Summary

InFormation
Folding in Architecture
Joachim Krausse in conversation with
Nikolaus Kuhnert and Angelika Schnell
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ARCH+: Architectural Design's special issue on 'Folding in Architecture' provoked a strong interest in the fold among architects. For the last three years, magazines, symposiums and students have been inundated with architecture that is literally 'folded'. This is unsettling, because at first glance, it appears to be based on a trend instigated primarily by American architects who, having few if any opportunities to build, are not necessarily concerned with the social, ethical or political aspects of the profession. This common European prejudice against the North American 'show(wo)men' should not, however, obstruct one's view of the fact that the idea of folding has not been taken up without reason. The debate is based largely on Gilles Deleuze's book 'The Fold. Leibniz and the Baroque.' The concept which Deleuze develops does not present folding as a mere formal construct. Even independent of Deleuze, folding seems to be more a spatial problem than a formal one, since it implies a breakdown of interior and exterior. The interior is presented as exterior, and vice versa.

Joachim Krausse: The real question is: What relevance does the idea of the fold have in architecture? It provides a model for theories of metamorphosis and 'Bekleidung' (Gottfried Semper). Folds are maneuverable borders which separate an interior from the exterior, yet also create an interior within the exterior and an exterior within the interior. Considered abstractly, it is only the type of bend - concave or convex - that determines inside and outside, meaning the gender of the space. In this unfixed state, the fold provides a model for metamorphosis. Transformation - even temporary transformation - requires veils or costumes. For example, the plastic covering used for practical reasons on buildings that are being restored or renovated has a strong aesthetic appeal which finished buildings lack. This stems from the culturally deep-rooted motif of metamorphosis which is unconsciously signaled by the folds of clothing. The extraordinary effect of Christo's Reichstag wrapping derives from this: at the right moment, he gave the aesthetic signal of a transformation actually taking place.

The fold refers to the theory of architecture as a third skin - after the first skin (immediate) and the second skin (clothing)?

In contrast to the fold in clothing, the idea of the fold in architecture is concerned not only with the fall of the fold, but rather it points towards the possibility of spatial formation and transformation of (curved) surface areas through movement. These movements are a kind of energy supply, an input which results in distortion. The distortion has set stages and the stages, set properties. The first distortion, due to energy supply, is a kind of wave form. The second distortion, the result of an even higher energy supply is the crease, an interesting transitional stage. The third is a break. Conceived as repeated sequences of foldings, the fold as a border takes on the character of an interim or transitional zone - a zone of overlapping and condensed information. This information defines itself as a way or process of directional changes. Once unfolded, this infomation is preserved only if the folds are marked by creases. Those creases turn the changing continuum into a structure with discrete elements. This change from continuous to discontinuous is the most interesting moment - it is described above as the second distortion, the crease. It is here that something essential becomes clear: the metamorphic potential of the fold. Because the fold is more than sheer surface, it creates space and provides information. There are two things to consider at this point: the external influence (energy supply), and the behavior of a system (dress, paper, tent, umbrella etc.) which will distort in a set way. For example, an umbrella has two states: closed, whereby the fabric is densly folded and made up of discrete parts, and open, whereby the fabric is unfolded and appears as a continuum. However, even when the umbrella is open, the discrete parts are discernable in the form of the frame, since the frame marks (informs) the fabric with the exact spacing of the creases. In other words, the character of the fold is that it protects this infomation. Unfolding means that the continuum is established again, yet the information is still preserved. The same is also true of a creased piece of paper: the energy supply and specific distances result in a certain static behavior, meaning, the piece of paper is informed - it is stable. Because something undifferentiated is transformed into something differentiated, a folding truss is always the carrier and container of information. Furthermore, foldings in these stage are always straight, finite and discrete. A jump in the continuum, which makes it possible to bring something from a small scale into a larger one, without changing the character of the information. Once in the third stage it is no longer possible to restore the continuum.

The transformations of the fold undermine the classical oppositions - figure/ground, inside/outside etc. - which still dominate architecture. These transformations produce ambiguous ways of reading, because they point towards the image of metamorphosis and at the same time metamorphose themselves. They produce zones of superimposition. This would mean that the idea of folding is much more universal and does not necessarily imply literal folding. The facades of Herzog & de Meuron have such zones of superimposition and cannot be described as sharply demarcated borders. Light modulation and jumps in scale produce different zones of perception which partly begin even before the building. They are information, and have an abstract as well as a sensual quality.

If the conventional separation of information from information carrier - represented through classical oppositions - is abolished or relativized, for instance with the fold, then a transitional zone emerges which can be described as a dissociated field between visual information and information of other kinds, for instance tactile information. That often depends on the question of light-absorption or reflection. If you touch a wall, you know where the border is. But this is not necessarily true with visual perception. Often patterns create an effect whereby they seem to lie on another plane. That is especially true of translucent materials. Multiple zones of visual perception emerge. When interestingly handled, these zones produce a kind of informational depth and the possibility of activating the surface beyond the given form.

There are also examples of formal disjunction - often with baroque facades. For example, in the Altstädter Ring in Prague there once stood a huge medieval city hall which was damaged during the war and later removed. Today the space is empty. In the 18th century, a church was built about 10 meters away from the city hall, facing one of its sides (St. Niklas, Kilian Ignaz Dietzenhofer). A very small alley divided the main view of the church and side view of the city hall. Originally, one could see the facade of the church frontally from a maximal distance of 10 meters or at an angle. Today the facade can be seen from the entire space where the city hall once stood. This creates an interesting effect. From a distance, almost the entire length of the space, the facade appears relatively boring and flat. A box-shaped, white plastered building with relief-like columns in front of the facade and black stone sculptures. But coming closer to the facade, it begins to vibrate, becomes dynamic. The white columns and the black figures contract into complex configurations, because suddenly only fragments, sections or 'assemblages' of actually separate parts are perceptible. Standing directly in front of it, the facade is no longer recognizable as a compositional whole. In this case, the different zones of information are formed in front of the building.

The anamorphic experience of mannerism was realized architecturally for the first time in the Baroque. The rigidity of perspective is dissolved through movement. Displacements away from the axis of view began because of the realization that a facade or image could be seen from relatively close up or at a sharp angle. In other words, it became apparent that axial and frontal view was not the only one possible and that other perspectives and qualities had to be considered. Of course, these first movement phenomena were realized within the perspectival world view. It has therefore been known for a long time that facades could create zones, namely dense zones of information, through the use of relief-like and sculptural elements. Facades can be seen as pictorial or sculptural. Furthermore, structural transformations or inversions are decisive when it comes to ambiguities. A glove is turned inside out, but the elements remain the same: topologically, it is a unit. The arcades in Bologna, for example, were developed through inversion. They developed out of the crossing and bending passages of the many cloisters there. These interior atriums were inverted outward, producing the arcade system that distinguishes Bologna today. This inverted folding process from inside to outside and its systemization into an urban communication

network took about 600 years to develop. The process was aided by an extraordinary combination of textual reading (Glossatoren) and public discourse (Scholaren), for which the arcades, as zones of condensed information, form the ideal urban hyper-text.

The same principle of inversion was applied by Rogers and Piano to the Centre Pompidou: the piazza in front of the building is simultaneously the city and the foyer of the museum. But examples like these do not help explain why this theme is so important today. How and why do designers use the concept of the fold? In addition to Deleuze, there is another influential book by Erwin Schrödinger, 'What is Life?', in which questions about ordering patterns in the realm of physics and biology are raised.

The book is very important, because in it Schrödinger, a physicist, suggests to biologists that life be identified as a molecular structure which is on the one hand an information carrier and on the other hand information with the character of a code - a genetic code. There is something incredibly sobering about this proposal. Until then, life was understood as something metaphysical - Bergson's élan vital. Suddenly, life was simply a molecule. Naturally, there was no thought of a DNA code as molecular structure at that time, but the search for it was a result of Schrödinger's proposal. If the physical structure of the molecule is itself information, but also the information carrier, then information is the way in which it is folded. A folding truss is itself information and not only the information carrier. A deep insecurity emerges from this, because occidental thought has traditionally and very successfully separated the two through transmission and abstraction of information. The origin of information as order has remained mysterious.

So, it is not the formal representation of the fold which produces something new. The process of folding is the generating principle?

Folding

The entire debate surrounding the genetic code, the relationship between information and information carrier (or text and hypertext) is based on folding. On the one hand, folding refers directly to space, the division between interior and exterior and the question of borders or surface. In this sense it has a lot to do with architecture or the built environment of the city. But on the other hand, folding is a more universal, theoretical idea that refers to the tension between information and information carrier, or between text and hypertext. It has to do with the topic of spatio-temporal structures, which relates to more fundamental questions which architecture cannot handle.

Unfolding is a wonderful word, because it emphasizes the process. Folding is not about the object, but rather about a process with specific laws. These laws are stored somewhere as information, coded. What kind of coding? It does not exist as a numbered or binary code from the start. That is only our method of identification. The code can exist in an entirely different way, as an immediate structure; for example, in the form of fibers and rods, or in the form of foldings or systems of branches, or as circulation systems.

The circulation system of a city, for example?

Or of a house. Movement and its patterns play a central role in every architectural example, including those we have discussed here, because movement emphasizes life and process. The arcades in Bologna are the direct architectural expression of a zone of walking and discourse, and the anamorphic effects of a baroque facade are only perceptible through movement. There are a few examples from this century, most of which come from architects who were in some way aware of the research being done in the natural sciences. Hans Scharoun, for instance, has often been discredited as a formal organicist. I believe that Scharoun's work is about the development of a genetic principle. He attempted to cultivate something from the seed of an idea. With his wedge-shaped forms, open or folded like fans, he demonstrated the growth process of a building. It is disappointing that the fascination that his interior spaces hold do not carry over to their exteriors. At that time there was no genetic principle for urban development.

Another similar approach is 'the house as path.' It was developed by Josef Frank, for whom it was much more a concept of rest than of excited movement. In order to achieve that, though, he had to develop a comprehensive concept of movement, a genetic model of movement spaces. This is only now beginning to make real sense. Frank is far removed from some kind of dynamic fiddling or a mimetic attempt to represent speed. He articulated a non-formal understanding of modernity for the first time. It is definitely not a coincidence that Frank belonged to the circle around Ernst Mach and that his brother was a famous physicist.

The circulation system as a key to seeing space is a rare exception in architecture. Such considerations are taken up in other fields, for example, dance: Rudolf von Laban developed a notation system for movement and with it, new spatial configurations.

Basically, such considerations have always remained isolated. They were never applied to complex structures. What is most interesting in designs are the passages between different patterns of movement. This leads us back to the theme of transitional zones, which we have already sited as characteristic of the fold. Transitional zones not only allow for connections, they also form a transition or a layering of mutually exclusive patterns. In music, the patterns can simply interpenetrate, but this is not so in architecture or urban planning. For different movement patterns, there must be zones to contain crossing or parallel structures. Passages can provide these transformations of mutually exclusive transitions. For instance, the small passage-way between Savignyplatz (in Berlin) and the Savignyplatz train station was never planned. It came about, because a connection was needed between the existing street system of blocks and the pattern of the elevated train tracks, which, in accordance to the train's own logic, wind in snaking bends through the blocks. Another example is the Paris boulevards. In this case, however, it is not about a formal difference, but rather the difference in flow speed between the boulevards and the streets, walk-ways and passage-ways.

Or transitions could be very short, more like cuts, which are laid down violently through the city, and connect things in the most condensed spaces. Instead of long transitions, there is the shortest possible transition from one pattern to another. This comes close to film editing: the tension which exists between two images. The 'third' image is actually seen, the imaginary picture that only the mind perceives. Neither the picture that has just disappeared nor the one that immediately follows is viewed. In 'Berlin - Die Symphonie der Großstadt' Ruttmann filmed the exact train ride, which went through a building. In this case he did not need to make any cuts, since the cut emerged through the filming. Such places were always sought out by film-makers because, in them, film corresponds to urbanism.

We have said that the genetic code of the city is a circulation system and that the genetic code contains infomation. Therefore, information is not something immaterial printed onto a surface or medium, but rather structure. This structure is literally defined through folding.

The Genetic Code

The metaphorical disappears to the extent that it is possible to describe a genesis itself. Urban development is a process that can be described, more or less unmetaphorically, with the idea of unfolding - including all of the 'non-organic' breaks. That would be a historical point of view. In urban planning, the pathways or movements of people or the vehicles which themselves engender space can be used as genetic elements (as the living) of unfolding. When a city is covered in snow, the actual patterns of movement are immediately visible. There are many patterns of movement which can as a rule overlap, strengthen each other in parallel, or compete. In such cases, their compatibility or incompatibility is directly exposed. The genetic code, the circulation system, of a city is not interchangeable. That, and only that, differentiates one city from another. Despite that, though, it does not determine the form, but rather only one set of rules, one principle, which in turn informs the parts of the whole. In organisms, this principle is the genetic code. The molecular structure contains the entire large scale in miniature. That means architects and urban planners can learn from nature without becoming formal organicists. The sequences which are formed through the circulation system are a structure which must ensure that the parts join with the whole - that is the task of information.

Schrödinger calls that the production of order from order. That does not discount the fact that one works with coincidences and introduces stochastic patterns, as in music. But the code itself cannot be ignored. To generate variants within a design and at the same time maintain unity, it is possible to work with game rules, as Kees Christiaanse did with his project for an office and residential block in Rotterdam. The individual

solution is not determined, but can take on very different forms. The set of rules ensures that the various forms are identifiable. The rules are neither universal nor arbitrary. They must be suited to the specific place.

We present two projects in this issue by the Dutch office MVRDV. These refer to, or are defined by codes in a certain way. A new department store in Rotterdam is understood simply as a band-like extension of a market, onto which the plan and functions are inscribed. This 'program folding' is organized with ramps, inclined surfaces and large stairways.

Ramps and loops were first used at the turn of the century in factory buildings by the Taylorists. Frank Gilbreth produced photographs and film images in which the exact flow of materials or sequence of work steps were documented. This is, of course, very technocratic and mechanistic. It would not be done the same way today. But basically, this kind of spatial continuum is very agreeable, because walking is discontinuous and only approaches the ideal of the continuum. Curves, ramps bring relief to this. Such concepts have a direct relationship to the space in which the user moves, which forms something like a sequence or structure that is identifiable as a code. And that is not only true of individual buildings, but also of the city. Although in the city there is also the element of physical self-organization, or the production of order from disorder.

Does that mean that the development of a city can not be solely described as a self-organizing process?

It is Schrödinger who differentiates between 'order from disorder' as a description of processes which operate according to the laws of physics, and 'order from order' as a description of organisms unfolding. As a physicist and quantum theorist, he questions to what extent the rules of physics are valid, because certain questions couldn't be solved by theoretical physics, for example, the contradiction between Einstein and quantum physics. Einstein, as a representative of the theory of relativity, stands for a set of terms which rely on determinism, while the quantum theorists arrive at a recognition of uncertainty. In the 30's, there were two fundamentally different formulations in physics: the first, the Theory of Relativity which was based on a continuum, namely, the space-time continuum, and the second, quantum physics, which was without a continuum, and assumed only discontinuous jumps. Schrödinger, with the knowledge of uncertainty, was interested in problems of biology, because the molecular biologists wanted to apply certain aspects of quantum theory (Delbrück) to chemistry and biology. What is treated in 'What is Life?' is a supposition or a hypothesis which was later proven by Watson, Crick and Wilkins. Schrödinger asked himself what the genetic principle actually was. What are genes? He developed the hypothesis that genes are molecules, based on the idea that they act simultaneously as information and as carriers of information. Schrödinger, through these questions from biology, was able to explain the limits of the laws of physics and arrived at the two principles just named. According to the genetic principle, orders relate to already existent orders which are carried from one cell to the next through cell division. These cells also retain the information from one generation of cell organization before it. Generative principle means the transfer of information between generations.

Also interesting are the orders which arise from disorder, which develop spontaneously out of self-organization, currents, rivers, etc. (Incidentally, Einstein wrote an essay about the meandering of rivers.) For instance, odd phenomena arise when a cup of tea is stirred. Centrifugal force ought to make the particles (tea leaves) swirl outward, but actually they remain in the center. This is because of the physical laws of current behavior. Simultaneously with the centrifugal forces, there are effects, which occur at 90 degrees from the direction of movement, precession forces, which make for a circulation or a crosswise rotation in the cup, so that the particles collect in the middle. These spiral-like movements bring the material into a certain form, out of disorder.

The computer simulation of an anthill which assumes two or three local rules distributed on self-organized principles in space does not realistically describe the behavior of ants or the development of a city?

City planning based on self-organization is limited. And as for the example with ants, I am also unsure, because it is such a complex system. It can be described as a self-organizing process, but do these ants move like molecules or according to their genetic code, which dictates certain movements? Here, a principle based on the organization of life is relevant. This is also true of people's motion patterns. For example, the fact that walking produces a discontinuous line, a wave pattern, because of the alternation between the right and left leg, is physical, i.e. mechanical. But the totality of walking cannot be reduced to the laws of physics. Other elements play a role, either behavior patterns which are either found in the genetic code or culturally determined. These create patterns of orientation or perception which are very complex and cannot be seen as immediate bridges between sequences of motion and pattern for motion, because cognitive processes are also involved. This is why, the question of urban planning cannot be reduced to a process of natural development, like the structure of an ant hill. The passage from one pattern, the physical, to another, for example, the cognitive, is much more interesting.

Architects are not always overwhelmingly interested in the natural sciences. When they are, then physics may be the most compelling science, since it relates to statics and construction. Schrödinger's thesis of the genetic code as structure could have had a strong influence on the architecture of this century, especially when given the structuralist debates of the 60's.

That has more to do with the traditions of the two natural sciences before the development of genetics. Previously, orientations in physics or biology could only be based on formal copies of natural phenomena. Schrödinger closed the chasm between biology and physics. Nobody had ever answered the question 'what is life?' that way - that central information is simultaneously structure. The discourse between architects and natural scientists began very late, if at all. Watson's popular book about the discovery of DNA, 'The Double Helix' was, as far as I know, first published in 1968. The examination of structuralism in the humanities as well during the 60's was such that structural and evolutionary concepts were unreconcilable. It was based on the reproduction of fixed structures.

You mean, for example, Chomsky and his generative grammar, whereby all structures develop out of a so-called, deep structure?

In linguistics and cybernetics, there is an understanding of development which is based on open circular structures. They attempt to compare technical structures with living structures. Therefore there was also a dramatic development in the 60's. In architecture, structures emerge as storage systems of rows and stacks. Growth is conceived as additive multiplication. As far as I know, Buckminster Fuller was the first to understand the debate in molecular biology, through his contact with Aaron Klug. Klug was a virologist at the Cavendish-Laboratories in England and a student of Crick, a neurophysiologist. Crick worked with Watson, who brought the Delbrück-school to England. Fuller helped Aaron Klug to identify protein shells of viruses in the late 50's.

But Fuller's domes could also be mechanically, and therefore endlessly, reproduced.

Tensegrity Structures

Fuller was an exception because he followed the logic of geometric transformation and experimented with it. Rudolf von Laban did the same. His kinespheres, space as movement, have very definite geometries and transformations between geometric figures, and they are often identical to the geometries which Fuller developed. Both were interested in the transformation of (geometric) figures and the rules of these transformations. Perhaps the term transformation is not entirely correct, because in mathematics, for example, coordinate transformations are always tied to a definite principle. Something much different is meant here. In common terms, transformation, for Laban and Fuller, means that something moves from one condition to another, becomes qualitatively different one; so it is more a metamorphosis. How does an octahedron turn into tetrahedron? That was their question, though one was interested in movement and the other in structural geometry. When an octahedron is turned into a tetrahedron, an inversion of outside space to inside space occurs. This is modeled - in contrast to classical engineering - when the junctions are made flexible. Movement between the rods is necessary in order to model this metamorphosis. These are folding trusses. Along with having structural characteristics like strength and load-bearing capacity, they are information. Fuller, for example, said of the tensegrity structures that they can only be explained on the grounds of hydraulic or thermodynamic principles. 'They will become what they want' is Fuller's characterization of the tensegrity structures. These

structures behave analogously to air or gas molecules in a balloon, which arrange themselves freely until they reach the state they want. At that point, they become fixed and form a tensegrity structure. Based on a thermodynamic state, in which the rods are defined like gas molecules he modeled the tensegrity structures, which are as elastic as a ball.

You said that the tensegrity structure is information. That means it has movable points, junctions...

Rods and fibers. The rods are like freely distributed gas molecules, without any connection to each other except the fibers. The fibers hold everything together and integrate the structure.

And allow for various unfoldings...

It could be defined as an unfolding of a thermodynamic state..

...that is the potential of the fibers or the junctions...

They form a set configuration, which has informational value. The structure informs the parts of where they must lie. Such a thing cannot be considered as static structure anymore, because it is about a thermodynamic structure which is an information structure.

The folding of a thermodynamic state would be entropy, meaning chaos?

The tensegrity structures demonstrate the change from entropy to anti-entropy. The rods which actually float freely in space, are evenly mixed and distributed in space, like gas molecules, for example. This state is called entropy. Entropy is the condition of not-information. In his examination of genetic codes Schrödinger spoke of negative entropy. He meant an ordering principle that is information. The tensegrity structures represent a highly ordered condition, which emerges from the highest possible state of disorder, namely the thermodynamic distribution of particles. It is defined as an information model, a tension structure, that leads to a two-fold structure of tension and pressure, which, according to Schrödinger would be the chromosome's structure. Perhaps the balloon is a good example, since a tensegrity ball bounces like a soccer ball or a balloon. These characteristics make it comparable to the fabric of a hot air balloon which, as can be observed under the microscope, have exactly the same geometric net structure as Fuller's geodetic dome or as the tensegrity structure. The membrane of a hot air balloon encloses the chaotic movement of gas molecules. Their movement ensures that the balloon's surface remains taut, as if there were pressure elements within it. But the pressure elements are actually the moving molecules of the chaotic gases, or the entropic state. Information arises where this entropic state is restrained, at the membrane of the balloon. It is exactly the same with chromosomes, which are found on the surface of the nucleus. At this place in the tensegrity structure, the change from entropy to anti-entropy occurs. This anti-entropy is an ordered state, but it is based on the movement that the entropic parts generate.

Tensegrity structures are also interesting, because they make it possible to model biological cells, particularly the behavior of cells and their membranes. Even more interesting, though, is that Schrödinger described the genetic code of chromosomes as rods and fibers. I believe Fuller knew absolutely nothing of this.

Information is not a nucleus which has effects on the surface, or membrane, rather, the membrane itself is the site of information. It is simultaneously the cause and consequence of information. Despite that, the cross-over from physics to biology remains unclear. The model appears to be based entirely on physics. How does biology, namely the genetic code, come into play?

The cross-over between physics and biology lies in the fact that the genetic code is a structure, or so to speak, an architecture. Whether that is defined as biology or physics depends on your point of view. Schrödinger explicitly said that the principle of order from order can be explained according to the quantum theory. (Physicists and biologists still search for physical explanations for life - and Schrödinger's suggestion was the start of this.) Tensegrity structures are based on structural considerations, but, tellingly, one can use them to model the membrane of a cell. Fuller lived at the beginning of the shift in the natural sciences. It was discovered that the workings of nature could not be described, at least not sufficiently, with conventional mechanical rules or geometries. Physics had long been incapable of defining life, meaning the irreversible evolutionary processes in their universal categories, while biology could describe the processes, but was not able to devise a set of laws. This contradiction was reconciled for the first time with Schrödinger's proposal. Fuller probably had no direct idea of this. However he had always been deeply mistrustful of the habitual rationalism of Euclidean axioms and Cartesian co-ordinate systems, because they were only able to grasp physical objects (in a container-space) but not space-time event patterns. He sought an energy-synergy geometry, which could be given physical meaning. The tensegrity structures demonstrate Fuller's structural thought process. He was not searching for object-based solutions, but rather the laws of the unfolding of a pattern. His main critic of conventional structural analysis was that it retained the conception of continual compression, even though nature made no use of it. This brought him to a complementary structure whereby, the pressure members have local and dicontinuous effects and the tension members have trans-local and continuous. The tension members, like cables, fibers, nets, etc., establish integrity. This is where the term 'tension-integrity' comes from, which was eventually shortened to tensegrity. The pressure rods of a tensegrity structure do not touch. In his patent application, Fuller explained that nothing in the universe touches. In summary, the complimentarity of the pressure and tension members tells the individual parts to unfold via their structural geometry.

Translated from the German: Elizabeth Felicella

The Art and Science of Folding Structures
Chuck Hoberman
p. 19

Our thinking and feeling in all their ramifications are fraught with the concept of movement.... The urge to explore movement - that is the changing in all its forms - determines the channels through which flow our scientific thought and ultimately our emotional expression.
Siegfried Giedeon:
Mechanization Takes Command

Watching the endlessly changing shapes of clouds on a clear day, the curling flow of a turbulent fluid, a time-lapse film of a growing plant, we sea forms metamorphosing into new forms. These transformations in size and shape reveal subtile and ordered natural processes.

Characteristically, such transformations occur continuously and are not broken into discrete steps, they are fully three-dimensional; and they move between completely different sizes and shapes. These qualities are factors I consider in the design of objects and structures that may be transformed in a manner akin to natural processes - a transformation that is complete, fully three-dimensional, fluid and continuous.

Fabricated objects that transform are familiar to us. Folding furniture, convertible cars, tents, and umbrellas can be changed in size and shape. Yet, examining these items, we see that their transformation is either limited (that is, not fully three-dimensional, not complete) or occurs in a step-by-step incremental fashion.

Hybrid Structure/Mechanisms

The type of transforming object I design has a dual nature: it is a mechanism because it moves; it is a structure because it spans distances, is self-supporting and creates usable space. In short, it is a hybrid structure/mechanism (also referred to as a folding structure).

For our purposes, we may define a mechanism as something that moves only one way. External forces may contribute to (or inhibit) this characteristic movement; but, essentially, only one motion is possible. Here a basic distinction may be made between the mechanism and natural phenomena. The mechanism, in essence does only one thing (repeatedly, reversibly, and controllably). In nature, transformation is dependent on endlessly varying conditions; it never repeats.

Classically, a mechanism is a device to produce a desired motion. Machines are built up of interconnected mechanisms, their various movements combining to accomplish some task (to move material, fabricate a part, assemble a product). Yet, the task and goal of the new structure/mechanism is not only a motion, but a self-transformation, a complete metamorphosis of form. In developing such structures new design principles are revealed and developed.

Among the principles that underlie all my work is the proposition that mechanism and structure are one: the links of the mechanism (transferring motion) are identical with the structural elements (providing support and shelter). Thus, having dispensed with any kind of complex, external device to control a passive structure, I search for special new types of mechanisms that can respond to specific needs and transform through the application of a simple force or pressure. The resulting designs may be classified into two basic transformational types: folding truss/linkage structures and folding-surface structures.

Design of Structure/Mechanisms

Among the design requirements of objects that transform completely, three-dimensionally, and continuously is the need for them to be made up of many pieces. Each individual piece of the structure is integral (unchanging); therefore, a complete change in size or shape will only occur if there is a rich and complex alteration of spatial relationships among all the integral pieces. To provide truly elegant and useful solutions, underlying design economies must manage this complexity, one such economy being the structural and mechanical unity referred to above.

Another quality key to structural metamorphosis is continuous fluidity. When an external force is applied to a transforming structure, the structure should not respond in a floppy and uncontrolled manner, nor with a kind of Rube Goldberg, complex sequence of events. Rather, it should respond in a smooth and controlled fashion. These particular qualities of motion are, in fact, dependent structural qualities, like stability and integrity. What is required is that structural stability be exhibited and maintained, even as these folding structures transform.

To understand one way to this stability, note that key geometrical features of a structure can help maintain strength and integrity - for example, shape closure (i.e., the topological equivalent of a sphere) or a perimeter continuously fixed to a ground. In the class of structures that are folding truss/linkages, key geometric features are maintained and held invariant even as they transform between radically different sizes or shapes. This results in a structural integrity exhibited in all phases of transformation and, equivalently, a transformation that is smooth and controlled. For the class of folding-surface structures, the geometric design economy expresses itself differently. In order to fold a surface, it must be divided first into facets that totally cover it. If the surface is a flat sheet, the division results in the mathematical operation known as tiling. While the number of tiling patterns that will totally cover a space is fairly broad, those patterns that are developable (i.e., that can fold) are far fewer in number. In a developable pattern, each facet is connected to all surrounding facets by pleat lines or hinges. Accordingly, each facet may be viewed as an individual piece. Yet, insofar as each facet is supported entirely around its perimeter (thereby forming a continuous surface), the transforming structure behaves to some degree as a unitary-shell structure. This quality may be enhanced through designs that emphasize symmetry, shape closure, gently curved surfaces, and consistent support points.

The Relation of Folding Structures to Electronic Media

It is my belief that folding structures may play a key role in our technological culture. The nineteenth century's technological imagination was expressed through its great structures (the Crystal Palace, Eiffel Tower, Brooklyn Bridge, etc). The most characteristic technology of our time is found in the microelectronics industry in combination with video and computer technology. These technologies have revolutionized our conception of what is visually possible; virtually any visual process may be represented. Through daily interaction with computer graphics, animation, video games, etc., a whole new class of visual and tactile expectations has been created. At an extreme these electronic media create a 'virtual reality' where visual, auditory, and tactile sensory inputs combine.

The process of representing a continuous metamorphosis with computer animation is conceptually simple: You take two static images and the computer will interpolate a smooth sequence from one image to the other. (In computerese, this is called 'tweening.') A recent advanced example of this may be seen in the movie Terminator 2 where the terminator may smoothly transform himself into virtually any shape while in a liquid metal state.

In scientific culture, the field of chaos mathematics maps methods to produce mathematical analogs of natural phenomena. Fractals may be used to represent clouds, trees, imaginary landscapes, as well as their growth and transformation. These mathematical tools are exploited in the scientific establishments and entertainment industry to continually accelerate our capabilities to represent any form, any type of transformation.

A basic question is: If this type of visual media is the key expression of the characteristic technology of our time, what is the place of the built environment and the designed object in relation to it? I see folding structures as providing a kind of bridge between the hyperactive electronic media and the static built environment. This intermediate experience directly engages the TV generation's expectations of visual activity, yet inhabits the realm of built structure. Folding structures may mediate the peculiarly disembodied quality of 'virtual reality' into a healthier and more grounded experience. In such a role, initially it will be those institutions utilizing computer and video in a public manner that will find a place for folding structures. These include science museums, theme and athletic parks, as well as various entertainment venues.

Mathematics of Form

Koryo Miura

p. 22

In 1990, we held a 'Structural Forms in Space' exhibition at the Design Gallery in Ginza Matsuya, Tokyo (Fig. 1). There we showed some of the models our laboratory had created in the process of research and development of space structures. The exhibited structures were no more than used items that the Institute of Space and Astronautical Science (ISAS) had employed in experiments or created as structural models. The fact that the structures, created to find extreme functions in the outer space, were exhibited as 'works' and attracted the attention of designers, shows that they were recognized as examples of contemporary design.

Space structures and design? To most people that would seem a very strange combination. First, these were foremost examples of architectural structures specifically designed for the zero gravity environment of space. Second, because there were no previous examples, the structures were not cold or devoid of feeling, but they had strongly expressed beauty and were really interesting.

However, the works were a little difficult to understand by a simple visit to the gallery, because the mathematics used in the creation of the shapes were not revealed. This short paper would give its explanation and inspire some discussion on the design of shape.

Extendible Masts and Collapsible Mathematics

Figure 2 shows the simplex masts used in the Akebono satellite launched by ISAS in 1989 to observe the aurora. Equipments to measure magnetic field were attached to the ends of the satellite's masts with lengths 5m and 3m. When the satellite was launched, the masts were retracted, but when satellite was reached on orbit it was extended.

There is one very strange characteristics in this mast. When the extended mast is retracted by means of a cable, it is automatically telescoped into helical form. At first glance, there is neither helical mechanism nor external force working. Why is this?

Nearly every child has an experience of making a rubber-band-driven model airplane. If we wind up the rubber band until it becomes hard to wind more, a lump suddenly appears. If the winding is continued after that, one more lump will appear. The appearance of lumps is discrete, and each lump is complete, that is, there is no half lump (Fig. 3). Of course, there is no special mold for the lumps.

The phenomenon of forming lumps is related to the maximum and minimum principle. The helix and the lumps minimize potential energy. The famous Swiss mathematician Euler applied the maximum and minimum principle to create his sleek curves, the Elastica (Fig. 4). The Elastica shows the most natural shape for a rod when both ends of a long, thin flexible rod are pushed together. This curve, which is the very embodiment of smoothness, reminds us of the batten used in drafting.

The principle to find the extendible mast lied in a trial to extend the Elastica in three dimensions. In other words, it is to seek natural solutions of 3-D Elastica. The concept of

the simplex mast structure is conceived in such a process.

However, engineering of actual hardware had to be pursued before this concept was developed in reality. In March of 1989, seven years after the birth of this concept, we were waiting at the Kagoshima Space Center for satellite Akebono (Fig. 5), whose mission was to observe the aurora, to pass through the sky above us. When the electronic signal was sent, the mast, which had been safely tucked into the interior of Akebono should open out beautifully into space by describing a helix. But, there was observed no gracefully spiraled opening in the space.

Origami and Space

In December 1989, in Ferrara, near Padova, the International Meeting of Origami Science and and Technology was held at the home of poet Lodovico Ariosto. The art of folding paper, expressed mathematically, is the process of "spatially warping a surface with zero Gaussian curvature, keeping its invariance." A Gaussian curvature is the product of the principal curvatures. The aesthetics of origami are in the restriction that only the folding process is allowed, just as the aesthetics of a Japanese haiku are in the restrictions imposed by the strict rhythmic form.

A creating origami by focusing on the mathematical restrictions is theoretically possible. The discovery of this process, which has created new forms and opened up new fields, attracts artists as well as mathematicians.

To build a huge solar-powered satellite or a solar sail craft would certainly entail the necessity of folding in a huge planar structure. We would require a method of folding flat surface in a natural shape. Let us take, as an example, a sheet of paper and compress it as much as we can (Fig. 6). The paper wrinkles irregularly and seems to provide no example to follow. But if we look carefully at the fine structure of the folds, we can discern a kind of regularity from what seems irregular at first glance.

If we imagine a sheet of paper with unlimited size and seek a potential minimum solution under the restricted conditions of the above Gaussian curvature invariant, the most natural folds should emerge. Of course, since we can not actually implement this origami in reality, let us perform it in imagination. If we can somehow get an image of the solution, all we can do then is the computation. In this way, a regularly curved surface like the herringbone pattern in Fig. 7 appears. That curved surface is now known as 'Miura-ori'.

The Miura-ori shape was known in map and origami circles almost ten years before reaching the space engineering community. It was first applied to Japan Olivetti's SPAZIO as Hidenobu Jinnai's Venice map, which demonstrated an extremely odd quality about it. If both ends of a diagonal line are pulled apart, it unfolds with one touch. Since the folds are memorized, there is no risk of making mistakes in folding, and the folds are difficult to tear. In the case of a media in written form, we could use it as instantly scannable map or an illustrated book (Fig. 8).

Of course, this principle is also being developed for its original purpose of space use. An operational experiment involving a solar cell array that can be simultaneously spread out in two directions is planned for the Space Flyer Unit, due for launching in 1996 (Fig. 9). The array to open out in space has a characteristic, parallelogram pattern.

Casting a Net in Space

What is a net? To those who think the answer obvious, let us pose another question. What is the shape of the mesh? According to a standard dictionary, a net is "a tool, made of diagonally woven thread, for snaring birds, animals, marine animals or marine plants." Because the mesh is parallelogram, the net expands and contracts flexibly in response to the struggles of the fish trapped in it, and the fish cannot escape.

Let us consider a triangular mesh. A search through visual archives does not lead to an example of a triangular mesh net. Such nets are inflexible and when stretched to their limits, they turn to their rigid original shape. The fish would, of course, escape through the stretched mesh (Fig. 10a).

Space missions often include plans for large parabolic antenna. One method for building a large parabolic structure is to construct trusses just as a dome on the Earth. However, the volume and weight of the load that the rocket can accomodate is restricted. Also, the arrangement of the truss resembles a triangular net made up of rods. If we construct a triangular net of cables, rather than rods, however, we should be able to realize a dome-like structure into space.

From ancient times structures on the Earth have been built mainly to support weight – we can even define the word 'structure' in this way. How then should we define structures in space with no gravity? The following is one sugges-tion to reflect on. The structure of a space system is described as "that which decides the relative position between elements." Triangular net mesh decides the positional relationship of three points, and as long as the cable does not slacken, that relationship will be preserved as the shape of the net's structure – the concept of 'tension truss'. If we draw the net's intersecting points tight so the cable does not slacken, we will be able to realize a tension truss antenna structure, using the triangular net, which is capable of sustaining an accurate parabolic surface in space (Fig. 10b).

The MUSES-B satellite, which aims to use this concept to carry a huge ten-meter diameter parabola into space in 1996, is currently being developed (Fig. 11). The parabola's triangular net will try to catch faint radio waves from deep space.

Structures with Intelligence

These shapes and characteristics of the space structure works, which we have examined, are clearly quite different from those we are used to. What they all have in common is extremely active characteristics. In addition to static structural elements, dynamic actuator elements are built in and their shapes should permit these active movements.

In addition to structure + actuator, it was almost certain that structures with additional element of intelligence would appear. Figure 12 depicts the world's first structure with structure + actuator + intelligence. This is the variable geometry truss (VGT). The VGT is a kind of spatial truss, which has a strong structure but also possess intelligence. It will respond to instructions and can expand, retract and bend.

Space structures, then, have evolved not only as mechanisms for strength but as intelligent mechanisms. These structures can adapt to their environment like a living creature, autonomously change shape and even link with other structures to form new structures. With their similarity to the adaptability of living creatures, these structures are called adaptive structures and researches all over the world have now begun for progress in this popular new area.

In the course of these adaptive structure researches, previously unimagined relationships in the shapes between man-made objects and living creatures emerged. Researchers are considering to operate multi-articulated structures like VGTs in space. They do not have rockets mounted on them so they move with a fixed center of gravity. Researches have explored the operative range in space under this condition and found that the range of operation of VGTs is severely restricted to a limited space. The shape of the operative range (or working space) is almost elliptical, and expressed by a beautiful surface and curved line in a form hitherto totally unknown (Fig. 13). The surprising thing is that this shape is extremely similar to the cocoon spun by a silkworm (Fig. 14). We can explain this through a rough analogy of the silkworm as a multi-articulated structure, and its operating range as the calculated operative range of that structure. This example suggests a universality that exceeds the scope of the rules controlling space, although of course, we do not know for sure.

What is the Basis of Space Structure Design?

We had to start from design's very beginning, because no one or creature on this Earth has experience in designing space structures, which should start from the assumption of zero gravity and, accordingly, no directionality.

If we go back to the foundations of design method, we find that the important thing is not only a relation of shape to general mathematics but also that of shape formation to the maximum and minimum principles. In the words of mathematician Euler: "Because the structure of space is under the complete direction of the Omniscient, phenomenon unrelated to a maximum or minimum principle does not exist in space." Therefore, the structures created in this way have the most natural shapes.

If there is any outstanding importance in the works we have examined here, it would be that behind each of them are ruling mathematical principles. While these principles are necessary conditions in the design of shapes, they are not sufficient conditions. We can only say that in the creation of a meaningful and harmonious space structure the human hand is also necessary.

Between the Lines
Daniel Libeskind
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The official name of the project is the 'Extension of the Berlin Museum with the Jewish Museum Department,' but I have called it 'Between the Lines.' I call it this because it is a project about two lines of thinking, organization and relationship. One is a straight line, but broken into many fragments; the other is a tortuous line, but continuing infinitely. These two lines develop architecturally and programmatically through a limited but definite dialogue. They also fall apart, become disengaged, and are seen as separated. In this way, they expose a void that runs through this museum and through architecture, a discontinuous void.

The site is the center of the old city of Berlin on Lindenstrasse near the famous baroque intersection of Wilhelmstraße, Friedrichstraße and Lindenstraße. At the same time, I felt that the physical trace of Berlin was not the only trace, but rather that there was an invisible matrix or anamnesis of connections in relationship. I found this connection between figures of Germans and Jews; between the particular history of Berlin, and between the Jewish history of Germany and of Berlin. I felt that certain people and particularly certain writers, scientists, composers, artists and poets formed the link between Jewish tradition and German culture. So I found this connection and I plotted an irrational matrix which was in the form of a system of squared triangles which would yield some reference to the emblematics of a compressed and distorted star: the yellow star that was so frequently worn on this very site. I looked for addresses of where these people lived or where they worked, for example someone like Rachel Varnhagen I connected to Friedrich Schleiermacher, and Paul Celan to someone like Mies van der Rohe and so on, and I was quite surprised that it was not so difficult to hear and plot the address that these people made: That they formed a particular urban and cultural constellation of Universal History. So that is one aspect of the project.

Another aspect was Arnold Schönberg. I was always interested in the music of Schönberg and in particular his period in Berlin. His greatest work is an opera called 'Moses and Aaron' which he could not complete. For some reason the logic of the text, which was the relationship between Moses and Aaron, between, one can say, the revealed and unimaginable truth and the spoken and mass-produced people's truth led to an impasse in which the music, the text written by Schönberg could not be completed. In the end, Moses doesn't sing, he just speaks „oh word, thou word" and one can understand it actually as a text as opposed to the norm of opera whose performance usually obliterates the text. When there is singing one cannot understand the words, but when there is no more singing, one can understand very well the missing word which is uttered by Moses, which is the call for the deed. So that was the second aspect.

I did a third thing. I was interested in the names of those people who were deported from Berlin during the fatal years, the Holocaust, that one knows only historically. I received from Bonn two very large volumes called 'Gedenkbuch' - they are incredibly impressive because all they contain are names, just names, dates of birth, dates of deportation and presumed places where these people were murdered. So I looked for the names of all the Berliners and where they had died - in Riga, in Lodz, in all the concentration camps. So this was the third aspect.

The 4th aspect of the project is formed by Walter Benjamin's One Way Street. This aspect is incorporated into the continuous sequence of 60 sections along the zig-zag, each of which represents one of the 'Stations of the Star' described in the text of Walter Benjamin.

To summarize this four-fold structure: The first aspect is the invisible and irrationally connected star which shines with absent light of individual address. The second one is the cut of Act 2 of Moses and Aaron which has to do with the not-musical fulfillment of the word. The third aspect is that of the deported or missing Berliners, the 4th aspect is Walter Benjamin's urban apocalypse along the One Way Street.

The building goes under the existing building, crisscrosses underground and materializes itself independently on the outside. The existing building is tied to the extension underground, preserving the contradictory autonomy of both the old building and the new building on the surface, while binding the two together in depth, underground. Out of the terminus of history, which is nothing other than the Holocaust with its concentrated space of annihilation and complete burn-out of meaningful development of the city, and of humanity - out of this event which shatters this place comes that which cannot really be given by architecture. The past fatality of the German Jewish cultural relation in Berlin is enacted now in the realm of the invisible. (It is this remoteness which I have tried to bring to consciousness.)

The work is conceived as a museum for all Berliners, for all citizens. Not only those of the present, but those of the future and the past who should find their heritage and hope in this particular place, which is to transcend involvement and become participation. With its special emphasis on housing the Jewish Museum, it is an attempt to give a voice to a common fate - to the contradictions of the ordered and disordered, the chosen and not chosen, the vocal and silent. Absence, therefore serves as a way of binding in depth, and in a totally different manner, the shared hopes of people. It is a conception which is absolutely opposed to reducing the museum or architecture to a detached memorial or to a memorable detachment. A conception, rather, which re-integrates Jewish/Berlin History through the unhealable wound of faith, which in the words of Thomas Aquinus, is the "substance of things hoped for; proof of things invisible."

InFormation/DeFormation
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Fußnoten
1) Historikern werden vielleicht Ähnlichkeiten zwischen den hier erwähnten Arbeiten und dem räumlichen Charakter der Barockarchitektur und/oder dem formalen Charakter des deutschen Expressionismus auffallen. Ich sage voraus, daß ihre Betrachtungen damit schließen werden, keiner der Architekten oder Theoretiker, die auf diesem Gebiet tätig sind, ist sich dieser Ähnlichkeiten bewußt gewesen. Da ihre Texte und Projekte nicht mit Analysen von Borromini, Guaranini und Bernini oder Referenzen auf Finsterlin, die Tauts, Pölzig, Häring, Mendelsohn, Scharoun, Steiner usw. gespickt sind, wird man annehmen, ihre Arbeiten seien in seliger Unwissenheit über diese Ähnlichkeiten durchgeführt worden. Diese erste Schlußfolgerung ist nötig, um die zweite zu untermauern, daß nämlich die Ähnlichkeiten weitaus wichtiger sind als die Unterschiede. So werden sie im Andenken an Marx behaupten, die neueren Werke seien bloß eine Parodie auf die tragische Größe der älteren (ein tautologisches Argument, da die erste Instanz die Begriffe und Bedingungen für eine Ähnlichkeit etabliert. Außerdem gründet sich auf dieses Argument zufällig die Finanzierung ihrer Berufstätigkeit). Wie interessant und erforschenswert die Ähnlichkeiten auch sein mögen, von größerem Belang sind die Unterschiede: wieder einmal werden Historiker das Wesentliche nicht sehen.
2) Vgl. Unger, R.M.: Knowledge and Politics, New York 1979 und Unger, R.M.: Social Theory, Cambridge 1987.
3) Auch andere poststrukturalistische Architekturtheoretiker, vor allem Jennifer Bloomer und Robert Somol, haben sich auf die Schriften von Deleuze und Guattari berufen, wenn auch in unterschiedlicher Absicht.
4) Anm. d. Übersetzerin: 'Grafting' und 'Graft', zu deutsch 'pfropfen, transplantieren, übertragen' bzw. 'Transplantat, Einimpfung', vom Autor jedoch oft auch im allgemeinen Sinne des 'Entwurfs' gebraucht, wird hier und im folgenden im Original belassen.
5) 'Collage' wird hier als zweckdienlicher, vielleicht etwas grober Oberbegriff für eine ganze Gruppe von Praktiken, z.B. Bricolage, Assemblage und eine historisch gewachsene Collage mit vielen wichtigen Verschiedenheiten und Ausprägungen benutzt. Diese Argumentation wird erhärtet durch eine Studie über die architektonischen Übersetzungen der verschiedenen Vorbilder, die die Collage und ihr verwandte Techniken liefern. Wenn wir weiter unten in die Erörterung affiliativer Effekte einsteigen, könnte man geneigt sein, zu sagen, die surrealistische Collage, die das Glätten der Nähte des Grafts betont, sei vielleicht ein geeignetes Modell. Obwohl dieser Standpunkt nicht unbegründet ist, scheint mir, daß die sogenannte Nahtlosigkeit der surrealistischen Collage wie bei allen Collagen in Wahrheit dazu dient, die Getrenntheit der einzelnen Elemente der Collage und damit der in ihr wirksamen inkohärenten Disjunktionen ironisch hervorzuheben.

Ein besseres Modell sind womöglich Jasper Johns´ kreuzschraffierte Gemälde, Drucke und Zeichnungen. Diese Werke weisen zwar sicherlich viele mit der Collage assoziierte Techniken auf, aber ihr Effekt ist ein ganz anderer. In ihnen materialisieren sich nicht-ideale, rasterartige Strukturen durch Grafting-Elemente, deren Form aus dem Gesamtgefüge herausfällt. Überdies sind auf manchen dieser Bilder weitere, wolkenartige Figuren aus dem Medium selbst aufgebaut und innerhalb des Bildes getarnt, die vollkommen außerhalb der vorherrschenden Formen/Farbensprache stehen. Für mich sind diese Werke gute Beispiele für eine kohärente Heterogenität, die durch eine intensive Kohärenz in den Elementen selbst erzeugt wird.

6) Zum Beispiel das Wexner Center for the Visual Arts sowie seine 'Scaling'-Projekte, z.B. 'Romeo and Juliet'.

7) Die ökonomischen und politischen Schwierigkeiten, resultierend aus einem Modell der Heterogenität, das auf der Katalogisierung definierbarer Arten von Differenz basiert, die ich mit Collage assoziiere, wird ganz klar weitreichende Implikationen über viele institutionelle Grenzen hinweg haben. Bei der letzten Präsidentschaftswahl in den USA war zum Beispiel ein zentrales Thema die weitverbreitete Frustration über die Anzahl offiziell anerkannter spezieller Interessengruppen (von denen es heute Tausende gibt), die versuchen, Entscheidungen der Bundesregierung zu beeinflussen. Wie zynisch man diese Situation auch betrachten mag, sie ist die unvermeidliche Konsequenz einer Gesellschaft, die den klassischen Konflikt zwischen Individuum und Gemeinschaft vermitteln will und Demokratie anstrebt, indem sie das Recht auf angemessene Vertretung und Anerkennung von Differenzen erteilt, d.h. Demokratie durch extensive Inkohärenz. Modelle für Heterogenität, die durch intensive Kohärenz zustandekommen, müßten nicht nur den Individuum/Gemeinschaft-Konflikt, sondern letztlich auch die gesamte Vorstellung von einer Demokratie, die auf Rechtssystemen beruht, neu überdenken.

8) Vgl. Robert Somol: 'Speciating Sites', in Davidson (Hrsg.): Anywhere, Rizzoli 1992.

9) Sicher haben wir Möglichkeiten für solche Grafts bereits gesehen, z.B. in den Arbeiten von Hejduk oder Rossi. Es ist vollkommen unergiebig, mit der Logik der Collage die Effekte von Aldo Rossis inkongruenten Entwürfen überlieferter Institutionen mit seinem Katalog autonomer architektonischer Formen oder die Effekte von Hejduks mythisch-poetischen, szenographischen urbanen Grafts zu erklären.

10) Siehe Unger: 'The Better Futures of Architecture', in Davidson (Hrsg.): Anyone, Rizzoli 1991.

11) Rem Koolhaas betont in seinem kurzen Programm für den Shinkenchiku Wettbewerb für eine Wohnsiedlung, betitelt 'No Style', worauf es ihm ankommt. Vgl. JA 7.

12) Viele Ideen, die im zweiten Teil dieses Textes eingeführt werden, sind Ergebnis von Diskussionen, die ich mit Greg Lynn und Sanford Kwinter geführt habe, sowie von ihren Schriften. Daß ich letztere hier nicht erwähnt habe, beweist nur, wie gründlich mein Text von ihrem Einfluß durchtränkt ist. Vgl. Greg Lynn: Multiplizitäre und inorganische Körper, 119/120 ARCH$^+$, Seite 108 f., oder Sanford Kwinter: Landschaften des Wandels, 119/120 ARCH$^+$, Seite 96 f. Ähnliche Themen siehe Crary und Kwinter (Hrsg.): ZONE Books 6: Incorporations, New York 1992.

13) Um das Thema einzugrenzen, hebe ich die DeFormation in diesem Text in erster Linie als Sache des Entwurfs hervor und berühre stadtplanerische Fragen nur, wenn sie sich aus dem Zusammenhang ergeben. In mehreren Projekten wurde versucht, die Merkmale, die ich hier mit DeFormation identifiziere, auf die Stadtplanung auszuweiten, so in Eisenmans Büro- und Wohnanlage in Rebstock und in dem Entwurf für das zentrale Geschäftsviertel in Montreal von Shirdel, Zago, Kipnis. Es gibt auch derartige Projekte, die sich der Mittel der InFormation bedienen, etwa Koolhaas´ Entwürfe für Euralille und La Defense oder Tschumis Entwurf für Chartres. Eine Auseinandersetzung mit diesen Arbeiten werde ich an anderer Stelle versuchen.

14) Zur Erörterung dieser drei Projekte siehe mein 'Freudian slippers, or what were we to make of the Fetish', in Lynn, Mitchell und Whiting: The Fetish, Princeton 1992.

15) Zur Erörterung von Eisenmans Schwache-Form-Projekten siehe mein 'A Matter of Respect' in der Sonderausgabe von A+U über Eisenman, Januar 1990.

16) Einer der faszinierendsten Aspekte von Peter Eisenmans Architektenkarriere ist seine unheimliche Fähigkeit, eine gesamte architektonische Entwurfs-These von einem Schlüsselwort oder -satz herzuleiten, auf die er beim Lesen von Kritiken oder Philosophie zufällig gestoßen ist. Daß schließlich auch die Quelle des fraglichen Begriffs erschlossen wird, ist zwar nicht zu unterschätzen, aber das Wesentliche liegt darin, daß Eisenmans entwerferische Erfindungen praktisch immer auf seine anfängliche Reaktion zurückzuführen sind, auf das, was er als die architektonische Implikation des Begriffs oder Satzes, losgelöst von seinem ursprünglichen diskursiven Kontext, sieht. Ob es nun Chomskys 'tiefe Struktur', Derridas 'Spur', Mandelbrots 'fraktales Scaling' oder Vattimos 'schwach' ist, Eisenmans architektonische Ableitungen haben mehr mit seiner stimulierten Intuition für potentielle architektonische Wirkungen zu tun als damit, den jeweiligen philosophischen Ausgangseinfluß zu vergegenständlichen. Bei seiner 'tiefen Struktur', seiner 'Spur', seinem 'Scaling' und seiner 'schwachen Form' geht es also kaum um Philosophie, aber sehr um Architektur. Diese Bemerkung ist keineswegs als Verunglimpfung gemeint. Ganz im Gegenteil - insofern als Eisenmans Werk einen Dialog mit dem philosophischen Diskurs aufrechterhält und gleichzeitig den Bereich architektonischer Wirkungen von der Verpflichtung entbindet, philosophische Wirkungen zu veranschaulichen/vergegenständlichen, ist dies vielleicht sein wichtigster Aspekt. Daß dieser Punkt in der kritischen Literatur über Eisenman - meine eigene eingeschlossen - nicht erwähnt wird, ist auffällig und zeugt von einem institutionellen Bedürfnis dieser Literatur, sich um jeden Preis eine Metaphysik der Vergegenständlichung zu bewahren, selbst auf Kosten der Aufmerksamkeit für die Architektur.

17) Camouflage wird häufig als Beispiel für Affiliationen, die glätten, angeführt. Eine wirkungsvolle Tarnung, etwa beim Militär, unterscheidet sich oft völlig von den vorherrschenden Einflüssen des operativen Kontextes und steht fast immer außerhalb der dominanten Stilmittel der Primärdisziplin (z.B. im Bekleidungsentwurf oder bei der Oberflächengestaltung von Schiffen und Flugzeugen). Trotzdem liegt der Effekt der Camouflage darin, daß sie die disjunktive Beziehung zwischen Umfeld und Eindringling zu einem anderen Kontext glättet.

18) Obwohl in der Erörterung der Affiliation bisher Form-zu-Form-Effekte hervorgehoben wurden, unterminiert ein Nachdenken über die schwachen Bindeglieder affiliativer Effekte außerdem den herausragendsten stark angleichenden Bezug in der Architektur, nämlich die Korrelation zwischen Form und Programm. 'Form folgt der Funktion' ist für das Verhältnis zwischen architektonischem Entwurf und Programm natürlich die Anpassungserklärung schlechthin. Stützt aber eine genaue Betrachtung der Architekturgschichte tatsächlich diese Position? Ich glaube, eine gründliche Interpretation dieser Geschichte hätte eine negative Antwort auf die Frage zur Folge.

Solange sie bestehen, sind die Beziehungen zwischen Form und Programm weitaus eher affiliativ als angleichend, eine Tatsache, die die endlose Anzahl von Umprogrammierungen (Privathäuser in Museen, faschistische Hauptquartiere in Abteilungen von Finanzministerien, Feuerwehrwachen in Psychoklempner-Praxen ad infinitum) mehr als bezeugt. Das soll nicht heißen, es gäbe keine Beziehung zwischen Form und Funktion, sondern nur, daß diese Beziehung im Kern schwach ist. Es ist der affiliative Charakter der Beziehung Form/Programm, der es Rossi erlaubt, seine typologischen Grafts zu produzieren, und Tschumi, über Dis-Cross und Transprogrammierung zu theoretisieren. Hat etwa der Entwurf irgendeines Gebäudes, das architektonisch signifikant ist, seinen guten Ruf jemals der Tatsache verdankt, daß es so gut funktioniert? Der eklatanteste Fall einer Form/Programm-Affiliation ist jedoch das Privathaus, denn niemand bewohnt ein Haus seinem architektonischen Programm entsprechend. Kann eine Theorie der strengen Angleichung von Form und Funktion erklären, wieso man im Bad liest oder im Wohnzimmer ißt oder der Sex woanders als im Schlafzimmer besonderen Spaß macht? Zweifellos war es die Frustration darüber, daß Affiliationen nicht zu Angleichungen erstarrten, die Mies van der Rohe dazu trieben, die Möbel festzunageln. Die affiliative Natur der Beziehung zwischen Form und Programm ist der überwiegende Grund für die relative Selbstgefälligkeit der DeFormation gegenüber der InFormation hinsichtlich des Themas Programm.