evolving output of time and time-related processes: form as pattern, as interfering parameters, as something self-organized whose stability can only be understood over time. Or, as Bergson puts it, only time is real. Space is there for abstractions; the motor of time generates reality. *The real itself is motorized*. And, in fact, it is technological: the real is a continuous process of production and differentiation. Therefore, as we have already observed, our

machines have slowly transformed from machines that arrive after the event into ones that arrive before it. In philosophical terms, our machines have changed from realist to ontological. In effect, the instruments of perception discussed above are nothing but rulers that have progressively taken on movement, slowly speeding up and becoming clocks themselves: perspective, which depicts substance in chiaroscuro against the revolutions of the sun; film, which accelerates or decelerates in relation to the sun; television, which instead of recording events in natural light captures them in its own shadow-free light with its own rhythms and iterations. In effect, we build machines to inhabit time rather than space, not just to connect perception and processes but, more importantly, to internalize these and connect them with the millions of rhythms and cycles in our bodies. Our own substantiality is at issue, our own experiential complexity.

If the old perspective was an instrument for viewing form in space, then the computer is an instrument for viewing form in time. Virilio correctly describes the supercomputers Mandelbrot used at IBM in the 1970s to explore fractal dimensions as telescopes. When the ancient Greeks looked at a cloud, they saw only a cluster of spheres. When we look at a cloud, we see a succession of iterations in time. Architects no longer look at objects, whether static or moving, but at movement as it passes through the object. Architects used to be obsessed with cubes and spheres; now they are obsessed with clouds, flocks, traffic jams, the growing of trees, the substance and surface of water. They draw less and less, and calculate more and more. They have stopped modeling form from the outside and generate it from the inside instead.

And why stop there? When design is understood as generative (before computing, this was mostly metaphorical), then an organized form of growth, with the implied stylistic specializations and selections, is bound to happen. *Design will become a form of breeding*, not unlike the breeding of roses or dogs. All design will move from singular objects to a multiple *range of objects*, creating populations of variations that are aesthetically

unique and individual but organized as a collective. Even when it concerns a single object, design needs to proceed by breeding, by artificial selection. Recall that Darwin's *Origin of Species* starts with a discussion of domestic variation. Each design office will be like a rose farm or winery specializing in a specific class of objects with specific properties. Inevitably, design will go tropical, with a vast number of species each occupying the smallest possible niche. Computing is fundamental to such a biotechnological evolution, enabling a definitive shift from drawn objects to computed processes, from subjective difference to objective variation, not least by closing the gap between design and fabrication. Factories, like architectural firms, are moving from being drawing-based to being information-based, and the machines that cut our steel and cast our concrete increasingly operate under numerical control. Design firms, in turn, will present themselves on websites through which we can order our preferred mutations, first of industrial products like lamps, watches and shoes and later for houses and larger buildings. More and more, design will come to be about the organizing of variation.

The computer is a mutative force, being itself a process, a motor, a source of instability, much more so than television. Its accelerative power is phenomenal: just as we tend to accelerate when driving through a tunnel, we tend to speed up our activity when using a computer, with no outside frame of reference to relate to. Anyone who uses these machines knows from experience that the hours spent are not comparable to those spent drawing. The form of fatigue is entirely different. In drawing, you have your moments; with computing, they are whole days. Anybody who started out drawing by hand and moved to computing – as I did – knows that, though on first sight the two activities seem to require similar techniques and qualities, the shift actually constitutes a fundamental change. On a computer, anything looks good (just as in the 1960s any sound coming from a synthesizer sounded good) – so execution is no longer the point. It's much more about guiding and controlling the process. Organizing the object is as important as modeling it (that's why it

immediately starts to sprout variations: organization controls variation). Digital modeling is not at all comparable to the modeling of, say, clay. Clay is dead and has no structure. In digital modeling, one builds an object by organizing it geometrically; the distribution of points and lines is crucial. It must be constructed from a lower, general state of information into a higher, more detailed state. Even modeling the simplest object consists of a very precise set of actions that iteratively supply information. *There must be a machine behind the design itself.* Instead of being understood as "design on a machine," design itself becomes a machine. When design becomes informational, the gap between research and design will also close. The way we gather and select information, the way we prepare the design, should be continuous with the design itself. At the moment, we are still wandering too much in the gap between theory and practice, between the so-called criticality of architecture and the practice of building.

Cultural critics, architectural critics to be precise, have no idea of the level of skill being attained in digital design techniques day by day, though still only at universities and hardly in architectural firms. The two-handed dexterity, the coordinated left- and right-mouse-button clicking, combined with keyboard maneuvering, and moreover scripting and programming, go far beyond the dexterity required in any hand drawing technique. On top of that, the software is much more abstract than even its own programmers realize. It moves easily from a mediative state to a generative state, from technology to technique. So much software is interchangeable – what is used in one discipline one day is adopted by another the next, however noble the programmer's intentions – that electronic adultery is rampant. Architects seize computers out of system operators', engineers' and interface designers' hands and make them theirs.

One final thought. We won't find digitization solely in architectural firms and factories. We will find computing at three levels of architecture: *before* something is built (design), *while* it is being built (manufacturing and construction) and *after* it has been built (experience). We will find it in the buildings themselves; not

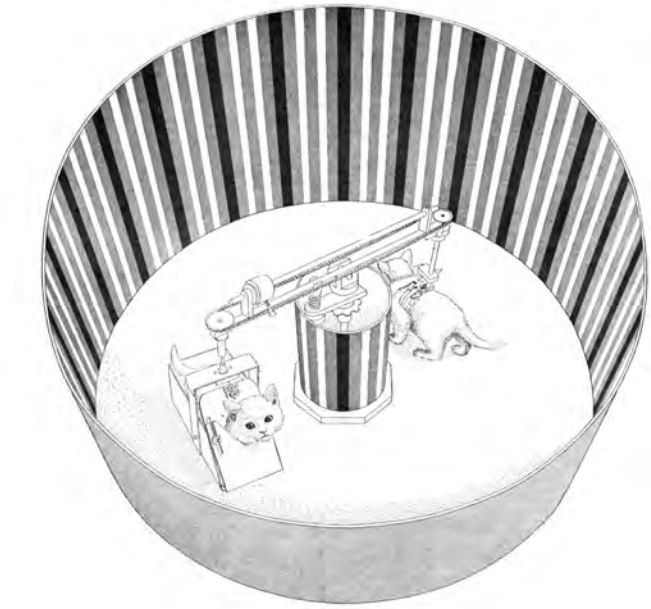
too far a remove from the early visions of Frederick Kiesler or J.G. Ballard ("The Thousand Dreams of Stellavista"), in which our houses have acquired personalities and our architecture a specificity we have yet to invent. A house that responds, a house that talks, a house that has moods, changes color – if we remember Louis Sullivan's quest to bring architecture to life through ornament, would this not constitute an enormous electronic revival of ornament? Hasn't architecture always devoted itself to life? As in electronic art, where responsive machines are distributed in new spatial configurations, architects will likewise install machines so that reality is charged, stimulated, amplified, electrified, personalized. Machines will thicken the experience of the present, multiply the present. Buildings will have to become less and less like rulers and compasses and more and more like machines attaching themselves to our movements, dreams and rhythms.

1. Paul Virilio. *The Art of the Motor* (Minnesota, 1995): 133.

The Primacy of Experience

Action, Perception, Construction

In 1963, Richard Held and Alan Hein[1] conducted a classic and rather merciless neurological experiment in which two kittens were raised in the dark under very controlled conditions. The main element consisted of a physical carousel that restricted the kittens' movement to a circle; they were connected to each other through a central pivot. One kitten was able to move freely around a circular track, while the other was strapped into a suspended gondola, which was pulled by the free cat that had its feet on the ground. As the young animals' brain tissues developed, their actions and perceptions were integrated into their individual neurological systems. After a number of weeks, the kittens were released from the carousel. The cat that had been active moved and behaved normally, while the passive cat stumbled and bump-



Sensorimotor feedback apparatus with kittens, "The Kitten Carousel" (Held and Hein, 1963).

ed into objects, afflicted with agnosia – a condition of *mental* blindness brought on by neurological rather than physiological causes. The free cat was able to link the act of walking to its own perceptions, while for the other, action and vision were severed. It could not coordinate its movements with what it saw, because in its experience, action and perception had never existed in the same continuum. Held and Hein's now famous and oft-cited experiment showed that these two faculties are inseparable – perception relies on action, and action is only possible through perception.

Naturally, continuity of action and perception can only exist in a body where, as Merleau-Ponty says, "a perception is not followed by a movement, but where both form a system which varies as a whole"[2] – that is, through the *Gestalt* of a body schema or body image. This system is constantly fed by movements and actions; it coordinates and consolidates them, otherwise it would never be a whole. Furthermore, the system must be plastic enough to incorporate new movements. Somewhat further on in the chapter on the body in the *Phenomenology of Perception*, Merleau-Ponty gives the examples of a woman with a feather on her hat (it must have been the early 1900s) who automatically bends her head when passing through doorways and a driver who automatically skirts obstacles and rounds a curve without having to stop the car, take measurements and do calculations before proceeding[3]. You become the car. Through the body image, we are capable not just of creating a system of interconnected actions that fit the contours of our bodies but also of extending them into space. On the other hand, as Oliver Sacks makes clear in some of his saddest patient stories, the opposite also applies: we can shrink into bodies that are smaller, such as when someone loses the ability to use his or her legs after being confined to a plaster cast for weeks. The body schema "is not fixed, as a mechanical, static neurology would suppose; body image is dynamic and plastic – it must be remodeled, updated all the time, and can reorganize itself radically with the contingencies of experience." In an anti-Kantian swipe, Sacks adds, "It is not something fixed *a priori* in the brain, but a

process adapting itself all the time to experience."[4] In this view, experience is not simply existence in the present; experience is something else. What does the present actually happen to? What does it mean to experience something? Does it just mean that what we are is shaken up or activated? Or is it pure becoming and transformation? In fact, it is neither: not a continuation of the old nor the pure creation of the new, but a present that happens to the past. It *can* only happen to the past – what else is there? It happens to what you have become at that moment, to memory and habit as much as the body schema, which is a particular sensory-motor form of memory. But if the memory structure were static and fixed, the present couldn't happen to it, which immediately implies that it necessarily must be a plastic system, one that differentiates over time, as much as one that gains structure and solidifies. Experience is that which projects us forward and gives us a future, but simultaneously projects us backward and gives us a past with memories and habits.

In the experiment with the cats, it always struck me that something very fundamental in relation to architecture was being researched. The fact is, two things that neurologically share a continuum are architecturally still considered as distinct. Are we architects not trained to plan movement first and extrude it upward into the image afterwards; that is, are we not trained to first draw the plan, the *surface of action,* and then extrude it upward into the elevation, the *surface of perception*? Are we not trained to treat floors and walls as discontinuous? In addition, are we not trained to treat walls, floors and columns as discrete elements? Should we, in parallel to the body schema, consider an architectural schema as something fundamentally plastic, topological and continuous? Should we not consider this continuity between movement and image as the "original curve," the *Urcurve* that feeds action into perception and perception into action? And as we do, should we not also realize that this curve is by nature one of *construction*, since it connects the horizontal act to the vertical image?

Freedom and Experience

> *"We designers are the inventors of images of freedom."* [5] *Sanford Kwinter's crucial sentence in his philippic on Post-Koolhaasian Dutch architecture first struck me as completely ridiculous ("Read Foucault – an architecture of freedom can never be anything other than an architecture of power!"), precisely because Dutch architecture nowadays is nothing but a gridding of images: an ongoing attempt to save the Dom-ino model, in which image (wall), action (floor) and structure (columns) seem to be forever separated. But then it occurred to me that it could mean the images themselves are structural and therefore must be blurred, be part of the background. Freedom lies in the potential for seeing, the potential for action: freedom not as in freedom of choice but as an experiential tension within the decision-making machine of the body.*

Suppose it were possible to paint a picture of freedom. Would this painting have to be a very bad one, very academic, perhaps with a prisoner looking out a barred window with the sun's rays slanting in, his face turned upward, eyes staring? Even if the painting were more intelligent, something monochromatic and sublime, once we had painted an image of freedom and hung it on a wall, most of us would start laughing. It would be like a Monty Python scene; we would all realize that *the image was where freedom was not*. All freedom would be occupied by the image; the image would obscure freedom. Supposing we are inventors of images of freedom and would actually invent such a thing, would it then be best to hide it, to have the absence of the image of freedom? Then again, how would we let everyone know we had hidden the image and that we could finally enjoy our freedom now that its image was safely locked away? Realizing, or materializing, this void is indeed our main task, but only with the knowledge that it can't be an image on the wall or a hole in the floor. How can we be connected to the unseen; how can the unforeseen happen?

Let us stay with this image of freedom as the void.

It has often been stated that it would suffice to replace the determined with the undetermined, to replace the defined with the undefined, the fixed plan with the open or free plan. This has been reasoned as follows: when life produces images, moving things, furniture, the only way for architecture to provide for this so-called lived freedom is to retreat from the experience, take a few steps back in scale into pure structure, support and service. To create the greatest common denominator of all possible movements, architecture would have to retreat into the empty envelope, into the providing of pure infrastructure and structure – in short, move toward urbanism. Instead of the old crystalline architecture that disciplines behaviors into pure habituation, we would be left with an open field.

In this view, the body would be Master of the Universe, master of all things. It produces program effortlessly; it throws its actions into an outside world like light into darkness. Alas, this tireless Cartesian machine is a fictional character (mainly Dutch in origin); no act simply takes place in open space, no movement is unrelated to other movement. In the late 1940s, Merleau-Ponty already stated that, on the one hand, action was nothing but the world passing through the subject, and on the other, as organisms, we are only *structurally* open to the world; that is, only our bodies define what constitutes the outside world. Here, he is already departing from the classical distinction between idealism and realism, even between knowledge and world. There is no either/or: the world is neither pure interior (solipsism) nor the body pure exterior (representationalism). I am in the world, and the world is in me. This is a topological condition that cannot be described in terms of something volumetric, something with an outside and an inside. Its geometry would not be descriptive but would look at the dimension of the relationship rather than the volume – what Francisco Varela and Humberto Maturana call *structural coupling*.[6] Cognition, according to them, is lived experience, not located anywhere, in the subject or in the world; rather, subject and world coevolve, they co-emerge, *they structurally lock into each other's*

trajectories because of their transformability and plasticity.

If there is any intentionality involved, one cannot speak of it without speaking of the millions of movements in the world that are structurally linked to the millions of movements that condense into a structured body of experience. Finally, we would have to conclude that there can be no pure intention. No act is grounded; no act can be grounded; every act is in essence ungrounded or groundless; *an act is then only free when it is a leap*, a leap over this internal and existential void of freedom. Surely it must be a leap, because the body is tense: a tense, elastic structure charged with all these other movements, "old" movements that have been absorbed within the proprioceptive substrate of the body, old movements like habits that have been sublimated into higher structures with a tendency to act in the present. Merleau-Ponty refers to this as "abstract movement,"[7] a movement in the body that not only coordinates all actual actions *but also structurally and topologically connects all possible movements.* It is movement as an abstract capacity, the movement available in the body, a "background tension," he calls it, following the Gestaltists of the 1920s. In fact, this movement only becomes available to the body through the many actions performed in everyday life; it is not given, and one can lose it, too. *Movement is made up of movement*. The abstract and the real feed back and forth continuously, but only through the plasticity and elasticity of the structure. This concept of tension is very critical of the notion of intentionality, in which the body is solely seen as purposeful, as a mechanistic machine that has to start itself up every time a goal comes into view. Every act springs from this background tension, as a real, actual movement that "releases itself from neurological anonymity"[8] within a body where millions of processes go on simultaneously. In this view, subject and object must be deeply intertwined, hardly distinguishable, as are action and perception, the motor and the sensory. This is a deep critique of the architectural program: the mechanistic layout of all human behavior within a built system viewed purely as routines and habits. With the idea of rhythmicity – "an internal music," as Oliver Sacks calls it – an act

is never completely certain and always differs from itself.

Let us first briefly compare again, more precisely, the aforementioned categories of routines, habits and experience.

Routines are small programs that the body "runs" at specific moments in specific situations. They are scripts, little series of actions that are repeated over and over again. Kitchen-dining room. Bathroom-bedroom. Parking-shopping. Parking-office. Desk-meeting room. And so on. As we know, these are very mechanical scripts, *motor-scripts*, that are very often connected to mechanical objects like cars, computers, copiers, stoves and sinks, but also desks, beds, tables and the like. These acts are often accompanied by humming, or the radio, and mostly result in a bodily automatism in which one sometimes can't even fully remember executing a script, or in which the whole chain is broken when interrupted by some external event like a phone call.

Habits are of a different nature: they are of a larger scale, but often involve many routines. Generally, a habit is a social construct, an ethnographic one almost, in which practices are embedded fully in behavioral formalisms or lifestyles. The scope of habit is a true substrate of social and bodily clusters of actions that shape the way we work and live. But these crystals are not as frozen as we generally take them to be. We need constant feedback between memorized scripts and habits on the one hand and experience on the other. If not, we would simply execute programs, and all events and situations would be accidents. We need a plasticity that allows us to constantly adapt and to change. This is exactly what experience is: the becoming new of the old. It requires the full spatio-temporal engagement of the individual – as many early phenomenologists, like Dilthey, theorized a century ago. If an experience breaks away from memory, we call it an *Erlebnis*, a "lived experience"; when it is reintegrated into memory, it is called *Erfahrung,* "life experience." In that sense, *Erfahrung* is a deepening of *Erlebnis*, or an extension of the present in the body. But it is not sufficient to say that habit is a collective notion and experience an individual one. Experience feeds habit, not the reverse. Portions of the uninterrupted flow of experience are fed

into habit and memory. Habituation, the crystallization of behavior, should instead be viewed more as an emergence of repetition, more as a rhythm or a tune, an order emerging from different patterns of collective and individual processes. In this instance, an act can never be completely certain; it always differs from itself and is always ready to shift into another act or even slide into a "free" act. When every act, however intentional, is also oriented sideways, a lot of *in-between program* can unfold, both undetermined and unprogrammed "program."

The question then is: What kind of architecture would be responsive to such openness of action? First of all, it would be *an architecture of experience more than one of habit*. Experience comes first. But it should involve habit as well, not in the background but as something necessarily plastic and variable. In this sense, the relationship of routine, habit and experience should be continuous, not discontinuous. Often, when experience enters architectural design, it is applied as an extra feature, a bonus on top of the regular considerations of routines and habit. This mostly results in standard spaces with extra attention to lighting or the use of color and natural materials. But that is only an act of consolation, not a change, and certainly doesn't create continuity among the three dimensions of action. Continuity of routine, habit and experience should affect the geometry of the spatial configuration itself. I would like to try to take the topological view of the body and connect it to a topological view of program, to a topology of architecture, and even one of structure.

An architecture of the free would then be one that absorbs openness and the void, but not as program to be filled in. It would be one in which *the void is absorbed by matter,* where the void is not on the other side of matter but saturates matter, makes matter responsive, soft, one in which softness has become part of the geometry, leading to a literal flexibility. It is not a question of matter in space but space in matter. Instead of opposing image and movement, perception and action, or elevation and plan, I would merge them. I would opt for a geometry of the mobile, where the geometry has become part of the furniture, of the movable. Here,

we would have to go from a geometry of fixed points to one of open points, where points are part of the line, like springs,[9] which are responsive zones in the line, points that can both contract and expand, and that build relationships with other lines into a coherent flexible system. A tectonics of the responsive, of the springy and the flexible: in such a system, movement would never really dissipate and leave the structure, and the structure would never solidify. The building would be static, but the architecture would never be at rest.

The architectures of the fixed and the open plan – the respective crystallizations of the habituated and the unplanned – both focus *on the end of an act*, its objective or goal. Each says: No matter how an act emerges from the neurological jelly, it always comes out as a vector in space, an intention directed toward a goal. The only difference is that the intention of one is singular and that of the other is multiple. In this case, we would always be on the other side of freedom. Viewed over time, these types of architecture will always *react* to an act in the same way, with either disciplinization or indifference. This other architecture is an architecture of the *responsive*: it is inter-active, with action occurring between body and world and causing them to merge into one experiential system. Our alternative, topological architecture, locates itself at *the start of an act*, in the affect, at the capacity of action, in the haptic field of potentials. The direction of this vector coevolves between world and body; it is a direction with no outside or ground, and in this sense, *space is a byproduct of movement*, and movement does not take place in space. The void is not spatial and in front of us, but on the other side of the eyes; space is in the body. We should not forget that an act is always directed toward *situations* that have not yet become actual. Architecture should not *wait* for the real, should not passively wait for things to come, for life to happen; *it should itself be part of it*, be active, charge the present, multiply it with topological continuity. We do inhabit time more than space; we must build houses in time more than in space. (Don't believe architects who say that we occupy space, and that our intentions are directed in space.)

The rest would then be a question of methodology.

Instead of moving toward urbanism and the empty shell, leaving movement to furniture, architecture must move to the level of furniture, where it nestles in twirls, displacements, and shifts. There, it maps all movement as movement in tectonics itself; it absorbs minutiae, the tiniest things: a voice, a change of muscle tone, a cup falling, a pile of papers. The need to connect all the things we do, all our concentrations, to live either fluently or in tension, to make chains of actions without seams or hesitations, is interpreted in architecture, where it becomes structural. This architecture materializes the undetermined, it determines the undecided, not by deciding on a name but by articulating the nameless and building the amorphous; it shapes the formless and the informal – *it depends fully on the experiential without prescribing any specific experience*. It maps potentials within a medium that is both highly structured and soft; it restructures by coordinating these potentials, and here it opens up to the real. Within this soft coordination, the real emerges and never recurs in the same way; now experience and geometry are merged in matter.

V2_Lab

We should now take a look at an actual case in which the thoughts developed above were tested in an architectural design. Since we are relating architecture to experience, it is no accident that the case concerns the offices of an art institute. The V2_Lab is the office of the V2_organization, an arts and technology initiative based in Rotterdam. The lab is meant to be a space where artists and staff interact to collaborate on the production of art. For the design of the V2_ organization's offices, we developed two diagrams, one flexible, the other mechanistic, and then intertwined them. We unite the two by multiplication onto a higher level, where the abstract movement of both architecture and body exist on one continuum, resulting in real, actual, action.

a. In the mechanistic diagram, we mapped the planned movement in the building, in a quantifiable scheme of all actions as seen through the purely mechanistic filter of running lines, bubble diagrams and organograms. This is the classic method of dealing with the organization of behavior in an office: one connects all functions via lines, as in a railway network, with each function as a station between movements. Habits, tasks, work: every action is viewed as repeatable. Every action is described by a vector within a system of architectural elements such as walls, ramps, an (elevated) floor and many desks distributed over the floors. An action can only safely repeat itself if it doesn't interfere with others. Now, generally clients are in the habit of drawing these kinds of diagrams, which is understandable, but architects are generally in the habit of simply materializing these diagrams, which is not so understandable.

b. In the flexible diagram, we mapped all the tension, all the movement communicating in between; this is exactly the reverse of keeping events separate and connecting them through a medium in a topological relational system of potentials. Digitally, this model consists of what I call a springs-and-strings model made up of lines programmed as flexible matter ("rubber"): when a force enters it, it not only deforms but also responds. This diagram is truly a machine in the sense that it actually moves and vibrates. We achieve this by making a number of springs control a system of strings. The springs are determined by five parameters: elasticity, damping, incompressibility, density, and friction. We can choose to make them very stiff or very flabby, according to the desired interaction we would like to induce; the character of the material is related to the dimension and form of the machine. "Data" and "scape" are not separate entities; the "scape" is already a structure with a certain capacity to absorb certain information. In this structure, there are no points, only zones of contraction and expansion. There are no lines either, only coordination of the various zones by means of waves.

Then we started contemplating how to coordinate the flexigram model of springs and strings with the mechanogram of sticks and hinges. The flexible system is made up of five parallel strings connected to a large central spring; therefore, each change is processed throughout the whole system. The mechanical system is different; since it consists of points and lines, one can add or subtract elements without changing the configuration of the whole too much. So although the flexigram undulates and vibrates, the various positions of the snare lines need to be checked against the mechanogram. Let's follow the lines from bottom to top. For instance, line five moves up, ergo there is "a table." But at the same time, line four moves down, ergo there is "a ramp to an elevated corridor." Line three moves up high: "the elevated floor." We get the same result for line two. Line one follows the edge of the window. So instead of the mechanistic diagram being materialized in a system of separate elements, the elements are all read as modulations within a single system of variability.

At the next step, all five snare lines – now in their static positions as curves – are connected by ruled surfaces, resulting in a dented landscape-like surface. So the becoming-surface hasn't made the lines disappear, neutralizing the longitudinal orientation; they are still readable as creases in the surface. That is, lines are pure orientation, and when absorbed in a single surface, they generally tend to lose that orientation, but here this is partially registered, since the ruled surfaces create a variety of creases of varying sharpness. When the fold between two ruled surfaces is sharp, it orients more in the longitudinal direction of the lines, and when it is less sharp, the difference between both surfaces is smoothed out and the orientation becomes multidirectional. The surface introduces extra lateral movements. There is an increase in order, just as when ridges emerge in dune formation: they appear out of the surface, the field of sand, but do not separate themselves from it. Generally, we read either one or the other, field (open) or line (directional), but the ordering principle actually lies in the mixture of both.

Let us now focus on a single area in the office: the table

contour derived from line five and the corridor ramp derived from line four. Remember that we have a mechanistic diagram functioning on top of a much more open landscape. According to this mechanogram, we read very precise sets of routines and habits connected to these areas: working for the desk and walking up and down the ramp for the inclined surface. But we must ask ourselves: If those two areas are so well defined, what is the landscaped surface in between? It is not covered by the list of programmed routines. It is not fully defined: it is possible for something more to happen there. The actual connection of the one contour (table) to the other (corridor) is in fact a transformation of a table into a corridor, and this materialized in-between is actually larger than the objects/edges themselves. Habituation, tasks, and performance are still there: three people can sit to one side and work, for on this edge it is 100 percent table. The other line indicates 100 percent ramp: people walk up from the existing flat floor onto the new elevated floor via this curved surface. It exactly follows the mechanistic diagram in which corridor and table were separate entities. But since the edges have names ("table," "ramp") and the in-between does not, there is no way to say where the floor stops and the table begins. All this is absorbed by the materialization of the undecided: the *potential* of the program (which of course is not programmed) is in the field, the ruled surface. Architects usually expend their energy on things that have names, not things that don't.

When we concentrate on people's actual movements and behavior, using the motion-capture diagrams of actual actions, we can observe how the two interact. Of course, if we traced a thousand behaviors around this area, most of the lines would coincide with the running lines of the mechanistic scheme – which is actually a good result. Let's look at what actually happens on a single day. Suppose one morning you feel exceptionally happy or excited. Upon entering the space, you could, as I have seen people do, suddenly speed up, run across the surface alongside the table and then walk up the ramp into the corridor. Or you could just walk straight ahead, as unexcited as on any other Monday, and proceed

down the hall to your desk. On another day, you might walk up the ramp but not proceed; you might stop, turn right and sit down on the large surface between table and corridor and drink tea with the person at the table. This happens sometimes in the afternoon, when people are in need of a break. Sometimes they walk up the slope to speak with the manager, who is then suddenly three feet below, sitting at the table. Since the surface is in between and therefore less defined in its functionality, it leads to a wide range of behavior.

This behavior, we must emphasize, depends on how a person feels. Action regains its bandwidth, its elasticity, its potential, purely in relation to feeling. The vibrations of the "rubber" strings reemerge in the traces of behavior: it is the same tension in different materials. This "beach" between objects, this beach moving among the standard elements, was not in the program; it is an *intensification* of program, or more precisely, a "tensification" of program. And it is exactly because it materializes the undetermined that it creates tension and freedom. If we consider that all action develops in interaction between ourselves and the world – what Francisco Varela calls *enaction*[10] – then freedom must be understood as such. Freedom is not action unobstructed by the world. Freedom is interaction, enaction, new action, where an act is a creation, an experience. We generally understand experience as the experience *of* something, but here we should leave out the "of"; this is disconnected experience. Nowhere in the program list did the client state that it wanted a space for lying down in the afternoon and drinking tea, or a space where you can change your mind and walk back. The standard option of leaving the space between table and ramp open would never afford such behavior. But here, the undetermined landscape precisely affords a much wider range of actions, but all ones that function as subsets of office work. We have not added wildness to office behavior but rather intensified it and therefore created something productive and desirable: freedom in work. Movement does not stop; there is no final equilibrium; the machine does not leave the architecture when it is realized as form. The diagram does not stop being a

machine when it is materialized, and, more importantly, the diagram was never immaterial in the first place; it was constructed in the digital rubber of the strings-and-springs model. This is exactly where the movement goes, or even the "rubber." The flexibility of the rubber is shared *over time*, through concept and percept, by the conceptual machine, the materials in the built structure (plywood and rubber and plastic), but also the neuroelectrical flesh of the human body. It is shared and thus not located, not anchored. *It is the unlocated affect that is distributed over diagram and matter simultaneously*.

In essence, the movement in the building is informed by the movement in the architecture; that is, the abstract movement of transforming a table into a ramp directly affects the behaviors implied by both the ramp and the table. This topology is linked directly to the abstract movement in the body, the potential for action. Every general intention carries a lateral orientation; all longitudinal intentionality carries a transversality; all habitual transparency is haunted by an opaqueness; and therefore every straight line comes out as a wave. One movement *interferes* with another; it multiplies it, and therefore both merge; actual and memorized movements interact; bodily movement and geometry act along one continuum. This is why habits should not be set against free movement, play, or experiment. Habituation is an increase in order. It makes our rhythms stronger than we are; but even when there is a high level of repetition, it should never simply be crystallized in a top-down order of building. It should be different each time it recurs; it should emerge time and time again, negotiating with the background time and time again. The structure's plasticity and the human body interact continuously, sometimes forming crystals of behavior, and sometimes slipping and becoming new.

1. From Varela, Thompson and Rosch, *The Embodied Mind* (MIT Press, 1997): 174–5.
2. Maurice Merleau-Ponty, *Phenomenology of Perception* (Routledge, 2003): 127.
3. Ibid.: 165
4. Oliver Sacks, *A Leg To Stand On* (Touchstone, 1998): 194.

5. Sanford Kwinter, "FFE: Le Trahison des Clercs," *ANY* 24 (MIT Press, 1999): 61–2.
6. Humberto Maturana and Francisco Varela, *The Tree of Knowledge: The Biological Roots of Human Understanding* (Shambala), 1987. Varela later broadened the crucial concept of *autopoiesis* and *structural coupling* onto the level of perception and action with the notion of "enaction." See: Francisco J. Varela, Evan Thompson and Eleanor Rosch, *The Embodied Mind* (MIT Press, 1993), especially Chapter 8.
7. Maurice Merleau-Ponty, *Phenomenology of Perception* (Routledge, 2003), especially Part I, chapt.3.
8. Ibid.: 125.
9. The term "springs" refers to the specific definition of points in the software we use to generate form. This "strings-and-springs" model should be distinguished from "lines and points" as they exist in drawings.
10. Francisco J. Varela, Evan Thompson and Eleanor Rosch, *The Embodied Mind* (MIT Press, 1993).

The Soft Machine of Vision

In Conversation with Arielle Pélenc

The following conversation took place on the occasion of the exhibition Vision Machine *at the Musée des Beaux-Arts in Nantes, France. This exhibition, curated by Arielle Pélenc, featured hundreds of mostly 20th-century artworks that examined the problem of vision: how it emerges, how it is structured and how it relates to body and space. At her request, I designed a large structure to house the works, which was kept in the museum until long after the exhibition was over.*

> *AP: When you first came to Nantes, you were very much concerned with proprioception when you discussed these perceptual experiments by the artists in the show.*

LS: In short, proprioception – a neurological term – is the internal consciousness of muscles and tendons within the whole of the bodily posture. To explain better it might be convenient to refer to Oliver Sacks, the English-American neurologist and writer. He wrote the famous book *The Man Who Mistook His Wife for a Hat*, a compilation of 20 case studies from his practice in New York. What I find so interesting about contemporary neurologists like Sacks, but also Ramachandran and Antonio Damasio, is that they are the most anti-Cartesian thinkers in the world. There's no ego-homunculus steering a machine of flesh waiting passively to be started up again and again, no mind-body split, but a complex system of feedback loops, structural changes and interactions. To them, consciousness is not the holy center onto which the world is projected and from where it is observed. It is part of the structural relation with the world, part of the body itself and its transformations.

Proprioception, especially to an architect, is a very interesting concept. It is the self-perception of the body, but it is both blind and unconscious. It is completely self-referential. Actually, when you lose your sense of proprioception (and Sacks describes such a case), you can only slightly make up for it through pure, conscious attention. Instead of just picking up your cup off the table to bring it to your mouth to drink your coffee, you would

have to lock in consciously on the cup with your eyes and "send" it to your lips, without taking your eyes off it. Proprioception is nothing but your sense of movement related to posture. An architect would say space is outside the body and where the possibility of movement lies, but neurology teaches us that movement is first and foremost part of the structure of the body. And, even more interestingly, the structure of the body is plastic, capable of transformation. Movement is an abstract capacity stored in a plastic structure of the body. The body is tense, never at rest; movement is always there and has to be actualized by action, and every action is written into this soft structure of the body again and again in order to become coherent and habituated.

How do you see the relationship between vision, body and space?

This is very much related to proprioception. Just look at what the museum generally is as a structure – what any museum is, for that matter. There is the floor; it is horizontal, as is usually the case. All action takes place on this surface; all movement is planned (by architects) on this horizontal surface. Then there is the wall. It is vertical, perpendicular to the floor, and on it are the images, the pictures that make up the museum's exhibition. That is the surface for seeing. We should always realize that this architecture is that of the Cartesian body: the part that sees is separated from the part that walks. You either walk or see. Perception and action are completely separated. The way the bricks that make up the museum are stacked on top of one another, along the vector of gravity, is exactly the posture of standing, of the standing body. It doesn't bend, twist, run, dance, jump, lie down or move about in any way – no, it is a column of flesh. So this absolutely passive concept of the body is related to this other concept, which holds that seeing is always considered as measuring yourself against the horizon, the datum of horizontality. You see, it is completely related to not only the Cartesian splitting of mind and body, but also of subject and object, of body and world. This concept still holds

in cognitivist thinking, where the world is passively projected onto the mind, which, after some information processing, projects its actions back onto the world.

> *What were your first ideas for how our exhibition,* Vision Machine*, could get around this problem of separating action and vision?*

When I saw all the images – the chemical experiments of Karol Hiller and Sigmar Polke, the emergent images of Kupka and Morgner, the drug experiments of Henri Michaux, the algorithmic hallucinations – I saw one thing only: the vortex. It's like the Lucretian *clinamen,* that small instability from which everything originates. The vortex, or the swirl, has played an enormous role in the history of art and perception. It is, of course, organized around a vertical axis, and when the vortex is related to perception (by Poe, by Blake, by Rimbaud), it becomes the axis of vertigo. And vertigo is falling within one's own body: it could be heaven, but often it is hell too. There are hundreds of descriptions of visions of spiraling structures with people going up or down. And the vortex is often accompanied by very strong, glowing colors or bright lights. Just think of Huxley's mescaline experiments in *The Doors of Perception* – or all the reports of near-death experiences. Pure psychotropic trips! This lightening of the body is always related to hypervision, extra vision: the colors are thousands of times brighter; everything shines; it is pure happiness. All these visions contain radiant objects, like palaces made of emeralds or gold, diamond forests, rivers of ruby, and the like. Hallucinogenic imagery is deeply related to jewelry and gems, as we hear in, for instance, the song "Lucy in the Sky with Diamonds." Huxley's essay that is always published together with *The Doors of Perception*, *Heaven and Hell*, extensively discusses the reciprocal relationship of shiny objects with trance and ecstasy. Heaven and hell are obviously not our normal spatial categories; they exist on that aforementioned vertical axis, spiraling up- and downward.

This is a clear indication that the posture of standing up is

not the only one that enables a human body to see things, so to speak. Now, in architecture in general, horizon vision is that of outer orientation, and vertigo vision is that of inner orientation. The former is that of finding your way, the latter of losing your way: the spirals of the labyrinth. Now, mind you, I didn't want to build a labyrinth; I am interested in a productive mixture. So I am in between; I am always in between. I agree so much with Varela that the in-between is the most radical position, because that's the one that works; the extremes are only ideological and therefore inconsequential.

You have also often referred to various cave images as vision machines.

Yes, I used three different historical concepts of the cave as related to vision. I am taking the liberty of skipping Plato's cave; these three are the ones that were most on my mind while I was designing the exhibition. One is a fantastically strange, mathematical cave of Charles Sanders Peirce; the second is the cave paintings studied by Jean Clottes and David Lewis-Williams; and the third, of course, is Frederick Kiesler's Vision Machine, on which you modeled your exhibition.

OK, let's start with Peirce's. Where does it come from?

It's from "The Logic of Continuity," the eighth lecture in the series he did at the Cambridge Conferences in 1898. Before we can discuss that, I have to quote it extensively:

> Now I am going to describe an unbounded three-dimensional space, having a different shape from the space we know. Begin if you please by imagining a closed cave bounded on all sides. [...] I will also suppose that you can swim about in the air regardless of gravity. I will suppose that you will have learned this cave thoroughly; that you know it is pretty cool, but warmer in some places and that

> the different parts have different odors by which they are known [...] neroli, portugal, limette, lemon, bergamot and lemongrass, all of the generically alike. I will further suppose that you formerly inhabited a cave exactly like this one, except it was rather warm, that the distribution of temperature was entirely different, and that the odors in different localities in it with which you are equally familiar, were those of frankincense, benzoin, camphor, sandalwood, cinnamon and coffee, thus contrasting strongly with those of the other cave. [...] They are open to one another. You can swim up to the other balloon and try it. You pass through it readily; only in doing so you feel a strange twist, such you have never felt, and you find by feeling with your hand that you are just passing through one of the corresponding balloons of the warm cave. [...] Finally, you are told that the outer walls have been removed. You swim to where they were. You feel the queer twist and find yourself in the other cave. You ascertain by trial that it is so with every part of the walls, the floor and the roof. They do not exist any longer. There is no outer boundary wall. Now, this is all quite contrary to the geometry of our actual space. Yet it is not altogether inconceivable even sensuously.

For Peirce, this was a sort of sensual-mathematical proof of the existence of continuity, which is very close to the emergence of topological space in the 19th century. Generally, we understand topology as the most abstract of spatial descriptions, but here it is directly connected to smell and touch. As Peirce says, "Nothing but a rigid logic of relations can be your guide in such a field." This taught me various things. First, the feeling body itself is a space. Second, it is a space of internal relations; there is no depth, no horizon, just sensation. So, third, it's not only the relations that are continuous but also the geometry of the actual space. It seems that the space of sensation doesn't need walls, floors or roofs; suddenly the outer boundary wall has disappeared! Sensations

network with sensations, creating their own space of continuity. My question has always been how to create an actual space that incorporates that bodily space, that doesn't interrupt it, that rubs over it, activates it and negotiates it. Not that I want people to float or swim, not at all, but I want to have bodies deploy more postural freedom than the standard architectural trinity of sitting, lying and standing.

> *It seems that designing a space for viewing works of art in such a way makes them continuously connected; seeing the works and feeling their impact is immediately related to the space itself. It's interesting, though, that your first neurological examples had to do with vertigo, while in Peirce's space there is no loss of orientation, since the subject is floating or swimming. Let's proceed with your next cave example.*

That one is derived from the cave studies done by Jean Clottes and David Lewis-Williams and published as *The Shamans of Prehistory: Trance and Magic in the Painted Caves*. They studied rock paintings in the most important caves of Southern France and Northern Spain. These paintings played an important role in rituals in which the shaman went through a series of mental transformations. For all these incredibly beautiful, horizonless paintings, the authors have distinguished three stages of altered consciousness. The first stage is the imagery of scintillating scotoma, the flickering zigzags of migraine vision or ecstasy. Very well described by different authors – again including Sacks, in his beautiful first book, *Migraine* – these are the images you'll see when you take mescaline, or psilocybin as it comes in certain mushrooms, or after long sensory deprivation, or when you combine vigorous dancing and rhythmic sounds: the basic shamanist routines. The second stage is translation, the continuation or preservation of these images through better-known ones. For instance, 20,000 years ago a zigzag was translated into a painted image of a snake. The third stage is the one Clottes and Lewis-Williams actually call the vor-

tex, or the funnel. After the rite of passage, the spiraling tunnel, one enters a world where the real and unreal are no longer separate. The shaman has entered this level of transformation, of metamorphosis, where he can change into a bison or a fox.

In order for this to work, the cave paintings have to "float" on the rock, not be fixed in a frame, not be related to any outside, because the outside is actually *in* the wall, or *in* the body. Clottes and Lewis-Williams discovered a fantastic feature of cave painting, one which brings it extremely close to interactive electronic art. A lot of the paintings, like an antelope or the head of a bison, were only half-painted, the rest of the image was the shadow thrown on the rock by the torch because of the specific topography of the rock! With the torch, they saw half a bison here, half an antelope there, and finished it in paint! That is exactly the relationship I would like there to be between my structures and the images on them – one in which the structure is not a means to carry and support the images but to lift them in such a way that the body looking at it "flies in": the wall becomes a window for entering the image. To achieve this, it is absolutely necessary to implode the distinction between here and there, here-eyes and there-horizon, and let the horizon be swallowed by the point where you are. As an architect, you can only do that by leaving behind the distinction between floor and wall, between vertical and horizontal. That is where you enter the realm of topology, of rubber-sheet geometry.

> *Let's move on to your final cave, Kiesler's. He was, of course, one of the first architects of the continuous and topological.*

Yes, there are two cave projects I want to refer to, actually. The first one that has served as a guiding example for our purposes was the *Blood Flames* exhibition. In 1947, Kiesler was asked to design the exhibition for the Hugo Gallery in New York, a straightforward rectangular box. He started by painting a red band of variable width around the whole space, going from the floor over

the walls, across the ceiling, and back onto the wall and floor. The band formed a complex network crossing over the single space. This illustrates quite powerfully what Kiesler always meant by "endless": he meant continuous, a continuous band of relationships, in this case between artists and artworks. The paintings follow the band as it swirls through the space: paintings lie on the ground, jump between wall and ceiling, hang at an angle again, and some are actually upside down on the ceiling. By the way, I always found these exhibitions of Kiesler's more interesting than his Endless House, because they are more articulated; the various directions of the bands make the endless more readable and more expressive, since with an egglike volume all the directions start to even each other out, and the space becomes more introverted than extroverted. Though Kiesler on several occasions very clearly stated that the Endless House was not an egg, nor was it amorphous, and it was also clear that he used *bands* of wire mesh to model the house, I still feel it could have been more rigorous, using the tectonics of flexible bands more than resorting to the claylike sculpturism of massing.

His Vision Machine, which you named your exhibition after, is of a more abstract nature, sort of between Peirce's cave and Kiesler's own exhibition design. The simplest way of explaining the machinery would be that in Kiesler's view there is a parallel between the installation of images as a machine and vision itself – a reversal of the vision machine into a machine of vision. It's obvious that his 1938–42 drawing of the Vision Machine hardly shows boundaries between the brain and the paintings surrounding it. For him, sight is a flow, a continuity, and the Vision Machine is a sort of pedagogical, demonstrative apparatus that shows, as he says, "that neither light, nor eye, nor brain, alone or in association, can see. But rather, we see only through the total coordination of human experience."

> *You call your Vision Machine a "wet grid." That seems like one of your oxymorons, like "deep surface."*

Yes, the grid is one of the oldest tools in architecture. If an architect wants to create order – from that perspective – he jumps into his metaphorical helicopter, flies up, and drops a grid onto the situation. It is a military action. The grid is directly connected to the literal view from the top and to the top-down view of order and coherence at the same time. Now, that grid, the Greek grid, is something completely different from what we call a network nowadays. Let us not forget that both terms are diagrammatic: they are explanatory schemes, they are literally "views," percept-schemes used as concepts. The network is, of course, the contemporary view of emerging order, of self-organization, of bottom-up coherence. So the first view is where order is forced upon matter from above, while in the second view, order emerges out of material interactions: pattern, stability, order on the edge of chaos. The wet grid, then, is an in-between situation, very close to a liquid crystal, where order is neither the solid-state condition of the crystal nor the completely liquid state of "free" movement. Actually, a liquid crystal is not a halfway form between liquid and crystal but a higher form of order. Liquid does not have enough coherence, has no holistic properties, cannot act as a whole; on the other hand, solid-state crystal is a whole but cannot act because it consists of only one state, so it only survives in stable, unchanging conditions. The wet grid is neither exactly lines nor surface, neither dimension one nor dimension two, but strategically in between, and stronger than either one. It is not neutrally halfway though, not like one-point-five, since by its nature it cannot be homogenous; it must be a heterogeneous assemblage of multiple dimensions. Patches of weakness and patches of strength together make up the hybrid of softness. The softness of the grid makes it transformable. It makes it stronger than a rigid grid because time is inherent in the structure. Points can become little knots or springs, and the springs may unfold into lines again; the lines may split up and become more structural, more like surface. But, as you see, with this interior view of the grid, the bottom-up view, the lines are suddenly not flat ink anymore; they have taken on material properties. This is no longer molding the clay from the

outside by drawing; this is building a machine of variability, one of modulations, of continuous variations.

So I don't draw. I'm not up there in the air dropping black lines onto the world.

Isn't the "wet grid" also connected to the research of Frei Otto?

Yes, very much so. For Frei Otto, it is a way to calculate either the branching of columns or of roads (ill. p. 134). Taking roads as an example, he set up an experiment with woolen threads. First, he mapped all the possible goals in a situation as pins on a board. Then, he connected all the pins with woolen threads, so you could go from any starting point straight to any end point: a grid without any detours. But obviously this is an incorrect way to set up a road system. There is no hierarchy, no coherence, only the possibility of individual routings at the cost of having an enormous surplus of roads. In his experiment, Frei Otto then made a wonderful decision: he lengthened all the woolen threads by 8 percent, indicating the average amount of detouring for all the routes. Then he added a little water to the system, and the moistening of the threads made them stick together in certain places. What actually happens is an economization of detouring, the organization and regrouping of the extras. When the system dries, one sees an emergent, self-organizing order in which the lines suddenly form a network instead of a grid, where in some instances eight lines have stuck together to form a thick line next to large open spots, and sometimes thin lines form a small-scale web, more like a surface. Suddenly, there is a hierarchy in the system, as in a liquid crystal: there are patches of thickness, of clear singular orientations, in a sea of thinner connections of multiple orientations, in a heterogeneous whole whose dimension floats between one and two. Of course, these are computers: Frei Otto used empirical computers to calculate shape and structure.

So how do you work with computers?

The computer is the main tool for evolving from the interior of a system towards a drawing, pushing the drawing into yet another system, and evolving it from there towards a new level. So it alternates between emerging orders and projected orders, and each time it jumps another level toward actualization. This is different from working with the standard draw-diagram-and-materialize-form procedure. Architects always make conceptual diagrams, infograms, ideograms (just observe how they switch between 0.3-mm pencils, ink, thick black lead and felt-tips); they sketch and sketch and work their way out of the complexity by a process of reduction, mostly by doing Euclidean redrawings of the sketch until it becomes a single-lined, clear crystal, with edges defining where each architectural element ends. I work very differently, because on the computer this materialization of the line, between vague and thin, can be instrumentalized, and instead of me animating the curves with subjective feeling, I let the software do it. I work with what I sometimes call *sensograms*: diagrams that incorporate both the extensive and the intensive, and an equal amount of physical movement next to psychological movement. This diagramming of feeling is essential to me, not only when dealing with art, where the pulses of attraction and rejection are simply programmatic, but also as a way to basically affirm the world as one of movements. If you study the little sketches by Finsterlin in the exhibition, which are absolutely amazing, you could speak of calligraphy, machine states of automatism, mental machine states drawing the lines – but it would still be very hard to circumvent subjectivism. There's no way Finsterlin could have shared his method with others, and I consider that a weakness. Well, at least in architecture; maybe not in art.

I analyzed the existing Musée des Beaux-Arts de Nantes as typical of a classicist center-periphery relationship. The periphery is the gallery, horizontally vectorized; the center is the central atrium, basically a cupola, a dome, vertically vectorized: the eye immediately looks up towards the light. Again, the one stresses more the importance of the feet, the other that of the eye. Now,

my design technique, my methodology, has been quite complex, a sort of hybrid of digital computing and material computing, because I wanted that transfer from computed to materialized to be as smooth as possible.

On the computer, I put eight double lines on the grid of the Musée, from the entrance through the entire depth of the building – this is the general orientation of the movement. Very simple. Then I put four "vortex forces" in what I would call a self-choreographing machine. This machine, which looks like a hand, coordinates the movements of the vortices. Now, I should explain how this works. A vortex is a rotating force that develops over time according to various parameters. They use this in Hollywood to make films about catastrophic tornadoes, such as *Twister*, by the Dutch director Jan de Bont. It's very impressive software; you can have dirt, cars and cows flying around in the tornado. I used the vortices for movements, gestures, but the skeleton that coordinates them works interactively; it's not like a hand operating a marionette. Skeletons in animation software are generally used to build the bodies of people or animals that will act in scenes, but of course if you can connect "bones," you can use them to build any kind of skeleton. So in this case, we're building more of a machine than a body. But although this machine's movements are mechanistic, the tips of the bones are connected by elastic bands. It's like teaching four dancers a certain type of rotating movement separately and then connecting them with elastic bands. That would change their individual movements into a new emergent pattern – and this is what happens within the structure of the eight double lines.

After we'd studied the behavior of this system and knew what its possibilities were, we adjusted the limitations of the different bones in the skeletons until everything was in accordance with our general intention for how to read the program – I'll come back to that. What the system basically did was to let some of the lines form complex nodes while others split up. Reading from the entrance of the Musée towards the end of the atrium space, three lines formed a knot, then this knot split up into two lines moving

to the left and one to the right, forming another knot on the right side of the atrium, connecting to yet another group of lines. It's more complex than that, but that gives a general idea of the capacity of this system to form a soft grid out of parallel lines. Normally, a grid is formed by overlaying two perpendicular systems, but here, it was generated by lateral movement in a longitudinal system.

> *And how is this system related to the actual artworks we have in the* Vision Machine *exhibition?*

The first lines were placed on one level in the computer, eye level. And when they start to twist and curve in different directions under the influence of the vortex, two things can happen. One, when a line moves down, is the tendency to become "floor." Second, when lines split up, they have the tendency to form roofs of spaces. All splits between double lines are interpreted as volumetric space, and the others that don't split up as accessible surface, i.e. floor. This is very important in relation to the program, the paintings and images. The four skeletal arms with the vortex forces attached to them correspond to the four categories you conceived for the exhibition: the *mondes invisibles*, the *mondes émergentes*, the *vision machine* and the *mondes connectés*. Actually, the sizes of the forces are related to the sizes of the works in the four categories. All of them, in all kinds of different ways, relate to the in-between of cell and grid. In architectural terms, the floor transforms into domes: tiny helmet-like domes for smaller works like Michaux's and Finsterlin's drawings, in-between ones for medium-sized paintings like Polke's and Kupka's, and the largest domes for large paintings like Yves Tanguy's. Of course, it is connected to vision: the cell is the monad, the helmet or the capsule. It is the eye of the tornado, where the vortex gives the most vertical inclination to the system, where it opens up the most to vertiginous images of ectoplasm, hallucinogenic imagery like Henri Michaux's. The grid is what connects, where the influence of the vortex radiates and is distributed more horizontally

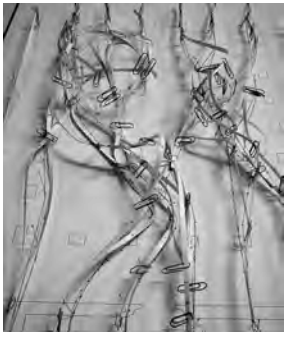
from one node to another. So the grid and the cell aren't simply opposites, like gallery and atrium, but opposite states of one continuous system: every time you see, you're also walking; every time you walk, you're seeing. The result is that no painting is 90 degrees vertical and no floor is 0 degrees horizontal, except when you're outside the influence of the vortices.

How do you translate this system into construction?

To recapitulate, we have started with a system of eight double lines that can twist and bend with the forces of the vortices. These rubbery lines form knots and splittings. But they have no structural capacities you can use for a built structure; they are built to absorb perception and movement but not gravity. Now, what usually happens is that architects place columns under the diagrammatic lines and then realize the resulting form. That is the worst solution. If we can interpret the structural (de-)formation into perception and action, then why not construction as well, to synthesize all three?

As the rubber lines in the computer model were moving towards each other and at the same moment another group separated, we took a snapshot – absolutely a top-down action – of a group of 16 lines with a certain pattern at a certain moment. Deleuze would call this movement by limits, "the passage to the limit," an action very much like that of a gearbox: when a certain stage reaches its limit, a threshold, you must make it jump into another state. That was the moment to switch to paper modeling. We printed this snapshot of Klee-esque quivering lines onto a sheet of paper, like a drawing, and glued it to cardboard. We introduced 16 strips, this time made of strong, thick paper, which we tried to make follow the twists and bends of the ink lines. But instead of trying to rebuild it as a model, we used the paper as a new way to "calculate" the shape. In fact, this stage was more like a paper computer. If two lines of ink were bending in the same direction, we interpreted this as a tendency to connect, so we split up the paper line and joined it to the other with a paperclip, some-

where up in the air, since the ink lines are on the flat paper of the diagram and the paper strips can move three-dimensionally up and down. Now, this is a very old structural principle, a Gothic principle, in which the vault is nothing but a surface that emerges out of a splitting of the lines, i.e., the columns. So we were suddenly building vaults! Vault-helmet-cells that emerged out of a surface with zero thickness, like blisters! From then on, we had a very basic structural principle that could easily be built in wood. And of course, because the whole thing was done on the computer, all the information of the curvature was easily translatable to a milling machine that cut all the wood for us. So when we finally twisted the computer into a conceptual device, it still ended up as a very instrumental machine, which is actually the whole secret.



NOX, wetGRID exhibition design for *Vision Machine*, Musée des Beaux-Arts, Nantes (1999–2000). *Left* Paper Machine based on digital vortex pattern. *Right* View from upper gallery.

We have a kind of alchemy of materials: (1) rubber, (2) paper and (3) wood. There is a sharing of information, a continuous flow and exchange between them. Of course, the main question then is how that movement is extended, how it progresses through the works of art to the body.

Yes, we have to look carefully at the different works to see how the machinery as a whole works on the body. Obviously – and I have to say a lot of artists don't realize this – a painting is part of a wall. A painting is already an installation. A painting is hung straight from a vertical wall, and we stand vertically in front of it. Now, our paper bands have not merely been incorporated in a wooden structure. If you look carefully, you'll see there are two interrelated elements: the first is the variable wooden lattice that bulges and deforms with the vortical forces, and the second is the wooden bands that run over that surface, as an intermediate between the spatial structure and the artworks. The wooden bands follow the paths of the paper bands from the second-phase model, the one after the rubber-vortex model. These bands, like Kiesler's in *Blood Flames*, go from being in a pretty steady eye-level position to swirling over the ceiling. Keep in mind that these works have frames and generally have a recognizable top and bottom. I don't just want to turn images upside down; what I want to do is make the conceptual space of the works drive the architecture of the space itself. Can I make the perception-sensation of the works the architecture? I mean that literally, not metaphorically. I don't want to interpret; I am not interested in language. So some of the works are more photo or painting than others and therefore are hanging almost at a 90-degree angle, and others are flying across the ceiling.

Like the Michaux drawings!

Right. What a difference from the Yves Tanguy, which is only tilted five degrees forward. Michaux's drawings, made under the influence of mescaline, are at the ceiling, but very close to your face, only a foot or so away. The drawings allow for this too, since they don't have a clear top or bottom. So you start to look up and you lose that reference of the horizon. You look up at a work, and you don't have top and bottom anymore; you can just turn in any direction. And you see people doing this in the exhibition – they stand right in the vortex. It's actually quite shocking to me now,

after having worked on the project so long and seeing the rubber tubes twist and turn on my computer screen, to see all that movement locating itself in people's necks, hips and shoulders. Between standing up straight and looking up with your head stretched fully backwards, we have many, many different postures. You see people tilting their heads, backing up, bending their knees, but also sitting or even lying down and looking up. So it's not that at a given moment we are in a mental design space and proceed slowly into a physical space of sensations and feelings. No, the rubber feels, the paper feels, the wood feels, the paintings feel, the people feel, and they all affect each other. There are no boundaries. You see? Continuity is not a formal thing; it's everywhere at once; it's an expressionism that runs all the way through.

Africa Comes First

A Conversation with Rem Koolhaas

As we – we the digerati – were slowly starting to dream of a "transarchitecture"[1] in the mid-'90s, "transurbanism"[2] had already been developing for a while. If transarchitecture was an architecture with a theory but no materializations, transurbanism was the opposite: exploding cities, in-between cities, city regions, city airports, cities without urbanism, growth without planning or theory. And while we were experimenting with wiring up geometries, global networks and global economies were actually producing new cityscapes: not the homeopathic enclaves of New Urbanism but a migration of cities themselves, a migration within urbanism itself. In short, as computing got involved in architecture, media got involved in urbanism. Both saw it as their primary mission to save us from "design," from the idea that the world needs personal intervention, either through happy subjectivity or cultural negotiation, either through an individual or a collective signature. Nothing is less true. When going from objectivity to materialist, no detours are required, only means of production. In this sense, I don't think that learning generative computing is that different from going to Lagos.

I have been wanting to interview Rem Koolhaas for a very long time, because he is following this other vector – not so much one of computing but one of a world which, in a way, designs itself: *the world of the default*, of the generic, where the diagrams are not taken from other disciplines but are the actual operational forces of globalization, of mediated technology and modernization. Koolhaas himself has coined the word "¥€$" for this world of neo-liberal compliance to global flows of capital. Koolhaas' world is one of criticality and of resistance, while at the same time one of immediate confirmation and "surfing the flows." As he said in an interview several years ago, "I am only interested in joining in."[3] Obviously, this position is highly paradoxical, but that doesn't need to be problematic in itself; the real question is if it leads architecture anywhere.

We can observe three specific types of such resistance in Koolhaas; the first is the *undesigned*, the second the *unbuilt*, and the third a resistance of the *unsaid*. Let's look at them one by one.

The Undesigned

The first resistance is more an acceptance: an acceptance of the ready-made, of certain matter and materials, of what he has on many occasions called "junk,"[4] something that has now begun to alternate between American junkspaces and African junkpiles[5]. I am especially interested in how, for Koolhaas, the image becomes a material; how facts become a material through photography (and subsequently how photos become part of design through Photoshop): and later in Africa, how materials seem to acquire a hold over the image, in a continuous blurring and reprogramming. And then there is his clear obsession with product catalogs, which is an architect's main source for materials to use – much architectural design consists of organizing things already designed by others, such as doorknobs, tiles, and ceiling and wall systems. The specific nature of the undesigned lies in the matter-of-factness with which Koolhaas selects materials from these catalogs, with a mixture of irony and indifference, where the catalogs seem to function almost as magazines, and are applied in design like magazine clippings. Realism has never been a style in architecture, as it has in the other arts. While resemblance might be an issue in painting, in architecture our buildings always look like someone else's in one way or another – resemblance is a given. The generic is nothing other than this unstoppable flow of materials, of preformed stuff. Before Koolhaas, the real had a bad reputation in architecture; reality was always perceived as that which prevents an object from coming into being (while in philosophy it is precisely what causes an object to exist), that which resists an idea instead of producing it. In this sense, Koolhaas is much more of a producer than a director. Images don't drop out of nowhere; there is an infinite availability of them. Images are ready; they always preexist, though his reuse is a critical, ironic one (since it is about the critical choice of a material *over another one*, not of it specifically). His realism isn't merely a case of good old-fashioned Dutch objectivism but an acute sense of machination and technology, of how social systems collaborate with machines to produce the generic, the default and the standard. For Koolhaas, the cultural

act of architectural design isn't about adding idiosyncrasies to an existing stream of forms; rather, it involves a certain consciousness of the technological force field of modernization itself. All desire is channeled through this system. He is not only more interested in how things are than in what they mean, but also in how they become real, and how the real is produced. It should be clear to us that modernity has now reached a stage beyond deconstruction, one in which its language has been completely erased in favor of a pure technologism without progress or ideology. Modernity now means an increase in complexity and dimensionality brought about by more and more networking.

The Unbuilt

The second resistance lies in the *unbuilt*, which concerns his thoughts on concepts, theory, statistics, the potentially very productive separation between theory (AMO) and practice (OMA), and how one haunts the other. Theory is not a basis for practice but runs parallel to practice; it is a practice in itself, highly organized, almost more so than the architectural office. People like Sanford Kwinter, Robert Somol, Michael Hardt and Scott Lash are taken aboard not to ghostwrite the production but to become involved in the production itself. Koolhaas is not against intelligent theory, but he is against the idea that thinking exists only outside architecture and that you must shop for intelligence elsewhere to be able to understand or design buildings.

Theory is generally a safe haven, a leafy campus where so-called true progress is made, while building is a sort of half-heroic, half-impotent attempt to "get it built." Such halfheartedness has always prevented Koolhaas from staying for too long in the USA, where architecture is on the campus and building is in the cities. I think his strategies have often been more concerned with "getting things unbuilt": pushing the theoretical moment precisely over the threshold at which a design must be accepted by a board, a jury or a private client. This is exactly why he's so interested in politics and power, in pushing a design too far for theory

to cope with it, but also making it difficult for juries to fully grasp and discuss, or too hot to handle for clients, who are often caught in similar situations of high-risk undertakings. Koolhaas' theoretical radicalism occurs precisely *where the object flips into the real*, and not before it becomes real, as is generally the case with theory (in this respect, his work shows a surprising lack of theory). All conceptuality concentrates on the mechanisms by which the designs are tested for operationality. This is not the same as a radical theory, since that doesn't mean anything if it doesn't get built (owing to bad luck or bad taste); rather, it is the theoretical moment that lies precisely in the mechanisms of acceptance. Koolhaas' "realism" is not a pragmatic way of dealing with radical theories but a theory of radical pragmatics itself. In short, the projects deal much more with strategy than with design, and therefore the – statistical – diagram has taken a very important place in this strategy, since it objectifies choice and approaches a client not as a body that likes or dislikes certain architecture but as a decisionmaking body, a body of planning and politics. The diagram always maps the forces of realization and therefore positions itself in the preparatory stages that precede the design. Koolhaas has one of the most impressive unbuilt oeuvres of any contemporary architect. Of course, many architects have unbuilt projects, but nobody ever would have heard of, for instance, Utzon's Sydney Opera House if it had not been built, since its radicalism was a matter of design, not of strategy. Koolhaas has hardly ever accidentally lost a competition; his losing entries have almost always had to do with the political mechanisms behind production. This is probably why he always wins now, turning things upside down again.

The Unsaid

Of course, if one kind of resistance lies in the choice of materials and a second in conceptual strategy, the third logically concerns the materialization of concepts. Why does Koolhaas talk so much, but never about architecture? Why doesn't he ever mention aes-

thetics? We can't be sure whether this is resistance; it certainly resists architecture, but it might be that the fact that what he says has nothing to do with his designs or buildings actually enables him to build so much. So let's call this the unsaid, because the hinges between Koolhaas' recording and production techniques are somewhat hidden, and often secret. If one places theory on one track and practice on another, that is indeed "a strong position," as Koolhaas puts it. But many questions naturally arise, especially about architectural design, because when all thought is concentrated around the undesigned and the unbuilt, the question is how these are rechanneled and remobilized into design practice. To leave a huge gap between theory and practice might be productive; it immediately calls methodologies and aesthetics into question, because even if these are suspended or outsourced, they are still present and must be relentlessly interrogated and exposed.

At a certain point, we had the chance to discuss some of these issues, especially with respect to his visits to Lagos, the capital of Nigeria, which constantly balances on the edge of complete chaos. Again, the question arises how such visits relate to architectural design[6], but we will discuss that in the final part of this essay. Let's look at the short but intense interview first.

> *LS: First there was the USA, the "badly designed built," then Asia, the "quickly designed built," then Africa, the "undesigned built."*

RK: [Laughs.]

> *It's really amazing to go to the US first and then Africa. Baudrillard did it the other way around. The French intellectuals always did Africa first and ended up in the US later. You ended up in Africa.*

Well, for now.

Speaking of Lagos, what really interests me is how you gather material. The photos from Lagos are quite different from the ones you did for Atlanta or The Harvard Guide to Shopping.

What do you mean by "different"?

The ones on the US are always at eye level – they're of signs. The ones from Africa are from the air – they're of structures.

There are also lots of pictures in the Lagos book that are from the ground. I was there with Edgar Cleijne, a Dutch photographer who has been involved in Africa for 20 years and had been traveling there for all those years taking pictures, and I discovered him at a certain point. I started traveling with him from the very first. He really showed me the way. Video by itself often works much better. Photographs are much too confrontational; you're always creating such a moment. There's much less paranoia with video. Don't forget, Lagos is really very dangerous; you feel that every situation has a sort of built-in limit.

And those aerial photographs?

We borrowed President Obasanjo's helicopter and flew over the city for two days.

Do you write in between? If you're continuously taking pictures, how do you get around to writing?

I'm always making notes, you know that.

When are you going to finish the book?

I'm going to write this summer. Three times, for three weeks at a time, I'll take time off to write.

Do you know yet what it's going to be like?

No, but sort of. Of course, I gave some lectures. Lectures are the skeleton, the main structure, but I don't know yet what kind of tone I'm going to give it. I thought I might make three totally different voyages of discovery out of it that arrive at totally different conclusions, and then a sort of integrative synthesis. It's going to be something like that. I only know how to do it once I've started. I'm taking the next three months off, more or less. And it took a very long time before I understood myself what Lagos was about, but I see it now as a sort of rest stop that was actually very well planned. A number of planners were important – Doxiadis, and Julius Berger, who built the autobahns in Nazi Germany. They went to work there and actually put all the emblems but also the practices into a kind of infrastructure, and the culture went into a kind of reverse and became poorer and poorer.

How do you see these self-organizing structures?

They look like self-organizing zones at first, but later I slowly realized that it's not simply self-organization, because it all takes place within the former infrastructural projects of the modernization project. It is, in fact, a continuation of a culture, and these things would not be possible without that network. All that misused infrastructure enables the society to keep going. In other words, a drive-in would not have been possible by accident, without the best operational strategies of Western planners. To me, that's what's fascinating.

I also saw diagrams of those areas around the highways.

Yes, I made other drawings of them, too. We called them friction zones. They're all around intersections, if you look closely, and the crazy thing now is that it's getting much richer because of that and linking back to that modernity right away. It goes back and forth. When there's more money, it disappears again, and it gets

planned, and there's more public space and gentrification.

Green spaces everywhere?

Yes, but it's mainly the introduction of the concept of upgrading. Cleaning up public space so there's simply no room anymore for all those spontaneous phenomena. They eliminate the friction, force it out, and so it's forced to go to other places. A kind of Potemkin activity. There are massive investments, massive profits from oil. That made possible a really cohesive mobilizing policy, and just at the moment that it's finished, the whole culture goes downhill because of corruption, and there's a complete evaporation of the public sector and everyone is thrown back on their own resources. So now an endless series of negotiations is necessary in order to survive, and the more poverty, the more of those there are. And the only way that is possible is through the flexibility of the infrastructure, thanks to the slowing down of the infrastructure, which no longer functions as circulation but as a kind of area of exchange, a market, in fact. What's so fascinating now is that, for example, in some places traffic is moving faster again, and so that chance for exchange is gone again. There is then invariably more crime, because slow exchange is simply no longer possible and other forms of exchange must be found.

Architecture has become a sort of slow infrastructure. It would be very interesting to study the programmatic cycles of that.

It is a very cohesive situation of self-organization and organization, and precisely because of that, it becomes a kind of mega-organization, which concerned me too in the same way. I think that's the most important thing, and it's a phenomenon I've felt coming for a few years. First, there was the rhetoric and the whole story that planning was no use anymore, but this clearly needs adjusting, because planning, although it never was as useful as you thought it was, nonetheless in its misuse or other experimen-

tal use gets new meaning again. In any case, these situations are unthinkable without planning and the possibility of planning.

How are they reacting to that in Nigeria?

We're trying to penetrate Nigerian society in all sorts of ways. We've been on Nigerian television a couple of times, on a kind of breakfast show. And we're also guest-editing a Nigerian magazine, so that we, too, get a kind of infrastructure; and we have a permanent person from Nigeria working here at the office, so if anything happens we have our own way in there.

First you moved along with, photographed with, all the experimentation and friction zones that arose whole, bottom-up, and then you ran into classic top-down interventions again. How do you feel now about all the gentrification there?

You could be critical and say it's a cosmetic operation and it's not authentic enough, but of course it is a kind of racism to deny countries their gentrification. And at each moment it's so different; there are phases. I find that amazing. For four years now, I've been going there for a week every three months, and every time it's completely different. The total flexibility is amazing. Really amazing.

What you run into there is, of course, what you mentioned when you wrote on the Lagos project in Mutations*: "We think it is possible to argue that Lagos represents a developed, extreme, paradigmatic case study of a city at the forefront of globalizing economy." Lagos is full of recipes, inventions. It seems as if you've investigated two forms of flexibility. The first is America, stacked floors and grids, where it's always a Cartesian choice. And here, you describe a system that is clearly different, open-ended. It is a much more open construction, and at the same time much more*

structurally built-in. Almost an urban-planning typology. You could argue that this is a new step in your work.

Of course, that was already there, in Melun Sénart.

For me, that was too much of a gridded space, where you compose using the emptiness in the grid. Africa follows much more of a field logic. "The material logic of Lagos is convincing," as you say. New spaces are being invented there. The emptiness in Africa stands in open connection to an overloaded infrastructure; in a grid, this is necessarily closed off.

I think your arguments are more interesting than mine.

What fascinates you in America at first irritates you later. This is very clear in the junkspace text.

I think it's a kind of political move, more than anything else. I went to America for the first time in 1972; then it was seen as absolutely scandalous even to go there, and I think the book – *Delirious New York* – was actually a kind of marketing research. For a while, it was interesting to see where it would lead, but at a certain point, I think a sort of political indignation came across, and also a kind of unease about the lack of control in your own life. I didn't want to endlessly be singing for the system, and so it was essential to go to Africa in order to develop more initiative and power in Europe. I think that America was power, and that in Europe you can build up power. No one talks about power. But let's talk about junkspace. What do you think of that text?

Fantastic – pure Hunter S. Thompson, Koolhaas on acid. It conveys a fascination with the subject more than it presents a critical argument with respect to junkspaces – which is good.

Do you find it credible that junkspace is described as something that has great influence on present-day architecture?

> *Yes, of course. The book has been attacked here and there because it supposedly generates no theoretical arguments, it's not a new* Learning from Las Vegas*. That's ridiculous; that's its power, I think. It has enormous influence; at UCLA suddenly they were all using escalators in their designs; even the very curvy designs are populated with them, and with Replascapes and gambling machines.*

Junkspace and Junkpiles

In American junkspace, all materials are cast from images. You take a Venetian wall, create a mold of it and cast it in any material. Everything is overdefined, but the connections are empty. In the African junkpile, all images are assembled as materials. You take a few wooden crates and a bit of chicken wire and make a wall out of it. *Everything is made of something else*; everything is undefined except for its connection to other things. Objects in junkspace are garbage before they enter circulation; objects from the junkpile are never taken out of circulation[7].

It is absolutely clear to me that Koolhaas' "fact-finding missions" are not simply ways to escape overloaded European history but also part of his cinematic design methodology of cutting from one place and pasting somewhere else. His recording techniques for hunting down the undesigned all over the world are not just a kind of architectural war journalism but a design technique. This is why Koolhaas' books are like obese magazines: the essay always appears between hypnotic series of images (like a photo shoot with the latest model, or ads), and we hardly ever get an image as illustration for the text. It's also why most of his architecture has something in common with graphic design. All segmentation stems from this – a chipboard wall part right next to a piece of corrugated acrylic sheet: if you don't want to design, just exhibit the whole catalog. All the disparate selections stem from

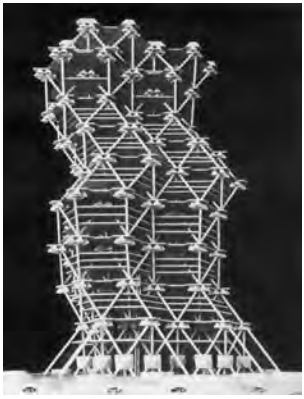
this traveling, this sequencing, this concept of montage and layout: choosing one material for this façade and another for that one, a tree trunk for one column and a industrial steel beam for the next, Cor-Ten steel, visible concrete, chain link – it doesn't matter. Well, quasi-doesn't matter. But the edges are like the edges of photographs, rectangular, and the assembly always comes out as a grid. If you want to use images as materials, it is not the middle (the image itself) that is of importance but the edge, where it functions in connection to others. In a grid, nothing connects. The images are like addresses: there is no friction, no tension, no adjacency. In fact, you get the feeling that the real is absent and over. It is not an *ontological real*, where we meet things and facts in person. We are served Polaroids: it is an *iconological real*. With Koolhaas, images never overlap or blur each other out; they never create a space, except for the grid itself. A problem therefore crops up, one we often see with his followers too: an archival indifference, a blind additivity. If "the real" requires photographic and videographic engagement with the world, a stripping and skinning off of its imagery, in the end you merely come home with trophies. You end up a collector, an archivist of the real. This means the real has already happened – it's over. As it becomes impossible to remobilize these images, design becomes a process of quoting from the world of the undesigned. It is a powerful message, but a message nonetheless. And it is no longer diversity, variation and endless possibilities that mark a moment of actual experience, but the stacks and rows of the archiving system. At its best, design becomes cultural criticism, highbrow consumerism. One cannot suspend choices by drifting from one image to another, gridding all choices and making hesitation or resistance the most sublime choice of all. The implicit restlessness, and images' immediate "readiness" when observed in the real, are not at all the same as availability in a catalogue, and such restlessness gets lost entirely in the matrix of choices in a spatial grid.

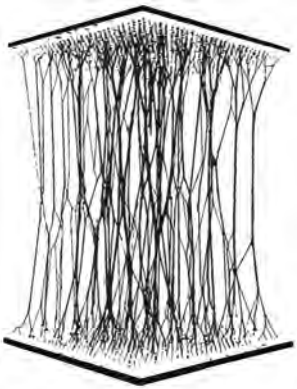
Before we dismiss Koolhaas' work as pure gridding and segmentation only, we should realize that during the mid-'80s this

sense of discontinuity of materials emerged along with the idea of the continuous floor surface. *Where the images were precoded, signified and consumerist, the floor became decoded, vague and activist*. This separation between what comes up from the floor and down from the ceiling has always been pervasive in Koolhaas' projects. As the floor slowly lost its architectural definition and clarity, it became an urban field of connectivity where the programmatic wreckage was exposed. The plan was doing everything the elevation wasn't. *All action was continuous and connected; all perception was segmented and interrupted*. Basically, America is in the elevation and Africa is in the floor. Koolhaas has arguably been trying to move away from this distinction, to complicate and intertwine the two, to work more on the complexity of volumes, to somehow make the surface affect the volume, make the images and their relations affect the massing. But of course, the organization of materials and material organization are not the same at all. In America, movement is between images (it is a flow *of* images) and yields simple gridded structures. In Africa, movement is *in* images and yields complex proliferating structures. So the real question is one of structure, not of imagery and signs.

Of all the critical architects[8], only Koolhaas has seriously worked with an engineer. When he started working with ARUP/Cecil Balmond, nobody else was doing so, and most were still getting engineers to fill the space between the roofing and the ceiling with steel or concrete. Not Koolhaas. His notion of materiality, however thin, has led him into collaborations that have moved engineers up to the start of the process rather than the end, and instead of waiting for the architects to initiate the design, engineers began conceptualizing their work. There is an evident constructivism in Koolhaas' work; all his skyscraper experiments, from the networked Togok Towers in Korea to the "skyhook" building for Central Chinese Television in Beijing, relate directly to El Lissitzky's *horizontal skyscraper*, the *Wolkenbügel* of 1924. How to live in the sky? How to move the street into the sky? These questions are much more interesting than the earlier questions of how to occupy a segment left open in a grid, because that

void is neutralized by the system, while this void is genuinely constructed and evokes another form of life. This concept of the void is a crucial issue: (a) is it left open as a leftover (as in Exodus or Parc de la Villette), or (b) opened as an in-between (the Seattle Library), or (c) open in the structure itself (like an attic)? The first void is completely defined but absent and empty, while the last is completely undefined but present and materialized. In this sense, there is still a huge qualitative difference between, for instance, Louis Kahn's Philadelphia City Hall, where the void creates a structural transformation and all diagonal columns become interrelated, and the Seattle Library, where the diagonals are incidental ("episodes," Balmond calls them) and simply leave a space at the edges of the building without affecting anything substantial. Kahn's project, though regular and crystallized, is much closer to Frei Otto's system of relaxation of structural members, which create a new network[9] through agency, which is a true constructivism in the sense that the form is constructed during a morphogenetic process of "form finding." You can't get any more readymade than Frei Otto's material computing techniques. It is a mobility of





Left Louis Kahn with Anne Tyng, Design for Philadelphia City Hall (1952–7). *Right* Frei Otto et al., Analog machine to generate a tower structure by placing wool threads with a certain overlength between grids at the top and the bottom. The whole system is subsequently submerged in water and taken out to have the threads self-organize into a complex network (IL 35, 1994). See also p. 194.

members during a process that doesn't break away from structure but actually creates structure through differentiation. Such constructivism is a positive act, not one of negation. The Seattle Library's book deposit, the black box in the interior of the building, is a direct descendant of Eisenman's deconstructed houses. It operates on the same techniques of cutting and shifting, completed by an exterior wrapping, though it is unclear how exactly the horizontals of the internal shifts create diagonals on that exterior surface. With Kahn, the diagonals saturate the whole volume; as with foam, solid form and open space start to merge. If one compares a typical deconstructivist tower, such as Eisenman's early 1990s Max Reinhardt Haus (which is pure criticality materialized, "anti-phallic"), to Kahn's Philadelphia City Hall, it becomes clear that Koolhaas' Seattle Library takes an in-between position: it has enough constructivism to move away from pure criticality but lacks enough material agency to make it to the level of Kahn's masterpiece[10].

The central question becomes: if we have an industrial world, a world of the composite, how can we relate that to an African-style readymade connectionism? How can we find techniques in which material organization informs the organization of materials? First comes Africa, then the USA. Africa is the software, not because of its presumed authenticity but because of its empirical computational logic: real-time solutions. Koolhaas' Lagos book is full of organizational structures in which objects and flows of exchanges interact and create complex structures that far exceed the possibilities of the grid. Often, they are flexible occupational strategies which can quickly fill an entire space and still connect to existing infrastructures: dotted cloddings, stranded affiliations, spiraling alignments, fan-shaped structures, laminations, delaminations, splits, curlings, detours, et cetera. All of them are self-organizing figures which, as Koolhaas repeatedly states during the interview, are intricately connected to the infrastructures of planning. So it's not some kind of revisited ad-hocism or megastructuralist plug-and-play, but an intensive spilling over of an infrastructural system, one of internal border situations, in

which peripheral effects are successfully adopted at the center of a system. It is a field logic that blurs the boundaries of linear structures. Borders are turned into fields, blurred by continuous reprogramming, and reprogramming is constantly stimulated by the erasing of borders. According to Koolhaas, it is precisely this connection of friction zones to the infrastructural network that makes Lagos exemplary. For that, it is necessary that the structure is provisional – not that it is left open and empty, but that there is a structural overlapping and blurring that is always under pressure, always in a rhythm of redefinition. This Lagos is, in a sense, more structuralist than the anthropological Africa brought back to Europe by the Forum group in the 1950s.

The unsaid now becomes this: instead of using Calcutta ("I believe in Calcutta minimalism, not in Swiss Minimalism"[11]) and Africa as ethical and anti-aesthetic categories, we should consider them as aesthetic categories. What's important is how life operates, not what it means or signifies. It is simply not enough to decorate the Hermitage with Cor-Ten steel (which would be absorbed by ¥€$ without hesitation) for the sake of criticality: only aesthetic decisions of true agency count. Instead of using ¥€$ to say no, we should make indigestible images: images that can't pass through the media, images that are no longer images but have become structures and opened up to life. Koolhaas' project is on the verge of breaking away from the semiological, but it hasn't arrived at an ontological position just yet – quoting from life is just not the same as living.

1. TransArchitectures was the title of a series of exhibitions on digital architecture organized by Odile Filion and Marcos Novak in France in 1996–7.
2. TransUrbanism was the title of a symposium on the relationship between new media and city sprawls organized in 2001 by the V2_Organisation. Speakers were Edward Soja, Rem Koolhaas, Scott Lash, Mark Wigley, Arjun Appadurai and Lars Spuybroek. See *TransUrbanism* (V2_Publishers/NAi, 2002).
3. Anna Tilroe. *Het blinkende stof: Op zoek naar een nieuw visioen* (Querido, 2002).
4. Rem Koolhaas et al. *Content* (Taschen, 2004): 162–71.
5. Rem Koolhaas et al. *Mutations*. (Actar, 2000): 650–720.
6. We have to keep in mind that virtually all Dutch architectural theory is of an urbanist nature. The Netherlands has hardly any relevant architectural history before the 20th century; one won't find any Palladios, Ruskins or Schinkels there. Dutch architecture started

with the Housing Law of the early 1900s, and ever since, all architecture has viewed itself as mini-urbanism, and all buildings as mini-cities. The fact that Koolhaas' main occupation lies in the production of architectural form but his main theoretical obsession lies with cities is therefore no accident; it is a typical Dutch trait of being uncomfortable accepting architecture as a cultural act in itself. His ghostwriting of manifestos for Manhattan (*Delirious New York*), Atlanta (*S, M, L, XL*), Dubai (*Al Manakh*), the Pearl River Delta (*Great Leap Forward*) and Lagos while maintaining silence about his own architectural designs – what we here call "the unsaid" – might seem a professional incongruity of the first order to most, but not to the Dutch. It becomes particularly startling when we realize that these cities have no need of urbanist theories anyway (which is probably why they are applied to architecture). His main urbanist theory, however, that of the Generic City, which he qualifies as an urbanism of "multiple choice with all boxes crossed" (*S, M, L, XL*: 1253), does not apply to Lagos.

7. For a discussion of the difference between garbage and junk, see Scott Lash, *Critique of Information* (Sage, 2002): 152.
8. These include architects like Peter Eisenman, Daniel Libeskind, Rem Koolhaas, Frank Gehry and Coop Himmelblau – all advocates of "deconstruction" who create architectural form by breaking away from normative structure, in which all elements are defined by their linguistic coding. The act of deconstruction is therefore a critical one, one of analysis, of neutralizing meaning through dislocation, which is inherently an astructural act. But the move away from 1950s structuralism as a system for producing meaning leads to a fallacy, since buildings have to be constructively coherent. For a more extensive discussion of the relationship between deconstruction and our constructivism, see "The Structure of Vagueness" (in this volume: 130). Koolhaas is the only one of this group to have incorporated construction as a positive act, i.e., something that itself adds to design and therefore moves away from criticality as sheer negation.
9. For a discussion of Otto's form-finding techniques, see the next chapter, "The Structure of Vagueness." For an explanation of Otto's tower, see "Machining Architecture," also in this volume: 184.
10. I think the clearest distinction one can draw between the two is that Kahn's design is tectonic and Koolhaas' is essentially stereotomic. Many of OMA's designs are generated through the hot-wire cutting of polyurethane foam, which is a purely stereotomic way of working. Only when these techniques are applied to large-scale massing, as in very large projects such as the Togok Towers and the CCTV Towers, does stereotomy become tectonic again, since the volumes start acting as structural members themselves. Also see my conversation with Arjen Mulder, entitled "Steel and Freedom," in this volume: 264.
11. Rem Koolhaas, in an interview with Bart Lootsma, "Rem Koolhaas: In Search of the New Modernity," in *DOMUS* 800, January 1998.

The Structure of Vagueness

Analog Computing

Within the history of methodologies in architectural design, the usage of empirical techniques has been somewhat obscured and hidden. Design methods tend to be based on historical references, canonical buildings, laws of proportion, symbolic language, or simple experience and tradition. Though it is common knowledge that architects make scale models, often in wood or plaster, we must keep in mind that these models are mere representations and as such don't inform the built result. I would like to look here at special cases in which the models' materiality itself generates form and structure. It is not very well known that engineers have used material models to actually generate forms and structures rather than to imitate them on a smaller scale. From the 18th century to the 19th, engineers in England and Germany used so-called catenary techniques to test designs by architects; for instance, Robert Hooke used suspended chains to see if arches designed by Christopher Wren actually fit within the desired curvature. Of course, the catenary curve hangs downward, which means the chain's links are all in tension, while in an arch all bricks are in compression. Such an inversion is a discovery of considerable magnitude. What remains unclear, however, is how, for instance, Antoni Gaudí came to use these techniques for the design of the Colonia Güell Church[1], the unbuilt predecessor of the much more famous Sagrada Familia in Barcelona. Though Gaudí didn't actually use metal chains to create catenary curves – he used threads with tiny sandbags – it is no small modification from engineering to design, from using the tool afterwards in order to establish structural validity to using the tool during the design process itself. Since the latter is necessarily generative, the hanging chains have to form a system of multiple interacting catenary curves that relate directly to the design of (in this case) a church. The formula for a single catenary curve – which looks a lot like a parabola but isn't one – had already been worked out by Euler, and the design of a simple element like that wouldn't need the analogy of a model; an architect could simply use the formula to draw the necessary curve. The Güell Church, however, consists of many

brick arches in various complex hierarchies, and such a system cannot be drawn by simply adding up a number of perfect catenaries. It needs both a systemacy and a procedural order, with decisions on which threads to hang first. Since the chains are flexible, we must realize that the first is constantly transforming – and all subsequent ones are continuously transforming – as we reposition and add new curves and weights. Anyone who has seen the famous hanging model with the hundreds of threads and tiny sandbags will note the striking resemblance to a typical computed wireframe model. I think we can safely call Gaudí the first computer architect.

In the 30 or 40 years after the late 1950s, Frei Otto and his team at the Institute for Lightweight Structures in Stuttgart experimented with material systems for calculating form, which were similar to the chain modeling technique Gaudí used for the Colonia Güell Church but used a much larger variety of materials. Each of these machines was devised so that, through numerous interactions among its elements over a certain time span, the machine would restructure, or as Otto says, "find form"[2]. This manner of *Formfindung* is directly opposed to "giving form," *Formgebung*, the German word for design, which implies the forcing of passive matter into shape. Most of Otto's analog machines consist of materials that process forces by transformation, which is a special form of *analog computing.* Since the materials function as agents, it is essential that they have a certain flexibility, a certain amount of freedom to act. It is also essential, however, that this freedom is limited to a particular degree set by the structure of the machine itself. In classic analog computing, most movement is contained in gears, pistons or slots, or (often) in liquids held by rigid containers, but in Frei Otto's machines, almost all materials are mixtures of liquids and solids or else start out liquid and end up solid. The material interactions frequently result in a geometry based on complex material behaviors of elasticity and variability. Some of us still tend to think materials act like Cartesian billiard balls, with full linear causality, but elasticity alone introduces much more complexity than that. Moreover, the involvement of so many agents generally shifts a system's dependency to feedback,

i.e., nonlinearity, where effects change causes, rather than only causes having effects. These agents include sand, balloons, paper, soap film (which guided the design of the famous minimal surfaces for the Munich Olympic Stadium), soap bubbles, glue, varnish, and those I will discuss here: the wool-thread machines[3]. Though Otto used this technique less than, for instance, his soap film techniques, he used it specifically to calculate the shape of two-dimensional city patterns, as well as that of three-dimensional cancellous bone structure and branching column systems. Otto called these structures optimized path systems. All are similarly vectorized systems that economize on the number and length of paths, meaning they share a geometry of mergence and bifurcation.

For our purposes, we shall take a closer look at the wool-water technique, which follows an algorithmic three-step procedure:

Step 1 (figure left): Map all the targets of the system (in this case, houses) on a board. For demonstrative purposes and the sake of simplicity, the targets are arranged in the shape of a circle, but there can be any number of targets in any configuration. The points can be mapped on a supporting surface or merely on an open ring, which will give the clearest result. To ensure the basic connectivity of the system, you must connect each point to every other using wool threads. In this case, this simply means each house is connected to every other by a road. This stage of the system consists only of crossings; it is a typical surface model, a wireframe of lines that neatly make up a surface.

Step 2 (figure middle): Since we are always forced to take detours in cities, no single road ever leads straight to a single house. So in step two, it becomes necessary to give each wool thread an overlength, or slack. In this case, Otto's team decided on 8 percent, a random figure but also a generalized one, since the amount of detouring need not be averaged down to a single figure for the whole but can be differentiated throughout the system.

Frei Otto et al., Wool-thread machine generating an optimized path system between targets. *From left to right* Step 1 (system), Step 2 (overlength) and Step 3 (after wettening and self-organizing).

Step 3 (figure right): Now, dip the whole system in water, shake it carefully underwater, and take it out, slowly bringing it above the surface. The wet threads will tend to stick together, and as they begin to merge, they will lose this capacity at other points, since merging means elimination of available overlength. All overlength is processed out of the system by a surplus of cohesiveness. Since the paths come from all directions, the mergences do too, resulting in a system organized by gaps, or rounded holes, and surrounded by thick mergences of threads (sometimes more than eight) and smaller fields of crossings.

The first step contains only geometry and no materiality; then materiality takes over during a reshifting stage; and the procedure comes to a halt in a state of full geometry again, but this time, a geometry that is not imposed on the material but results from material interactions. It starts out explicitly Euclidean, but it does not end that way, because at the end there is no longer any clear division of dimensions. While we could call the first stage of the system a geometrical surface – a system in which all directions are equally present – the final stage of the model is much more complex, consisting of patches of crossings, mergences and holes. The crossing patches have two dimensions, which means that in these areas many directions are still available in the system – many lines keep crossing each other, as they do in the initial state. The merging patches consist only of one dimension, where the system takes on a single direction – multiple lines stick together

to form a main artery. And the holes, of course, are areas where we lose all dimensions and no directions are available. While the first stage consists of homogeneous tiling, as in a lattice, the last stage consists of heterogeneously nested patching, as in an aggregate. The end result (step 3) is based on looseness but is itself not loose or weak but rigid and tight (when attached on an open ring, the threads come out of the water straight and horizontal!). It is a strategy of flexible, individually weak elements cooperating to form strong collective configurations. What emerges is a complex or *soft rigidity* that is very different from the top-down, simple and *frozen rigidity* of the first stage. We should therefore resist the idea that the first stage is a rigid order and the end result just a romantic labyrinth or park. The arabesque order of the end result is as rigid as the grid of the first stage but much more intelligent, because it optimizes between individual necessities and collective economy. Actually, if one were to draw lines on the photographs of the respective stages, one would find the total length in the first stage to be 100 units; the second stage, of course, would measure 108 units, but the last would measure only 85. So the reorganization results in a considerable tightening and shortening of the system. We tend to think orthogonal systems perform best, or most economically, but this is incorrect.

Frei Otto has done similar experiments with glue threads. When two sets of parallel threads, separated in two orthogonal directions, x and y, are made to touch, they don't form an orthogonal grid, as one would expect; rather, all four-legged nodes transform immediately into three-legged nodes, and the whole surface shortens considerably. Ergo, the total length of the elements in a grid of hexagons and pentagons is much shorter than in one consisting of squares. It's simply the quality of the order that precedes the quantity of the elements. Yet this is not a clear and easily legible form of order but a *vague order;* in the final wool-thread model, it is hardly possible to distinguish between surface areas, linear elements and holes. Surfaces can function as linearities, lines can cooperate to form surfaces, and holes can exist on all scales. Everything between the dimensions is materi-

alized. And though the dimensions are clearly singularities arranging the system (the mergences into thick lines are like the ridges of dunes, which orient the sand's surface to the wind's forces), it is continuity that makes them emerge. And though the order is vague, it should nonetheless be considered very precise, because nothing is left out. There is no randomness; there is only variation.

The truly amazing feature of this system is that it is in fact structured by holes; the nesting of holes is the driving force behind its formation, though architects are trained to think that holes are, in the end, subtracted from a system. This machine does not operate on subtraction or addition but on multiplication, in the classic sense of early systems theory, which states that a whole is always larger than the sum of its parts. Here, porosity is an emergent property. The first stage (step 1) is basically *drawn*, contrary to the end stage (step 3), which is processed by a machine, *calculated*. All the singularities that coexist in the final result – all the curves, all the mergences, all the holes – are interrelated; nothing can be changed without affecting the arrangement of the whole. All the lines are mobilized simultaneously, in parallel, whereas drawing is serial, with one line drawn after the other. A drawing is always created in the visual field, while the analog machine follows a partly blind and informational logic in which the image is the end product of the process. And though this technique should be considered as a hybrid of the top-down and the bottom-up, the drawn and the generated, its intelligence lies in the fact that nothing is "translated": the drawn is not "translated" into the real. In itself, it works at full scale. In this sense, it is not even a model. This *direct proportion* is one of the main features of analog computing, which simulates not through numbers but through an empirical rescaling of the real. This brings us to an important distinction between size and scale. A model is normally a matter of *size*: it is smaller and therefore a representation of a real object. Our system is in itself real and built; its transformation into a building, city or park is purely a matter of *scale*. Scale is topological and organizational, while size is purely numerical and geo-

metrical. In our case of the optimized path system, it is the materialization of the ink as wool *beforehand* that makes it work. The organizational and informational stage is material, not immaterial, as is so often assumed. It is the material *potential*, the material, distributed intelligence, that sets the machine in motion, in a transfer of water turbulence to wool curvature. Then it is the stickiness, the hairiness, and the curvability of the wool thread together with the cohesive forces on the water surface that bring it to a halt again and inform the end result. It is simply impossible to do this in ink. It is an intensive technique within an extensive system, and though the quantities (surface area, number of houses, et cetera) are given beforehand, the quality emerges through the interaction and multiplication of different parameters. Generally, intensiveness is a deformational property (like heating), but here it also becomes a transformational property (like boiling): the threads restructure and reorganize to "find form." The system as a whole passes a critical threshold. The degrees of freedom of deformation, which are more like extensive movements within an internal structure, become intensive, qualitative changes in the structure through transformation.

Wet Grid vs. Frozen Grid

The classic Greek lattice grid is a system that separates infrastructural movement from material structure. Simply put, the structure is that of a solid, while the movement is that of a liquid. We must consider the orthogonal grid as a frozen condition, because its *geometrical* state of homogeneity relates directly to a *material*, crystallized state of frozenness. Frozen states are simple states, and of course these were the first to be mastered by the geometricians, but to understand complex states we need to develop complex geometries. We are generally taught that geometry is the higher – the more abstract and pure – form of materiality, which is a misconception, because though geometry urges the necessary exactitude, it is totally imprecise. Any geometrician arrives after the event, when everything has dried up, and can

therefore deal only with the extensive state of the material, measuring length, width and height. The wet grid, Otto's aggregational grid, is one in which movement is structurally absorbed by the system; it is a combination of intensive and extensive movement, of flexibility and motion. The geometry does not follow the event; it coevolves with materiality, is generated through analog, wet computing. One could call the organization of the final stage wet and its structure frozen, since it has come to a halt. Though it is no longer moving, it has attained an architecture of movement. In this sense, movement must be viewed as information, as pure difference, because we all know that "information," if it does not cause change, is superfluous. It simply has not in-formed, has not entered the form. This means movement in itself cannot be called information: it must be internally processed as a (temporary or permanent) transformation. Physical displacement through movement must be processed as a structural change. Basically, my argument here is that all movement as deformation is merely indexical and meaningless if it does not result in structural transformation. Movement freezes are merely *traces*, momentary stoppages of a bygone present: they are not structured through time, are not *paths* that allow movement to be repeated over and over again and slowly condense and evolve. Traces can never form a system; they are individual. Paths are collective. But paths are not *roads* either; roads are collective, all right, but not emergent, since they lack the capacity for reconfiguration. With state-controlled roads, the distinction between the field's surface material and the road's prevents the system from adapting.

Each phase of path formation should function as an analog computer for the next one. There should be enough solidification to record and enough plasticity to enable changes. This makes Otto's optimized path systems similar to contemporary multiagent computing programs based on ant colonies with their pheromone distribution. Ants have no idea they are building a complex road system around their nest; they are simply foraging, finding food and bringing it back, and meanwhile excreting pheromones. The secret behind the emergence of a path system, however, is that

the pheromones evaporate within a certain period. In this way, the trails of the ants that return soonest to the nest are selected out for path usage, since their trails are the freshest and still have enough pheromones for the next group of ants to detect. Over time, we can observe an abundance of initially zigzagging radial patterns sprouting from the nest turning into a complex but optimized path system that self-tightens. This can be either a straight highway between a single food source and the nest or a more complex forking morphology with multiple foraging points. Similar multiagent systems have been translated into software packages truck drivers can use to calculate the shortest route between multiple addresses in a day's delivery schedule.

A real-time, analog computing model requires two things: a system that is internally structured (otherwise it cannot process information) and external flows of information. This simply means there are always two states coexisting, simple states and complex states, in gradation. Higher states of information can only occur within lower states of information; the two coexist hierarchically but on a continuum. They do not exist next to each other; rather, the generic and the specific share the same continuous, topological space. One always engulfs the other. We must start from a state of equilibrium that already contains information in its structure; then we need disequilibrium to increase the amount of information, and then we need equilibrium again to memorize it.

The brilliance of Frei Otto's model is that flexibility is taken literally and materially: the real movement of the water flow becomes the abstract movement of the wool structure, resulting in a coherent language of "bending," "splitting," "curving," "nesting," "aligning," "merging" and the like. All the arabesque figures in the final state of the model immediately relate to complex configurations. To understand this complexity, however, one must understand the nature of a curve. For Aristotle, any curve could be described as a mixture of straight lines and circle segments arranged in different orders. The later curve of differential calculus virtualizes both the straight line and the circle respectively as the *tangent* and the

approximative circle that today is still an important indication of curvature[4]. In 17th-century shipbuilding, however, control of curvature was based wholly on material intelligence and not on geometry. The curves needed for a ship's hull were "lofted" at full scale using splines, thin slats of wood bent into shape with the help of lead weights. The spline is still present in all 3D modeling software, and though it now exists in many different forms, it is always based on that very important notion of materiality. Modern-day splines are the Bézier spline, the B-spline, and NURBS – it is no accident that Pierre Bézier worked for car manufacturer Renault. After shipbuilding, splines were transferred to the even more complex technology of building automobile chassis, and since car manufacturing is completely industrialized, the spline had to attain mathematical precision. A digital spline starts out straight and becomes curved as information is fed to it. The initially straight spline has an internal structure of "control vertices," or CVs, and when these are moved sideways, it takes on curvature. Therefore, the number of CVs on a line indicates the type of curvature: how far it is from straightness and how close to circularity. In short, a *geometrical* straight line going from A to B doesn't have enough structure to be moved into a state of higher complexity: moving either A or B only results in a rotation of the same straight line. The spline's prestructuring through the range of control vertices makes it *parametrical*. The only difference between a material spline and a digital one is that in the material version the overlength is external and in the computerized one it is internal. In Frei Otto's model, the wool thread going straight from A to B in the initial state (step 1) is charged in its final state (step 3) by a whole field of other influences and directions, from C to D and from F to G, et cetera; the line is taken up in a field of potentials that make it an intensive line, which is simply a curve. *A curve is an intelligent, better-informed straight line*. Keeping in mind that Frei Otto's model is a path system, this curve should be read as a road with a variable openness on which one can partly retrace one's footsteps, change one's mind, hesitate or forget. It is not labyrinthine, causing you to lose your way completely; rather, it

complicates your way, makes it multiple and negotiable. A curve is a complicated straight line: it still goes from A to B, has an overall direction and takes you somewhere, but it manages other many other subdirections (tangents) along the way. It negotiates difference; it is differential precisely through connecting, through continuity. The frozen grid is always segmented and Euclidean, while the wet grid is always a continuous network, topological and curved.

Vagueness vs. Neutrality

In architecture, flexibility has always been associated with the engagement of the building with unforeseen events, with an unpredictable or at least variable usage of space. During modernism, this flexibility often resulted in an undetermined architecture, in an averaging of program and an equalization, even a generalization, of space – in short, in the transformation of an architecture of compartmentalization into one of generality and openness, seen in halls like Mies' Neue Staatsgalerie in Berlin. But we should ask ourselves: How does such generality affect the emergence of events? General, Miesian openness is only suitable when all desired events are fully programmed in advance by strictly organized bodies, as in the case of a convention center, fair or museum – when the organization of events is tightly controlled, not by the architecture but by management. A generalized openness in itself always has the effect of neutralizing events and being unproductive, because the type of space is not engaged in the emergence of events. It is flexible, of course; it is open, yes; but it is totally passive. All activity is assigned to the institutional body. The architecture itself does not engage with the way events and situations emerge; it is indifferent, neutral, with respect to this. It states that life is merely the effect of decisions already made behind the scenes, of acts that are repetitions of previous acts, with intentions that are completely transparent. The Cartesianism of the grid applies not just to its geometry but even more to the neuropsychology of the homunculus, which decrees

that decisions necessitate an internal control mechanism. In its ambitions, the frozen, orthogonal grid is not very different from, say, the Miesian box or hall in architecture: it aims to find a structure that enables life, chance and change and can itself last and endure over time, spanning the unforeseen with the foreseeable. The strategy of the grid and the box has always been to average out all possible events, to be general enough for whatever happens. Now, certainly a lot of what we do is planned, and a lot of what we intend is transparent; we script and schedule ourselves all the time. But engaging with the unforeseen does not mean events are just accidents befalling our calendars.

The whole question here comes down to a study of the relationship between flexibility and movement: how does the body's flexibility relate to that of architecture? I want to argue here that extensive bodily locomotion is only possible when it is intensive first, both in the body and in the system. There is always a direct relationship between the system of motion and the internal mapping of movements in the body. Consequently, in the frozen grid, the body must act as if it is in an archive, constantly picking movements off the shelf, every act a reenaction – the body itself is a frozen grid. The wet grid views the body as a complex landscape of tendencies and habit chreodes that form grooves (lines) in less defined areas that are surfaces. All modern neurology describes the body as a wet computer, constantly evolving, adapting, practicing, managing, coping and scripting. If one follows this line of thought, the problem of flexibility is not so much "opening up space to more possibilities," as is always stated, but the concept of the *possible* itself. An event is only ever categorized as possible afterwards. The possible as a category lacks any internal structure that can relate the variations to one another; it does not produce variation by itself – it is without *potential*. The choice has always been between determined functionalism and undetermined multifunctionalism, between early and late modernism, between the filled-in grid and the not-completely-filled-in grid. But potential is something else: "Potential means indeterminate yet capable of determination … The *vague* always tends to become

determinate, simply because its vagueness does not determine it to be vague … It is not determinately nothing" (Charles Sanders Peirce)[5]. Vagueness comes before the situation and actively engages in the unforeseen, while generality neutralizes the forces making up the situation. *Architects must replace the passive flexibility of neutrality with an active flexibility of vagueness.* In opposition to generality, vagueness operates within a differentiated field of vectors, of tendencies, that allow for both clearly defined goals and habits for as-yet undetermined actions. It allows for both formal and informal conduct. But more importantly, it also relates them through continuity, puts them in a tense situation of elasticity. The informal doesn't come out of the blue; it emerges precisely from the planned, but only because of intensive elastic planning. It is a structural Situationism that allows for *dérives* and *détournements* as structural properties. The transparent intentionality of planning and habit is stretched by the sideways steps of opaque intentionality. It does not mean the unforeseen has been successfully tamed and reckoned with: things are precisely left unplanned, but the foreseen is now structured so that it can produce the unforeseen and the new. How? Since all linearity is embedded within fields of nonlinearity, there is an enormous surplus of information in the system, a *redundancy* that allows behavior to develop in multiple ways. This redundancy is opportunistic and pragmatic, offering multiple routes toward a goal, but it doesn't afford anything to happen at any place.

At the level of design, this might be close to what J.J. Gibson has theorized as affordance[6]: a form affords certain actions and creates opportunities but doesn't determine them. Nonlinearity doesn't mean a breaking of the line, or even a relaxation that can stretch infinitely; it means a more fundamental bendability, a looping or a feeding back of the line. This means there is enough definition to allow a range of behaviors, but not so much definition as to single out one form of behavior (to be subsequently categorized as a function), nor so little definition as to make everything possible. So vagueness is not some state of amorphous indeterminacy; it is structured by singularities, by

transformations in a larger field of deformations. And this applies to all architectural issues, not only the ones that relate to activity but just as much to the ones that relate to structure, since it is structure in all directions (vertical as much as horizontal) that evokes activity, be it of loads or of people. In the realm of vagueness, structure and infrastructure are continuous. Charles Peirce developed a radical rethinking of vagueness, which has been an important philosophical issue since the time of the ancient Greeks[7]. For Peirce, it all revolved around a logic of continuity. "The principle of continuity is the doctrine that our knowledge is never absolute but always swims, as it were, in a continuum of uncertainty and of indeterminacy," he wrote. "Now the doctrine of continuity is that *all things so swim in continua*"[8]. Or – even more confidently – "continuity is the great evolutionary agency of the universe"[9]. Continuity, or vagueness, understands things in the opposite way to what we know as elementary, not as prior to relations but as a posterior result of relationality. It is a universe where relationality is a given, and things – objects, beings, events – emerge from it. It accepts dimensions as much as Euclid's elements; it just doesn't accept them as discontinuous, only as generational, as sprouting from one another.

An Architecture of Continuity

The techniques invented and suggested by Frei Otto have been diverse, varying from the application of already invented techniques to ongoing projects and more fundamental research into material form-finding. Not surprisingly, his optimized path system machine is unique within his body of research, because he has hardly ever had to bother with horizontal structures. Essentially, his research has been into the complexity of the elevation, the structure, not the plan. He has always been invited to cooperate with architects who had already developed the plan, and his contribution has been in the subsequent engineering stages. We should try to develop a different agenda. Patterning effects, configurational emergent effects, happen at all stages, in both the

plan and the elevation. Instead of following the plan-floor/extrusion-wall method, we should opt for a method in which elevation and plan become more intertwined and coevolve into structure. How interesting it would be to let the catenary technique generate a plan as well as an elevation, rather than merely hanging chains from prefixed points on a plan. For centuries, the order of the design process has been: first the plan (action), then structure at the corners (construction), which is finally filled in with walls (perception). Such an order, we must note, is completely Semperian, since action is the plan, or what he calls the earthwork, construction the tectonic wooden frame, and perception the woven textile walls. This must be finalized with the fire, or the hearth, which in our terminology would constitute a fourth category of sensation[10]. Our agenda should be to short-circuit action, perception and construction – which is precisely what constitutes an architecture of continuity. Getting weak textile threads to team up into rigid collective configurations is a direct upgrade or inversion of the Semperian paradigm. But they should be three-dimensional from the start: plan threads should be able to twist and become wall threads. All these techniques already exist in textile art: complex interlacings occur in crochet, weaving and knitting. The art of the arabesque is as old as architecture; it has just never been conceived at the scale of structure. And this certainly has technological reasons – the arabesque has always been accommodated by manual labor, while the straight extrusion was necessarily associated with standardization and industrialism. We should be careful, though, not to mistake the vague for "free-form architecture," or for the streamlined or the amorphous. We should strive for a rigorous vagueness, rethinking repetition within sets of variability, rethinking structures within ranges of flexibility and redundancy. The more we move towards the vague, the more articulation has to become an issue. If there is no technology of design, a technology of manufacture becomes nonsensical. With machines under numerical control, we also need the design process itself to be an informational procedure; it needs clearly stated rules and scripts to generate a structure of vagueness.

I have argued here and elsewhere that starting with the soft and ending with the rigid will offer us much more complexity in architecture. And here I am not referring to Venturi's linguistic complexity (one of ambiguity) but to a material complexity (one of vagueness). Obviously, the science of complexity has produced many diagrams of the vague, and these have often been dropped onto rigid architectural structures or typologies. That is not the way to go. Though *deconstructivism* proved successful in breaking down most of the top-down ordering tools we were used to in architecture (contour tracing, proportion, typology, axiality, et cetera), it proved totally incapable of instrumentalizing complexity itself as a material, architectural tool. It understood every act of building as an implicit counteract, a negation – and meanwhile, the engineers silently repaired it. We should, however, understand all objects as part of a process of emergence, *the made as part of the making, not the unmade*. Our goal must be *constructivism*, or emergence, and anything that emerges should coemerge. The way we see is emergent, the way we move around, the way we act in relation to others, to our habits, to our memories – all these emergent patterns should coemerge with a building's material structure. This makes our agenda one of a postindustrial constructivism, a vague constructivism. All behavior is material; all structure is material. All three constructivisms must run simultaneously, intertwined: a constructivism of form, a constructivism of seeing and feeling, and a constructivism of structure. The loads and forces working through our bodies to create social patterns are no less real than those running through columns and beams. There have been many attempts to borrow images of complexity and feed them into either circulational, formal or structural diagrams – Klein bottles, weather maps and so on – which were interesting, but not interesting enough. We should create complexity by feeding these modalities into each other through continuity. We should feed circulation into structure, feed structure into perception, and feed perception into circulation. It doesn't matter where we start, as long as we loop vagueness of action into vagueness of structure into vagueness of perception.

1. Jos Tomlow. *Das Modell, The Model* (Institut für Leichte Flächentragwerke, Stuttgart IL 34, 1989). Also in: Mark Burry, *Gaudí Unseen* (Jovis, 2007): 98–101.
2. Frei Otto and Bodo Rasch. *Finding Form: Towards an Architecture of the Minimal* (Menges, 1995).
3. Ibid.: 68–70. Also in: Frei Otto, *Pneu und Knochen, Pneu and Bone* (Institut für Leichte Flächentragwerke, Stuttgart IL 35, 1995): 174–82.
4. To better understand lines and their curvature, one can compare them to the way a car moves. A straight line, with its first-degree ("linear") curvature, holds the wheels in position. Second-degree ("squared") curvature, as in a circle, ellipse or a parabola, rotates the wheels. The third-degree ("cubic") curvature of differential calculus adds to that rotation a change in speed: during acceleration or deceleration, changing the direction of the car turns curvature into something completely different from the circles and ellipses we have been used to in architecture. After Gauss, these lines could be made into double-curved surfaces, which could be analyzed using so-called Gaussian analysis. The approximative circles (the biggest circle that fits on a point on the line without intersecting it) that fit in the cubic curves can be multiplied with one another: a sphere or balloon gives a positive Gaussian curvature, a saddle negative curvature.
5. Charles S. Peirce. *The Essential Peirce: Selected Philosophical Writings* (Bloomington, 1992).
6. James J. Gibson. *The Ecological Approach to Visual Perception* (LEA, 1986): 127–43.
7. See, for instance, Rosanna Keefe and Peter Smith. *Vagueness: A Reader* (MIT, 1999): 58.
8. Charles S. Peirce. *Collected Papers of Charles Sanders Peirce, Volume 1: Principles of Philosophy* (Cambridge, 1932): 1.171.
9. Charles S. Peirce. *The Essential Peirce: Selected Philosophical Writings* (Bloomington, 1992): xxii.
10. For a more thorough discussion of Semper's categories, see the conversation with Ludovica Tramontin entitled "Textile Tectonics" (p. 226), "The Architecture of Continuity" (p. 208), and the introduction to this volume, "Experience, Tectonics and Continuity" (p. 12).

Sensograms at Work

In Conversation with Cho Im Sik

CIS: Your approach to architecture seems to contain a deep critique of the architectural program – the mechanistic layout of all human behavior within a built system viewed purely as tasks, routines and habits. Instead, the programs in your projects come in between, as the materialization of the undecided, as a "space of accidents." How, then, do you deal with a preconditioned program?

LS: Well, I'm not so much against the architectural program, but I'm against what is implied with it. First of all, the program is a list, a series, which to me is quite a passive way of ordering. Then, often with the program comes a relational diagram – a bubble diagram, an organogram, et cetera – a precise ordering of the elements from the list in a more dimensional network of relationships, which is not as passive as the list but mechanical nonetheless. I think there is a deep desire in humans to be mechanical, machinelike – we all long to be reliable, even more so to ourselves than to others. Somehow we have to be able to count on ourselves, to be predictable in our behavior. We tend towards repetition; it makes sense, because it takes less energy. On the other hand, I think we should be careful of materializing this desire too much, because architecture is notorious for its ruthless reflection. "We shape our buildings, thereafter they shape us," as the alleged Churchill quote goes.

The human body is not an archive; it is not a cabinet with millions of drawers where we just pick the desired action out of a drawer when we need it. No, memory interacts with the present, and, as modern neurologists tell us, memory is not a fixed archive, it's a plastic, flexible system of interconnections, where often-repeated movements (putting on a coat, doing the table, cleaning the windows, et cetera) share the same space with new and unknown actions. There are tendencies, inclinations, next to pure habits and routines, next to desires, hesitations, mistakes, forgettings, et cetera – many movements interact, group and overlap with others. This tension within the body is given; there is always a tension between what we think we should do and what we actually do.

This means that in my architecture, I don't want to move away from program towards non-program, undefined areas of pure leisure and play. That would be the typical utopian vision from the 1960s. I'm far more interested in finding play *within* work, in finding the undetermined *within* the determined. The "space of accidents" – the notion comes from Bernard Tschumi – is, to me, far too much part of this oppositional thinking that sets the necessary against the accidental. I think I want to connect more to a certain "openness" of mind, where we count on both things we know are going to happen and things we don't.

So I wouldn't mind preconditioned program so much, but *I would mind preconditioned architecture*. And though I know there is a lot of tectonics and articulation in any program, we as architects should always try to find a moment of life and resistance.

> *In recent years, there has been an important shift away from all kinds of preliminary techniques, like sketching, and toward diagramming. Is this a development typical of architecture, or do we see it in other fields as well?*

Diagramming is indeed the most important innovation in architecture of the last 10 to 15 years. I think, on a technocultural level, it means a move toward *metadesign*. Metadesign already happens a lot in graphic design and industrial design, and it basically means designing with templates; others can use the template to design an actual product. It's designing the method of design itself. There's a metadesign for a Nike shoe, for a Swatch watch, for a Mini Cooper, et cetera. It's a very peculiar thing: the design is open enough for people to transform features but closed enough to make it communicate a brand. But it's not just about changing a few colors and adding some accessories; it has to happen more at an organizational level. A metadesign consists of a system, a network of relations that make the thing the thing without actually designing it. It's an informational system. Maybe "template" isn't the right word; it's still too much like "mold." We need flexible, variable molds that can "modulate," as Gilbert

Simondon puts it. Now, that variability has to be mathematical first, before it can result in a unique form. So information is code. The variation needs to be processed by a system. It's a networked system of decisions. Basically, it means a whole opening up of designing one object to a whole family or range of objects, like brothers and sisters. One day, in the near future, we will be able to design our own shoes, our clothes, our cars, our own chairs (just as now we can design our own websites) – and the question of how is answered by coding and metadesign. You'll buy the code, or the DNA, of a company, a template of a certain design family – a style, of, let's say, BMW – and then design your "own" thing. Don't forget, this design family can be as complex as is suggested by branding and lifestyling: you could have a BMW code not only for a car but also for a chair or a watch. Probably most of these interactions will happen on the Internet, since such variability makes the concept of a shop or a showroom explode. You would make your own variations and, of course, these variations would happen within this digitized continuum, meaning that the information of your own design would immediately be transmittable to a production machine that assembles all the parts and sends it over to your house.

> *Let's go back to the issue of diagramming in architectural design. In your case, it's based not so much on optical abstractions of later-to-be-realized forms but on informational and often material techniques that place themselves at the interior of a process instead of the exterior of a form, like a sketch or a model, for instance.*

A diagram is generally understood as an upgrade of the schema. Whereas in a schema the positions of the elements in the system are fixed – even in Christopher Alexander's diagrams of *Notes on the Synthesis of Form* they are fixed – in a diagram they are flexible and variable. My critique on the contemporary use of diagrams is two-sided. First, they aren't used systematically enough – not nearly as systematically as Alexander's technique, which

was, as we should acknowledge, a very important step toward informational procedures for generating form in architecture. On the other hand, and second, they're still too static, like images. D'Arcy Wentworth Thompson, the famous morphobiologist, stated that the diagram was a locus of forces. So – forces and systemacy. For my diagramming techniques, I use flexible interactive systems that deal with both. I have different names for them – flexigrams, kinetograms, thermograms, even awarograms, but my favorite is *sensograms*, because they map intensities, intensities in the body ("feelings") as much as in material structures. I also like Brian Massumi's "biogram" very much. They're flexible because they're not rigid: they don't know just one solution. They're interactive because one change affects the whole system. The old sketch method would go like this: first you look at the parts (rooms, stairs, entrance and so on), then you try to take a look at the whole; this is most often done using very old tools like the grid, the box or the axis. Then the design work is the difficult "shaking up" of these two viewpoints – concentrating on a part and trying to see the overview – and bringing them as close as possible, trying to close the gap between the whole and its parts – a very old philosophical problem. That's how we learned it at school. But a flexible, variable system processes forces as information, in which the parts and the whole interact. The whole is not preset; it emerges. I'm trying to move architecture in the direction of system theory, which means a nonlinear interaction between the whole and the parts, and such interaction can only take place because there is continuity between them.

So I'm not that far from Christopher Alexander's change from diagram to pattern, stated in the later versions of his book. But for him, pattern was a variable pattern of fixed elements, like doors, rooms and volumes. For me, pattern is where the elements are variable, too. My critique of Alexander would be that although he shifts to a bottom-up procedure for the relations, the parts are still preselected top-down. What I do is build a machine, mostly or partially on the computer, that one could call a "virtual whole": a matrix, a geometric system where all relations are set but not

fixed, and then all the information is processed over time. The processing occurs through rules, which are the opposite of laws (like laws of proportion). Laws are global, while rules function only locally. It is an extensive machinery that processes information through intensities, in a machinelike procedure of interlocking steps, like a series of algorithms, often involving both digital and analog techniques. The whole is like a matrix: it's a system of relations, and if you change one thing, the rest changes too. In the sketching technique, you'd be working on one part, and the rest doesn't change with it – if I start sketching a certain room, or the staircase, the rest doesn't change with it, right? In my machines, it does; all the drawing pencils are interactively bound together, first in an abstract system of lines, and then later during the process it becomes more and more clear what those lines can be.

Let's look more closely at an example. I understood you were working on a building for the Teletubbies?

Well, not for the Teletubbies themselves but for the company that makes the television series. This company, named Ragdoll, is owned by Anne Wood, who created this fabulous program for very small children. A sort of Carl Gustav Jung for kids. She is a very remarkable woman. She had a shop first in Stratford-upon-Avon, Shakespeare's hometown in the British Midlands, and while she was making children's television upstairs, she was showing tapes of it downstairs in the shop, to see how children responded. She has a very interactive view of television. Anyway, she proposed making the building half headquarters and half children's experience, with both parts based on the relationship between work and play.

For the offices, we decided to look very precisely at the office pulse, so to speak – at its biogram. We observed that of all the people, a third were quite immobile, another third moved a lot around in the building itself, and the other third often worked outside the actual headquarters. So first, on the level of numbers, that meant on an average day only 65 percent of all personnel

were in the building, though we couldn't exactly say which two-thirds that was. If you had an office building with work stations dedicated to tasks and not actual people (since it's never the same third who are out), you could make it work – you could actually build it two-thirds of normal size. This is what they call a flexi-office; there are many versions, but this is the simplest. Second, on the level of mobility, we needed an architecture that would be open and stimulate communication.

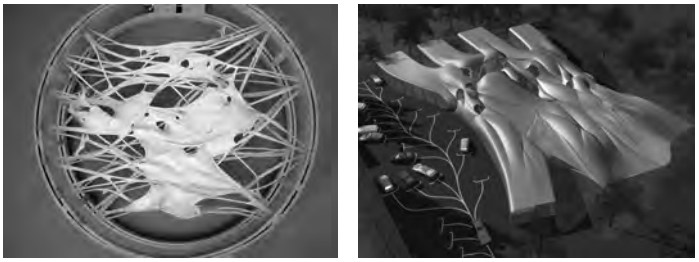
But a graph of variable occupancy doesn't directly lead to architecture, does it?

No, that's the whole point. It's not a datascape. The first, quantitative analysis has to be fed into the second, qualitative analysis. This is the whole point of information not being a separate category but being in-formative. We need program mapping techniques that are both extensive and intensive, looking both at extensive properties such as surface area and at intensities such as communication, interaction and transformation. It would already be a huge improvement to take the standard color diagrams we generally use for program and "warm them up," making them more like thermograms. At least then activity could vary, gradually transform from one state to another, heat up or cool down, flow or crystallize. For that to occur, you need a system that relates activities and exchanges information while reconfiguring. But such a system would structure itself only programmatically, not architecturally, and this is the main reason I moved to material diagrams, because they produce form and structure during reconfiguration. They operate on extensities as much as intensities, and relate the action in space to the perception of space and the construction of space.

What we did was to make a variation on Frei Otto's material diagrams. I had already looked at these before, when I was doing the *Vision Machine* exhibition in Nantes and when I did my proposal for the new World Trade Center, but for the Ragdoll headquarters, I wanted to improve it. Since in Frei Otto's wool-

thread model the system is two-dimensional, I wanted to find a way to make it three-dimensional, to have the floor immediately inform the elevation. If you look carefully at Frei Otto's wool-thread model, as we have done in the essay "The Structure of Vagueness," you notice this complexity emerging out of the interactions of flexible elements. But these are for routes in a village; we cannot just extrude the lines upward to make it a company headquarters, especially when we don't need corridors like large-scale roads. The elevation has to become part of that complexity. So we made this sticky, gluey piece of machinery to generate our structure. My first decision was to make the machine of horizontal proportions, because after visiting the site I was convinced it should probably be a one- or no more than two-story building. The other thing is that the machine needed various gradations of mobility. So this flat machinery only needs a relatively small elevation to become three-dimensional. I think for a multistory version you would need to set up another type of machinery, probably one that deals more with layering and the interrelating of these layers both structurally and programmatically, in a manner resembling phyllo dough.

Eventually, we came up with a double round ring with a network of thin rubber tubes in it that were some 5 percent too long, enabling them to interact. We made the tubes shake and stick together in wet lacquer, in a very complex pattern, and as they were curing for a period of one or two hours, we vertically separated the two rings slowly to produce pockets of space between the glue membranes, a bit like foam. The system creates a network of spaces that are either wide and open or very closed, capsule-like spaces for creative work. All these spaces are structural; tubes from the ground run up and become the edge of a column or the edge of a room, which then, at the top, closes into the roof. It is a foamlike structure of nested but half-open pockets that are all interlinked. It is completely structured by vagueness; all elements are in transition. You can never tell when the column stops to become a wall, or a floor becomes a column, a fold becomes a beam, or a beam becomes a room, even. It is fully con-



NOX, Soft Office, Headquarters for Ragdoll Television, Stratford-upon-Avon (2001). *Left* Rubber-lacquer machine. *Right* Rendering of front perspective.

tinuous, but it doesn't lead to some kind of amorphism; it operates on very precise sets of lines that guide the articulation. It would really be something to work there – you might find pockets where nobody can see you, there are elevated spaces where you are diagonally connected to the other spaces, and there are quite generic open areas. And you can choose or reserve a space on the company's intranet. Whether you want to do some writing on a television series, or sit with others and talk, or do some administration, you can change, vary. It's all yours, but you never have your own room. In general flexi-offices are designed with standard open spaces for communication and cubicles for concentration next to them, but in such architecture there is no interactivity, no tension, no communication. In our case the architecture is part of management, in such a way that it expands the idea of work as a series of tasks into a more relaxed state that allows for more variation of activity. Especially in a productive environment like this one, it could prove very useful.

It's essential, though, that your sensogram distributes information to all levels: program, form and structure. Basically, what I do with these sensograms is relate flexibility to movement. Flexibility is translated into movement, and movement into flexibility. So the presupposed movement of people, their *potential* movement, which by the way is very psychological, is abstracted into the language of architecture, and that abstract movement loops back and relates again to people's movement.

But that hardened rubber-lacquer model still needs a second treatment, correct? You can't directly have the form of the actual rubber tubes in the architecture.

Yes, I don't think there is any analog or digital technique that doesn't need a new set of operations before it becomes a building. Machining techniques are always stepwise operations. One set of rules deals with a certain set of architectural problems, and then these need to be married with building problems. Our machines are set up to operate on continuity, to create integrated relations between all architectural elements, not only the programmatic ones, but also the structural elements. I think one needs to have a clear idea of how to proceed before even setting up the initial machine. We digitized the model; we photographed it and reworked it digitally into a latticework of wooden members that were actually planar, like in Nantes, but then covered with layers of wooden planking. I'm not convinced that was the correct methodology. I always felt that it should have been digitally reworked at the level of the machine itself. I think you have to study systems materially and analogously, but maybe then it's better to try to program or script them, because you'll have more control. Analog techniques are by nature "dirtier" and need to be cleaned up in the subsequent steps. I think pure digital techniques are by nature cleaner and more configurational, but on the other hand might not immediately give structural results. So we need a combination of constructivist and configurational. You would obtain the rule set from the analog experiments, but the actual morphology would be generated digitally. Move from experiment to research. I think research means a clearer framing of the experiments, and I understand design even more as operating on variation and parametrization. I feel that in experiment the results often blur the distinction between accident and variation, and that is something we should prevent from happening. In merging research and design we opt for systems, rule-based systems operating on variation. There would be less accident in the model, and there would be the possibility of resetting the parameters, rerun-

ning the script without having to do the experiments over again.

We never got to these restudies, because the project was stopped for other reasons – it turned out to be impossible to build on that site, and they couldn't find another one. It would have been a great opportunity to study how it actually works. I've done the same in the water pavilion, the Nantes exhibit, the V2_Lab – spending hours on observation and taking notes.

> *Such a pity. How does using diagrams at the beginning of the process differ in result from conventional design methods? Does it actually work better?*

The goal is to make the diagram as real as possible. You don't want to have an abstract system and start "translating" or "mapping" it onto architecture. You want to work directly in matter itself. So you need to build a machinery that can reconfigure the real, which is exactly the reason why I used Frei Otto's techniques – probably in a way he would never use them – because the abstraction is material itself, a rescaling of the real, but still real. But it is a different directness or objectivity than what we normally understand as such in architecture. That type of objectivity would simply move elements' positions, but the elements would be fixed in advance ("room A," "room B," "lobby," "conference room," et cetera). Here the movement has structuring capacities; it makes a relational system transform into a structural and spatial system, a morphology – in this case very close to a pizza, a single layered plane full of pockets and blisters. Now, this means that the system at the end of the process is not the same as at the beginning. So what is that machine at the beginning? If you look at the rings with the tubes you'll notice that the tubes at the edge of the ring hardly cross, not anywhere near as much as in the middle. So there's already a rough programmatic setup of the program: the more generic spaces are at the ends and the more interactive ones are in the middle. There needs to be a bias in the system; you can't start with blind agency and then suddenly end up with a headquarters. These machines work from simple states to complex

states: it starts out extensive, then becomes intensive and ends up extensive again, not unlike cooking, where you rearrange and transform ingredients through heat.

I think a diagram is the best way to instrumentalize "inspiration," though it is completely opposed to inspiration. We devise machines so as to make them come up with the ideas. When does something become architecture? When does architecture enter the design process? That is the most important question in any design process. Can you start with an image – the image of a face, a crowd, a dog or a group of trees in the mist – and end up with a building? Of course not; that kind of inspiration will get you nowhere. The image has to become material, something to work with. And it only works when you extract information from it that has the potential to become something else, not a picture of something but the internal, organizational structure of something else. Finding this vector, constructing this vector-toward-something-else, can be done only by machining, by seeing structure and architecture beyond image and before one "sees" actual buildings. It's not inspiration but intuition, more feeling than seeing. It is a professional way of dealing with this moment of blindness, of being in between one's sense-contraction of the world and one's expression of something new. Basically, you go from one image, a memory, to another image, a new building, through abstraction, and this abstraction should never be completely lost. Now, there are very simple forms of diagramming, like using visual imagery; more complex ones, like gathering data and graphing techniques; and very complex algorithmic techniques. In the end, what counts is what the diagram can do for you.

OK ... What can the diagram do for you?

Mostly, diagrams are "read." This means their abstract capacities are often left in the building as traces in language. This seems logical, since the abstract capacities of architecture are typical food for the mind. Walking through a 16th-century villa by Andrea Palladio doesn't make any sense if you don't know about music

and early harmonic systems. The two most important diagrammatic architects of recent years, Rem Koolhaas and Peter Eisenman, still see the diagrammatic capacity of architecture too much as something linguistic, i.e. as metaphysics. The architecture of architecture – as I tried to explain in the notion of metadesign – is, for them, still a property of language. A concept to them is a sentence, an explanation: cultural criticism in Koolhaas' case, criticality in Eisenman's. My diagrams are more "sensed"; they are more felt than read. They are felt in the day-to-day decisions and hesitations we experience. Basically, my architecture deals with consciousness and awareness, of how the experience of being here, in this uninterrupted stream of presence, is constructed. So the sensogram is at work on both levels: architecture *and* people. I'm extremely interested in this continuous "thickening" of the present. What does it mean to have something happening? What is a situation? What is a fact? With Rem Koolhaas and Peter Eisenman, the real has already happened; the architecture understands and comments on it, addresses it through language, and presents this view to the inhabitants, visitors, whatever you call them. It is always consumed afterward. They just reexperience the real as it was already foreseen in the diagram. However, I think the diagram is something that should be placed in between the world-as-imagined and the world-as-experienced and therefore stop being expressive before it becomes language. It comes close to what the painter Francis Bacon called the *brutal fact*.

What's that?

Bacon asked himself the same question: How does it become real when it matters? Where does the moment of the real lie? He was neither a figurative realist nor an abstractionist. He felt that neither was capable of evoking the brutality of fact. Abstract art shuns realist depiction because it cannot show the forces working on the real, and doesn't show the diagram. Abstractionists do work with the diagram; they paint the forces at work, the forces that create the real. I think it's Duchamp's 1911 painting *Moulin à*

café that has the first diagrammatic arrow in it. Figurative art, on the other hand, depicts the forms after the effect, after everything has been done and the forces have left the scene. So one art form comes too early, the other too late. Now, let's look at one of Bacon's most famous works, *Three Studies of Figures on Beds*, from 1972. We see two men copulating on a bed and a large circular arrow not unlike Duchamp's, set against a monochrome orange background. We see both figure and abstraction: we see form and force working simultaneously. Now, what is "the fact," exactly? Is it (a), the moment of the original copulation; (b), the moment Bacon painted it; or (c), the moment when you see it as a visitor at the museum? If it were a realist work, the answer would be (a), and if it were an abstract work, the answer would be (b). If it were a realist depiction, you would experience feelings, but it wouldn't matter, since it would be after the fact; you would be too late. If it were an abstract work, you wouldn't be able to empathize, since you'd only see forces. So for Bacon, (c) connects (a) and (b). In his work, the forces are in play; you even see an arrow and gestural deformations. But these forces don't stop at an amorphous state: they go further, join in to form the situation. You see the start of contours emerging, but the forces don't complete them into an "image." That's left for you to do. The brutality of fact is there precisely when you look at it; you join in the formation process. All three moments are synchronized. Obviously, it's a moment of sensation, not of mindful contemplation. That's what I'm aiming for with the sensogrammatic approach.

If you had seen the exhibition installation in Nantes, for instance, you would have been amazed by the difference between this world-as-imagined and the world-as-experienced. There was a constant sense of disbelief: the precision of geometry coinciding with a vagueness of form. One could see all the twists and turns of the vertiginous forces, all the subtle changes of light, the multiple orientations of the surface, reinforced by the different angles of all the paintings and etchings, but one could hardly "read" it. There was hardly any time for reflection, as the architecture was

one of engagement and experience. In my architecture, life runs parallel to the diagram: *they move in the same direction*, they intertwine, they couple, but never oppose each other. One never *meets* the diagram, as in an Eisenman; *one lives it*. Or, as Varela would say, one enacts it. Or, maybe better still, in my own terms, the sensogram *is worked out*. When you turned your head in that exhibition, or started running, looked backward, sat on the floor, twisted around to see a painting, the forces of flexibility became the forces of movement in a whole variety of postures.

> *It is understood that the computer is part of your conceptual process, leading a complete shift from Euclidean geometry to topology, from tectonics to textile, from object to process, from crystalline space to the undulating field or medium. You have even mentioned the necessity of computer-aided conceptualization and manufacturing. What do you think is the future potential of this tool?*

It is the future *per se*; there is no other future. But architects have to learn to deal with it conceptually. They always thought it was "just a tool," a means to something else: architecture. This is a complete misunderstanding of (a) what computing is and (b) what technology is. There are no innocent tools: no tool is separate from its purpose. Tools make us think differently, and, even more importantly, feel and wish differently. Machines are social fields; *technologies are countries we live in.* You cannot "do" computer without "thinking" computer. Let's not forget that a lot of the design tools we use in predigital architecture, like copying, rotating, aligning, et cetera, are basically early, primitive computer tools. Everything on the left side of the software menu is something we were already doing with other tools. Software packages start to differentiate on the right side of the menu. Bernard Cache said, "The compass and the ruler are very simple computers," which means we have always used computers. So there is no inherent opposition to design with and without computers. Gaudí always said the Sagrada Familia was the first of hundreds of

designs like that. He was right, if we add a hundred-year gap. And if we take away hand labor and Catholicism too. He was right, however, about computing and about bringing the absolutely singular to a city. Computers, we should always realize, are *steering devices*: they are vehicles, in a sense. We have them because we understand the world as one of processes, of interactions where dynamics and structuring are not opposites. In a time and world where we can truly think complexity, we shouldn't deny ourselves an architecture of the complex. I don't think it's responsible that as we acknowledge the complexities of life, of perception, of social patterns, we architects keep throwing cubes at the world. Minimalists just can't accept life in its impurity and complexity. Since the 1950s, we have had new views in mathematics, physics and biology, in cybernetics and information theory, all based on computation. Turing machines, genetic algorithms, complex systems, fractalization, fuzzy logic, et cetera, et cetera – where is architecture in all this? To me it is absolutely irresponsible to keep drawing cubes in a time when we have the mathematics and physics to deal with processes, time and complexity. Boxes average everything out, and they deny architecture's involvement in the emergence of events.

> *Realizing that we cannot just simply "materialize" freedom in architecture, the question becomes: How can we connect to the unseen? How can the unforeseen happen?*

You might know of the beautiful concept of *potentiality*, the old word for virtuality, which states that nothing would happen if there weren't first the potential for it to happen. It's a concept of Aristotle's that differentiates between mathematical possibilities ("mere possibilities") and real or physical possibilities. That difference is very well discussed in Giorgio Agamben's book *Potentialities*. Somehow, we have to connect – as architects – the abstraction of space, this memorizing of events that have already happened, to the reality of time, the continuous flow of events. Strangely enough, this continuity is given (there are no "bad

times" for events), but not the actual content of the events. We know things will happen, even at what pace, but not *what things* will happen. So space needs to become a tool in this whole production of the "what." I'm very interested in how architecture can help to increase this dimension of tension, tendency and potentiality. You know, that's my whole problem with seeing consciousness as intentionality: it assumes that consciousness is something like seeing, that locking onto an object in space with your eyes is the same as thinking, as being mentally engaged with the now and the near future, being alive, being open to what happens or could happen. Being conscious, being aware and fully engaged in the now, doesn't mean you lock onto the future as an object. Architecture can only encourage this openness of mind through an architecture of connectivity, of topology, of the continuous. For too long, architecture was a tool for controlling life by looking at events as the repetition of former events, and every new event was an "accident," something acting against the *substans* of architecture. The new doesn't come from the future; it comes from the past. That's what potentiality is: a mating of old existing events patterning into tendencies, an *unfolding* of events.

> *An important aspect of architecture is its materiality, and most matter usually resists rapid transformation, so how does liquid architecture go beyond the "moment of freezing"?*

The fact that I'm interested in movement doesn't mean I want buildings to move around. I should stress the concept of abstract movement in the architecture. It's not a wall with the word "movement" painted on it. It's about stretching, twisting, bending, shifting, delaminating, curling, bulging, rotating, merging, splitting. Or, more complex, twisted splittings, stretched twistings, rotational mergings, et cetera. Normally, it would be insane to describe a form using these words – they are verbs, no? Signifying actions, not forms. But here we have a certain interference of form and action, perfectly described by this type of words. All my works are networks of these movements, one movement multi-

plied by another. Since I'm interested in movement and change, I'm interested in systems that are created and structured by change. But that doesn't mean you can use any movement (of water or whatever), freeze it in an instant, like a three-dimensional photograph, and then build it – that would be the craziest distinction between concept and structure, no? Movement has to become structural, to be structurally absorbed into a system.

What is a curve? It is a line that does multiple things, not just one; it integrates, and therefore it is structural. As I said before, a line never curves by itself, only in relation to others. We don't design with curves, we just lay out relationships. And relating them makes things take on curvature, because that which relates creates the thing. So the word "movement" is immediately abstracted, because it means nothing other than continuity of relations. In all these diagramming techniques I use, you see that the more flexibility leaves the system, the more structure is gained. That is why I resist the concepts of both "datascape" and "animate form." In the former, information enters a preset form (often a cube); in the latter, all information is directly materialized as a form. I work much more with interaction between information and form: basically, I'm only interested in the structuring, patterning effect in between the two. That's why I tend toward iterative processes, stepwise methodologies, because every time the form is changed it absorbs the information differently. It's a slow process of hardening, from architecture to building. In the end, all the movement that was in the first diagram is separated into abstract movement in the architecture and the real movement of bodies and minds.

The Lives That Are Hidden

In Conversation with Arjen Mulder

AM: There is a topic we haven't discussed yet that I feel is very important, and that's the relationship between art and architecture.

LS: I know. It worries me.

Why is that?

My whole family comes from art. If I knew one thing for certain as a child, it was that I wasn't going to be an artist. Now I'm swamped by art commissions.

Yes, well, that doesn't have to worry us here. We should look more closely at the relationship between art and architecture, though – it's a very old one.

Yes, and generally seen as a formal one. There is a diagram of Corbusier's that has hospitals and schools on one side of the graph and churches and museums on the other. Of course, on the left it says "function" and on the right it says "art." So less program allows for more art, for more sculptural treatment of the volume. I don't think the relationship between the two is necessarily formal; I think it's about life. Goethe said: Guide a blind person through a house, and if it is good architecture, it will feel to them like a well-choreographed dance. For him, architecture was much closer to dance than to the visual arts. And right he was – what a great idea to take a blind person through a house! I remember John Berger telling me he had a blind photographer friend, and Berger would take him to museums to photograph the works of art. In my spaces, that would probably work even better. Since floors relate to ceilings and walls, I think it would be interesting to try. Somehow, that physical, felt relationship must register in the photo.

Goethe's example brings me immediately to the Son-O-House. In this interview, I really want to go step by step

through some of your artworks and understand what they are doing and how they relate to architecture.

The Son-O-House has a long history. It started as A House for Robots; that's what I called it at the beginning. I thought that would be the most amazing thing: robots living in a house. We always think the lowest of machines, like our cars, which we house in garages, or our Xerox copiers, hidden in the darkest corners of the building. The robots were going to be a family; they even had a robot dog, and all their behavior was rule-based, like watching television – robots watching television! – or having fights, loving each other, sharing breakfast, playing with the dog, everything. But it wasn't going to be like a television soap, quasi-reflecting our own lives; there was going to be no story, no narrative, no identities. All the relationships were going to be external; all interactions would operate only on rules of engagement, according to a relational logic. And the system would proliferate; functions would repeat over and over. The man would fall asleep and never wake up; the dog would start to rule everything; the children would order pizza all the time; whatever – they would live their nonorganic lives. We couldn't really make it work on the site, mainly because we wanted to work with projections, and the site – a business park – wouldn't allow the public there at night. So we changed it from projections to sound.

The idea of a house stayed with me, however. I thought it was really important to make a house an artwork, or vice versa, to make an artwork a house. In that sense, I think all architecture should be an artwork first, and, as Ruskin would say, carry "the lamp of life." So, not architecture related to art by sculptural form, but by a concept of life. In that sense, it starts as art and can end as architecture, but it doesn't have to. Or it doesn't have to completely, as in this case. That's what I wanted to do here, too: design a house but not develop it to the end, stop the design procedure before it became an actual house in the architectural sense, with an address, furnished, a property. I think *lives are lived aesthetically before anything else*: we contract feelings, we cluster feel-

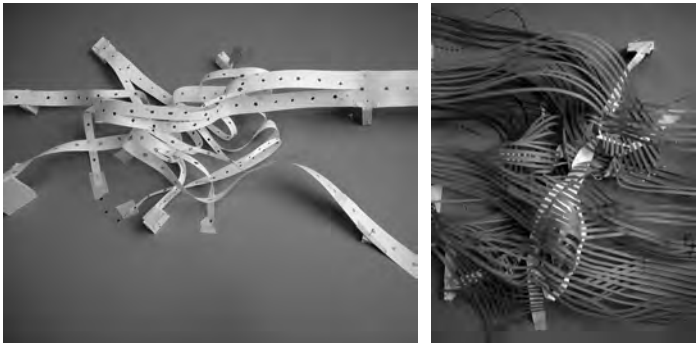
ings, we cluster impressions and arrange movements and colors. Whatever we do, we do it for aesthetic reasons first, because we feel, see and move. So art is not off to one side, as in Corbusier's diagram: art is at the core. That's what drives us; our lives are paintings, in a sense, or choreographies, if you like, or maybe even action paintings that combine movements and notations. I wanted to create such a "proto-house," not a house with all the rooms and furniture, but as a node of movements and feelings only. Not a house as "a place in the world," but a house that anybody could enter and live in, act, move, have feelings, leave traces, connect to previous "inhabitants." Dislocated, not anchored. I wanted every movement registered – every turn of the head, every look, every bending of the knee – not as actually doing something, like washing your hands or opening the door, no, all these movements were registered without their purposes, blindly, just like Goethe's dance. So we started looking at movements first.

> *You recorded the movements of people in a house around the sink or a chair or door. They look like long extrusions in time, in which a person no longer simply moves but becomes a time-object, like a three-dimensional chronophotograph by Etienne-Jules Marey.*

Yes, we looked at three scales of movement: those of the whole body, limbs and extremities. In a house, these movements correspond respectively to rooms, pieces of furniture like beds or sinks, and smaller accessories like cups or drawers. We traced these movements in such a way that you lost the specific function but gained a precise insight into the complexity of these actions. Like you said, we made Marey's kinetograms three-dimensional and traced all the limbs as continuously varying relationships between the three scales. It's like looking at a house without the specificity of rooms, cabinets and drawers: it's just increasing scales iterating from each other.

Then, like Naum Gabo, we asked ourselves how we could connect these movements through a new relational logic. He al-

ways traces simple objects as lines moving in space, creating three-dimensional bands. Since Gabo was a constructivist, he always connected these traces of movement or bands into a complex network of curving arches. I also wanted to work with bands, but to allow them the possibility of curving in more than just one direction. We took strips of paper, as we did in Nantes, but we cut them down the length of the strip, making an opening; one side of the opening could bend in a different direction from the other side. The cuts followed all the information from the kinetograms on three different scales; there were large, medium and small cuts. We took three strips of paper and coded them with three cuts each, with all the cuts at different positions. The moment when matter as a continuous field starts to generate singularities, it becomes expressive. Comparing it to Frei Otto's wool-thread models, we would say that instead of a thread (or band) having a single overlength, it now has a quadruple overlength, i.e., it can connect to four other band segments in four different directions to create structure. So we had three strips with cuts lying flat on the table, and then, as Otto dipped threads in water to make them coalesce, we stapled them to each other in the middle of each subsegment, basically linking up the movements on the level of scale. The moment you start stapling them together, they form



NOX, Son-O-House, Son en Breugel (2000–4). *Left* Paper machine, stage 1. *Right* Paper machine, stage 2.

arches – many, many arches on many different scales: overlapping arches, twisting and turning into each other. Thus, the structure emerges from movement – a clustered system that self-engineers from flat on the table to elevated and voluminous.

How do these arches become the complex set of surfaces of the final design?

Well, at the moment you have these white bands, linear elements; they need to move up in scale to become surface. No different from Gothic ribs. Architects and scholars often complain that Gothic ribs aren't really structural, but they're looking at Gothic as Viollet-le-Duc did, with structural determinism, as if the ribs are elements, and they are not. They drive the design, and they actually drive it structurally, meaning they are either the centerlines or the edges of vault surfaces. Since Gothic methodology follows a line-to-surface technique – i.e., they design from linework like tracery or reticulation toward surfaces and volumes – we have to understand that of course the ribs are structural, but not structural elements.

So, following that logic, we made each paper strip the middle of a curved surface that sprouted sideways out of the paper model. In other words, the arches partially became domes, and these domes transformed again into columnar ends so that they could stand up. So we don't have dome-architrave-columns; instead, we have a double curvature that can tear loose and increase its curvature to obtain the narrower section of a column. That's why all the tendrils are pointing outward. This also makes the structure accessible from all sides. It doesn't consist of an addition of domes, however, as in the Hagia Sophia. The domes tear off or merge into large ones, or they peel away to become smaller ones, some as small as a cabinet. It is a system with porosity, like multilayered phyllo dough, but never a single closed volume to define an action like a room. So, contrary to what contemporary critics say about double-curved, topological architecture, this structure is not a single shell, or even a multiple shell system: it is a continuous system that pro-

duces singularities, sharp creases that produce divisions, tubular column states, torn openings, everything. There is a continuous dislocation of surfaces; one crawls over the other, curling away to become another.

> *Is that the point at which Edwin van der Heide entered the process? His sound system is simply amazing. It changes constantly into complex patterns.*

Yes, there are some 25 infrared sensors in the structure, in all these different spaces, from the largest one to the smallest ones. These sensors can track your movement, and these movements trigger transformations in the real-time-generated composition. In music, we know either order or chance, as in reading from a score or improvising. And interactive sound works are often no real improvement on that, because most of the time you have sounds stored on a computer that are simply mixed or sampled through visitor interaction. But that doesn't make it music. So it's either a whole that's precomposed or a mess that's real-time. Edwin did something very different. He made a parametric system of relationships – of course – in which when you change something through interaction, the rest changes with it. So, in a way, the composition as you hear it at a certain moment in time is a memory of all the other interactions that have occurred before, but not as single notes or sounds but as a development of the system. It's a plastic memory. Now, what makes it also spatially such a great work is the fact that the sounds are based on interference patterns. There are five zones of speakers that all produce certain frequencies, but with every interaction, every time you trigger a sensor, there is a shift in that pattern through very subtle changes in frequency. This means that when you hear the sound produced by the five groups, you also hear interference from similar frequencies, like an optical moiré, which makes it impossible to tell which sound is coming from where. The sound dislocates itself. So moving through the space, stopping, pausing, moving on, even crawling, sticking out your hand, pointing, looking up – all these

movements are registered not in an index but in this *sonogram* of all previous visits that triggers a continuous variation of space. In a way, the house is haunted – all architecture should be haunted in this sense of an evocation of spirits. There is a reversal of sound-body relations here; it's not like dance, where you move to the rhythm of the music; here, you are actually producing the sound, then the sound changes, and you in turn change with it. What would Goethe's blind subject say? He or she would hear movement transforming into music, and the music would be that of dislocation, and you would be moving to the music too! The diagram of the sound, the sonogram, stays active, changes, stabilizes, creates tendencies, like Xenakis' *Metastasis*, but ones lived and formed simultaneously. Is that not what we would love in art in a house: that our lives themselves would make the work, and that they would affect the space and how we live in it?

> *The music is clearly interactive because it changes over time – but what about the architecture?*

Well, that requires a double answer. One is that the changing music follows – or has – an architecture. The second is that architecture itself can be an architecture of change or music. One argument with two sides. So the first one is that although the music is interactive, the question is *what* actually changes. If it were just random change, there wouldn't be any interaction, correct? At least, there would be no music. You can't just have blind transformations without any directionality; tendencies, patterns of development, are always necessary for interacting beyond a short-term Pavlovian response level. So behind the real-time changes, there must be a coordination that spans time: in Edwin's case, a rule-based system of relations. And it is not an overall scheme; it operates from sound to sound. It's the painting behind the music, so to speak. OK, it's programmed code, but it functions as a sheet or a script. That's my first argument: behind the changes, there must be something that organizes change – the sonogram. It's not a transcendent control mechanism (therefore,

it's incorrect to say it "is"; it's virtual), but it does make the sounds cohere into music rather than just a bunch of sounds. It's like having the code working behind the *Goldberg Variations*, but instead of the 30, as we now know, you would have thousands, always transforming into each other. What I am saying is that interactivity can only happen when a system has architecture. The second argument is that of course architecture can change, but then you need an *architecture of change*, and that directly means an architecture of continuity or vagueness, not an architecture of timeless stability of fixed rooms with determined functions but an architecture of transformation. Change has structure, too. Or, to word it more strongly, transformation has form and geometry – just look at Marey's chronophotographs. I know many would like to write off architecture as an old medium, since it can't change, but that is simply a misconception, not so much of architecture but of time and form in general. There is a continuous back-and-forth between the present and memory.

> *Susanne Langer has a whole section in* Feeling and Form *about motion in drawings and form and how that actually connects to life. She says, "Permanence of form, then, is the constant aim of living matter; not the final goal, but the thing that is perpetually being achieved and that is always, at every moment, an achievement, because it depends entirely on the activity of living. But living itself is a process, a continuous change; if it stands still the form disintegrates – for the permanence is a pattern of changes." For her, all art is about making living form. I thought about that when I was in the Son-O-House and the pattern on the exterior seemed to communicate with the music even more than the intertwining domes of the interior.*

Yes, there is nothing metaphorical about saying architecture moves. Architecture operates with dimensions – lines, surfaces, volumes – and dimensions are the realm of movement. If we now find a way to bridge dimensions – to cross from line to surface to

volume through continuity – movement will pervade the structure. That's why an orthogonal grid of lines making a surface doesn't evoke any movement, but a typically decorated, interconnecting set of curves, like in a Jackson Pollock painting or a piece of William Morris wallpaper, does. Movement lies in the way the lines grow or multiply into a surface, in the jump from one dimension to another. So it's not so much in the nature of lines themselves – "curves" – but how they organize themselves to become a surface and move up a dimension collectively. I think that is exactly what a living architectural form would be: shifting sets of dimensions, moving one movement into another while moving up in scale as, stepwise, the lines of the paper model become a volume.

The surface pattern is something special. There is a certain flicker to it, a certain iridescence, a mosaic state. There are various reasons for this. One is the issue of covering or tessellating double curved surfaces. This type of surface can normally only be cast by a liquid material that hardens into a rigid state or be covered with violently deformed sheets, like those used in shipbuilding. Now, if you cover a double curved surface with wooden planks, for instance, it results in something very interesting. After the first plank, you can add a second and a third, but after a while it stops working: the plank moves away from the adjacent one. What you then need to do is introduce another direction, not orthogonal to it but slightly diagonal, like when you apply a bandage to an arm. So you get parallel planks, but they break into small

NOX, Son-O-House, Son en Breugel (2000–4). *Left* Photo from south side. *Right* Kuba Shoowa cloth of embroidered raffia, Congo (early 20th century).

packages; it becomes an aggregate, a heterogeneous assembly of parallelism and nonparallelism. Similarly, we cut a thousand strips of metal with the ends at an angle. We made the angle so that three strips would tend to close into a triangle. Then we just started somewhere.

Without a drawing?

Yes. That made the builders very nervous! But we had prepared models, and a booklet with all the rules in it: "If this, then that," like an algorithmic rule set, but to be executed by hand. Our main rule was, if the third strip doesn't form a triangle, move the strip back and don't cut it. So we got this pattern of closing and opening triangles in constant variation. It's impossible to draw. It operates on rules, and the complex pattern emerges: it's neither by necessity nor chance. To make this extra visible, we used expanded metal for the strips, and expanded metal has obliquely oriented openings, because it is produced by stretching, and this creates the effect that, depending on where you stand and what angle you look at it from, sometimes the surface is fully transparent and sometimes it's fully opaque. This creates the flickering effect when you walk around it. So, again, it's an architecture that changes.

These patterns are very similar to other time-dependent processes, like leopards' spots and zebras' stripes. Or in human design, like African Kuba Shoowa cloths, for example, which are small square rugs where the maker chooses a basic pattern, often based on diagonals and alternating colors, and then makes a little "mistake" that has a gradual effect on the system as a whole. Sometimes you see the diagonal grid unravel and slowly become zigzagged; sometimes it suddenly breaks and shifts to another pattern state. It's not a grid imposed onto a form but a system that operates on a relational logic, which can always vary and change. And the changes help you to move around an architecture without corners.

So now we have moving bodies, paper, steel, sound, back to moving bodies – life does seem to find a continuous flow through it all.

The Son-O-House is an artwork for a small number of people, since it is located in a park. I want to move on now to the D-Tower (ill. p. 223), which was built for a whole city. I want to concentrate on the issue of life, not on how it was made or designed. It consists of three elements: a 40-foot-high physical tower, a website, and a questionnaire asking people about their emotional lives. The artist you collaborated with, Q.S. Serafijn, wrote all the questions, which were about four topics: love, hate, happiness and fear. As I understand it, a selected number of people answers the questions daily, and at night the tower is lit in the color of the dominant emotion of that day: blue for happiness, yellow for fear, green for hatred and red for love. My question is: How different is that relationship to life when you're making an object for a larger number of people – in this case, a whole city?

I am very interested in a renewal of the monument, though generally that is the worst form of nationalist representation, with the memory of a state being petrified into sculpture. But the transformation of that form of monument into 20th-century abstract public art hasn't tackled the problem at all; it just viewed it as big art and never seriously engaged with the problem of collective memory or feeling. I mean, whatever critical things we can say about Nelson's Column in London, for instance, he is *loved*: the body of Nelson is a source of affection. And it is no accident at all that it so vividly demonstrates the duality of being both a structure – a column – and an image – the statue. Many of my artworks are towers, but without that unresolved distinction. I try to make the structure itself an image. Or, more precisely, I am interested in the moment at which it is *no longer* a supporting structure but *not yet* an image. Though in some of the towers it is more apparent than in others, they do seem to be rising up. As you once said, the D-Tower strongly resembles a jellyfish, slowly floating upward in the water, with a body like a balloon and the tentacles hanging downward. At the level of clustered feeling, the D-Tower

is not so different from the Son-O-House, because both use art to wrest feelings from memory and experience. But if the question of the Son-O-House is how to make a proto-house, the question of the D-Tower is how to make a proto-monument: i.e., though there is no representation of a city or a community in the tower, it still is a contraction of feelings that does present to us the feelings of a city. But one has to work that out on multiple scales; that's why we have the tower as both an object and a website with a questionnaire.

> *This difference between representationalism and presentationalism has been perfectly theorized by – again – Susanne Langer, in the book I mentioned before. Art contains virtual experiences: a virtual feeling is actualized in humans and comes to life within us. She is very clear about art being nondiscursive, or in your words, proto-discursive.*

Yes, the object has a premature, not fully developed shape, and the website is continuously engaged in processing feelings and emotions in the city – "How much do you hate your boss?" "How scared are you to walk down the main street?" "Do you love your wife?" et cetera – though these are pretty ordinary daily emotions, these literal feelings are not the content of the artwork. Not at all. It is the transformation into color that is the work of art. When you drive by at night and you see that the tower is green, it has an immediate impact – why was hate the most deeply felt emotion today? The green is unspecified: it is a democratic hate, and it affects us all. It is raw, much rawer in its statistical, generalized state than the specific hatred of one person directed towards another. So it is presenting you with feelings that are more complex than the emotions expressed on the website. But if art is virtual life, it is real life that feeds it, and real life that radiates from it again. So, in that sense, we are taking Susanne Langer literally: the actual feelings are virtualized, and this virtuality in turn evokes real feelings, but these are not the same as the first ones. There is no symbolism; it is not a symbol of the feelings of the city

but much more of a machine that operates and processes and distributes. As in the Son-O-House, there is a dislocation of feelings, feelings wandering across the city. When the Situationists used a map of London to walk through Paris, they turned the map into an active machine. Often in art, we see that mapping comes after the event, but in the D-Tower, and especially on its website, the mapping displaces emotions from one part of the city to another. It's not doing what it seems to be – showing the emotional lives of the inhabitants of specific neighborhoods – but quite the reverse: moving emotions to other quarters, spilling them out across the whole city. It doesn't record life; it disperses it. It transcends personal lives and presents us with life as such. I always feel that life is something that travels through you, not the other way around. Expression has to separate itself from the subject.

> *You've been developing this theme of life more and more, even with animals. You are also building a huge D-Tower for animals.*

Yes. It is called Hidden Lives – I was reading *The Wind in the Willows*, and I became fascinated with speaking animals. Ratty, Mr. Toad, Mole, Mr. Badger – they're just fabulous. It's not animals acting like people, as is so often stated; it's people acting like animals, their lives being lived as pure singularities. It's not about personalities – it's not a book about all rats or all moles that vary according to their individual personalities – it's about different animal species. Differences in identity are replaced by differences between species. As we sit here speaking, at this table, that is how I feel different from you: as a toad differs from a rabbit. A radical, insurmountable difference. If you're a mole, you're a mole, and if you're a rat, you're a rat. It's simply magic that we can share this space if it wasn't for life to guide us.

The site is a long stretch of highway that is littered with very narrow invisible tunnels, just one-and-a-half by three feet, but sometimes 100 feet long or more – tunnels that have been dug under the highway so the animals can cross the road without

having their habitat interrupted. There are dozens and dozens of them under that two-and-a-half-mile stretch of highway, for toads, rabbits, moles, everything – even larger ones for deer. And it's all invisible. What we're doing is putting sensors in seven of these tunnels and letting the data inform seven spherical lights in a tower. So when you drive by at night, you'll see how many animals have been using the tunnels that week; there's a different sphere for each kind of animal. You won't see colors, like in the D-Tower; you'll only see the white light levels varying. But the contraction of feelings is totally different. It's not your own virtual life you're experiencing; it's the animals' lives, animals living your life. Humans who turn into animals – as shamans do – always do so to become spirits, to steal the spirit of a rabbit or a fox. The seven lights are large glowing spheres, and, as we know, spirits are spherical. So it's not that different from the haunted Son-O-House, where your life becomes entangled with other people's previous lives. Instead of a photograph, we take their sonograms, like a sound imprint. One day, I will do a tower for missing people. The D-Tower is haunted, too – a tower of spirits, every day chanting their unequivocal hatred or love. You can actually visit the Hidden Lives tower. You can park your car, walk over to the tower, and go underneath and be inside that huge pipe filled with the seven glowing spheres.

NOX, Renderings of Hidden Lives, Tilburg (2007–10).

> *I heard you call it an "animist chapel" during your lecture at the Netherlands Architecture Institute last year. It would be great if hippies discovered the place and came back every year to do their rituals, as an iron alternative to Stonehenge. It does seem to project the spheres outward to the moonlit sky. The whole tower evokes this sense of life, though. It seems that the elements themselves have non-mechanical, living relationships.*

Yes, there is an obvious Gothicness about the tower. There is something of Caspar David Friedrich's oaks in moonlight in there. He painted them over and over again in different light settings. Another thing I would like to do: build a forest of oaks out of chrome metal, all different. In the Hidden Lives tower, all the components are undefined, exactly like the twigs that are lying around on the forest floor until a bird picks them up to make its nest. How do elements without any identity become parts of a whole? They aren't parts of a machine, like nuts and bolts that get made into an engine by accident. It's not like William Paley's deist watchmaker, nor even like Richard Dawkins' blind watchmaker. The parts aren't "parts" in that sense. They are only parts, or better, components, because of the relationships between them, *relationships that are external to their terms*, as Hume says. Real building, real construction, operates purely on such exteriority. So do real human relations. It's like using the mosaic pattern of the Son-O-House to build the structure itself – something I really wanted to do, because I felt that the jump from texture elements to massing assembly there didn't pass through structure enough. Here, the elements build the tower themselves; it works by pure association or contiguity – Humean structure. Some elements are more linear, to add height; others are more crooked and three-dimensional, to add intricacy. To build a tower from it, you need to both pack and stack – stack the more linear elements and then interweave them with the more three-dimensional ones. Generally, architectural structures work with sticks and nodes – stick lines and node points – but here the nodes are spatial. You can no longer distinguish

clearly between nodes and sticks; sometimes the irregularity of an element is used to lock into another. Sometimes they cross and connect in a typical way; sometimes they run more in parallel; sometimes they move under and over each other, like woven fabric or felt. We scripted the generation of the tower on the computer: 1,600 elements nest and pack according to only six algorithms, at varying angles, from an elliptical ring on the ground that grows upward to create this curved pipe shape. In a way, it's almost too difficult for humans to be that direct, and blind, when building. Again, this has to be built without a drawing. In that sense, it has to be built by animals. Or robots, for that matter.

My dream is to build a tower like this, 1,000 feet high – a sort of ecological Eiffel Tower. You would have to build it with robots, with cranes being fed algorithms. Imagine a tower that builds itself, with no drawing, no builders on site, just parts being assembled, crane robots cooperating with welding robots. People would only drive the trucks to bring the parts to the construction site at the beginning. They would make huge piles of the parts, probably millions of parts, and the machines would simply pick them up off the stack and start. And when it was finished, ten years later, it would start sending messages to people, which would pop up on their mobile phone screens. It would be like a huge brain, a ferro-organic AI tower.

NOX, Renderings of It, Flims (2005). This project for a "one-legged D-tower" in a Swiss ski-resort visualizes the ratio in presence between natives and second-home owners. We planned an automatic system registering the usage of roads in the city that controls the lighting system of networked veins in the tower; by doing so we show the hidden tension in the small town that grows from 1,500 people in April to 25,000 people in the December.

Machining Architecture

Machining Design

> *The organization of a machine (or system) does not specify the properties of the components which realize the machine as a concrete system, it only specifies the relations which these must generate to constitute the machine or system as a unity. Therefore, the organization of a machine is independent of the properties of its components, which can be any, and a given machine can be realized in many different manners by many different kinds of components. In other words, although a given machine can be realized by many different structures, for it to constitute a concrete entity in a given space its actual components must be defined in that space, and have the properties which allow them to generate the relations which define it.* – Humberto Maturana and Francisco Varela[1]

How do things come into existence? Answering this with the term "design" is slowly becoming as obscure an explanation for artificial objects as "creation" is today for natural objects. Why would we accept divine intervention in architecture when we have stopped accepting it in nature? Perhaps we should use the same answer we came up with 150 years ago for natural beings: things come into existence by variation, internal movement and agency. Forms are born into families and populations; this means they are partially the same as their predecessors and partially different; we denote this with the term "new." What does it mean when such newness can no longer be attributed to a designing author? What would be behind such an ontology, and how could it be instrumentalized by designers? To answer such questions, we must first look at the history of ontologies themselves. All ontology works via abstraction; we cannot go from the real-as-it-is to the real-plus-one-more-object without passing some schematic stage, neither in nature nor in design. However, the history of explanatory schemes has transformed from reductive to generative, from abstractions that point backward in time (idea and schema) to those that point forward and are pro-

ductive (diagram and code). One by one we will examine these four ontological abstractions – idea, schema, diagram and code – that each match with their own concrete actualities – respectively form, reality, assemblage and being – before we arrive at a methodology for architectural design.

The oldest of these must be Plato's distinction between idea and form, in which form was not considered real but an imperfect projection of an ideal state of being, which was the unchanging figure of the Platonic solid, the Form or the archetype. Therefore, the real could never be experienced by the senses, only understood by the mind. The second ontological model, a huge improvement, because it allowed for actual sense impressions and experience, was Kant's separation of scheme and reality. Kant asserted that for the real to exist, it must pass some schematic state, because for something to be recognized it must be schematically categorized or housed (in the mind) among past empirical encounters. Both the *eidos* and the schema are very geometrical constructs, and all subsequent design must inherently follow such geometrical exactitude. In short, they allow only for the replication of form, not for the generation of it. What these reductive theories failed to explain was how there could be real communication between the two sides of the passage from abstract to real: that is, how there could be a physical relation between the two instead of a metaphysical one. They failed to comprehend how things could be new and how we could know new things.

After reductive ontologies, we should take a brief look at generative theories. The shift from one to the other happened at exactly the same moment as the reversal from the objectified state of nature toward a more natural state of objects. In other words, geometry and life started to change positions. Before that time, life could only be understood geometrically; since then, the geometry of forms has increasingly been understood as forms of life. Kant already saw it this way, but argued that although we knew nature functioned organically, we should still describe it mechanically. At a certain point in *Critique of Judgment*, he discusses the branches of trees bringing forth leaves and the leaves

in turn feeding the branches[2], and in this process he sees a fundamental, organic causality that is as much progressive as regressive – not far from Maturana's autopoiesis[3] – but he clings tightly to *Zweckmässigkeit*, or purposiveness, which is of course problematic where effects influence causes. So, though Kant accepts formation (*Bildung*), it is still largely directed by an external drive (*Trieb*). Surely an even more biological understanding of form, a generative ontology, must accept the coexistence of schema and form within the same continuum – a continuum that, accordingly, must be participating in the real itself. The schema cannot be ideal; the abstraction must be real. Such generative ontology is often understood as a continuous unfolding, a progressive differentiation, a gradual increase in information as an object takes on form and grows. In this view, designs are grown. Bergson's distinction between the virtual and the actual allows for this, since it incorporates time and a process of creation, as does Deleuze's couple of diagram and assemblage. These last two ontological couples presuppose the schematic state to be variable and topological, and actualization to be a product of differentiation, since the actual cannot by definition be identical to the virtual. It is important to understand, however, that these ontologies, though they thrive on variation, do not result in a world of pure difference. There are two types of difference, as Bergson famously stated: difference in kind and difference in degree. So, although forms in their generative structure don't teleologically point towards purposiveness, they are still organized by differences in kind – or, as Maturana and Varela call it, organization. Organizations vary from each other in a different way than structures do. Structures are a subcategory of organizations. To simplify somewhat: the difference between an oak and a beech tree is of another order than the difference between oaks themselves.

How can there be discrete organizations (like objects, which they are not)? How are they selected? How do they, once selected, become a structure? And when there is a structure, why is it different from others that fit the same discrete set? This can only be so because the reality of the schema has its basis in mate-

riality. When looking at matter, we must acknowledge two fundamental states: (a) it is organized, and (b) it has the capacity to reorganize. For Bergson, the fact that it was organized meant an implicit equation of the virtual with memory. The reductive theories always needed an external body (God, architects) to activate the process, to enable the shift from one side to the other, because matter was considered passive and incapable of passing over by itself. But let us begin to consider things as mobile in themselves – and, along the way, get rid of creationism in architecture. This notion involves the now well-known concept of self-organization, in which materials are active agents that seek agency, that seek order, an order that is not transcendentally established but emerges bottom-up. I want to add immediately, though, that this emergence is always contained in a framework that is highly historical: all form is the registration of its history (and memory does exist in the real, simply by being a form), and its ontogeny is always a recapitulation of its phylogeny, as Ernst Haeckel stated. The real as it is rests in its history; the real as it becomes is a change that happens to a past. Things do not drop back to a primordial pulp state in order to become new. The new doesn't emerge out of nothing, not even from a fully mobile state; it emerges from that which is already organized. The relation between organization and structure exists in all objects, whether organic or inorganic, designed or grown – and for the purpose of this essay, it is important to continue to mix them up. Clearly, such an ontology must first tackle the question of how an organization that is closed and singular can have multiple material structures that must be open or else they cannot vary. Or, as they say in biology, "a variation that is real of a type that is illusory"[4] – we never see The Oak, only oaks. Somehow, forces in the world are capable of first *converging* into an organizational singularity and, while passing through that point, then capable of *diverging* into many different actual structures. Such an organization simply has to be a topological structure, or it would not be able to change and create variations of itself. A typological structure is not capable of transformation (only deformation), since its components are fixed.

A topological schema concentrates on the *relations* instead of the components.

This is why Maturana and Varela are correct in classifying organizations as "machines": since their transformations happen over a certain time period, they *process* transformations in a formative procedure, a process Varela had earlier called in-formation[5]. For the same reasons, Deleuze and Guattari are correct in classifying them as abstract machines, which means on the one hand that abstractions function as machines themselves and are generative, and on the other that machines are abstractions and convergences. They are not, it must be stressed here, arguing for a full shift from mechanical to organic; life is as technological as machines are alive, which they indicate by the term "nonorganic life[6]." In their view, even organic evolution has a machinic component, and the technological phylum extends far into the natural world. It is an active process of abstraction; life is between the components. As God was earlier replaced by Nature, nature is now being replaced by life – and we can stop capitalizing them, too. It's a vitalism of undirectedness, of immanence, a *Trieb* without purpose. Though immanence always means a presence of life as such, it creates a history of forms that guide and channel that blind pervasion of force. Energy and time do not fly about; they occur in material forms and structures and nowhere else (this is the convergent part), but as they happen, these forms transform and change (which is the divergent part).

Let us now take a closer look at what such an ontology of material agency could mean for architectural design. As indicated above, the process includes a convergent phase of selection and a divergent phase of design.

- Contraction or convergence – a movement of virtualization, in which information is gathered, selected, graphed or mapped and then organized into a virtual machine. A movement towards quality, order and organization.
- Expansion or divergence – a movement of actualization, in which the organizational diagram germinates and becomes

formative. A movement towards quantity, matter and structure.

Though this division clarifies what goes into an organization and how it comes out as a structure, it is still unclear how the first stage is actually connected to the second. Though it is evident at this point that it should be a continuous process and should be phased, we could still take *any* diagram and drop it on *any* kind of building to produce *any* form – which is simply the most horrendous thing I can imagine. Both the phases should be (empirical) machines in themselves. Machines connect only to each other, like molecules, which means *the phases in a process need to be steps in a procedure*. Here, we need to specify that an organization is understood as a system. For an organization to be a machine, it needs to be a system. For a system to differentiate over time, we need a procedure. For a procedure, we need rules. All relational logic asserts that relations are external and therefore follow a rule-based, not law-based, logic. Designing with rule-based systemacy is the opposite of geometrical exactitude. Rules are of an organizational nature, while geometrical properties are of a structural nature. Or more briefly: rules are parametric, while properties are geometric.

I think, later, when design is fully permeated by computing, we will leave the diagram-assemblage couple in favor of the code-being couple, as a final biologizing of design. This is inevitable, since the diagram, though conceptually a machine, lacks the instrumentality and operationality of code. The most promising developments are being made with parametric and algorithmic procedures, which are processual and iterative by nature, though they tend to be applied in smaller areas and rarely for the whole design. But most programming and scripting in architecture is still too often of a schematic nature. Computing is not about formulas generating forms to be cast in concrete. Likewise, in evolutionary biology, the shift from genotype to phenotype is not understood as a linear transfer of "information." The chemistry of the genotype doesn't directly result in the biology of a phenotype, an individual being. More and more, biologists refer

to the problem of random variation being too divergent to produce the actual variation we observe in the natural world, even when tamed by natural selection. Somehow, this variation needs to be more *biased*[7], more self-directed, and this probably occurs in the physical space between chemistry and biology – in a "morphospace" between the genospace of genetic code on one side and the phenospace of the living invididual on the other, with the ecospace of populations one step further. Thus, in ascending order of size: genospace, morphospace, phenospace and ecospace. Since D'Arcy Wentworth Thompson, many morphobiologists have suggested that not all information can lie only in the genes[8], but that the actual physicality of development must have some biasing influence on the process. If the code itself is already material, and its history is material, then so is its development. Thus, for design, too, we need stepwise procedural thinking, serial methodologies that, like the linear string of the DNA molecule, are activated at different moments of the procedure, which are material, and biased, from start to end. And though codes and scripts are always linear, that doesn't mean the process is linear (there are always higher-scale effects – "transformations" or "singularities" – that feed back to lower-scale agency), but it does mean the code is present and active during the whole procedure, which is a crucial difference from the diagram, which is only present at the start of the process and never mixes in with materiality itself.

The Four Stages of Machining

Since this theory of form generation is so dependent on material agency, let us rephrase the procedural techniques within a material framework before we apply them more specifically to architectural design strategies. Clearly, the abovementioned conceptions of order and how organizations transform into structures – how they are intensive, how they are topologized first and then become extensive, metric forms – are deeply rooted in what Manuel DeLanda[9] calls the "intensive sciences," like thermodynamics, topology and dynamical systems theory. Architects gener-

ally consider form to be solid, but this is a matter of scale, and often also time or temperature. As stated above, material form has two major properties of organization and reorganization: it is both stable and flexible. It is flexible enough to be moved out of equilibrium and coherent enough to be moved back into equilibrium. This means that a theory of solids cannot explain the spontaneous passage from organization to structure. I believe it was Viollet-le-Duc who stated that architecture was an art of crystals. Yet this would only support a theory of type, one of archives and catalogues but not of self-generative form. In between, we need liquid states, or at least more viscous states that allow for reconfigurations. Now we can already be somewhat clearer about the stages of design leading from Maturana's organization to structure, or as I formulate it, from a system to a morphology:

a. we need to select a *system* and create a configuration for the machine based on this selection;
b. we need to *mobilize* the elements and relations in that system;
c. and we need a phase of *consolidation* to finally make the system ...
d. result in an architectural *morphology*.

From system to flexibility to rigidity to morphology. In the convergent initial phase, there is an acceleration, a topological mobilization that passes through a very narrow channel, after which the process slows down and consolidates by taking a divergent path towards a geometric form[10]. As this still sounds quite obscure, we must clarify more and go through the stages one by one.

I. Systems and Organizations

> *We never think of transforming a helicoid into an ellipsoid, or a circle into a frequency curve. So it is with the forms of animals. We cannot transform an invertebrate into a vertebrate, nor a coelenterate into a worm, by any simple and legitimate deformation. Nature proceeds from one type to*

> *another ... To seek for stepping stones across the gaps between is to seek in vain, forever.*
> – D'Arcy Wentworth Thompson[11]

D'Arcy Thompson has always been brought forward as a champion of topology in biological form, but the above quote indicates that in his view, topological, gradual variation doesn't result in gradual differences. Of course, all changes are *small changes*, but they add up to *large differences*. Differences in degree result in differences in kind. And though transformations are intensive, they have the power to either individuate or mutate (one never knows one has just passed a bifurcation). Though a transformation can have a great effect, it is always a relatively small step, and the newness of the new can never be appreciated right away. On the other hand, the quote from Thompson makes it strikingly clear – more than most of us would like to think – that type is relevant not just in biology but also in architecture. Obviously, when we set out to design a tower, for instance, we are not going to start setting up a machine configured horizontally, like a house[12]. And now that we know we deeply need a topological technique to generate designs, it will always be necessary to *topologize type* (in our case of the tower, topologize verticality), not just fly in a topological figure or system from somewhere. I think there has been too much emphasis on the divergent, proliferative capacities of intensive design techniques and not enough on the necessary initial selective procedures. Because if we are going to mobilize elements and relations, what system are we going to do it in? What is a system, actually? A system is a network of relations between active or variable parts – "agents" – that through interaction results in larger-scale patterning effects[13]. In architecture, since the system is prearticulated, that means there must be some correspondence between that articulation and the architectural outcome. Manuel DeLanda has given us some clues about how to operate in these stages. First, he advises us to look empirically at the real populations of buildings, and second, he advises us to rethink type as a "body plan"[14]. So, if one needs to design a tower, one should look

at all the other towers, look at their diversity, analyze their differences, map them, organize them, look at their internal relations, and look at their "body plan." Body plan, as opposed to type, is a much more abstract classification than pure resemblance or identity. In short, for self-generative design techniques, we need empirical research (since it all happens within the real) into already existing forms; then we need to construct body plans from this research through analysis; then we must make sure these machines are able to process information (or difference) through a mobilization of their topologically connected components; and finally, these components need to be able to consolidate and take on a form, first as a design and then as a real building.

Let us continue with the tower design for a moment. The phase of the machining procedure (after research and analysis, which are convergent) would start with the actual decision on the configuration of the system. Systems always operate on mobile agents and their mobility is always rule-based. In our case, these mobile components need to relate to the preexisting systemacy of a tower, i.e., its structure, consisting of either columns or a skin-core typology. In this context, it might be interesting to highlight the tower-generating machine (see illustration p. 126) developed at Frei Otto's Institute for Lightweight Structures[15], which is based on the column system of a tower. Since it is not the purpose of this essay to fully investigate the complexities of these techniques[16], I will discuss them only briefly. What is relevant in this context is how the machine is actually configured in relation to the notion of a body plan. The tower-machine consists of two grids, one at the top and one at the bottom, at a certain fixed distance from each other. In between the grids are lines with a certain amount of flexibility, or in this case, with the lines materialized as wool threads, a certain amount of slack. After the whole system is dipped under water and shaken horizontally (the mobilization phase), it is taken out of the water and the threads immediately self-organize into complex branching systems (the consolidation phase). Now, I need to emphasize that this is by no means the only possible method for tower generation, just one of many

options. What is important to observe is that the transfer from columns to wool threads doesn't simply concern the topologizing or flexibilization of structural components but, above all, the abstraction of a column system into a path system – in this case, a path system for vertical loads. If we only topologized columns, it would be more difficult to get a divergent result. The columns would only *deform* in the next phase of mobilization. Something more important, however, occurs in the following phase of consolidation, that of *transformation*, where mobile elements transform into so-called singularities, i.e., higher-scale states of structural entities[17]. This means that the potential of a system can only be observed in the successive phases and needs to be fine-tuned and tested accordingly. We require that all systems operate on internal shifts, on critical thresholds, rather than remaining with the sole deformation of its initial geometrical setup (to then be "mapped" or "translated"). In Otto's case of the wool-thread tower, the resulting singularities are very divergent: the strands form *single columns* (when single threads become concrete or steel), *thick columns* (when multiple threads merge), *spatial columns* (where diagonals form nodes), *diagonal columns* (which generally come later, when one is bracing the verticals against the horizontal wind forces), *megacolumns* (when many diagonals form one large spatial tube), and *metacolumns* (like the centerlines of cores). Paths are of a higher order, more abstract than but as empirical as the columns themselves. And because they are material (or scripted as material), all movement is transferred in an intensive way, which means movement dissipates by transforming into structure.

II. Mobilization and Machining

We have researched and developed many design techniques that use the mobility of a system and consolidate it into form. Many techniques are possible, from cellular automata that interact and slowly build a structure to the literal transfer of movement, as in animation software. In general, we should observe that in digital design an (inevitable) shift has occurred from the usage of ani-

mation techniques to the study of variation as such, first in typical 3D modeling software and later in more sophisticated generative tools or scripts. Though movement of elements in a system can produce a wide range of variation, this range is typically *isomorphic*, while variation includes sets of transformations as well as deformations. As in the tower example, the system needs enough flexibility to produce deformations, but these are deployed only to produce transformations, i.e., to cause mergences, crossings, braidings, et cetera, to occur. For now, however, what is most important is that we allow the system to produce a whole range of variations, that we don't look at just one solution but carefully study the various outcomes and reset the system and its variables according to these. In machining as a design technique, the tuning of the system and how it processes change is crucial. All machines have a minimum and a maximum state, and we must build sliders between the two. As stated above, earlier techniques like animation are based on deformation principles, in which a primitive like a sphere, a cylinder or similar is bent and curved through stepwise processed movements. Though all these movements are topological and therefore variable, they are fundamentally of an *indexical* nature, which means we have to conduct a "photographic" freeze-frame registration in the consolidation phase. Though there is a considerable accumulation of time during the mobilization phase, the consolidation phase takes but a moment. This can only become structural when reread through structural members afterwards that are then topologized as if they were part of the mobilization itself. In general, the animation techniques have been of a formal nature, which means there is a quasimaterial phase of deformation but the transformation into matter is typically a posteriori. I propose techniques that are more *constructivist*, in which structural members join in the variability and therefore focus more on the consolidating phase of the procedure, and therefore on the materiality of the system. Systems that focus on formal variability or on programmatic variability tend to lack the power of synthesis. Systems that focus on structural variability act as diagrams both for program and form; i.e., it

is always better to let the machine come up with the ideas instead of designers forcing them. Constructivist systems that operate on material agency are based on truly transformational principles, in which consolidation is often directly a self-supporting or self-engineering of the system. So the deformative needs to be a preparation for the transformative, which needs to result in structural integrity.

III. Consolidation and Self-Engineering

The system is not merely shaken or deformed under the influence of motion. It actually passes a critical threshold, a point of *self-stopping*, where it transforms without being able to be reduced back to the original state. The often symmetrical state of the initial setup is fully broken into new complex geometries. These techniques are not only constructivist – they build as they move – they are also of a *configurational* nature: they form patterns while they build. In this sense, one always needs to go back and forth between mobilization and consolidation to see what effects emerge and how the configuration relates to a set of figures. Since a limited set of variable figures in the consolidation phase is replaced by a matching of these figures in larger configurations, it might be good to clarify this limitation as much as possible. In short, the intrinsic constructivism of the self-stopping of the system needs to be clarified as much as possible into pattern formation. "Pattern" simply means that all movement results in a stable – not static – structure and no figure stays unconfigured or accidental. So literal mobilization is replaced by a precise test of variations of figures, but only in relation to configurational results. While the indexical technique allows us to be exact during the mobilization stage, and the constructivist technique gives us more precision for the consolidatory stage (and is by nature more emergent), the configurational method combines the best of both. While based on the same notion of broken symmetry, the figure-configuration method allows for a more precise calibration of formal, structural and programmatic information. But before we proceed with matters of design, i.e., how machining relates to action,

perception and construction, we should investigate the fourth phase of the machining procedure, morphologies, which is highly dependent on the techniques described above.

IV. Morphologies and Transitive Geometries

> *How did we ever get the little bones in our inner ear, which directly originate from the jawbone in reptiles? That is unimaginable. The creationists would say that this transformation is impossible because during the transfer of these bones from the hinging position in reptiles to the inner ear of mammals the lower jaw would be hanging loose. This is of course not the case. The transformative shapes have a double joint, so the functionality is kept when one of them moves to the inner ear position. There is always this huge redundancy. This leads of course to an organic machinery that is* everything but optimized [emphasis mine – LS]*, seen from the traditional principles of human design.* – Stephen Jay Gould[18]

We generally understand bone structures as mechanical, but as we learn from Stephen Gould's example, even between two mechanical states we cannot explain evolution without topology. Even if forms were caught in a fixed schema, they wouldn't be able to transform to another state by accident or divine intervention, because these transformations operate on redundancy. Parts that have one definition can change and obtain another definition, but parts without any definition can do likewise. It's "everything but optimized"; redundancy is a full upgrade of the optimized, which was already an upgrade of the minimal. This is a morphology of the *provisional*, not the optimal. Generative techniques are often proposed under a sign of efficiency and optimization.[19] However, since the generative relies fully on the topological, and since the topology is real – as it is relational, which means everything is materialized – one also gets the less determined, the vaguer in-betweens. This means no geometry of com-

plexity, no morphology resulting from an epigenetic process can be fully Euclidean or elementary, because *it is the relations that produce the elements, not the other way around*. The variable comes before the elementary. The logic of relations is a logic of continuity. And therefore, all shapes generated through intensive processes are transformative shapes and have a transformative or, better, a transitive geometry. Forms never come out clean.

Since the logic of relations is based on exteriority, i.e., it's the parts that define the whole and not vice versa, it means building and design must follow the same upward transition between dimensions. In this sense, a design is built. If you follow an assembly theory[20] of design, i.e., a material design methodology based on agency, you have to work your way up in dimensions. In short, the *systems* discussed in this essay are generally line systems (consisting of "figures"), the *techniques* are almost always line-to-surface techniques (which are constructivist or configurational), and almost all the *morphologies* are surface-to-volume geometries. It is only because the dimensions are not given beforehand and emerge afterwards that they turn out continuous instead of discrete. In other words, with a transitive geometry, the dimensions of building are not mechanically added up but organically synthesized[21].

Lines, surfaces and volumes in architecture don't necessarily respectively imply columns, floors (or façades) and building mass; therefore we must be careful – especially in this essay – to avoid simply equating one with the other. For example, a line can be the centerline of a tubelike volume, or a surface can bend into a column. But it must be explicitly stated that it is *necessary* to make the system architectural. There are countless ways of applying these methodologies to architecture, but they must be specified. And, as we know, all specification germinates from generic states of being. In the example of Frei Otto's wool-thread tower-generating machinery, the threads are specified as columns, and this is crucial, or they'll end up as folds in drywalls or even painted on them. So, to summarize: (a) the machine has to relate to architectural elements, but (b) it needs to transform them, not just

deform them. Though these transformations can be unexpected, they need to be qualified architecturally all the same. In every case, we want machines to come up with the ideas, so (c) these transformations need to perform fully on the architectural level. In an architectural framework, this means transformation takes place in the more generic, simpler states of specific body plans (façade plane, row of columns, floor plane, row of rooms, row of houses, roof plane, stacked planes of floors, et cetera), or builds relations between such subsystems and progresses into more complex structures. Looking at the morphologies, we can observe a transformation of surface states to volume states, and therefore only a specific number of morphologies come to the fore, all having transitive geometries – going from small-scale to large-scale:

a. *Deep Surfaces:* Surfaces on either a flat or curved plane that are deformed generally perpendicular to that surface. They can be tubes or flat planes that deform. These planes can be horizontal, like floors, or vertical, like façades. A subset of the first category would be *porous surfaces*, in which the deformations are structurally transformed because of local or global tearings.

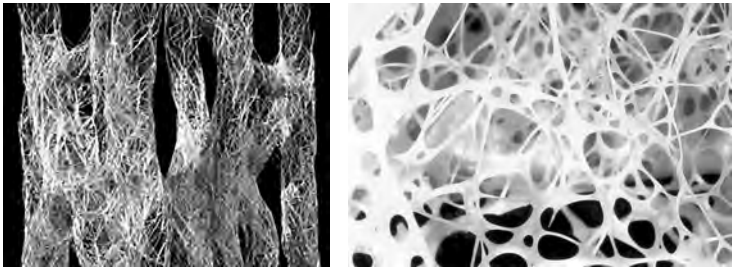
b. *Blisters:* Single flat surfaces that are locally transformed to become volumes. These are both deformational, like the bulging effect in the first group, and transformational, since there is a structural change in the surface from singular to locally double. Blister states are often the first to occur after the typical deformational states of the first group. When they occur in column systems, they result in bifurcations of columns. When they occur in floors, they result in eye-shaped apertures. They can also result in ribbing or folding of smooth deformations, similar to the ridges in dunes.

c. *Phyllo:* Either double-layered or multi-layered phyllo. The first is a double-layered blister system in which the pockets lock together in such a way that they start to share curvature. When the figures don't lock into each other but are allowed to inter-

sect, they form X-shaped configurations. This happens even more in the multi-layered system, where stacks are diagonally connected through packed structures of sponge-like morphology. This is a more complex state, and many transformations have to be coordinated into a more networked system. When this level occurs in column systems, we see a networking of formerly bifurcating elements, as in the wool-thread tower discussed above.

d. *Sponges:* Pure multi-oriented morphology, either vertically stretched or unstretched. This category is often divided up into wet and dry foam, with the former consisting of packed bubbles and the latter of complex polyhedra. Sponges are column systems, and foam is a wall system, but they follow the same Eulerian rules.

It might seem surprising that machining techniques result in just four morphologies, but since they are all gradual states, they can vary in expression. Most of what we see in "topological" architecture is in the deep-surface category: simple to complex deformations, but no transformation. What is crucial is that they are formed out of more generic states of architecture, whether a mere façade, a floor, a few floors, or a whole volume. The methodology does not in any way prescribe how much of the generic state



Morphologies produced by interacting of mobile agents *Left* Filament structure of the "phyllo" category (micrograph). *Right* Cancellous bone structure of the "sponge" category (micrograph IL Archive).

should be involved in the mobilization of the system; that is clearly up to the operator-designer.

What needs to be brought into the equation, however, is the fact that generic states coincide with generic states of behavior, and the fact that all transformations have implications for how humans interact and deploy activity.

Machining Life

In the machining of architecture, which is the procedural passing on of information from one level to another, we should distinct three levels of machining: (a) *the passage from organization to structure* – the issue of methodology, as discussed above; (b) *the passage from design to building* – the issue of fabrication, which will have to be addressed in another context[22]; and (c) *the passage from building to people during their daily activities* – the issue of experience, which I will address in the following paragraphs, albeit briefly.

In the end, these machines are for bodies to experience. How are the built structure and the body's behavior related? What goes into the machine – movement and agency – is related to what comes out – movement and agency. The movement that drives the machine is the movement that drives the body[23]. Though the former happens during the design, within the framework of methodology, and the latter occurs during real-life experience, they can still be synchronized and short-circuited. Let us ask ourselves again what constitutes an experience. As stated before[24], experience is not simple existence in the present; it is the new happening to the old, i.e., what constitutes an existing person at a certain moment. But the old is not real, though it exists in what we are; it exists virtually in the schemata of our memories, of our habits, of our bodies. The new, the present, the now, *can* only happen to the old – what else is there? It can happen only to what you have become at that moment – to memory and habit as flexible, operative schemata. Oliver Sacks said about the body schema: "It is not something fixed *a priori* in the brain, but a process

adapting itself all the time to experience."[25] In architecture, we are obsessed by habits, and rightly so, but often we mistake them for mechanical acts, for what we call "usage." Buildings aren't used, they are lived in, and experience in the present – *Erlebnis* – always corresponds to experience built up and filtered in the past – *Erfahrung*. A habit should not be understood as the sculpting of a passive schema that only archives its actions to enable their exact repetition. I think we should distinguish two types of schema, for single and multiple bodies, i.e., groupings, and naturally people can only form a group by deploying various postures that can coexist. Social morphologies, configurations of groupings, are as patterned as bodily postures; they are constructs as much as bodily postures are. We can classify group formations in a similar way to how we classify acts performed while standing, sitting, walking or running. When we line up, sit at a conference table, walk down the street, choose which side of the stairs to walk up, sit on a bench, stand at a counter, window-shop – anything – a huge variety of behavioral schemata occurs between architecture and furniture. And, again, neither should be considered as fixed crystals – though they are crystallizations when they occur – since they emerge in the everyday continuity of life.

Schemata are highly cyclical; they consist of rhythms and periodic patterns, as described by Henri Lefebvre's rhythmanalysis[26] and these are exactly what enables variability or change. This does not mean there is no "program" in the architectural sense; of course there is – just as there are habit and routine, or to put it more forcefully, habit and routine are there *at the outset* of all design. It is merely that we need to consider them as potentially flexible, as rhythmic and periodic, with a flexibility that is limited to different degrees, like a melody that can be modulated. So it's not functional mechanicism on the one side *versus* total openness and freedom on the other. It's variable blocks or rhythms: we do follow rules, but not a single set. The rules of each set of actions differ. In a way, *we live rhythms of rhythms.* We should remember that in architecture a generic state of form directly corresponds with a generic state of behavior; that is, mechanical design spurs

mechanical behaviors. Therefore, it is very important to set the range of variations, the degrees of freedom, beforehand when setting up the machining methodology, since they need to be productive only in a selected field. For instance, to go back to Frei Otto's tower model for a moment, the elevator core can only be generated by threads without slack (though they still relate to the ones that do have slack). Therefore, in topologizing the body plan, we need not apply the same amount of variability throughout the whole system. Not all space needs to be so interactive. Not all bodily posture needs to be variable; not every social grouping has to be possible at any time. Often, we want and need singular states of working and living. And all these variable gradations should be fed into our machinery. It would take us too far at this point to classify all the variable states; what is important is to appreciate that life becomes part of the system not afterwards but beforehand. The actual feeding of movement into the system (during the mobilization phase in the machining of design) is that of human action itself; all the variations in structure and form directly affect the range of variations of behavior. Second, this movement can *only* be reciprocally fed back into human action when abstracted into structure (during the consolidation phase). There is a constant looping and sharing taking place. This "movement" is simultaneously that of a single body, of groups or social morphologies, and of forces and loads. There is an engulfment of schemata all happening at the same time. Bodily posture (which coordinates vision and action) is fundamentally a constructive act by itself but should viewed in all its variations in relation to social morphologies – of single individuals, pairs, lines, rows and queues, packs, crowds, groups in any form – and is as molecular and material, varying between crystallized states and liquid states, states of configuring and reconfiguring. All social morphologies correspond to the formal morphologies we have developed (deep surface, blister, phyllo and sponge), where the plan – the surface where normally only the groupings occur – transforms from a regular state to more a complex state that affords more perceptual orientation and more connectivity. A building is nothing more or less than a

continuous sharing of movement, agency and life. All schemata are continuously rubbing over each other; during design as well as during experience once they are built, they feed movement and structure into each other, channeled by perception – they constantly feed action and vision into each other, channeled by structure.

1. Humberto Maturana and Francisco Varela. *Autopoiesis and Cognition: The Realization of the Living* (Dordrecht, D. Reidel, 1980): 80.
2. Immanuel Kant. *Critique of Judgment* (Hackett, 1987): §64–5. In these paragraphs Kant also coins the term "self-organization," which many authors choose to forget. Kant, especially in his last book, was heavily influenced by Blumenbach's concept of epigenesis, which was diametrically opposed to the not un-Kantian concept of preformation. For a thorough discussion of these topics, see Helmut Müller-Sievers, *Self-Generation: Biology, Philosophy, and Literature Around 1800* (Stanford University Press, 1997): 48–64. Or see Charles Armstrong, *Romantic Organicism: From Idealist Origins to Ambivalent Afterlife* (Palgrave, 2003): 13–29. Another book of great interest is Peter Hanns Reill's *Vitalizing Nature in the Enlightenment* (University of California Press, 2005).
3. Humberto Maturana and Francisco Varela. *Autopoiesis and Cognition: The Realization of the Living* (Dordrecht, D. Reidel, 1980). Biological systems are machines that produce nothing but themselves; therefore, they must be both organizationally closed and structurally open.
4. Ernst Mayr. *Populations, Species, and Evolution* (Harvard University Press, 1970): 4–5.
5. Francisco Varela. *Principles of Biological Autonomy* (Elsevier, New York, 1979).
6. Gilles Deleuze and Felix Guattari. *A Thousand Plateaus: Capitalism and Schizophrenia* (The Athlone Press, 1988): 411.
7. Mark Kirschner and John Gerhart. *The Plausibility of Life: Resolving Darwin's Dilemma* (Yale University Press, 2005). Similar arguments have been made by Eva Jablonka, in: *Evolution in Four Dimensions* (MIT Press, 2006).
8. See for instance: Brian Goodwin. *How the Leopard Changed its Spots: The Evolution of Complexity* (Scribner, 1994).
9. Manuel DeLanda. *Intensive Science and Virtual Philosophy* (Continuum, 2001).
10. This is not all that different from cooking, where we observe the same combination of acts that are top-down and processes that are bottom-up. In cooking we find techniques that are preparatory, such as cutting, slicing and grinding, combined with mobilization techniques that are either cold, like whipping and stirring, or warm, like roasting, boiling, poaching, baking, steaming, et cetera. It is the same combination of extensive quantities and intensive qualities, with intensive procedures acting upon extensive elements (ingredients) to prepare them first systematically, then mobilizing them either by external or internal movement, after which the whole consolidates and transforms into a dish that is more an expression of the recipe than an execution of it. The combination of recipe, ingredients and techniques is based on a much more precise history and offers us much better examples of machining than the history of architecture, which is generally based on canon, type and sketch. In addition, architecture and cooking (like fashion) share a relationship to the body, taste and habit that distinguishes them from the other arts, which makes them more conservative and less open to experiment and idiosyncrasy.
11. D'Arcy Wentworth Thompson. *On Growth and Form* (1917–42). Quoted in Stephen Jay

Gould, *The Panda's Thumb* (London, Penguin, 1990): 160.

12. There are, however, houses that are mini-towers, like Melnikov's, and even towers that are horizontal skyscrapers, like El Lissitzky's.
13. See for instance, Ludwig von Bertalanffy. *General System Theory: Foundations, Development, Applications* (Braziller, 1969). Or see Fritjof Capra, *The Web of Life* (Flamingo, 1997).
14. Manuel DeLanda. *Deleuzian Ontology* (published on the Internet). The idea of convergence is strongly defended by Simon Conway Morris in *The Crucible of Creation* (Oxford University Press, 1998) and *Life's Solution* (Cambridge University Press, 2003).
15. Frei Otto. *Pneu und Knochen, Pneu and Bone* (Institut für Leichte Flächentragwerke. Stuttgart IL 35, 1989): 174–82.
16. See "The Structure of Vagueness," in this volume: 130.
17. We find a similar distinction to that between deformation and transformation in Cyril Stanley Smith's shift from lattice to aggregate, where the lattice is regular and homogenous but can be slightly deformed, as in systems of packed spheres such as exist in foam. Such packing systems have an internal threshold, above which the system breaks into an aggregate, which is a much more heterogenous structure. In the packing of circles on a surface (as in the famous Radiolaria tesselation), we find similar stages; a regular hexagonal pattern can be deformed until a limit of the system is reached and suddenly pentagons and heptagons emerge that can deform in turn. With Smith these shifts occur during a process of enlargement, which is similar to the ones we discuss here. See also "Steel and Freedom" in this volume: 264.
18. Stephen Jay Gould, quoted in an interview in *Een Schitterend Ongeluk* ("A Splendid Accident"), originally published in Dutch (Contact, 1993): 384.
19. Peter J. Bentley, ed., *Evolutionary Design by Computers* (San Francisco, Morgan Kaufman, 1999).
20. Manuel Delanda's *A New Philosophy of Society* (Continuum 2006) offers a very clear distinction between totalities and assemblies, based on Deleuze's reading of Hume. In Hume's empiricism, all relations are external to their terms; i.e., parts have not been predefined to fit a certain whole. For Hume, all larger-scale assemblies are based on association or contiguity, which always works according to a logic – not an overall rationale but a logic of direct adjacency.
21. It is *interdimensional* – dimensions are nothing but the organization of movement. The procedure of system (lines), techniques (line to surface) and morphologies (surface to volume) should be viewed as a building of movement upon movement.
22. See "Steel and Freedom" in this volume: 264.
23. I am not at all in favor of human movement being plotted against a façade or against a lineup of sections. Generally this type of morphology is "streamlined" – real movement creating real form – and lacks an abstract systemacy. In the constructivist or configurational method this real movement passes through structure, which abstracts it by becoming morphological pattern and subsequently feeds it back into people's movements. Again, this is the main reason why an architecture of continuity does not result in smooth forms only.
24. See "The Primacy of Experience," in this volume: 76.
25. Oliver Sacks, *A Leg To Stand On* (New York, Touchstone, 1998): 194.
26. Henri Lefebvre. *Rhythmanalysis: Space, Time and Everyday Life* (Continuum, 2004).

The Architecture of Continuity

In Conversation with Ludovica Tramontin

LT: In the introduction of your book NOX: Machining Architecture, *you say, "The book tries to develop a clear agenda. It states that an architecture of complex, topological geometry can be pursued only through rigorous means." However, today topological geometry in architecture is generally identified with free form; an architecture produced with computers is immediately associated with an absence of control and rigor. In addition, if we use one definition of topology – the study of continuity – this continuity seems somehow difficult to reconcile with the division into parts that is generally necessary in architecture.*

LS: Well, these are the basic questions. There is a huge misunderstanding nowadays about the word "topology" in architecture. According to the famous German mathematicians Gauss and Riemann, it was an "analysis situs," a geometry of position more than of objects. It doesn't look at metric distances but at the organization of an object; it looks at systemacy, not physical features. Or, to put it even more simply, it looks at relationships more than at elements. Therefore, it understands that a single organization may contain many possible structures ("invariants"), because an object can change its features and shape without changing its organization. Diagrams are always topological. So for topology, variation is a given, and variation is understood through curvature. Clearly, an architecture of variation is not "free," since all variation is controlled by that systemacy. Blobs – that word gives me nightmares – are just uncontrolled variation, variation in all directions, in all degrees. In a topological architecture, the elements are a result, a *product* of the relationships, not *a priori* given. The elements are more determined states within less determined relational fields of continuity. Here, we need to understand how topology, when applied to logic – as was done by Charles S. Peirce – becomes continuity, or what he calls "thirdness." Secondness is still occupied with determined states of number, but in thirdness "points become neighborhoods" and dissolve in continuity without any sharp boundaries between the parts. To put it

even more strongly, continuity is a purely relational field without any parts yet – in this view, parts are "nascent," as Peirce says. There is a primacy of the relational over the elementary, and elements can only be understood as continuous. Likewise, for instance, there is a decisive difference between a fold and a corner. A fold in a piece of paper, for instance, doesn't interrupt the continuity of the surface, but with a corner, both surfaces just end there; at that point it becomes a nonelement, not even a part. Corners are where architecture is at its deadest. The architecture of variation is not against parts. Of course there are parts in buildings; you just can't design architecture by moving parts around and trying to join them up. You have to design them as nascent things, things born out of continuity. Things cannot be predefined; they obtain their position from relationships. It is more an architecture of weaving than of tiling.

> *You have always associated your work more with textiles. This idea of weaving is interesting. It sounds so old.*

True; it's Gothic. That's basically what we're discussing here: the old battle between classic and Gothic, between classicist elementarism and Gothic continuity. Without wishing to be rude, in my mind that is not even an issue of equal terms. I am totally Gothic and Nordic. In classicism, all the elements are preexisting: the column, the architrave, the pedestal, and so on. In the Gothic, everything is a result of the relationships between the ribs – the venation or, as it is officially called, tracery. Many ribs bundle together to *become* a column; then the bundled ribs split up and start to *weave into* a vault. That's why there's so much variation in Gothic vault design. The ribs behave in a very textilelike manner; it is a pure art of continuity. There is nothing else that compares: we have studied the Rococo shells, the Art Nouveau water plants and whiplashes, but none of these operates like the Gothic bifurcations, the fans and the bundles. Ribs are folds, not corners; they are the center of something, not the end of it. In classicism, the relationship between the elements can only be restored through

ornament, which is why ornament is always curved, since the elements are usually straight. That's also why Alberti had to formulate beauty as a product of structure and ornament, to repair the joint and restore continuity. Which immediately threw him back into an unfortunate metaphysics of showing the truth (structure) and hiding it (ornament). And, at the same time, adding a subordination of the organic to geometry. In the Gothic, elements are much more relative because they are created by this abstract proto-element, the rib. Half-structural, half-formal, it exists on many scales. And Gothic beauty is much more *configurational*: it is the pattern created by multiple figures that each have their own degrees of variation.

> *Your forms are always the products of acting forces following rules. The pages of* NOX: Machining Architecture *are full of very precise, almost mathematical diagrams. These procedures are not at all based on any kind of inspiration or accidental intuition. I think you can see in the book that with the earlier projects, there seems to be more of an interest in the forces themselves, and with the later projects, more of an interest in controlling these forces. So later, there is more a sense of the aesthetic, though the formed object is very different from the classicist aesthetic-mathematical model that identifies universal beauty with proportion and harmony of parts.*

Yes, that is completely correct. Pure emergent morphogenesis is not enough; there is just no certainty that the outcome will be architectural. There is just no way we can have a flock self-organizing on our computer screens and say, "Now it looks like a museum!" and stop the flock, freezing the form. Remember, we were all doing that?

> *Absolutely.*

We all found this swarm software, which was pretty incredible, by the way. It can be applied to abstracts dots, to starlings, to her-

rings, anything, even to the velociraptors in *Jurassic Park.* The swarming code consists of rules, but these aren't exact instructions; all rules are variable, with a minimum and a maximum. There are only four rules: (1) follow the one in front of you; (2) don't get too close to your neighbor; (3) don't get too far from your neighbor; and – very important – (4) move around obstacles. You have these four flexible rules operating in real time on your screen, and all these abstract dots suddenly take on the grace of a swarm of birds or a school of fish. It's amazing, and it was the first piece of software that was able to generate a self-organizing system in a computed environment. Somehow, we all thought we could make architecture with it. The problem, of course, is that it had no memory, as an architectural system would have. It was just a moment of stopping; it had nothing to do with the systemacy of floors or structure. Architectural systems have another form of systemacy, and morphogenesis or self-organization happens *within* that framework. So when generating architectural form, you need a systemic approach, and that does mean you need some bias, not external, but built-in. Obviously, there are inherently structural properties to swarming, and if you think carefully, you find it's all about distance between members. Therefore – when used very precisely – it could be used for generating a column-beam system, maybe even a multistory version. You can imagine how you could orient a railway station's track system to the city, for instance, with multiple entrances. But this proves my argument: instead of looking at starlings, we should look at columns. It should never be used formally; the formal approach is always the weakest. Blobs are always formal; that is why we need to get rid of them. There has been a lot of discussion about complex systems, but most of them have forgotten to architecturalize the discourse.

To answer your question, yes, my obsession has moved from pure forces to more controlled systems, which were at first still pretty accidental and lie now more with aesthetics. So it's about coordination and coherence, as with a flock of birds, but specifically within architecture. Architecture is a discipline. This is

such a difficult and important issue. Actually, I position myself in the late-18th-century break with the beautiful, with Kant, or even more with Diderot and Coleridge. For Diderot and his contemporaries, there was a new idea that broke with universal transcendentalism, with God, goodness, and so on, the forces of harmony that shaped the world as it was. For them, matter itself became active – what they referred to as irritable, matter as irritable – in total opposition to Descartes' inert matter that had to be shaped into form by transcendental powers. They called this "epigenesis," which is actually an early understanding of what we nowadays call complexity or self-organization. There is this amazing quote by Coleridge from 1812: "The form is mechanic when on any given material we impose a pre-determined form, not necessarily arising out of the properties of the material, as when a mass of wet clay we give whatever shape we wish it to retain when hardened. The organic form, on the other hand, is innate: it shapes as it develops itself from within, and the fullness of its development is one and the same with the perfection of its outward form. Such is the life, such is the form. Nature, the primogenial artist, inexhaustible in diverse powers, is equally inexhaustible in forms."

> *So in classicism the forces are transcendent and mechanical or elementary, and with the Romantics they are immanent and organic or continuous. What happens when we look at this in light of the aesthetic?*

We arrive at the distinction between beauty and sublime. Beauty is about proportion – as you said, harmony, goodness – the forces that shape are in control; they are divine. Aesthetic pleasure is then nothing else but a re-enjoying of goodness, i.e., the laws of nature. With Kant's *Critique of Judgment*, this all changes: beauty becomes fragile; the object is overwhelmed by forces, not shaped by laws. All forms are haunted by the abyss. My problem with this notion of chaos, however, is that the forces are immediately *too large* to deal with, and therefore the Romantic experience can only result in more passivity and contemplation (of a cosmic

force). In that sense, the Romantics just replaced one transcendental power with another, that of good with that of evil. Exactly as Mario Praz stated years ago in *The Romantic Agony*, they are of the same unapproachable nature. I want to be in between the beauty and sublime, between the small pleasures of the controlled and the overwhelming forces of the chaotic. As Deleuze once said, "Every object is exceeded by the forces that shape it," but that doesn't mean we should just unleash forces and blur the object into oblivion. We have to appreciate the fundamentally paradoxical nature of Deleuze's statement. To shape means to construct, and since we're talking about self-organization, this force needs to be made immanent – what we call a "constructivism," close to a self-engineering. The forces that shape are then suddenly in a continuum with the forces that destroy. Since the coordination of elements is necessarily flexible, there is also a limit, and what brings the elements together can also make them fall apart. So again, we arrive at the Gothic, at articulation and coordination. In this sense, we could understand the Gothic as being in between the mechanical and the organic, I guess. I realize very well that the 20th century was obsessed by the sublime, by transgression, by deconstruction – I am not. Art ended up in autonomy, which I think is just an aesthetics of the mind, pure concept, pure judgment, pure passivity. It's a dead end. I believe in the body and in the embodied mind. So, every question relating to aesthetics must be answered by taking into account what constitutes a bodily experience.

> *When you think of this choreographing of forces through procedural techniques, the question is what kind of bodily experience is required to grasp their aesthetic quality.*

Usually, aesthetic experience is an extra experience added on or complementary to the bodily execution of the program: *venustas* plus *utilitas*. In my work, this has always been very different. I have always stated that perception cannot exist without action; I have often spoken about proprioception, about posture, about

action as something variable, not as the pure repetition of mechanical habits. I stated that behavior needs to be viewed as a continuum of habit and experience, of memory and the present, of formalized states of behavior and informal states. But this could still be seen as a development of program *alongside* or separate from aesthetics. That is what has changed in my work. Something cannot be beautiful (or ugly – I have often defended my work as ugly) alongside being performative on the programmatic level. It cannot belong to the mind when seen (both the beautiful and the ugly are of the mind) and to the body when enacted. That is not possible. When there is a real continuity of perception and action, of wall and floor, there is also a continuum of aesthetics and program. So the "bodily experience" is not just the moment when the aesthetic transforms into the programmatic; rather, the aesthetic itself is a bodily experience, and that, I think, is what we should call the sensuous: that which is between beauty and the sublime. It is not pleasure, it is not lust, it is not awe, it is not sensual: it is the sensuous.

> *The sensuous, then, is a kind of directness in aesthetic experience, but an elastic directness, maybe, which never becomes either fully distanced and contemplated or purely unconsciously experienced by a body. The question then immediately arises of how this is framed in architecture. In your book, you insist on finding architectural design techniques; it is clearer and clearer to me that your interest lies in architecture, a fundamental architecture without any sort of mediations.*

That elastic directness you refer to is spot on as far as I'm concerned – because we cannot simply throw Kant's judgment out the window for some kind of neuro-aesthetic immediacy. I don't believe that at all – there is still synthesis going on. I think what we need is some kind of reflection at the bodily level and not a mental judgment, so it doesn't slip from the body to the mind. It's a deepening of the bodily experience, what philosophers normally

denote by a shift from *Erlebnis* to *Erfahrung*. Let me see if I can frame that more architecturally for you.

All architectural problems are problems of scale – in short, massing, structure and texture. Now, empirical experience can only apprehend the parts; we never "see" the whole, right? We engage only with details. With Kant's aesthetic theory, we apprehend the parts first and recognize the whole afterwards, mentally, in judgment. But that's only necessary when they are separate entities, the whole and the parts. I believe more in Hume's associationism, or what William James called "radical empiricism" – seeing the relationships as much as the parts. It probably means you don't see a whole, but you see more than just a plurality of parts, if we can call it "seeing" in the first place. Ergo, if you design the object in such a way that relationships and elements exist in a continuum, then the aesthetic automatically becomes sensuous. So, when the object we are talking about is not fully determined, as in classical beauty, nor fully undetermined, as in the sublime – somewhere in between necessity and chance, in a flexible, *vague determinism*, or a sort of *directed open-endedness* – then the parts need to be open too, so to speak. The parts have to be gradual states in a field of continuity; they need to have middles, but they shouldn't have ends. I think the deepening we were speaking about before means there must be a resonance of this continuity with your sense impressions: a bodily resonance. More a continuation of perception in action than in contemplation. I think the sensuous recognizes both the highlighting of the middle and the vectorizing of the ends. It is neither crystallized nor liquid but a heterogeneous or viscous mixture. I think this brings it closer to Gestalt, which is more about rhythms and patterns than about finalized forms. Form needs to be haunted by entropy but not swamped by it; it needs coordination but not stability.

Let's look at that in the framework of architecture: the issue of massing, structure and texture. If you look at contemporary architecture, you see there has been a significant change in the idea of surface treatment. What was the postmodern image has now become pattern. Dozens of architects work with pattern,

or even ornament, which is a huge improvement on the postmodern image that only had to be decoded by the consuming mind passing by. But then contemporary architects do not relate it to massing; basically, the pattern is applied to the surface of the volume as if it is an image. Just look at Herzog & de Meuron's work: beautiful surfaces on awful volumes, and you see it with many more architects: the surfaces become patterns of continuity, woven patterns, porous patterns, whatever, glued onto a volume with corners. How can OMA do a diagrid and at the same time have those corners in the Seattle Library? I find that incomprehensible: how can the pattern advocate continuity while the massing is based on the discontinuous? The massing is treated first as solid foam cut by hot wire, which in Semper's terminology is nothing more than stereotomy, and afterward the structure is stuck on like wallpaper. There is no communication between massing and structure. The massing is conceived by a deconstructivist modus operandi, by shifts and folds, and then later repaired by the engineer. And then they add extra elements on the corners to repair the nonfitting of diagrids. The move from fold to corner is already thoughtless, but materializing the corner with a column is always a fatal step to take in design. It makes patterns lose their continuity and their capacity to create volumes. What could be sensuous falls back to beautiful – at best.

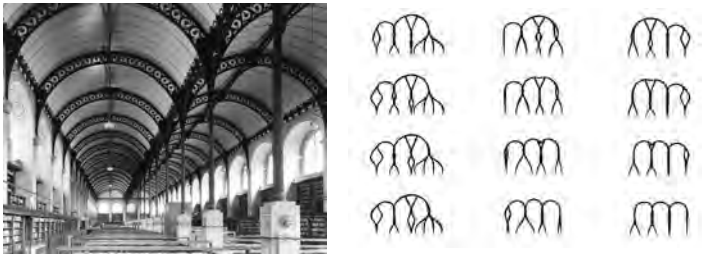
> *You're saying there is no continuity of massing, structure and texture in these cases.*

Yes. It's an absolutely major issue. I think it means that the bodily process of experience – I wouldn't say cognition – runs parallel with the architecture of the object, which runs parallel to its own ontology. Obviously, an architecture of symbolic language would not allow you to shift from *Erlebnis* to *Erfahrung*. The sensuousness of the object is "reflected" in the sensuous experience: it's mirrored, or resonated. When perception continues in action, corners simply won't do. I am trying to make ornament three-dimensional – that's what it means, I think, architecturally speaking. It

takes the sensuous to the level of structure. To realize what that means, we need to fully rethink the relationship of textile and tectonics, or drapery and structure. With Semper, ornament is already material from the start; his material categories of the four elements follow an order of hard to soft, but also – as most people forget – from large scale to small scale. In his seminal *The Four Elements of Architecture*, the order was – going from heavy to light and from large to small – (1) earth/floor, (2) wood/columns, (3) textile/wall, and (4) fire/climate – and I always add, in the same order, action, construction, perception and sensation. We should rethink this in terms of textile becoming rigid, becoming structure and becoming mass. Ornate structure. The continuity of textile should be understood as three-dimensional, not superficial.

Let's look at an example. Speaking of making ornament three-dimensional, maybe the Jalisco Library is a good one?

It's my most Gothic project. If we take the three scales again, I think it's always best to start in the middle, with structure. What's so helpful with that is that you can work your way upward to massing or downward to texture; the information is more easily distributed. So it all starts with structure, but it's living, hot steel, not the beams you order from the steel contractor. The structure is derived from Henri Labrouste's Ste.-Geneviève library in Paris: a column continuing in an arch and becoming a column again. That



Left Henri Labrouste, Ste.-Geneviève Library, Paris (1851). *Right* NOX, Columnar figures for the design of the Jalisco State Library, Guadalajara (2005).

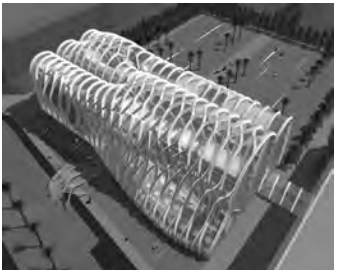
is an initial continuity. We started with three of these bays next to one another, each spanning 50 feet across. So in terms of massing, one block is made up of three parallel bays – this bridges massing and structure at the start of the operation. Obviously, a building with that depth needs daylight access not only from the façades but also from the top. So we made it glass all around, following Labrouste's curvature. That light needs to enter deep into the building, so the structure needs to generate a porosity that it doesn't have with those initial columns just going down. We developed a number of what I call *figures*: the I figure (a single column), the A figure (a column that splits downward), the O figure (a column that splits and merges again), the Y figure (a column that splits at the top and rearranges two parallel bays into one double-sized bay). Each of these figures has a direct effect on the floor: every time the column splits, the floor opens with it. In this case, lighting, structure and space are all generated by the same operation. These figures interrelate, or what I call *configure*, into larger patterns. Figure-configure: a matter of scale. By the way, Gestaltism has often been called configurationalism. These configurations can increase and decrease according to certain rhythms, and the figures also develop in the longitudinal direction, to make it more stable. Instead of adding diagonal bracing afterwards, we started weaving in both directions, laterally and longitudinally. Light starts to pour in, and space becomes fully mobilized and deployed. It seems such a logical thing to do, letting columns create voids. It has a very aesthetic effect: the voids become like negative buildings, or internal façades. The exterior massing also becomes an emergent effect, the result of all the interwoven figures and configurations.

So from an initially simple set of operations, everything follows in all directions: space, aesthetics, structure. The porous system not only lets light in but interconnects several departments. This is a university library, so the floors would tend to become separate departments that don't communicate. Between the columns on each floor, we have a set of reading tables, so when you sit reading and studying you can look around at this

three-dimensional arena of tables. And texture is also an effect; there is an increased scaling-down of the structure because of the woven diagonals, so a closing effect starts to occur, a shift from lines toward surfaces. All the columns are composites of three tubes braced together by diagonals, like Foster's columns in the Sainsbury Centre, but then projected outwards. The heavy triangles at the exterior give a strong sense of movement to the façade when you pass by, so that when you look along the surface it might seem closed, but when you look onto the façade it fully opens up. It doesn't jump from one-dimensional lines to two-dimensional surfaces; rather, it transforms. Again, it fully occupies the in-between. It is a typical transitive geometry, as I described in "Machining Architecture."

> *So we can say that the structural diagram in the Jalisco Library is acting as a generator of texture and massing. The continuity is "made rhythmic" by transitive states of classical architectural elements – "transitive geometry," as you said. Continuity doesn't end in smooth surfaces, as is believed nowadays by most advocates of the topological in architecture. To discuss that further, can we take a closer look at your projects like the Son-O-House?*

Well, "made rhythmic" is the correct way of putting it. I don't believe in unarticulated continuity. Smoothness is only of one



NOX, Design for the Jalisco State Library, Guadalajara (2005). *Left* Building seen from the north. *Right* Structural system.

order: the order of massing. It clearly works in art – look at Henry Moore or Brancusi or Anish Kapoor: pretty strong proof. But it doesn't solve architectural problems, which are – to repeat – the relationships between massing, structure and texture. It's simply a scale issue. Volumes in art can be considered as solid. And the forces that shape the volume are immediately the forces that shape the surface, in this case polishing it. That's why polished smoothness is the art of streamlining, since the forces that shape are running parallel over the surface and essentially operating from the outside in. I don't streamline at all; on the contrary, I work from the inside out. But more importantly, I work from line to surface, in a constructivist sense, that is. The lines are soft figures that make strong rigid surfaces, through, in a word, weaving. With Son-O-House, we had a similar aesthetic: articulated texture on an articulated massing, two orders. First, that massing is highly articulated by sharp creases, sharply edged openings, and bulging band surfaces, but with smoothing effects, for instance, in which two or more bulging bands merge into one larger, smoother one. Second, on the lower scale of texture, the Son-O-House is also very articulated, with a self-organized mosaic pattern of stainless steel strips. If you compare it to the D-Tower, you will find an articulated volume with smooth texture, but fully articulated by structure. So all kinds of combinations are possible, and it all depends on how structure mediates the different scales. In short, such a mediating structure as the guiding principle of articulation we know as tectonics. Tectonics exists on all three scale levels, not just the middle one of load-bearing structure; it is the influence of structure on the other scales, upward to massing, and downward to texture. Son-O-House is a dome or vault too, much larger, except it tears up into several bands, and these bands bulge out again to act as beams. Actually, the main middle dome of Son-O-House is supported by a few of these tentacle-like beams. So the first-order articulation of my volumes has to do with construction by surfaces: tentacle-like proto-columns in the Son-O-House, fully curved round columns in D-Tower. This makes the D-

Tower simply a Gothic vault. All second-order articulation – that of texture – immediately follows from this.

> *But then there is also the lighting effect: scaling down the surfaces toward lines makes them very responsive to light. As in many of your projects, it seems the aesthetic effect is the collaboration of lines into surface without any loss of line articulation. But such structural-geometric effects depend on the building's relationship to the movements of visitors and to changes in the surrounding environment, especially the lighting conditions. Some of your objects create an almost collective spectacle of glowing effects within the urban scene.*

I call it the glow-shape. Volumetric effects of surface become light effects in relation to the position of the sun. It transforms simple issues of transparency or opacity into incandescence. That's what the mosaic does in the Son-O-House: breaks it up, multiplies the highlights and, through multiplication, makes the surface in all its variable orientations rhythmic and sensible. In car design, for instance, where they struggle with real streamlining and can't do too much creasing and ribbing, they need very complex gradient metallic coatings to communicate the variable curvature. We don't need that. It has nothing to do with chiaroscuro, or with Corbusier's "magnificent play of volumes in sunlight" – that's pure Platonism. That is pure perceptual determinism. The Platonic solids of modernism used overdefined volumes with underdefined, naked surfaces. We do the reverse: lumpy, vague volumes with highly articulated surfaces. With the glow-shape, there are hardly any shadows, at least no defining ones, since there are no corners. Space, light and geometry seem to merge, follow the same vector. And this incandescence is not just a material property; it is also a geometric one. We cannot separate the continuous geometry from lighting, nor from the sensations stirred up in the body, nor from the actions deployed. My images are action images. The geometry is rhythmic, of a continuous variation, which means that


Left NOX, D-tower, Doetinchem (1998–2004). *Right* Gothic Vladislav-Hall, Hradschin, Prague (1493).

a moving body immediately relates to it, but only when mediated by light. The object lights up with action. It couldn't be more true. This is the case with all my interactive work, where objects literally light up, like HtwoOexpo and D-Tower, but also with the reflective surfaces, like Son-O-House and Maison Folie in Lille. Lighting creates action; action creates light. Nothing could be more sensuous than the light that lights up a body! That is exactly the aesthetic of articulation; as I said, the sensuous recognizes both the highlighting of the middle as well as the blurring of the ends. Just look at the Maison Folie façade – a façade, of course, and not as structural as the Jalisco Library, but what an amazing effect. When you pass by on the street, the surface glows, and its glow changes; it moves as you move – why not call this interactive, too? Where does action lie if not between the object and the body? With that façade, as with the *figura serpentinata*, there are no corners, only continuous modulation; every movement creates a new movement. There is no way you can stand still in front of that façade; there is no frontal position facing it. Space is propelled by the surface; it's not space surrounding a glowing object.

> Venustas, *meaning physical beauty, comes from venis, blood, while formosus, beautiful, comes from formo, which is the heat that moves the blood – the etymological root of the word "beautiful" implies the act of mobilization. From your answer, I see the articulation of your architectural objects as acting like heat, a moving of light. You can't really grasp whether the light is shining on your objects or radiating from them or both. Space in architecture seems to be released depending on the experience of the body, rather than already being there.*

There we have a full merging of Semper's four categories, no? Let's look at them again. Earthwork – that is the plan, the surface of human action. The wooden framework – that is construction, the act of building. Textile cladding – that is the surface of perception. And fourth, fire – that is climate, the realm of sensation. My argument has always been that the first three can only be viewed in a continuum when the fourth runs through them all – the realm of feelings, speaking on the level of human psychology, or the world of intensities, speaking on the broader level of materialism. I think that in this sense, Semper goes a step beyond Vitruvius' triumvirate *firmitas, venustas* and *utilitas*, because the categories cannot simply be added together. Yes, I like that a lot, space as fire, and I think it's correct, too. Burning surfaces that make us catch fire – that is true continuity. We architects have always mixed up space with Descartes' x-y-z, with this neutral, extended universe. Of course, space is there, but that doesn't help us at all; it doesn't help us to cross it or live in it, let alone design it. We should look at it the other way around: space is the byproduct of fire in matter, of the intensive, of feelings and sensations. This is so true – we know from everyday experience how much space depends on our moods. We should design with and for the intensive first, and have the extensive as an outcome. Such is life; such is form!

NOX, The Three Graces, Dubai (2008). Detail showing the hotel tower, one of in total three towers standing at the end of the piers of the Khor Dubai Wharfage, interconnected by a footbridge. The structural skin consists of an aggregate of deformed lattices; where the lattice is made purely of hexagons, the jumps in the aggregate are produced by pentagons, heptagons and other polygons. See also "Textile Tectonics", p. 236–7, and "Steel and Freedom", p. 266–7.

Textile Tectonics

In Conversation with Ludovica Tramontin

LT: You have often used the notion of textile tectonics. You refer to it in your book NOX: Machining Architecture*, and it gives the title to your piece in Tschumi's* Architecture at the Beginning of the 21st Century*. Let's try to unravel the different meanings. Maybe we should start with Semper.*

LS: Yes, above all, it refers to Semper's adoration of textiles and, of course, his four categories. It's such a beautiful way of ordering, from heavy to light, from rigid to flexible, not a pure materialism of built forms but more like the Greek earth, water, air and fire, the constituent elements that make up all the other materials and forms. But of these four, Semper's concept of the textile is the main driving force, the main productive element, the main agent of architectural form – not at all in the sense of masking, but in the sense of the woven wall being the *Urtechnik*, the original technique, for creating architecture. "Hanging carpets remained the true walls; the visible boundaries of a room," he says in *The Four Elements of Architecture*. And, "From which ancient techniques did the house's enclosure evolve? From none other than the art of dressing, that is, weaving and wickerwork." Architectural design is not about having ideas but about having techniques: techniques that operate on a material level. If we need ideas, they follow from techniques, and techniques follow from matter. It's about making matter think and live by itself. Of course, the *Stoffwechselthese*, which Semper is famous for, the theory of the transformation of materials, says buildings are no longer made of textiles, that textile has been transmaterialized into stone and steel and what have you. So it's not so much ideas that inhabit matter but other materials. Textile inhabits stone. Materials in materials – I find that astonishing. It's an abstract materialism, which saves us from idealism and realism at the same time. He was very conscious of that; he wanted to steer a course between "speculative aesthetics" and "mere engineering." But it is a very active, evolutionary materialism, a vitalism almost, especially when you remember that *Stoffwechsel* is German for "metabolism." It literally means "change of substance" – even more literally, a "change of fabric"!

But you always explicitly speak of a "Semperian reversal" when referring to textile tectonics.

I am interested in a pure application of Semper's *Bekleidungsprinzip*, in seeing if the principle of the incrustation of the *Wand* – to distinguish it explicitly from the *Mauer* – can be fully merged with that of the garment, the *Gewand*. I'd like hardening to run parallel to adornment, as in the double meaning of the English word "makeup." Sometimes it is not so clear in Semper whether there's a distinction between structure and ornament, between the wooden scaffolding and the woven wall. But since these are categories, not real materials, stone can play the role of both. Semper is very articulate on the tradition of incrustation not being simply decorative, saying that "art-form and decoration are so intimately related that it is impossible to consider them in separated views." Just to make it overly clear, I call this a reversal, but it is a reversal of the *order* of the four elements, where the tectonic precedes the textile. I want the *textile itself to become tectonic,* without the help of wood or any other support. Then, the soft elements will become rigid through collaboration, by teaming up, weaving, bundling, interlacing, braiding, knitting or knotting, and through this convolution the whole will become strong and rigid. That's also why I call it a soft constructivism, which has nothing to do with hard materials mimicking softness or liquidity but with softness and flexibility building structure. I take Semper's materiality literally, but not his materials; for me it is much more about how certain materials act, their agency, than which ones they are. They are more states of aggregation or density than actual materials.

Remarks about your architecture looking soft but being hard are omnipresent.

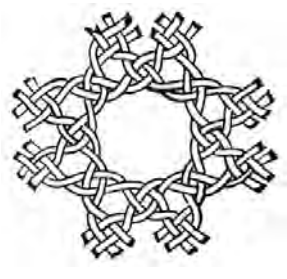
Like I'm interested in illusion! Those are remnants of postmodernism and deconstruction, like Krauss' formless, Eisenman's blur and Agamben's weak form. I always considered that a mistake.

There is no weak form, only the soft architecture of hard form. We should always separate architecture from buildings. Architecture can be soft while buildings are hard. What is architecture? Organization.

Like the deconstructivists, I have always criticized grids or typology, in which an archive of forms directly provides you with the necessary building, going from hard to hard without any abstract mediation. There is no morphogenesis, just replication. But when the Eisenmans criticized this form of architecture, they simply thought all coherent form was wrong and all order was fascist and had to be weakened or broken down. But when they eventually built a form, they just solidified the *critique* of it, which is a completely formal act. They gave us a critique of top-down architecture by breaking it down, but they never understood that the true reverse of top-down is a bottom-up process, and a bottom-up process inherently means constructivism. Building, morphogenesis and constructivism all run simultaneously and together. Constructivism is something different from constructionism or high tech: it involves a final product as the result of a process, and since that process is a material one, it's constructed as it's being formed, not afterwards by the engineer. My buildings don't look like they are sagging or melting, as in deconstruction – on the contrary, they are just rising up, emerging out of a process in which flexible, textile elements have just hardened into a form. It's hard, all right, just not crystallized. But I do agree that it's difficult to see this distinction between sagging and rising up, and we aren't really helped by all the other topological architecture, either; most of it is just rounded-off modernism or rounded-off deconstructivism.

Let's return to our examination of textile tectonics.

I think we need to look carefully at whether the microtectonics of the textile surface – texture – can become the macrotectonics of the edifice – structure and massing. Obviously, this is a reference to Frei Otto's analog computing techniques, in which soft, mov-



Left Gothic Rose window (14th century). *Right* Gottfried Semper, Knot of plaited threads. From p. 186 of *Der Stil* (1863).

able, flexible elements, not just soap film or paper or sand but actual wool threads, find each other and then collectively rigidify, find form. We should remember that analog computing is precisely such an inhabiting of materials by other materials; soap film on one scale can become a steel roof on another scale. In my book *NOX: Machining Architecture*, there are two iconographic images on the contents page: Frei Otto's wool-thread model (ill. p. 134) and, next to that, Semper's piece of knotted cloth. Frei Otto taught me that movement is not enough to generate complexity in architectural structures, even if we are interested mainly in dynamic systems. First, you need a framework in which the movement takes place, a framework of flexibility, a system, a system of variation, but one that is typologically constrained. Second, besides movement being processed by that system, we need consolidation. You can't just "freeze" movement; that's fake complexity, not structure. In Frei Otto's machines, his analog computers, a system *stops itself* through transformation. It transforms from soft to hard but, at the same time, from simple to complex. The thing is not the same at the end as at the beginning. That makes the final complexity irreducible to the simplicity of the beginning. All these machines operate on physical slack and curvability becoming structural redundancy, movement becoming structure. I worked for a long time with these techniques but found that the variations were too diverse, the ranges of curvature too large, and the

variability too difficult to control. Textile techniques like the ones I described above – crochet, macramé, braiding, knitting, weaving – do something similar to morphogenesis, but in a more controlled manner. They produce similar structural nets, but the interrelating of the flexible elements is much more controlled. Top-down and bottom-up alternate in a much more frequent manner and produce a very aesthetic result. The types of curvature – what we call "figures" – are less divergent and simply more stylistically controlled. In short, I would say that textile techniques are closer to what makes an architectural result, and more importantly, all ideas develop within matter, within the process of making; they don't enter architecture from the outside.

> *Just to make things clear, we're not only talking about real textiles but also about digital NURBS, splines.*

All Semper's fibroconstructivism, his references to twigs, wattlework and wickerwork, is immediately understandable to anybody doing 3D modeling with splines. The word and the function of "spline" as it's used in our software programs refers to a kind of wooden slat that has been used for centuries for drawing the curves of a ship. A spline can be a long wooden slat used on the factory floor to cut curves from wooden parts, or it can be a drawing instrument, a flexible ruler. A spline has enough resistance not to become wobbly but enough flexibility to produce a wide range of curvature. It has pliancy and resilience. In earlier days, you would bend the spline into the desired shape and hook leaden weights to it to stabilize the curve on the board or floor. So the spline actually produced third-degree curvature before they could mathematically understand it. A spline is an analog computing device. When we draw a spline on the screen, it can be straight, but that doesn't make it a Euclidean line, because that only has an end point and a starting point and nothing else; a spline has points in between. We can choose the number of these, and it has a huge effect on the type of curve. When these points are moved, the straight line starts to curve; that's why curvature is an index

of information. That's one thing. Second is that in a relational system like a textile technique, the curves never curve by themselves. They need to lock into each other, find each other, clip together; they curve relative to each other. It has nothing to do with the curves of Aalto or Niemeyer; although they're beautiful, they're always passive, single curves, drawn on paper; there's never any systematics of interrelated curvature. Critics often understand our techniques as a sort of digital clay modeling, which is also a Semperian notion, though he always preferred textile over ceramics as the main category. But clay is too docile; it has no internal structure and therefore cannot systemically process information. It is always fully yielding to the designer's hand, while with textile and splines you always have to collaborate and negotiate with the material.

> *To take all this a step further, we should discuss the scale of the curve. In your work and your teaching, we see interlacing return on many different levels, from surface to structure, and even massing.*

That's because in design, lines can exist on so many levels. A line can be a dashed or dotted centerline that organizes a whole band-like row of rooms or floors; it can be a continuous line that indicates much smaller elements like walls, beams or columns, or delineate the contours of elements like panels. The lines resulting from a textile design technique don't necessarily have to end up fully materialized and visible in the final architectural object; they can flicker between geometry and structure. In 3D modeling, the relationship between line, surface and volume is completely different from in drawing or sketching. In sketching, you're always depicting, tracing. On a computer, you're basically *building* the model. Somebody should film our hands operating the mouse for a whole day; nobody would say it's "all virtual" after that. There are two types of lines: lines that are profiles and lines that are rails. You can have a line that is *extruded* into a tube or an H-beam; you can have a line that is *lofted* with another line to form

a surface; you can have many more lines that are serially lofted, with only the outer ones ending up visible as the edges and the others absorbed by the surface. On top of the generative textile techniques, we have, of course, the technology of the software; taken together, these make it a design technique. There is a constant vibration of real and abstract; a real textile technology can become a technique within a digital technology, which then inhabits a building technology of steel and concrete and other materials.

In Semper's *Stoffwechselthese*, the textile weavings and bundles were *carved* from the stone, so there was a shift from one technique to style to another technique. But that is not a linear, progressive relationship; both techniques inform the style, which becomes an abstract zone between two real, material states. For Semper, a textile technique like weaving only made sense because there was a stone technique like carving. If you look at Frank Lloyd Wright's Ennis House of 1924, as discussed in Frampton's chapter "Text-Tile Tectonics" in his *Studies in Tectonic Culture*, you see that Wright integrates weaving with tiling, which is an old Orientalist topic. The engraved profile with the woven pattern runs over the concrete panels in such a way that it blurs the joints – and these tend to be very visible in concrete, since the joint is always chamfered. This is a well-known problem in wallpaper design, where you also have to create a motif so as to hide the edges of the paper. Today again, we have to create our own transitions. For instance, steel can be bent *or* torqued, but not bent *and* torqued, meaning a three-dimensional spline can become a round tube or a composite truss of two or three round tubes with diagonals bracing them, but never an H-beam. To make a three-dimensional spline rollable in the factory it has to be subdivided into smoothly connected circle segments, second-degree curves. But keep in mind that each circle segment is flat. Therefore, to make the curve three-dimensional, the next circle segment should be rotated orthogonal to the shared tangent, and this can only be done with a tube, of course, not with an H-beam, because in that case the two segments wouldn't fit anymore, while with a tube

they would. It's just an example, but there are many like this. There is a lot of information preserved in the material states of products. Never forget that we design with products, and that information should be interfaced through geometry and technology. Of course, we now have the option of moving toward half-products, to make the process more nonstandard, but for now, this is limited to cutting, milling and molding techniques. I find it striking that Semper's shift from weaving to stereotomy can now be a shift from weaving to milling foam for molds. But what's certainly different is that in his time, stereotomy could take care of a whole monolithic cross-section; we will always need to consider a *composite* assemblage, in which panelization immediately affects substructure and structure. Techniques, technology and geometry should always be considered as having effects on each other and not as disparate. What I find problematic is that digital design in most schools treats that abstract zone as a playground only, not as an interface between two material states.

> *How are textile techniques applied in your teaching? I remember that you and I taught classes at Columbia University in New York and the University of Kassel in Germany purely on textile diagramming, before the students knew what they were going to do later, before they had a site or a program.*

Method comes before anything else. You have to bring architecture to the site and to the program, not transform the site and the program into architecture. In my teaching, freedom comes at the end, and discipline at the beginning. It's usually the reverse; you get all the subjective freedom at the beginning, and then the students have to be disciplined in the later stages – what a misconception of teaching. The textile techniques we did are a subset of what I call figure-configuration techniques. Students start studying techniques like braiding, weaving, crochet, macramé – sometimes as part of a full textile studio, as you said, and sometimes as part of other curve techniques, like hairstyles, Gothics, knot

theory, or arabesques in wallpaper and wrought iron design. Anyway, figures are defined as very simple lines with either one bend or two, seldom more. They are all splines. Each figure has a minimum and a maximum state of bentness, and this is all controlled by moving the points on the line, so the technique is inherently parametric. We categorize them by how variation is organized within the figure. A figure can have two fixed ends, a fixed end and a loose end, or two loose ends. For instance, when I had students analyze the arabesques produced by Jackson Pollock, they found that they all had two loose ends. So variation is expressed throughout the whole length of the spline. But that doesn't mean the line is imprecise. Because of the biomechanics of the elbow, wrist and hand, most curves start out shallow and become increasingly curved at the end. It's typical tendrilism, like in Art Nouveau's whiplash curve, which starts with a very slight bend and then suddenly twists and turns – as in a shift from a shoulder-elbow line to a wrist-hand one. When we had students look at Art Nouveau curves, it became clear that they always had one fixed end and one loose end. Since all these curves were connected to rectangular frames – either a fireplace, a doorframe, a page in a book, a poster or a menu – the rigid start of the whiplash was always aligned with the straight sides of the frame. Now, in a third category, that of textiles, all variation is between two fixed ends: there are loops, knots and shifts.

Then the figures are combined into so-called configurations.

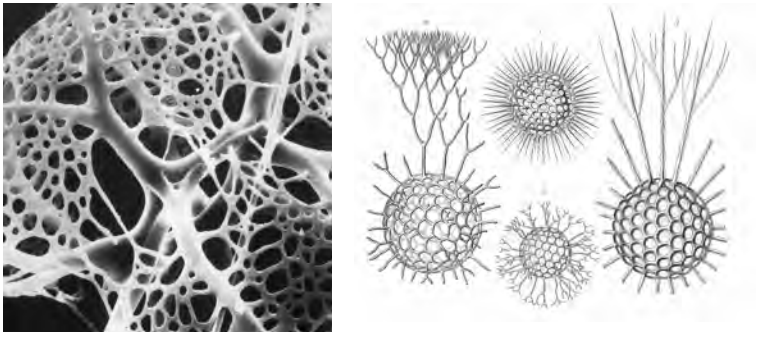
These configurations are often already close to a typology – a flat carpet for one-story buildings, a strand for larger blocks, or a vertical strand for towers. Framing it within what we discussed before, figures are figures of movement, and configurations are patterns of structure. The configurations always start out quite homogenous, almost like a curved version of Dutch structuralism, which is not what we want. I would like configurations to be closer to liquid, more like blocks of rhythms, resonating patterns. We

allow for the homogenous versions only as "tight," figures tightly connected without any extra flexibility, to start the design procedures with, and then we always ask the students to develop them toward a looser setup, or toward combinations of loose and tight. If you just take the figures as immaterial lines, they behave like any other modular system or grid. Bringing in looseness helps bring back the materiality of the line and adds sliding-along to locking-in by increasing the variability of the curve. I think it is very important to take the figures for what they are and see what kind of variations can occur in their pure connectivity. Of course, the first sets that emerge from such studies are often lattices, which are completely tight. Now, one should not stop with such lattices, since the figures allow for much more variations of connectivity than the straight lines in a grid – they can slide, bounce, hook, whatever, not just cross. One should study the outcomes of the more loose connections very carefully, and study the configurational outcomes of these. I think on that scale level I would distinguish between (a) lattices, (b) deformed lattices and (c) aggregates – that is, combinations of deformed lattice states plus jumps, or cracks, or holes, anything of a higher-scale complexity, what we call transformations. If you look at radiolarian skeletal skins, for instance, you'll notice that they are not perfectly spherical Bucky balls at all. Or course, geometrically the perfect sphere was the first to be mathematically solved in such nested patterns, but three-legged nodal nets are in essence *parametric systems*, not *geometric forms*.

> *You did studies with students of double-curved complex shapes in plaster, and then the students had to cover them with circles of various sizes and study the resulting patterns.*

Yes, first to make them understand why a closed surface cannot be covered – what is called "tesselated" – by hexagons only. Many students around the world working with Voronoi diagrams don't understand this, especially with respect to a double-curved sur-

face. Either they orthogonally project such a pattern onto it or they blend it with the existing isoparm geometry of their shape, which means the hexagonal pattern is deformed to make it fit. Both are wrong. Some deformation is allowed, as it occurs in wet and dry foam or in cracked mud patterns, but only a tiny bit; usually these patterns jump into other configurations when there is too much deformation. So, secondly, we do so to make them understand it is not a pattern to be applied afterwards, but that it is part of a systemic relationship between form and pattern. We have been trying to get away from prefixed geometries like spheres, to work on the agency of the small elements themselves, to see how they pack and what kind of geometries emerge from that. Suppose you take a cylinder (not a closed shape, by the way);



Left Frei Otto et al., Detail from a Radiolaria structure. From p.119, IL 33 (1990) showing the complex aggregate of three-legged nodes producing a large variety of polygons. *Right* Ernst Haeckel, Radiolaria, Table XIV, showing the erroneous tesselation of the surface into hexagons only (1863).

you can tesselate that with same-sized circles to obtain a hexagonal surface pattern. Then start to deform that surface slightly, and you'll notice that the hexagons deform with it; instead of the symmetrical polygons you get asymmetrical ones. Then, after you deform it some more, smaller circles suddenly need to be inserted, and larger ones, surrounded respectively by five and seven other circles, that is, pentagons and heptagons. That last step is the step

of aggregation, of transformation: the system breaks into another distribution of elements. So the rule that guides these systems is not the application of a hexagon but of a three-legged node (which can configure into all kinds of polygons). Ernst Haeckel never understood that when he studied radiolaria in the 1860s. Buckminster Fuller did a hundred years later, but he could only apply it to completely regular geometries. We can apply it now to any double-curved geometry; even when mixing concave and convex, in all irregular manners, we've written scripts for that (ill. p. 225). Then there are even more complex aggregational singularities, large cracks, shifts, columnlike alignments, et cetera. Frei Otto's studies of radiolaria show dozens of types of such "imperfections," which are not faults, but geometrical forms of management. So the figure-configuring step is nothing like the element-structuring step, where elements just all add up the same way. So though there seems to be a lot of difference between the curves of textiles and the three-legged nodes of Voronoi tessellation, their complex systemacy is not so different, since both are based on continuity. I do like to work with textile techniques, because it teaches students an inherent materiality of scripting; they need to study it in both an analog and a digital way. It also creates an understanding of flexibility and parametrics. Of course you can start purely parametrically too, without referring to textile, but that depends on the school, on the general level of the students. It is always funny to see how the folksy aesthetic of textile techniques ends up totally advanced in architecture.

The inherent aesthetic of textiles is very powerful.

Absolutely. I think what it does is create a continuum of the mechanical geometry of structure and curved organic ornament. It takes curves out of the realm of streamlining, styling and elegance, which is all stereotomy, and introduces them into the realm of tectonics. Semper's distinction between these two is very close to Adrian Stokes' distinction between carving (corresponding with Semper's stereotomy) and modeling (corresponding with tecton-

ics). The former works from a block down to a sculptural form; the latter works upward and adds elements into a form. I remember we had students working with braids, and of course after the research period they came up with all the different types, but all tight. Then, when they started to loosen some of the curves, they created variations that were stunning; the curve that could close surfaces was the same as the one that could create openings. That's something you could never do with a grid, right? You can deform it digitally and make it *look* looser, but it's basically the same grid. That's what you still see a lot in digital design: these old 1990s deformation techniques, which are simply a top-down manipulation afterwards. We work with elements bent on a smaller scale and then configured into a large-scale system, which is an informational procedure; nothing is deformed, ever. What one needs to study, as I have argued in the essay "Machining Architecture," is the shift from deformational to transformational, from system to patterned morphology. The system is not at all the diagram – the problem with the diagram is that it functions only at the beginning – but a systematic setup which then, following a stepwise procedure of transformations – Deleuze would say "singularities" and "expressions" – becomes a form. So the procedural code is informing different material states all the time, and that code is different when it acts upon wool, like in knitting, than when it acts upon mullions or panels. So we are not "knitting" houses or "braiding" towers. The parametric relationality is expressed differently when it concerns wool than when it concerns wood. It wouldn't surprise me at all if DNA code turned out to act the same way. You can imagine the same string of genetic code working at the start of embryological development and having quite different effects than later in the process. Code is a "way of working," but when the materials change, the way it works out changes with it.

Our classes are not so much studios for design; they're really about design techniques. Sometimes we even ask students to come up with five designs generated by one systemacy. They never work on one design; you always see huge matrices of vari-

ation emerge (we call them "parking lots"). Out of these matrices evolves a set of minimum states and maximum states, that is, states in which the parameters create average patterns and exceptional ones, with all the mixtures in between. Then, after that, we start looking at the site and at program. The site makes a system – in any state – deform or develop in a certain direction, but it never provides the initial systemacy. I don't believe at all in Steven Holl's "building the site." The same with program, because every type of program has its own mixtures of large and small spaces, of determined and less determined spaces, which all fit somewhere in that systemacy. So program is neither directive. It is really the architectural systemacy itself, which, however, is related to type and morphology. Clearly, a tower, a housing development, a concert hall, all have their own morphologies and need to be calibrated with the chosen systematic setup.

Since all these systems are parametric, they are based on variability, and textile variability is based on interlaced curvature. What the design of textile techniques in teaching gives us is a precision that goes far beyond diagram-metaphor – architects now speak about how their spaces are "woven" (just as years ago they stated that their buildings were "transparent") which they simply are not. Weaving requires rules and systemacy. On the other hand, the technique allows you to control the amount of realization, to be precise with the weaving itself but be more open with the actual component or element that is woven. As I said, it can be floor, structure, rooms, towers, panels or even combinations of these. It doesn't necessarily mean that all the steel members need to be woven, or all the circulation. I prefer any technique to start by nesting itself between everything, so it can potentially affect everything, but we should be careful not to let it *end up* in between.

> *But it is definitely a tectonics; that implicitly means you deploy techniques at the structural level.*

Right. When you move too close to massing, the technique becomes formalist, and too close to texture, it will bring you surfaces

but not necessarily volume. I guess textile tectonics gives you exactly what it says: tectonics, with a lot of spinoff on the surface level, while the volume stays a bit behind, slightly undefined, as we've already discussed in an earlier conversation ("The Architecture of Continuity"). I think it must mean that I am closer to the roof side of Semper's problem than to the earth side. Frampton's Semperian reading of Utzon and Piano has had a big influence on me: How to solve the opposition of roof enclosure and earthwork? I thought a lot about that when I was working on the competition for the second Centre Pompidou in Metz. I took a system of portals in a linear organization and started to split the portals and weave them into a shell. It was a move from a line system to a surface system, thus developing from a hierarchical system of large primary portals and secondary girders at the sides of the building into a system without hierarchy, in fact consisting only of secondary elements, a shell. So the big, heavy portals lined up on the ground and interlaced at the top into a light network of ribs. This resulted in a massing, like any institutional or civic monument, such as the US Capitol, for instance: it has wings at the side and a dome in the middle. This is a very old problem in architecture: the ground plan plays the horizontal, urbanist part, and the dome makes the vertical, architectural landmark. Block and sign are combined, but mostly it is architecturally unresolved – they're just added up and quasi-knitted together. Classicism can't solve problems for you; it can only create them. I honestly think our splitting and weaving technique tackled that old issue: the foundation and the roof share the same continuous geometry.

> *But then it is a tectonics of continuous elements, which is curious, almost paradoxical. For Frampton, the continuous always leads to unhappy sculpturism, carved earthwork – stereotomy, not tectonics.*

I want to stay far away from sculpturism. It doesn't solve anything; it doesn't even recognize architectural problems. I totally agree with Frampton about Gehry – though we should be forever grateful to

Gehry for stealing the technology from high-tech architectural offices – but it is pure formalism. Though there is a very powerful, floral logic behind Bilbao, it's not structure; it's *hardened geometry*. When you look at the steel system, all the members are at the positions of the polygons. Normally, you'd have secondary substructure there and have the larger members somewhere else – but where? So there is no tectonics at all there, only sculpturism. And then it's full of corners. What we do is very, very different. Textile tectonics is a *topotectonics*, meaning it's a tectonics of continuity, not of elementarism; that's exactly what makes it so difficult for critics to read. When studying tectonics, they are accustomed to seeing joints in discontinuous surfaces. With sculpturism, they're used to seeing smooth surfaces of continuous geometry. I do joints and continuity – articulated continuity. Just look at my Jeongok Prehistory Museum: it's full of articulation, joints, rounded holes, spiky connections, ribs. But it is a roof that merrily connects to the ground, rejoins with the ground – to put it even more strongly, it *becomes* ground. Tectonic earthwork. It's not dropped on the ground, like Piano's Klee Museum. Though I find it fascinating – I find all Piano's work fascinating; there's such a huge battle going on, rising from the ground versus flying back to earth, earth projects versus sky projects. Beautiful façades versus beautiful roofs. Now, to successfully have a roof on the ground, tectonically you have a big problem to solve, since the light structure of the roof is generally not capable of supporting floors. That's where our scale jump comes in to help, since the textile techniques are deployed on the level of structure, not substructure – which you'd get with a shell – it can still manage floor loads.

There's something else. Remember the famous diagram of Corbusier's with the four houses in a row, with the classical Maison à Garches and picturesque Villa La Roche?

Yes.

This is another very old matter. The classical starts with the whole – a box, a set of boxes, a cylinder, whatever – and then subtracts

the parts. The Picturesque adds up the parts to a loose whole. It's always one or the other, though in Villa Savoye you get both at the same time, two in one. I think we are solving that, the choice between whole-to-the-parts and parts-to-the-whole, between subtractive design techniques and additive design techniques. Textile techniques are *multiplicatory* techniques: the whole and the parts interact, send information back and forth; it's solved because of continuity. There is communication all the way through; if parts want to bulge, stick out, articulate, they can, but they're corrected by a loose whole, since you never get corners. That's the rule: no corners, although sharp creases and tearings are allowed, since it's all material. With the Prehistory Museum, we managed everything with curvature; it starts with one bay at the top of the hill, and it then runs down and develops into three bays, not separate but three convex zones with two concave ones in between, and then, down the hill, where the section fully merges with the ground as a wide span, it functions as an entry hall. Normally you would have to add up these typologies – single bay, triple bay and hall – into a composite volume; here, they are all transitory states of a single volume.

> *The multiplication of typologies in a single volume results in a condensation of information on the surface. In the surface of the Prehistory Museum, everything is there. Semper's concept of the textile drives everything, as you said at the beginning.*

That's why I don't need ornament. All minimalists nowadays have moved to ornament; we don't need to. In my designs, ornament carries the load. I don't believe Semper is the theorist of ornate surfaces; I think he is the theorist of articulation, of making and elaborating, and in that realm structure and ornament can never be opposed. We need structure to become sensuous and ornament to be material.

The Aesthetics of Variation

In Conversation with Arjen Mulder

AM: I recently read your extensive interview in the AD issue on "architextiles" from December of last year, which was called "Textile Tectonics." In it, you seem to do your utmost to make everybody think your work is so deeply rooted in architectural history …

LS: Yes … well …

… which didn't convince me at all until right at the end, when you suddenly relate everything you do to the two major methods of creating architectural form, classicism and the picturesque. It seemed overly historicist, but it's really about relating the whole to the parts, and how to get around choosing one or the other.

At a certain point, I was looking again at Corbusier's famous diagram that he made after his booming start in the mid-'20s, after building some of his first villas. He was classifying his own work. At the top is Maison La Roche, which has a so-called picturesque composition of volumes. It stems from early Romanticism, with its interest in the rural. A picturesque mode of ordering means it follows an *additive* technique of massing. For instance, you'd have a farm, and when you got extra cattle or had children, you'd just add a room or a stable, without any preconception of a whole, harmony or proportion. The second building in Corbusier's line is the Maison à Garches, a simple uniform shape with a rectangular volume – this follows a classicist *modus operandi*. That technique starts with a whole and then *subtracts* the other elements, like loggias, columns, windows, et cetera. So the former uses a method that progresses from the parts to the whole, and the latter works regressively from the whole to the parts. Until the early 20th century, these were the only design techniques we had in architecture, one based on contingency, the other on order.

And then he added a third option.

That's exactly what it was: a third option. Though in the diagram he numbers them three and four, both designs – Maison à Stuttgart and Villa Savoye – basically follow the same model. The last one, the Villa Savoye, embodies precisely that third option. In the design, Corbusier actually draws the picturesque and the classical simultaneously, superimposed on top of each other, with an irregular volume framed inside a regular square volume. That's quite astonishing when you think about it, because if quasi-accidentally the rooms of the Maison La Roche were to grow step by step, additively, they would suddenly fit inside the Maison à Garches. The great thing is, of course, it only *nearly* fits. In the Villa Savoye, there are spaces left over in between the two models, so when you're outside the picturesque model, you're still inside the classicist model. This leads to the well-known window at the top of the house, which doesn't offer a view from the interior to the exterior, as in a normal house, but from exterior to exterior, because being in between two models left this ambiguous outer space – which Robert Venturi later theorized as "contradiction."

> *That's the Robert Venturi who wrote* Complexity and Contradiction*, the book that started postmodernism in architecture. Wasn't your inaugural lecture at Georgia Tech entitled "Complexity without Contradiction"?*

Yes. In the house for his mother of 1964, Venturi put a huge split in the middle that makes the house readable as either a single volume with a cut or two houses moved close together. So it's an either/or in which the subtractive and additive coexist, and thus contradiction came to mean "ambiguity" in Venturi's thought. Architects have been struggling with this third option since Corbusier: how to understand contingency and order at the same time, within the same continuum? It was always Mondrian *or* Pollock, necessity *or* chance, as in the title of the famous book by Jacques Monod – well, that was *Necessity and Chance*. Never both at the same time. It's our most important philosophical problem to solve, not just in architecture but everywhere. Keeping it short, I'd

say that in theorizing this third option, Venturi's terminology with respect to complexity was correct, but with contradiction he was mistaken. That's simply because complexity doesn't have another side; it's a contemporary form of monism, and actually, complexity occurs precisely because there is no contradiction, because there is continuity. Nothing is put aside. As Charles Sanders Peirce says, "All things swim in continua." Or, to put it a bit differently, you could say all the determined occurs in the undetermined. This brings us to Peirce's definition of vagueness and potential, a definition I have been referring to several times before: "Potential means indeterminate yet capable of determination ... The vague always tends to become determinate, simply because its vagueness does not determine it to be vague ... It is not determinately nothing." So we have ambiguity as an *overlapping* of two determined states and vagueness existing *in between* two determined states. I think complexity operates on vagueness, not on ambiguity or contradiction. To conclude, again with Peirce, "The vague might be defined as that to which the principle of contradiction does not apply."

Architects can't understand order and contingency in an ontological relationship, as producing each other; they just see them both as structures.

Why is that?

They understand order as form, and contingency also as form. It's like the Vitruvian Man: because the body is symmetrical, they draw it as symmetrical, which is ridiculous, because I am never symmetrical, not even when I try very hard. I'd have to be dead to be symmetrical. Architects mix up organization and structure, the virtual and the real. Of course, my body is a symmetrical organization, but that doesn't mean I am in a symmetrical position. They always understand these states as existing on the same level, like the regular and the irregular, or repetition and difference. Of course, order is not on the same ontological level as contingency. Order is not form; it is organization. For an order to be expressed, it has to be differentiated and become contingent. Everything is

contingent, unique, actual and different – things *can* only be contingent; there is no other form of existence. In that sense, I am looking for an upgraded, radicalized picturesque. That would be a great title for a new book: *The Radical Picturesque*. We can design objects that are symmetrical in organization but asymmetrical in form. But to be able to do that, you have to understand that it is not a contradiction. Let's go back to the third option for a moment. What would you need to make parts configure into a square? You'd need coordination; you'd need a set of rules operating locally, *not of form but of formation*, to make the parts coordinate in such a manner that in special cases it would result in a whole. In other words, it wouldn't be enough just to have the parts added on to each other, as in the picturesque model – it does need to be radicalized. It would need correction or, as we call it nowadays, feedback. Smaller-scale events would lead to larger-scale effects that feed back onto the parts. Regressive causation at the same time as progressive causation. Interaction. The relationship between the parts is nonlinear, multiple; there is an actual multiplication of the whole and the parts; they share information and communicate. So we had already additive techniques and subtractive techniques, and now we have *multiplicatory* techniques, too, as a third option. And they understand order as flexible, topological and vague.

Doesn't that refer to Deleuze's "anexact yet rigorous"?

It's amazing to see that quote turn up again and again, but yes. I think he used it for the first time in the famous Vincennes lecture of 1979, which was a preliminary version of one of the last chapters of *A Thousand Plateaus*, where he suddenly talks about the vague and the vagabond. There's a section where he distinguishes between the round and the circular. While the circle is an a priori form, a formal essence, the round is an a posteriori form, a vague essence, something that results from a process and doesn't have a midpoint or a radius. It's constructed on the line itself. But the line is topological, flexible; it's made by bending, curving, like riding

your bike or driving your car. So here we have the topic of our conversation: it's created by *continuous variation*, by what he always calls "matter-movement." This is a direct descendant of Diderot's intertwining of matter and movement. It's matter as active, as epigenetic, as self-organizational, as formative – all things we now classify under complexity theory. Now, the rigor lies in the fact that precisely this movement, this flexibility, is productive; this continuity is actually capable of producing "things," as Peirce would say. It's not slime or oceans that result from continuity, but discrete objects. So gradual variation on one level creates episodic variation on the next, deformation leading up to transformation. But first, we'd need to look at gradual variation. I had no idea it had such a history in aesthetics.

> *I know about gradual variation from Darwin, but not from aesthetics.*

It's in Hogarth's *The Analysis of Beauty* – which is a very intriguing book – as the "gradual lessening of variety." All these discussions on uniformity and variety are about the whole and the parts, which takes place at the heart of aesthetic theory, and for that you have to go to the English. Because of their empiricism, they became the theorists, almost the physicists, of beauty.

Generally, we know two categories of aesthetics: one is beauty, and the other is the sublime. One is form without forces; the other is forces without form. It's not exactly the same as classicist and picturesque; they are related, but not the same. Hogarth uses the word "picturesque" several times, though, but along with that, also "grace," "intricacy" and, most importantly, "variety." On the title page of the book, he put a self-designed emblem of variety: a snake in a glass pyramid-shaped box, with the word "variety" on the wooden base. Variation is expressed first and foremost through the articulation of a curved line: the *serpentine line*, as he calls it. Shaftesbury and Hutcheson, the two most famous proponents of aesthetic theory 30 years before Hogarth, had already used the term "variety," but for them its

relationship to beauty was different: it was "uniformity amidst variety," meaning variety was controlled by an ordering mechanism of proportion and harmony. This changed completely with Hogarth. His position really lies between controlled beauty and the uncontrolled unleashing of forces of the sublime. The major problem with the sublime is that while it does away with God and goodness – the transcendent commanding bodies – it allows nature in through the back door, replacing one transcendent category with another. Hogarth is very outspoken on Burke's sublime: it is "variation without limit or termination" that fills the mind "with one grand sensation, [...] totally possessing it, composing it into a solemn sedateness." More than 45 years after Hogarth, it was Uvedale Price who finally fully theorized the Picturesque as "a station between beauty and sublime." The sublime is as passive as beauty. It shouldn't be too difficult to extend this criticism of the sublime to 20th-century autonomy, minimalism and deconstruction, all offspring of the sublime. It leaves us empty and refuses all interaction.

Hogarth's aesthetics is an empirical and living aesthetics; it's an active image that activates the body into a "wanton chase of the mind" through "an infinite variety of parts." Hogarth's most characteristic topics are hair and crowds. He goes absolutely wild when he's describing hair – "the flowing curl," "wanton ringlets," "the many waving and contrasting turns of naturally intermingling locks [that] ravish the eye with the pleasure of pursuit." He never reduces the serpentine line to a singular fixed figure; it is always about curves in curves, multiplying a movement into another movement, as with his examples of the horn and the cornucopia, which is bent but also twisted around its bending. I think what Hogarth does is push beauty in the direction of the sublime without actually wanting to arrive there, or to put it in modern terms, he keeps order on the edge of chaos. Especially when it comes to crowds and faces. His sense of the crowd is very close to our notion of the flock or the swarm, of local movements that construct a flexible, intricate whole, that become a "joint-sensation of bulk and motion" as he writes. In the preface to the book, Ronald Paulson uses the term "an aesthetics of the crowd,"

which describes very well Hogarth's idea of variety being constructive. It doesn't need a schematic underlying geometry. He completely rejects Shaftesbury's idealism: it is coordination and variety that make the parts "lose their distinctive shape [...] into a confused heap." So he positions it exactly between deformation and formalism. It's a formative concept in contrast to both; it works from the parts to the whole, so yes, it's picturesque, but the parts also lose their distinctiveness and become a whole – a vague and unclear whole that needs to be discovered and "pursued." It's a very old aesthetic problem to show an object or a figure amidst forces, between being torn apart and being created. It's everywhere, in Bernini's treatment of folds, of course, and in Bernini's treatment of hair, or more extreme, Mucha's hair. My goodness, is there anything more beautiful?

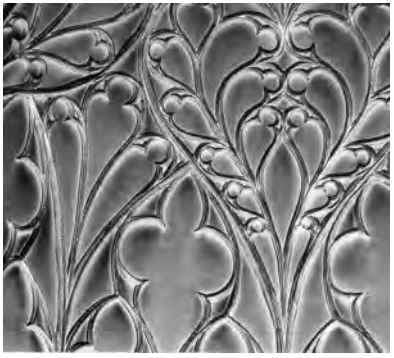
But aren't you simply discussing ornament here?

Sure, of course, but something else also. We have to understand that a philosophy of matter, one that explicitly upholds matter as movement, and that therefore doesn't make a categorical distinction between animate and inanimate – where *matter and life are on the same side*, so to speak – inevitably leads to an aesthetics of matter, simply because there is no inbuilt distinction between natural and artificial. And an aesthetics of matter then immediately relates to life and to living things – that is, possibly, but not necessarily, plants and animals. Vitalism is not a science, it is an aesthetics. So ornament, yes. We should discuss more art history here – Art Nouveau and especially the Gothic. I remember being in our water pavilion with an English art historian years ago, just after it had opened in 1997, and he was pointing at the sensors and how the grids were projected over it. Do you remember?

You mean the interactive grids that turned into ripples and waves when people jumped on the sensors? Wasn't that generated in real time by computers?

Yes, people jumped on the sensors, and immediately there were real-time-calculated ripples shooting from their feet. What was so amazing, however, was that the art historian cried out, "Robert Adam!" I thought he was out of his mind, but now I understand how correct he was. Adam's 18th-century circular ceiling ornaments would sprout over whole fields of stucco, filling them with life – not with an image or imitation of life, but putting life in the stucco itself. He was absolutely right in that comparison.

Anyway, Art Nouveau. Mucha's hair – pure proliferation. The curves in Art Nouveau are very different from Hogarth's S-curves. His serpentines have *two loose ends*; variation progresses all the way through the line, a bit like Pollock's arabesques, but the Art Nouveau curves have both *a loose end and a fixed end.* They are vegetal: that means they are rooted at one end and loose at the other and move with the wind or the water. As you follow the line, there is an increase of curvature. It starts out quite straight at one end and slowly becomes more curved, and then at the other end there are suddenly three or four extra twists and turns. That's why they often called it a "whiplash," and it's also the reason why Walter Benjamin called Art Nouveau dangerous: because it is an aesthetic of the dreamy and the figures float in the wind or under water, like water plants, which have a similar type of curvature. He thought this dreaminess, which is directly related to the sleeping women in Victorian classicist paintings, like those of Albert Moore, was keeping the revolutionary masses off the streets. That is why he was much more in favor of modernist transparency. The Art Nouveau house is a cocoon, a crimson velvet case. There is at once a strange passivity and movement in Art Nouveau. The bodies, mostly female, are almost always asleep, or gazing, daydreaming; the fabric is full of folds, and the hair curls in millions of tendrils. Like the the water plant: fixed on one end, free and moving on the other. Mucha's plates are just amazing. First, the art of variation is an *art of the many*. To deploy variation, you need *many* parts. Then they have to be coordinated: there needs to be a certain similarity of figure or else there is no proliferation. Proliferation is an extremely serial type of variety.



Left Georgian Gothic tracery of The Tribune ceiling, Strawberry Hill, Twickenham (1747–92).
Right Alphonse Mucha, Advertising poster for Job (1898).

Then we need effects that occur in one area to be feeding back into other areas. So it is an *art of multiplication*, too. One can only do this with curves, continuity. Then, fourth, you have to vary the variations: there are entanglements, strands of multiple hairs, mergences, crossings. See? It's not just hair blowing about in an invisible wind. There are individual hairs that become collective strands or tendrils, and they also form networks of crossings, so there are configuring properties in it. That's essential in this aesthetics, which is a vitalist aesthetics: life and geometry or life and construction are constantly intertwining.

With Mucha, you get the best proliferation, the best cascadings of hair, strands, tendrils, crossings. It's like with Horta's wrought-iron railings: you'd think the crossings were accidental. Of course, the mergences, like multiple lines merging into one strand, are structural, but the crossings that seem accidental are also being used to improve the structural properties of the railing. In short, iron lines progress step by step through a set of singularities into a networked surface that forms a railing – without becoming a grid, I might add. They move by forces, then they find each other, stick together and form structures.

You're saying it's not just ornament, it's structure.

Exactly. That's the point that everybody always misses, as if we're only tracing movement and these lines aren't capable of creating lasting structures. It's also my main criticism of interactive art: it simply replaces the obsession with form – which is memory – by an obsession with event – which is the present. Of course, to have the actual experience in the work itself shatters modernist autonomy, and I'm all for that. But to have only discrete "nows" one after the other, without any relationship, is as confusing as having Korsakoff's syndrome. You'll never be able to form concepts. Maybe I should clarify this a bit more. Let's put all forms between solid and liquid on a line. *Solid* is at one end. That's how architects generally understand form: as idealized, crystallized, a priori, archetypal. No dynamics, no contingency, only memory. I think the first one after solid form going toward liquid is *structure*; it's more open, not necessarily Platonic. It's not the dead clay of Platonism. There are forces, points and lines involved, but it is as static. Then we have *configuration*. It's the word some of the Gestaltists used for form. There is a moving back and forth between actual perceptions and virtual memories; it's much more dynamic than structure. Please note that in my description I expressly mix up the explanatory models of perception and of form, and this is always the case in aesthetics. The explanation of how sense impressions are synthesized is the same as how the whole and the parts make up aesthetic form. Now, let's proceed with the categories. Next to configuration, we have the modern notion of *pattern*, which is sort of in between information and form; it is generally considered as fully emergent. All these books on pattern nowadays are full of zebra stripes, shell pigmentation, sand ribbing, mud cracking, soap and bone structure, and so on. All the patterns that were single forms and formulas a hundred years ago are now very complex patterns, full of "imperfections" and irregularities. Then, I guess, closest to completely liquid, we have Deleuze's *rhythm*, his continuous variation and modulation. Waves, turbulences, proliferations; water with singularities, slightly viscous and thickened. It's quite an effective notion, because it circumvents Kant's schematism. With Kant, all the particulars you see – for example, a dog on a hot

Sunday morning – add up through synthesis into a generalized scheme of dogness, a memory structure that you obviously need during a new encounter to recognize a dog as a dog and not as a tree or cat. But the moment dogs add up to dogness, it freezes into a transcendent category that makes all dogs old dogs, which Deleuze happily saves us from: visuals with him stay active, operational. Perception and action form clustered entities – rhythms, he often calls them, or percepts, which are not perceptions. So they are memorized, but plastically, which fits with modern neurology much better than Kant's ideas. Images are active images, not just things you see. Now, again, we must realize that every theory of perception is inherently a theory of aesthetics. Seeing, making, seeing – it's all constructive. We can use that word as long as we're careful.

> *The argument is getting more and more structural. This is surely why you're so interested in the Gothic. You talk about it more and more. In the Italian book Ludovica Tramontin did on you (*NOX, *published with Edilstampa), there are dozens of references to the Gothic, and you both discuss it extensively.*

I refer often to the work of Wilhelm Worringer, especially "The Ceaseless Melody of the Northern Line," which is one of the chapters in his book *Form in Gothic*. Let's just start off with "In Northern ornament repetition does not bear this restful character of addition" – and by this he means Classicist symmetry – "but has, so to speak, a character of multiplication. The intervention of any desire for organic moderation and serenity here is lacking." A shot right between the eyes for Alberti. Symmetry is replaced by repetition, by the serial rhythms of multiplication.

Nobody really understood at the time how Worringer could have done this book on the Gothic three years after his famous *Abstraction and Empathy*, which became the bible of the early abstract painters. But it's the same expressionism: "the Northern line does not get its life from any impress which we willingly give it, but appears to have an expression of its own, which is stronger

than life." And then, of course, there are the lines Deleuze always quotes when he's discussing his concept of nonorganic life: "The pathos of movement lies in this *vitalized geometry*," and "When the natural barriers of organic movement have been overthrown, there is no more holding back: again and again the line is broken, [...] again and again it is forcibly prevented from peacefully ending its course, [...] it ends in confused, spasmodic movements, breaks off unappeased into the void or flows back upon itself." What's crucial here is the opposition not just to mechanical geometry but also to organic purposiveness, which is pure Alberti, where all geometric structure is made beautiful by organic ornament. No such distinction is made in the Gothic; there, the structure itself is "vitalized." It is curvability itself that creates the structure. It saves us from mechanicism and organicism at the same time. When we compare it to the S-curves of Hogarth and the J-curves of Art Nouveau, we can see that the Gothic curves have *two fixed ends* and that all flexibility is deployed in the middle areas. The ends can be parallel, aligned or diagonal (they are always tangents and therefore straight), but the curvability is in between. The restlessness is there because the tangents act like switches in a railway system: they can take over each other's movement at any time. And they need not do so only at the ends: one end can link up to a middle zone at any time, precisely because the systemacy encourages the sharing of tangents. And it is structural – infrastructural, actually – because loads and forces are movements.

I have said this before, in the interview with Ludovica Tramontin you mentioned and probably other times: there are no a priori forms in the Gothic, as there are in Classicism, like the column, pedestal, architrave, dome, and so on. There are no catalogues in the Gothic, like those of Vitruvius, Palladio or Serlio, to set the standard. In Gothic tectonics, everything is created out of ribs. There are no comparable elements in architectural history – the rib is actually much more of a proto-element. Ribs are quite abstract on one hand, and on the other they seem to behave as real, bendable, almost vegetal or textile elements: too weak on

their own, they have to bundle, weave, configure with others to become strong. So strength is always collaborative and emergent, a posteriori. It's maybe not so much structural as it is a constructivism. Columns are bundles of ribs in Gothic architecture, and these bundles loosen at the top into a fan and subsequently start to weave together with other unraveled ribs from other columns to form a vault. All forms are results of movements, structural movements that are shared, that are passed on from one to the other. What is crucial to note, though, is that movements and variations are not just tools of deformation: there are also structuring states of singularities – that is, transformative properties. Gradual variation leads up to episodic variation, to bundling, thickening, and when you look at the large radial windows in the Gothic, you see switches, mergences, a wide variety of patterning typologies. Of course, architecture is an art of ascending dimensions and scales, from line-column to surface-wall to volume-building. But while in classicism – as in modernism – they follow Euclid's leaps of scale, in the Gothic they never leave the line behind: it thickens, bundles, weaves into surfaces and curves into volumes, but the rule is never to leave the line behind. That is exactly what articulation means: holding on to the line. When I advocate an architecture of continuity, it is not at all one of volumetric smoothness or even of smooth surfaces: it is an architecture of the line. Smoothness and streamlining are restricted to the art of massing, while articulation is an art of tectonics.

It is in that sense barbarian, one might even say pagan, like Celtic band ornament – ceaseless interlacing, braiding, knotting – and its aesthetic comes very close to hair and textile art.

> *I would like to discuss some of your projects. I'd like to know what you're doing with all this history of variation. Are you moving towards a neo-Gothic, revivalist position?*

I am not really neo-Gothic, in the sense of following stylistic instructions precisely, but almost. I say "almost" because I want to

make clear that I take it seriously as an artist and as an architect, and that I don't want to jump from one capricious idea to another. Revivalism often refers to Pugin, and for Pugin the Gothic was virtually Romanesque; he stresses undecorated walls of masonry. Since I stress the ribs in the Gothic, it immediately puts me on the other side, at the decorated Gothic, a style that uses ribs in abundance, for every column, every window, every wall. The wall is fully Semperian: it is reticulated, a network of threads, not solid masonry. But when I talk about ribs, I'm talking about the articulation of variation, not the Gothic as an exercise of style.

First of all, Gothic and the neo-Gothic is everything I've described, but in stone. Things are not in stone anymore: our era is not monolithic but composite. Steel has added tension to our structures. So we need to take the methods and rigor of the Gothic to another level. But I have to admit that sometimes I go very, very far in my appreciation of the Gothic – if not to the point of becoming Ruskinian. I think I'm the only one left who likes to read Ruskin. He hated the Renaissance and idealism – just perfect. He launched Turner to everlasting fame. He calls Gothics "foliated," and on his list of the characteristics of the Gothic, he puts "savageness" at the top, and then "changefulness" – that's even more perfect. As far as I know, he drew the first algorithmic tree, the diagrammatic code of a tree, like an L-system. And a logarithmic acanthus leaf, too. And Ruskin painted the most beautiful rocks and geological formations – absolutely mindblowingly beautiful. He was a mountaineer. The stones of Venice were overtaken by the mountains of Switzerland. In *The Stones of Venice*, there's a chapter called "The Material of Ornament." I can't see anything wrong with that man.

"Lines of this kind are beautiful," he says in that chapter, referring to the lines of ornament that stem from natural curves like glaciers, worms and leaves, "because almost all these lines are expressive of action or of force of some kind, while the circle is a line of limitation or support. In leafage they mark the forces of its growth and expansion, but some among the most beautiful of them are described by bodies variously in motion, or subjected to force: as by projectiles in the air, by the particles of water in a

gentle current, [...] by clouds in various action upon the wind, et cetera."

So now we have argued for the merging of abstraction and empathy from both directions. One position is Worringer's, which states that Gothic structure is sensuous and evokes empathy. The other is Ruskin's, in which ornament is viewed as material and therefore potentially structural. It is inevitable that they meet halfway. It is also inevitable that they will be revived, because our digital tools enable that. Gaudí, Morris and Ruskin would hate me for saying it, but their sensibility is fully returning without the ideology of artisan hand labor. I am one hundred percent Digital Arts and Crafts. I understand all life as aesthetic – and configurational, and constructivist. We all long for this. We have been ripped off by modernism and postmodernism.

I used Ruskin for the design of one of the footbridges in Germany and for a project called Joe & Joey. The bridge is called the Ruskin Bridge, by the way.

Is that the round bridge?

Yes, perfectly circular. It's right in the middle of a natural resort on the Dutch-German border, and the site is so beautiful – the wind in the trees, the violent stream below the bridge, the beavers, the trout, the birds – I wanted to make a room out of the site, give it a middle, like hanging a chandelier in the middle of the ceiling. It's all about life, like the Robert Adam example I gave before. That's why it's covered with a huge mosaic made up of foliate curves that are pointed at one end and rounded at the other, to make the swirling forces more visible and sensible, like a turbulent vortex. The Gothic is never just about the pointed; it's very exact in its treatment of both the rounded and the pointed. In my view, the pointed operates on a higher level; I feel the round is sort of given. It's the basis of continuity. But the pointed is what emerges when multiple directions cannot be reconciled and this has to be solved by a double tangency. In Gothic ornament, curves can violently crash into each other and form spikes. The bridge is a huge 60-foot-wide ornament.

Imagine crossing a round bridge: you want to stay in the middle, look around at everything, talk to somebody – anything but cross over to the other side. Maybe you want to walk along the vegetal curves, looking down at the mosaic floor. All movement is concentrated in that midpoint. In "The Material of Ornament," the chapter I referred to before, Ruskin distinguishes between lines of contour and lines of force. So we have the circle – the line of limitation, according to him – surrounded by a world of forces – violently flowing water, wind in tall trees – which end up in the circle as lines of force and action. So the powers of variation are operating at the same time as the powers of limitation.

You might wonder why I'm suddenly considering a flat, mosaic ornament as a structural system, since my argument has been persistently structural. Ornament, as Ruskin says, *always* behaves materially, so there's no difference between, say, the wrought iron curves that intertwine and connect to make a structural surface and the same configuration on wallpaper. As long as it configures structurally. But what it does need to do is also relate to a second materiality, that of the built system it needs to fit into. In this case, it's the system of arabesques that creates the round configuration of the circle of the bridge itself. If there were no relationship between the figures and the bridge, it wouldn't work. So there's always a first-order and a second-order materiality, like with Frei Otto's analog machines, like with Semper's four elements. A materiality that informs materials.

Left NOX, Rendering of Joe & Joey, Rotterdam (2006–9). *Right* NOX, Rendering of the Ruskin Bridge, Herzogenrath/Kerkrade (2006–9).

And Joe & Joey is even more Gothic. It looks like a typical rose window that's jumped out of a church, with the tracery closing onto itself, forming a perfect sphere. How did you ever arrive at this?

I had two images in mind. One was Logan's Rock, which is a rock in England, what they call a rocking stone, which balances on a single point as a result of wind erosion. It was a big inspiration to Naum Gabo in the 1930s when he started to think about a kinetic structure, one that wouldn't stand but would lie about. Barbara Hepworth tried making a few, too. My thought was: Can I remove the pedestal completely and actually have a sculpture that can move, that rolls around? The second image is a watercolor by Ruskin: a huge, brown, round rock lying on the ground with green ferns growing from it. Mineral and vegetal. When I see that image, I immediately see *The Stones of Venice:* architecture as foliated rock, an architecture that has come to life.

In the case of Joe & Joey, the projection of life is a bit more direct than in the bridge. There's a huge half-ton weight suspended on the middle axis – by the way, the whole sculpture is 30 feet high, three stories of a building. It's in a large grass field right next to a highway. You can call it on the phone. When you call, you get two voices interrupting each other and asking you questions. They're quarreling, but they'll ask you to take a side, support one or the other – Joe and Joey are quite neurotic, like all couples – by entering a number, which makes the weight rotate forward or backward. Slowly, it moves, and at a certain point, it crosses a critical point and the whole ball starts to move, rolling forward or backward.

My dream is to have it roll around the world, over the valleys, over the fields, feeding on sunlight, people calling it everywhere. We'd have to follow it with GPS and map it on a website. But for now we'll just build it for northern Rotterdam.

What I always find so surprising is that you don't seem to really care if it's interactive or not.

Well, to me both the bridge and the robot-sculpture are interactive. The ornament is a machine; it processes, distributes and evokes movement. They are all structured by motion, and when they're built, it doesn't mean they stop moving. The machine keeps on running and drags as much life into its sphere as possible.

John Ruskin, Study of Gneiss Rock, Glenfinlas (courtesy Ashmolean Museum, Oxford, 1853).

Steel and Freedom

In Conversation with Arjen Mulder

AM: You did an extensive series of studio classes under the name Steel and Freedom, first when you were at the University of Kassel, then at Columbia University in New York. I was quite surprised by that. Can you explain what was behind it?

LS: Many insights converged. I was starting to understand that I was a constructivist, in the philosophical sense, that is, which means I believe all form is continuously generated, with a preference for time over space, but since it's a material generation, it must implicitly mean form is continuously constructed. Material emergence can only occur through structure. But my constructivism has been of a much broader nature. I also see action and perception in the same view, for instance, social group formation and interactions – even aesthetic pleasure for me is a constructivism, close to Gestalt and pattern recognition. It all runs parallel. I remember Scott Lash once summarizing my position after moderating a lecture of mine: "So it's not just an ontology of columns and beams but also of the plan! The plan is as constructed as the structure." And that's true: it's all movement and agency and materiality. So I started to look at the interaction between structure and life and naturally arrived at Cedric Price, Constant, Friedman, the Russian Constructivists – in reverse order – and became more and more interested in that history, trying to find my own way through it. Which is, of course, the history of the battle between steel and stone, between tectonics and stereotomy, between engineering and art. And slowly I became convinced that it was the core problem of architecture today – in terms of schools, the opposition between the Polytechnique and the Beaux-Arts.

But I'm going too fast. I should retrace my steps slowly and carefully. I should tell you about how one of my students brought in a picture of a kite made by Alexander Graham Bell.

The inventor of the telephone?


Alexander Graham Bell. *Left* Early tetrahedral kite. *Right* A later, much larger version of the same configuration called the "Cygnet" (1907).

The same. During the first decade of the 20th century, he constructed many kites constructed of tetrahedra – truly amazing structures, nothing like paper birds or dragons, but totally abstract space frames. I guess that's what they were, the first space frames. He made structure fly! Obviously a precursor of the revolutionary Constructivists, who wanted to live in the sky, far from the ground. What's more important is the material philosophy behind it: matter is no longer a solid; it's made of air, a structured void. It's a reversal from the stone, monolithic view of matter into a metallic, composite one. It looks not at the materiality of space but at the spatiality of matter. It's not too far removed from Cyril Stanley Smith's concepts of metal; he looks at metal as if it's foam – just incredible. For him – and he's a metallurgist, not a chemist – metal consists of two coexisting geometric states, one extremely regular, which is the *lattice*, and the other, less homogenous, which he calls the *aggregate*, a complex pattern of cracks that, when you zoom out, form a system not unlike cracked mud or foam. It means that steel, iron, metals in general, are of a light heaviness or a soft hardness.

That reminds me of what you've said about Semper.

Exactly. But for Semper, there is an opposition of the stereotomic and the tectonic, the first being an art of carving out from solids and the second being an art of construction, of bringing elements together. Earthwork versus wooden frame. This implies another

opposition, one of massing, structure and texture, with massing on the side of stereotomy and structure/texture being on the side of tectonics. I strongly feel that this has been the biggest problem of contemporary architecture: there are architects that only work on structure and others who only work on massing. But these three scales interact quite differently in the view of Stanley Smith, although he doesn't discuss architecture specifically but metallurgy and art. In his book *In Search of Structure*, there is an essay called "Structure, Substructure, Superstructure" – what a nice order, by the way – which I quoted from just now when referring to his distinction between the monotonous lattice and the heterogeneous imperfections and so-called dislocations of the aggregate. He says, "Structure on one level, by its imperfections and variations, always gives rise to a new kind of structure on a larger scale." So scale relations are generational: one brings forth another, but by differentiation, by transformation, what he calls "a new kind." Things don't simply add up. And it doesn't simply transform from structure to massing, either; it doesn't move from matter to mass, the term Stanley Smith uses to designate outdated views of matter as inert clay. No, it's structural – or, better, it's tectonic all the way through. Tectonics is what articulates material transformations of one structure into another over time. Or even better than that, tectonics is what articulates massing, structure and texture within a generative relationship. There is a self-crafting aspect to material structures. So it's expressly about articulation, not about smoothing out. Here we arrive at a crucial point, because I think it means tectonics doesn't comply with the structuralist view, which would be the fitting of

Left Aluminum alloy structure after heating, from Cyril Stanley Smith (1957). *Middle* Copper-silicon alloy structure. *Right* Foam structure ("soap froth").

structure within structure within structure. And I think this has been the major error of theorists occupied with tectonics and Semper. They have made it a problem of jointing. Meanwhile, for Stanley Smith, it's as much about not-fitting, cracks not as imperfections that deconstruct solid matter, as it were, but quite the opposite – it's the imperfections that make it work, that make it possible to grow in scale. As I said before, when we were discussing something similar, there exists the gradual variation of deformation, but transformations operate on jumps and cracks. In short, being a constructivist does not mean being a structuralist.

> *Let's go back a bit further. Steel started out as iron, either wrought or cast. Why has it been such a struggle for iron to become part of architectural history?*

That has been very problematic, and the beginning of that struggle, the 19th-century part of its history, is very different from the 20th-century part, which deals much more with industrialization. At the beginning, the discussions around the Gothic, tectonics and iron were very much interrelated. You can see why I'm interested now. Let's compare the major participants in that discussion: (1) Semper, who loved tectonics but hated the Gothic and iron; (2) Ruskin, who loved the Gothic but hated iron; and lastly, (3) Viollet-le-Duc, who loved both the Gothic and iron. Later architects have always accused Semper of not seeing the necessity of technological innovation, and said he should have incorporated iron in his architectural theory, especially in its larger-scale applications for load-bearing structures. For me, the problem starts with his lack of appreciation for the Gothic, which for him wasn't related to textile or knotwork at all, as it is for me – for him it was just naked bones, an architecture without *Bekleidung*. He didn't appreciate the Gothic's shift of ornament into structure. Ruskin is very different: his structural insights about the Gothic are quite wrong, his sections of vaults totally two-dimensional, but what an immense capacity for feeling! Like Worringer, he views the Gothic as an architecture of life. He says, "Imperfection is in some sort essential to all that we know of

life. It is the sign of a state of progress and change." He calls the Gothic an architecture of "changefulness." He talks about "the perpetual variety of every feature of a building," and an "active rigidity; the peculiar energy which gives tension to its movement." These are all quotes from "The Nature of Gothic," a chapter in *The Stones of Venice*. Viollet-le-Duc, in turn, is very different from Ruskin and is generally seen as a structural rationalist. On the one hand, he saved the Gothic from revivalism, i.e., sheer stylistic duplication, but on the other, he surgically removed the flying buttress and replaced it with the iron tension rod. Though he loved the Gothic and iron, he loved them for all the wrong reasons. He was like a 20th-century engineer, a structural determinist; he started to recode all the Gothic ribs – which are structurally undetermined, and that's what is so wonderful about them, their combination of indeterminacy and articulation – as members under either compression or tension, positive or negative forces. He reworked the crossvault into a space frame, almost – into a crystalline combination of brick compression and iron tension elements. With Viollet-le-Duc, architecture shifts from a monolithic state towards a hybrid, composite state. A mixture of materials, a mixture of elements. Basically, it's the true beginning of the modern joint, the joint as a technical problem; before, it was only an architectural problem. Suddenly we have this emergence of the joint and the detail, simply because components are now made in a factory before they arrive at the construction site, where they have to be assembled and jointed. Obviously, Viollet-le-Duc won the hearts and minds of the modernists, because his view of iron and the Gothic is a sanitized and industrialized one.

We should cast an eye toward Gaudí for a second, because he was the other person who led the Gothic away from revivalism; he totally renewed its structure into something that has grasped the imaginations of many theorists, especially people like Frei Otto and our contemporary Mark Burry. Instead of replacing the flying buttress with iron like Viollet-le-Duc, he internalized it with the catenary curve – one in the middle for the nave, two on the sides – which explains the bifurcating, treelike columns in the Sagrada

Familia. A catenary curve is fully comprised of stone – it's all compression. Gaudí, being a radical communitarian Catholic, hated industrialism, and therefore only allowed iron in the form of wrought iron, as artisan labor. He was a fervent reader of Ruskin and Morris. He renewed the Gothic but immediately made it impossible for architecture to absorb it because of his religious stance against industrial technology. Although his view was an innovation in tectonics, his technique was still traditionally stereotomic. Now, to proceed with this line of thought for a second longer, it must be noted that today Gaudí's major work is carved by machines, not God-fearing artisans but robotic steel machines with arms that maneuver with five degrees of freedom, which suddenly makes Gaudí's position completely contemporary. Gaudí would be saddened by it, but I have to admit, I rather enjoy that idea: a church full of tourists instead of parishioners, and made by robots instead of artisans. Gaudí disliked anything outside of Catalonia; when he was in Toulouse he already wanted to return to Barcelona, and these tourists from all over the world would have horrified him, but it is a clear sign that the aesthetic is a league above religion. That's what I believe, and that's also the reason why religion has always relied on art and architecture so much. The power of the aesthetic is much larger than anything else.

> *And what about Art Nouveau? It seems to have something of both positions, iron and brick, with wood and marble mixed in, too, as in Horta's house in Brussels.*

Art Nouveau was very much inspired by Viollet-le-Duc, but its success had to be short-lived because, as with Gaudí, its view of technology lay too much in the framework of craft – poor, underpaid artisans quenching, bending and hammering iron into fabulous ornament that ended up in the palaces of the middle class in Brussels and Paris. The riveted steel columns intertwine so beautifully with the wooden railings, and then, cut open at the top, they become complex tendrils, finding their way over the

painted whiplashes that sprawl out over the ceiling. There is an activity that runs through the materials, making them connect without jointing. It's simply incredible, but it's all executed by manual labor. Inevitably, riveted steel was replaced by the fully standardized H-beam, the extruded profile we know today. But Guimard – known for the Paris Metro entrances – took a position that was more developed than Horta's, since he opted for the more industrial cast iron rather than wrought iron. The whole Arts & Crafts movement simply had to come to an end because their artisans ended up as workers in factories. Viollet-le-Duc had to find his way into modernism, into the transformation of iron to mild steel. Art Nouveau was no longer possible within the realm of steel. Every convergence into a material, as in this case, is a tendency towards uniformity, and from there it diverges again into variation. The Goths and the Romans take over from each other all the time. The emergence of steel doesn't mean that structure is suddenly subordinated to massing, uniformity and discipline. Steel has its Roman, Miesian side as well as its Gothic side of changefulness and variety. But let's concentrate on the latter.

OK.

I think if we take a wider view for a moment, we can understand Ruskin's position on the Gothic as an aesthetic-ethical one, as he himself always stressed. For him, variety was a concept of life. It was a structure of open form, *unvollendet*, open to change, not finished and not perfect. And within that framework, I started to look at both Constant Nieuwenhuys and Cedric Price, in particular their respective projects New Babylon and the Fun Palace. How does structure involve life? They give different but similar answers to that question. Constant is in a way akin to the Russian Constructivists; in New Babylon there are many references to somebody like Naum Gabo, who was always interested in the structure of dynamics – not the other way around – but also to the so-called Russian desurbanists, who were moving away from the city towards a megaarchitecture. New Babylon jumps and crawls over the ground,

bridging it more than standing on it, in a structure that's not far from our previously mentioned cracking patterns. All angles are variable; enormous blocks break and bifurcate to create a structure of *détournements*. It's like cracked mud! It's exactly the reason why Guy Débord became so hostile to Constant. For Débord, the *dérive* was a breaking away from the city structure; for Constant, the *dérive* was a method for designing architecture. It's not a grid with addresses but a structure of wandering. And it's unfinished. The Babylonians who live there keep building; it's *under construction*; life and building are of the same order for Constant. Living is not what is contained by a structure: it is what structures. Life builds. Price goes in a similar direction but follows a different route. His Fun Palace, so strongly defended by Reyner Banham, was actually a Miesian structure, orthogonal, steel and void. A structured void. So in that sense, it is a major step forward, because in Mies' Neue Staatsgalerie, for instance, there is simple, smooth openness between floor and ceiling, while in Price's Fun Palace (ill. p. 50) the void is structured; it involves at least some constructivism, though not as much as in Constant's New Babylon. In the Fun Palace's structure, some volumes are suspended: a theater, restaurants, galleries, mostly art-related program. In the drawings, a number of cranes are connected to the structure: it's also under construction. Then you could add elements, programmatic volumes. It would grow and change over time. "Architecture should be an agent of change" was Price's motto. Now, how does it change? How does one add a volume?

Where is the freedom, exactly? Koolhaas' answer to this question would be "the void," as I've already discussed in "The Primacy of Experience" and "Africa Comes First." In his view, the void is the engine behind the whole system. But that is the void as pure and neutral availability, which is not enough: the existing configuration of programmatic elements at each specific moment in time would also be of influence. When you're building, you're both building into the void and building from an existing configuration of elements. So the question is much more how that structure relates to the void. If you look at the Fun Palace project through a

historian's eyes, you'll see a classical box with a picturesque infill, not too different from the Villa Savoye, which we discussed before – an aggregate of volumes in a lattice structure. The architectural structure takes on the role of infrastructure and of urbanism, and the furniture becomes architecture, that is, movable rooms. There's a double shift in scale. So both the structured presence of the void and the irregular contours and positioning of volumes would affect the decision to add a certain volume in a certain place. What's even more interesting is that Cedric Price worked with Gordon Pask, the English cybernetician. They were trying to work out a rule system for the generation of assembly, because growth is guided by rules. So it's like Price is on the border between two positions, one the Miesian grid, the other viewing structure as an emergent property.

> *Let's return to my first question about the student work, which I can now rephrase. What's really intriguing is that you and your students projected an image of the Fun Palace on the former site of the Palast der Republik, the old Volkspalast of the German Democratic Republic in the middle of historic Prussian Berlin.*

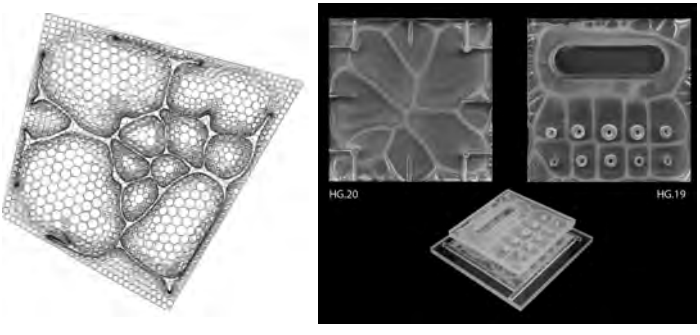
Yes, they have demolished the old Palast – completely revisionist Berlin city politics; what a terrible mistake. At that time, artists

David Fano, Gothic Palast, Advanced Studio VI "Steel and Freedom II" (Spuybroek/Tang), Columbia University, New York (2006).

had already taken over the Palast and were doing installations and exhibitions there, not too far removed from Constant and Price. But I made it a hardcore Gothic exercise. We argued that with Price, the lattice-aggregate relationship was too much of a dualism: it was like you'd have to operate within two structures, and we felt that structure needed to be involved in transformation. Then every change in action would have consequences in a change of construction and therefore would interact more precisely with following actions. I think that's what freedom is: not blind openness, or plug-and-play in a modular grid, but the structure of vagueness. Continuity, not openness. Vagueness, not neutrality. We didn't choose Gothic out of necessity, but as a systemacy of variation it does allow for a wider range of connections. We also applied this line of thought to Mies' Neue Staatsgalerie, and that ended up being very different from the Gothic exercise.

Which is also in Berlin.

Yes. We were thinking again about how to put material variation into the system of the gallery itself. What we did was have all the



Santiago Romero, Gooey Mies, Advanced Studio VI "Steel and Freedom I" (Spuybroek/Tang), Columbia University, New York (2005). *Left* Top view final design. *Right* Experiments with two parallel acrylic plates slowly separated with hot glue. Cell formation is directed by the drilling of holes in the top plate.

students work with a rigid double square made of acrylic plexiglass – corresponding to Mies' roof and floor plan – and put different kinds of liquid goo in between the two surfaces. Then we systematically started separating the surfaces vertically. We had students working with glue, Kraft American cheese, varnish, hot glue, et cetera. The results were incredible. When you put the two surfaces on top of each other with the goo in between and then slowly start to separate them, very complex structures immediately emerge, from very compartmentalized systems of cells to very thin threaded systems of columns of all sorts. With the cheese, we got laminated structures with pockets of space and floors folding. With glue, we got very delicate columnar threads, bifurcating, stranding, intertwining. With hot glue, we got these beehivelike cells, beautifully connected to the floor and roof. Very, very differentiated. All action directly resulting in structure. They all observed it very precisely, graphing and diagramming the results, categorizing the figures and configurations exactly. The idea was to generate a structure of vagueness such as I mentioned before, an open but structured system, not neutrally structured but full of potentials and variations. What was particularly important to us was the subsequent transformation from a monolithic goo state into a composite steel state. All the students had to rework that complex system into a steel structure. One of our typical "materials inhabiting materials" methodologies. Of course, what emerges is a system with a wide range of variations, from the largest to the smallest element. The elements aren't preset; they emerge from a continuity – the goo – but in the most precise expressions and configurations.

> *When I look at the students' work, it's like you can't clearly distinguish between ornate and structural anymore: ornament starts to take over the role of structure, and vice versa.*

Yes, it's what I call *delicate*. An architecture of delicacy. Architects working with structure and tectonics usually bring with them a message of strength and stability, but here, strength is a collective result, a collaboration of thin and even vulnerable interacting

members. Ornament becomes implied in structure. Again, we have to go back to Worringer's maxim of "vitalized geometry." I think we are close to the denouement of something that has been impossible to solve until now. Frampton's fantastic book on tectonics, *Studies in Tectonic Culture*, makes a very serious attempt, but in the end he cannot overcome a single problem: how to make praxis – the making of material structure – poetic? He has to add poetics to it, or direct praxis in a poetic manner. He has to put his hopes in phenomenology, which again and again runs into fatal dualisms, of body and world, body and mind, or, in this case, the mechanical and the organic. The dualities always stay in position, although they are bridged by lived experience. Phenomenology always has this irritating notion of healing, of naturalizing and humanizing. It's not sufficient to keep nursing our relationship with the world, since it's not an issue of bridging but of transforming. With the Gothic Palast and the Gooey Mies, we have something quite different: a merging of abstraction and empathy. We're not adding life to structure, like Alberti, but putting movement and life into structure itself. Frampton always refers to Eduard Sekler, who distinguishes among construction, structure and tectonics. I think it should be system, structure and tectonics. Systems are organizations in diagrammatic form, topological schemata. Systems are "living" structures, that is, structures that move and correct by themselves; there is a relationship of feedback between the components, which aren't merely inertly added together. At the end of the essay, Sekler even paraphrases Worringer, stating that structure should somehow be able to evoke empathy! Matter never stops breaking into pattern because of variation; that's exactly why the ornamental merges with the structural. That's why delicacy immediately evokes empathy: you develop strong feelings for it, as we always do when we encounter something vulnerable or young. Life is more exposed. This is why Cyril Stanley Smith so easily shifts between art and metallurgy in his essay. He speaks about paintings as if they're aluminum alloys! For him, matter is immediately expressive, if not expressionist. If we accept that there is communication

between scales via an active tectonics, then we automatically get a merging of engineering and art. We don't need an extra poesis to humanize the praxis of technology, as long as we allow matter to fully explore all the scales through variation. Everything is related to forces; everything is expression or formation caused by the interaction of forces in matter. Or, if we treat it as a system of matter, by the interaction of rules. All systems are rule-based. We just have to understand that gravitational loads, social forces and perceptual forces inhabit a continuum. I think the final difference is that Frampton's study is about the materiality of building, of *Bauen*, and that ours, following Stanley Smith but also DeLanda, is a *materiality of architecture*.

> *I'd like to explore that in a more architectural way. It seems that in architecture, these positions are generally split between those operating on the pure-engineering side of conception and the ones working on the formal side, the sculpturists.*

Well, we only need to look at Foster and Hadid, because they represent the Polytechnique and Beaux-Arts positions perfectly. Foster is at the end of a long line of steel architects, but with a slight difference. While the Russian Constructivists, Friedman, Constant, Le Ricolais, Buckminster Fuller and Price were very revolutionary, Foster put an end to all that. Norman Foster made steel right-wing – and corporate. It's a uniform, engineered industrialism that completely follows the laws of production, of engineered transparency. That's why he's become such a global architect. Uniform space frames, uniform diagrids, trusses, uniform structure all over. It's not constructivism but constructionism, a putting together, a fixing; there's no genesis, no agency. All forces are Newtonian. While with Foster the forces shape the structure, with Hadid it's the opposite: with her the forces shape the volume, the massing. It's stereotomy. Hadid is very close to streamlining: exterior vectors like wind flow over the volume, sculpting it into smoothness. Though it is not sculpting along a singular vector, as

with Erich Mendelsohn, but sculpting along multiple vectors. But meanwhile, there's tons of steel working behind the scenes. The sculpted matter is not really responsive; it's not completely dead and inert, either, but there's never a true systemacy that allows the forces to be internalized, that lets the structure internally respond and process the forces through reconfiguration, as in a system. The two realms of force these architects work in are completely different in nature – and they shouldn't be. Though one is fully materialist and the other is fully expressionist, they only get halfway to solving our problem. Blind variation is not the answer, and neither is blind uniformity. What we have to recognize is that in any such split, not just that between Hadid and Foster but that between technology and aesthetics in general, is that aesthetics tends to work on the level of either massing or texture – sculpture or ornament, respectively – and technology tends to operate on the structural level between the two. The solution, of course, is to listen carefully to Stanley Smith, and apply what he says to architecture. This would mean the forces working on the system could produce structure and texture and massing, as long as there's a systemic, tectonic flow of information between them. By the way, Frampton fully recognizes this, too; he doesn't support high-tech or sculpturism at all. He's much more in favor of architects like Renzo Piano and Jorn Utzon, who work both expressively and structurally. I understand that position, though I don't fully agree. My feeling is that with these two architects it is still the form that's constructed and not the structure that's formed, which is really constructivism, because it passes through all the scales while it's being formed.

Well, this brings us to another problem. When you refer to Gaudí working with his catenary threads and sandbags and Frei Otto with his broader view of analog computing, it's obvious that materials on one scale can be transmuted into materials on another. But the million-dollar question is whether all this is buildable. If you disconnect your method from buildability, you could obstruct direct communication

with industry. Your problem is not so much the merging of empathy and structure, it's constructability. You are on the edge …

… and sometimes over it. I know.

Why be so radical? Any utopianism here?

It's not that I'm that radical, but the tools are. It took me many, many years to get some control over the tools. In the mid-'90s we were still roaming around in cyberspace and were just discovering these tools of continuity. I became involved in structural issues very early on; you can't deny that there's structural innovation in the water pavilion, for example. But I have to admit that that was as far as we got. It took me years to "architecturalize" the tools and the discourse. I came to understand that although the tools were new, the problems were still old. You should use new tools to work on old architectural problems, not create new ones. You shouldn't build topology; *you should understand architecture topologically* – there's a huge difference. It took me years to get decent windows in my designs; we all called them perforations, or porous systems, or apertures, whatever, because were trying to think of openings as part of continuity and not as interruptions. It simply takes a lot of control, or better, craft. There is an incredible amount of skill and craft involved in digital design techniques.

That's only the first part of my answer. Next to this renegotiation of the tools into architecture, I absolutely do accept industrialism, but not Foster's kind. Industrial architecture – what I called constructionism before – is one of *products*, and the techniques are subsequently those of joining. I think we are now moving towards *half-products*, accompanied by a much wider range of techniques, especially with computer numerical control, or CNC. We're moving from an interest in building toward fabrication. This is why, for example, somebody like Jean Prouvé has become such an important example again. Though he was obsessed with steel, he wasn't obsessed with H-beams. He took steel sheets and

folded them, manipulated them into profiles, working from a half-product to a product through techniques. With Prouvé, you don't get that opposition of surface and line. He's much closer to the car industry's mergence of form and structure, as in the monocoque system, and though it's all fully integrated, it's still composite in nature.

There is a shift – a not very visible and still tentative one – from manufacture to fabrication occurring at the moment, where the former is still based on fixed products from a catalog and the manual labor needed to assemble them, and the latter is much more a late or postindustrial state, in which information technologies partially replace labor in transforming half-products into unique products needed for specific assemblies. In this view, the components aren't fixed and finalized beforehand but respond to their agency in relation to other components and adapt. It's a technological evolution in which all drawing-based technologies are being replaced, one after the other, by digital technologies – a *retooling* of the industry in which information flows directly into machinery that allows for much more variation at, eventually, a lower cost. Machines in factories are starting to be calibrated with the design technologies – laser cutting, water-jet cutting, plasma cutting, CNC milling – it's all computer-controlled machinery. But let's keep in mind that architecture is at the low end of industry. If we step back for a moment, we can see how slowly the technologies at the high end of the spectrum, like in the space and airplane industries or the car industry, even industrial product technologies, seep downward to architecture. It's no accident that these high-end technologies concern the production of vehicles, likes planes and cars, and require control over much more complex geometries that what we're used to in architecture. But it doesn't mean that architecture is going to be upgraded and that all components will suddenly be unique, and that's probably the most complex issue.

You're saying that part of the industry will stay traditionally industrial, making parts that are all the same and repetitive.

Of course, products will stay around; buildings consist of hundreds of thousands of components, and the smaller ones, from doorknobs to light fixtures to doors, will always come from catalogs. We aren't going to have buildings where all the doors are different. The question really arises at the large-scale level of components, like walls and floors, the structural system, the panelization of the façade. For sure, we are going to have buildings where all the panels – either in metal, stone or glass – are different. How careful do we have to be with integrating new technologies there? Some parts allow for much more variation than others. In general, I would say everything's possible in cutting but not yet in casting or forming. That is, any part can be cut in any shape, at any angle and to any length, but these are generally planar sheets like steel or glass or linear elements like extruded profiles. More difficult issues still lie in molding. A building normally consists of parts that are all the same, like bricks or panels. This isn't going to be replaced overnight by a fully variable range of nonstandard parts that are all unique. We have to create hybrids of standard and nonstandard, so to speak, and that also means the volumetric geometries will become aggregates of latticelike states like planes and cylinders and more complex variable geometries. So having computer-controlled techniques like CNC milling doesn't mean we can suddenly mill a whole building's counterform and cast it in concrete – that would just be replacing hand-carved stereotomy with robotic milling, which would be a return to architecture as monolithic. Rather, we have to understand these tools within an architecture of the composite, of assemblage, and that requires a deep insight into patterns of repetition that can be varied incrementally.

For certain projects, and also with students, we have looked at large façades as if they were populations and statistically analyzed all components during the design process. What always comes out is a *bell curve* of variation: a lot of average and a small number at the minimum and maximum of variability. This means that the middle area, the majority of the panels, can be solved with a mold used hundreds of times, and at the ends you're

using molds just a few times, or maybe only once. A smooth bell curve always needs to be broken up into a stepped, incremental graph of variation, with parts grouped in sets of repetition. If you only allow for one increment, you end up with a box or a cylinder. And then that new analysis has to be fed back into the original geometry. And so on and so forth.

That sounds incredibly complex.

It is, and of course the software is not on the shelves, or available to everybody, or taught at every university; a lot of this has to be scripted, and a lot has to be done by hand. I think one of the main reasons digital architecture has such difficulty integrating into building practice is because it requires such technical skills. Another reason is that at universities we still see digital architecture designed as if it can be built from some magic concrete, some reinforced ectoplasm, which again is stereotomic and monolithic. We have to recognize that it can only be steel structure, in a composite assembly, i.e., covered with panels of concrete or other materials. There is a highly technological component to digital architecture, while it is always drawn as if it's Beaux-Arts. It is so important to realize we have roots on both sides, at the Polytechnique and at the Beaux-Arts schools, and that our only way forward is to merge both into a fully new position.

Somehow, freedom is starting to play a role at every level, but also the notion of discipline. I read an interview in where you said something similar: "We will see a merging of Art Nouveau and Bauhaus, where empathy has been liberated from manual labor and machines have been liberated from uniform repetition," implying a move toward variation for the masses.

Yes, I have my ideological moments – it's inevitable, though. I was suggesting that it's possible now to machine curvature, to liberate ornament from the realm of hand labor to that of computer-

controlled machinery. But that is not my main argument. First comes the machining of variation, and secondly, one can argue – as I have – that curvature is the chief expression of variation. Variation comes before curvature. The replacement of manual labor, like that in Art Nouveau, by robotic machinery takes place on a smaller scale first, such as in industrial products or tiles and paneling in architecture – which is the third scale of architecture, after massing and structure. My second argument is the necessity of scaling ornament up into structure, from the third level to the second. Obviously, the digital tools will need to become productive on that scale, too. To me, a return to decoration without involving structure is no option.

> *In the last conversation we had ("The Aesthetics of Variation") you were proclaiming the rise of the Digital Arts and Crafts movement.*

It sounds somewhat ironic, or maybe even cynical, because "digital" seems so opposed to "craft," but it is not. I totally believe in a Digital Arts and Crafts movement. I think we live in a lousy aesthetics nowadays, pure semiotics, and we need to restore our relationship with the object. It needs to become one of feeling again. The digital realm enables and enforces that. At the start, in the early 1990s, it was constantly proclaimed as a step towards immateriality – what a mistake. It is the exact reverse: the digital will recapture our relationship with matter. I think it is absolutely vital to our culture that we move away from standardization and devote ourselves to pure variation and contingency, but this also implies a change in culture. A return to craft and decoration means more than just the customization of mass products and industrialization. Architectural ideology in postwar western society meant a move toward criticality or utopianism, which have proved to be false idols, because the production of objects just incorporates them as *visual culture*, as icons. Criticality turned out to be nothing but wallpaper, images and semiotics. If we need an ideology, we need an *ideology of the object*. This would consist of

how an object is made, how it is designed and bought, how it is priced, desired and sensed. All our morality is there: in an ethics of aesthetics, that is, in design. That is not "ethical design," i.e., designing according to ethical rules; it is an aesthetics of elaboration, care and articulation. I believe in finesse, in delicacy, in craftedness – in *an engagement of making*. But this doesn't mean we have to be in an artisan's workshop to design, or that we have to advocate a return to manual labor – I'm talking about crafted elaboration in design itself, such as we find in Celtic knotwork, Gothic tracery, the tendrils of Art Nouveau, because it adopts the self-crafting of matter as a design methodology. So, a shift from handicraft to craft in design. Or to be clearer, a shift from handicraft to digital design skills. So it's more of a Digital Crafts and Arts movement. That is what free matter means. Let us finally liberate the object. Obviously, at the beginning of the 20th century, our culture had to move away from this, not because it didn't appreciate these aesthetic qualities but because manual labor and class struggle went along with them, so we had to move to standardization and mass production. But now, at the start of the 21st century, with digital fabrication techniques – and I'll stress this again – this is *only* possible because industrialization is moving from preformed products to free matter. Everybody's been liberated – except the object. And so designers will have to work with matter more and more. It's the designers who've been alienated, not the workers. We always thought we needed to heal our relationship with labor, but it was our relationship with matter. And that absolutely means we have to be fully industrially engaged and take part in the process of fabrication.

It's not the old Arts and Crafts, but it's certainly a direct descendant.

Acknowledgments

This book is something of a hybrid, as architect's books often are – both a chronological and a formal hybrid. One could also say it is "almost" a book, in the sense that although it's a collection of essays and conversations, which implies a certain looseness, the themes are assembled around a very specific set of related problems in architecture – experience, tectonics and technology. The selected texts begin in an early period and lead up to the present. Most of the essays, and even most of the dialogues, have been thoroughly revised, more than doubled in size through the addition of new text. I have first removed sections that proved to stand up less well over time from each individual text and then sharpened its reasoning by narrowing it down to a single theme. A collection can show overlaps in its arguments; I have left these in only when they mark the development of an idea over a period of time, not to restate the same idea. I have revised the essays and conversations to make them fit better in a book structured by chapters. In that sense, the book has lost the character of a typical collection, which in general I find a weak concept unless the author is of special interest or the time span between the essays is very short. One can observe a clear interest in body and technology in the first three chapters; this then moves more toward experience and feeling in the following three. The argument slowly progresses towards a materiality and tectonics of architecture itself until, in the final conversations, all the topics become more and more interwoven within a historical context.

Architects – even those who teach and lecture, as I do – generally write essays on the occasion of a design or a building being published. Either a work is exhibited and one is asked to write an essay for the catalog or a building is published and a magazine wants to conduct an interview. Even when a text is for a publication with a longer life, its interest lies partly in one design or another. Thus, more than half of these texts contain some discussion of designs of mine (though none revolve around them), raising a specific problem: can one set up and conclude an argument with an architectural statement? In short, no, because a theory is never proven or legitimized in an architectural design, only tested or extended. I never believed one could read Canetti's *Crowds and*

Power and then start designing a football stadium. What I believe is that theory needs to be instrumentalized in diagram, in machining or scripting, or in any other systemacy, as long as it becomes an issue of method and technique and not one of theory or language. As far as I'm concerned, all true invention takes place in the realm of methodology: whatever the theory, the real question is what it can do for architecture in the broadest sense. Thus, every conversation here contains an extensive discussion of techniques. Half of this book consists of conversations, but I have selected only those that have a strongly theoretical outlook and truly elaborate on themes and ideas. Most of these conversations started face-to-face but concluded in email. This way of working allows one to develop a thought much more precisely, look up quotes, correct and rewrite, insert a question or two, or pursue a line of thought as I would in an essay, but in slightly less dense form. Such conversations often make for a highly readable blend of interview and essay.

I would like to thank everyone at the various universities where I have taught, reviewed or lectured for our many intense exchanges. I especially want to thank Joke Brouwer, Laura Martz and Arjen Mulder for their support, feedback and editing.

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Most of the essays and conversations in this book have been published previously in various other books and magazines, though all have been altered, some heavily, for this edition. Some have appeared under different titles, and a few titles have been used for other texts.

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"That buildings are made of elements doesn't mean that architecture should be based on elementarism; on the contrary, we should strive for an architecture of continuity that fuses tectonics with textile, abstraction with empathy, and matter with expressivity." This is the crux of the argument Lars Spuybroek makes in this book, the first fully theoretical account of his innovative work. The state of contemporary architecture is the product of a 150-year battle between the Polytechnique and Beaux-Arts schools of design, which has forced us into a stalemate between the radically opposed positions of high-tech and sculpturism. Spuybroek aims to do no less than mend this rift through rethinking technology as an extension of our feeling senses, materiality as the realm of activity and agency, and structure as the result of genesis.

Building on Gottfried Semper's materialist theory of architecture, he takes us from a philosophy of technology to a surprisingly historical argumentation that constantly revives the words of John Ruskin, William Hogarth and Wilhelm Worringer. Alongside a number of essays, the book contains extensive conversations in which we witness him refining and sharpening his arguments ("We will see a merging of Art Nouveau and Bauhaus, where empathy has been liberated from manual labor and machines have been liberated from uniform repetition"). In a period of theoretical tranquility in architecture, this book takes a refreshing turn back to the basics, one in which tools, methodology and architectural aesthetics are recalibrated.

Lars Spuybroek is Professor and Thomas W. Ventulett III Distinguished Chair in Architectural Design at the Georgia Institute of Technology in Atlanta. He is also the principal of NOX, an architecture and art studio in Rotterdam, the Netherlands. His previous books are *The Weight of the Image* (NAi Publishers, 2000) and *NOX: Machining Architecture* (Thames & Hudson, 2004).

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