

## Evolving Patterns

dZO

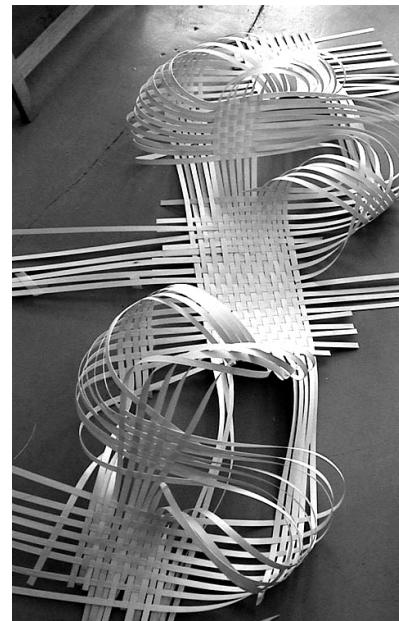
*“...modulating is molding in a continuous and perpetually variable fashion.” G. Simondon*

From the production of non-standard mass-produced objects to the digital simulation of draperies, dZO explored several strategies integrating digital design technique into conceptual and formal architecture research. In this text we would like to present a series of concepts and techniques that emerged in our recent work including “weaving,” “iterative process,” and “evolving pattern.” These lead us to the possibility of an alternative architectural design process integrating, in a new way, design and computation. We will show examples illustrating the potential of such a process in the work of dZO architecture.

Digital generative processes have changed the idea of pattern in the structural, functional, social and ornamental towards a more flexible concept. The pattern itself and its aggregation model can evolve and be transformed as the system expands and replicates. Evolving patterns may generate variation within systems such as mass production, emphasizing differentiation rather than repetition. Patterns have been a recurrent notion in our work and were used to redefine spatial notions such as the definition of limits (visual or territorial), the idea of materiality, and the relationship between architectural envelope and tectonics. Patterns

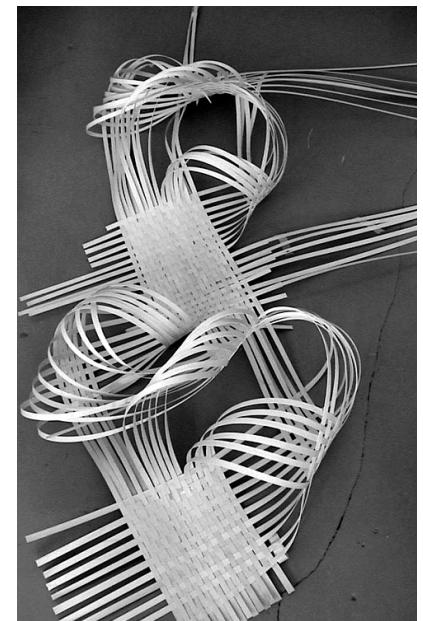
are not only emerging from the mere repetition of a unit. One can identify pattern when differences occur in the repetition process of any given system. For example, the presence of the pattern is evident in the city, because the city has a scale where we can identify seriality, reproduction, repetition, or sameness much better. Evolving patterns are based on the idea of responding to a dynamic environment. These patterns constantly mutate toward a better adaptation to the environment.

Historically patterns have been linked to ornamental forms and have evolved towards codification system and support of analysis (pattern recognition). Islamic architecture, often inspired by the logic of the textile, operates by blurring the ornamental and structural patterns with a unique intensity. The Middle East brickworks of the tenth century are fascinating as they integrate construction technique and ornamental forms. The most striking formal kinship between Islamic ornamentation and textile lies in the logic of the interlace. Like threads, which weaves over and under each other to form a fabric, the lines of Islamic ornamentation, whether vegetal, organic, or geometric make use of an over-under dynamic to guarantee the cohesion of the ornamental surface. The interlace has been a strong figure of this architecture, and beyond the ornamental motif, it has been used as an organizational and spatial concept of palaces.



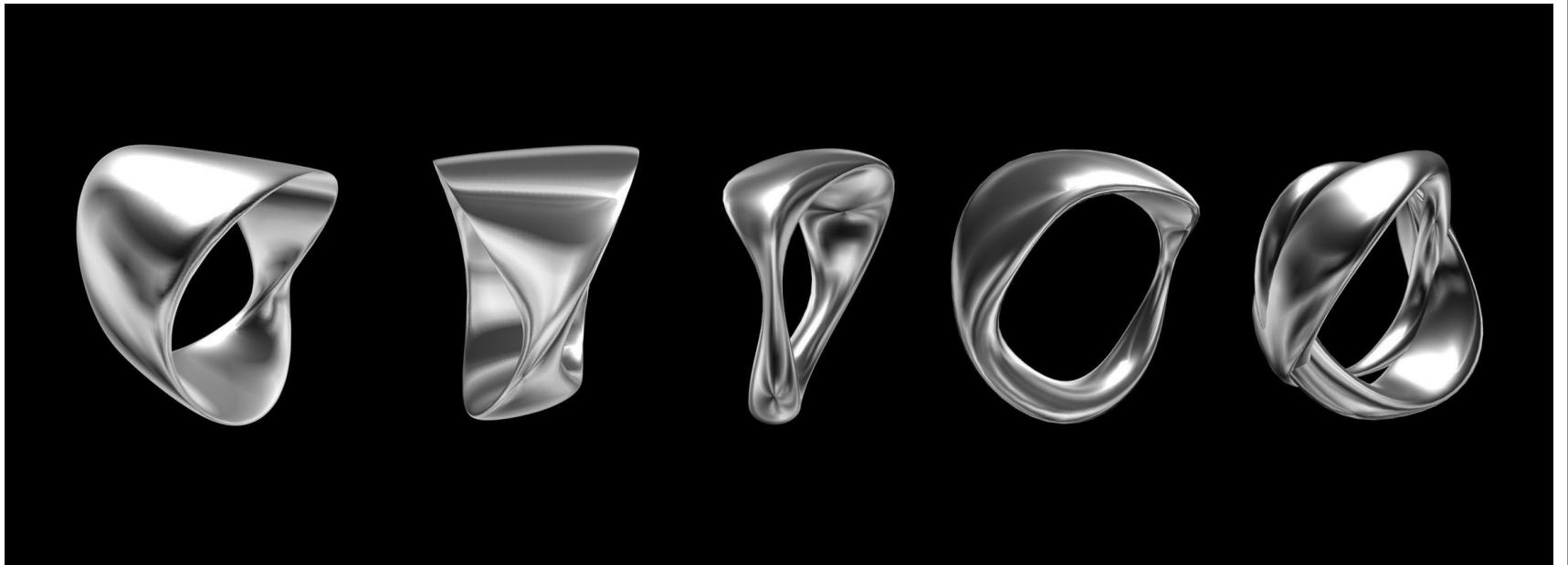
One of the first fabrication devices, which introduced the idea of variation in the fabrication process, was a weaving machine. At the beginning of the nineteenth century, Joseph Marie Jacquard invented an automatic weaving machine, with which woven patterns could be controlled by perforated cards during the fabrication process. These were clearly forms of fabrication where the idea of variation was actually integrated in the device.

Anthropological studies met the theory of German architect Godfried Semper who showed the way ancient cultures developed very sophisticated techniques of weaving while not having a developed knowledge of writing. Semper defined the knot and the textile as a key original



element of architecture like the soft woven mat of roof instead of the stone tectonic of the Greek temples. “Weaving” is not a formal or visual concept, but rather an original technique allowing fabrication of complex geometries. Because of its very binary nature, it is conducive to be directly converted into digital fabrication methods.

The mathematician Steven Wolfram applied several types of very simple Cellular-Automata-like model to generate patterns in which complexity and beauty approach the one of the natural world. Based on a very simple and reduced number of rules, this research proves that computer-generated patterns, after a high number of iterations, would approach organic form. For



Wolfram, the difference between the systematic and the organic is perhaps only a number of iterations. For example, the formation process of snowflakes can be simulated by the iteration of a systematic mathematical rule that produces visual patterns. This technique could be used for other models like fluid movement, or biological processes such as pigmentation. A set of very simple rules creates complex and even chaotic organizations in which internal logic is not visually perceivable.

These studies have triggered our interest in a new understanding of patterns, not as a mere tiling of the surface, but rather as a strategy to articulate the different temporal and spatial dimension of architecture. We

aim to develop structures that have a universal or prototypical quality that can be unfolded in different specific environments. Architecture is therefore a response to multiple patterns from social to contextual, from structural to ornamental.

Our projects are not systematic design processes; instead they converge toward the possibility of using a computational-based design model. The development of this model would allow a higher degree of variation and differentiation in architecture. This new design model should use variation, repetition, and proliferation, without reducing architecture to a generative process or a mathematical variation of ideal types. Without the component of dif-

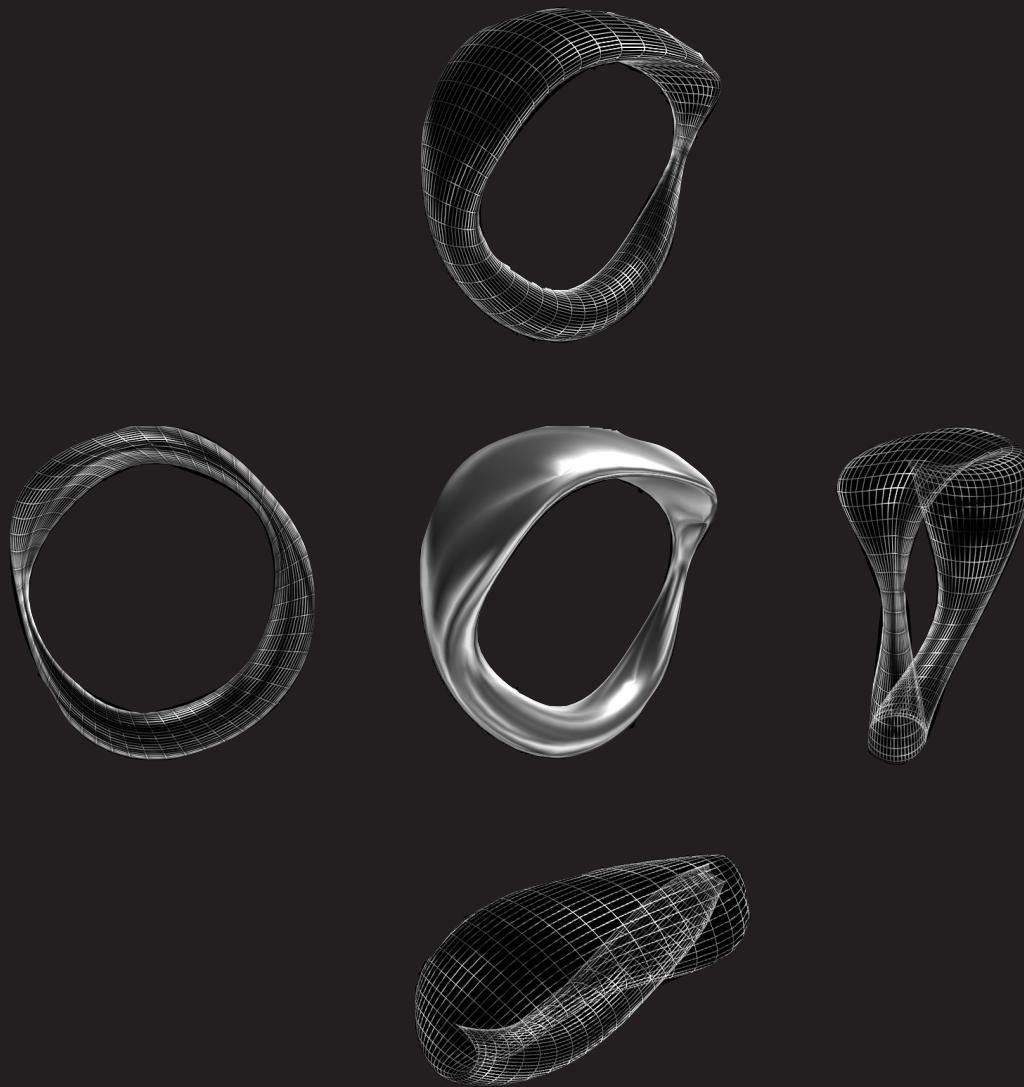
ferentiation, digital design processes are reductionist, closed, and incapable of discovering new innovative paths of development. How could we create systems that think as they perform and can evaluate their relevance at each step of the design process? Can digital technologies enable us to open our work and produce architecture as prototypes, responding specifically to local conditions?

In this respect, one can outline three principles of a possible computational design model:

1) The computational design model is a self-generative device: the rules of its expansion are automatically iterated from an initial set of conditions.

2) At any time in this iterative process, the model is open to input of new parameters. This introduces a cybernetic relationship between the designer and the computation model. In other words, it uses a generative process, where the designer interacts with the system and reshapes the codes to better adjust it to each condition. The concept of iteration allows any step of the design process to have a large number of variations and consequences of this decision.

3) The generation logic must be based on a concrete organization of matter (matter in a broad sense). Matter not only as materiality, but also as the other vectors of architecture: circulation, light, and function.



The following projects taken from our current research illustrate some ideas and a design strategy converging toward an integrated computational design model.

**Metaring: Mathematics of the Soul**  
Metaring, a collection of rings commissioned by a German jeweler, has allowed us to develop a great consistency and continuity between digital design and robotic fabrication techniques.

The rings, designed using "nurbs"-based geometry, follow a set of very simple geometric rules of transformation based on the relative position of three circles in space and the sectional transformation of the ring profile. The Metaring collection is generated using a mathematical algorithm that digitally inflects the shape of a three-dimensional torus. The result is an unpredictable and endless sequence of transformations, a geometric modulation of metal knots in space. Each instance of this sequence produces an object that can be

fabricated as a unique item by the use of a stereolithographic process where, layer by layer, a laser beam sweeps the profile of the ring and solidifies a gel. This design is not conceived as an object shaped in space, but rather as a reactive structure informed by time-space related parameters. There are no more prototypes to test the product behavior, but a metatype, belonging to the system, which cannot be represented as a concrete instance. Each singular object actualizes the potential of the

process and carries the traces of the precedent instances.

The increasing availability of rapid-prototyping technology transforms the traditional production system into an interactive chain. As a business model, we imagine that the global communication network would allow a better integration of consumer behavior and design trends by a quasi-real-time transformation of the Metaring model.

#### **Athena: International Competition for the Design of Landmarks of Olympic Activities**

As a point of origin, the landmark towers for the Athens olympic games took the study of draperies of ancient Greek sculptures, in particular the representation of the goddess Athena and the relationship between body and cloth. If on the one hand, her dress seems to contain and mold her body, in many representations one could say that it is, on the other hand, the body that is structured by the fabric as a kind of a crumpled body. The movement of the woven fabric denies its autonomy. The clothing is no more what is wrapped around, but rather what gives form to the body through its own transformations. In opposition to doubling or molding a limit, Athena's dress contradicts the permanence of its circumscription. The complex movement of the fabric structures the ephemeral state of the body. The continuous transformation of the drapery is operative in our project



a model to be reinterpreted, but as an effective force in the design process. It can be perceived as a process itself, since the essence of the drapery is only to fix momentarily an occurrence. In this sense it is both formless and contains a multiplicity of forms.

The landmark towers are shaped with three surfaces that twist together around the steel frame. The fabrication process for this surface is a combination of a pre-engineered steel frame with a free-formed shape produced by a numerically controlled wire foam cutter. In each of the thirty towers to be erected, the foam patterns will have a different relationship with the steel frame. In the logic of the body/fabric relationship, the foam surface dresses the frame in a different way in each of the towers.

**Art Arena:  
Art Film Museum in London**

Commissioned by a British art collector, this museum will present a vast collection of films about art, ranging from classical to contemporary art forms. The project addresses two main challenges: The first is to combine forty-five projection rooms playing simultaneously in an open plan, where visitors would freely move from one room to the other without lighting or audio perturbances. Programmatically, the typology of the multiplex movie theatre had to be blended with the typology of the museum. The second is to develop circulation patterns that

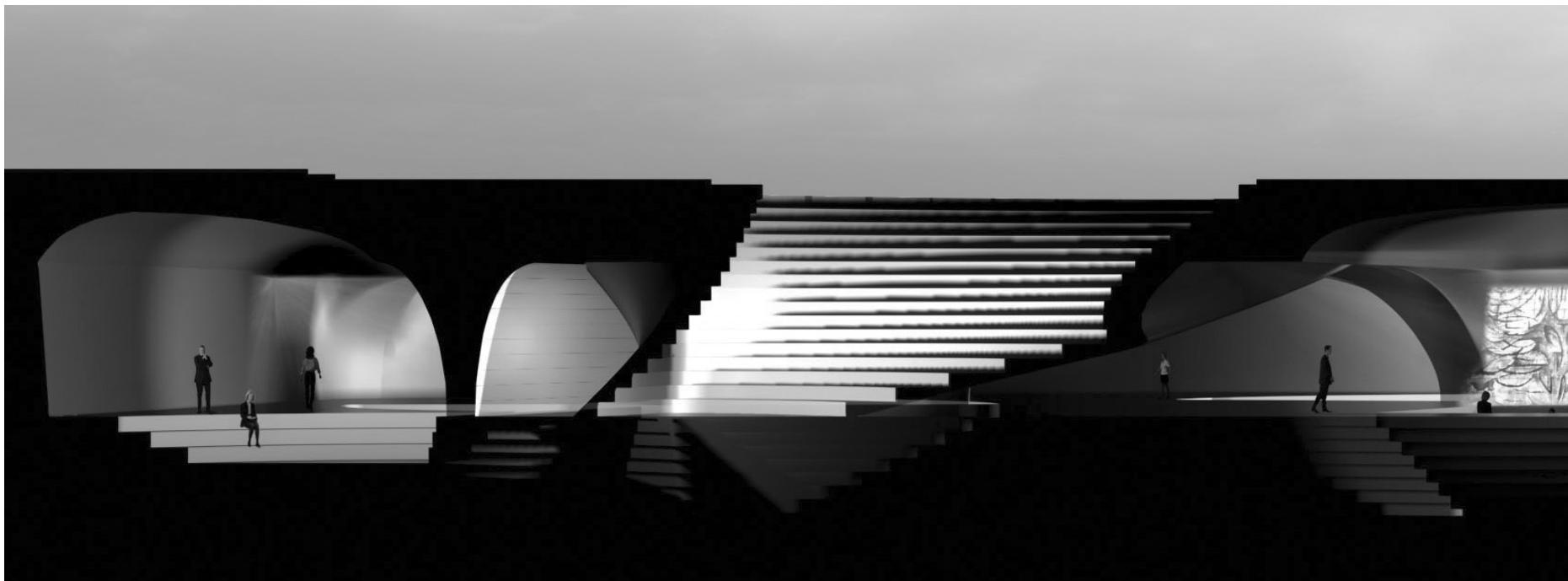
must be integrated with the movies schedule, which includes movie's duration ranging from a few minutes to two hours. Therefore the museum spaces had to be organized by time-based parameters.

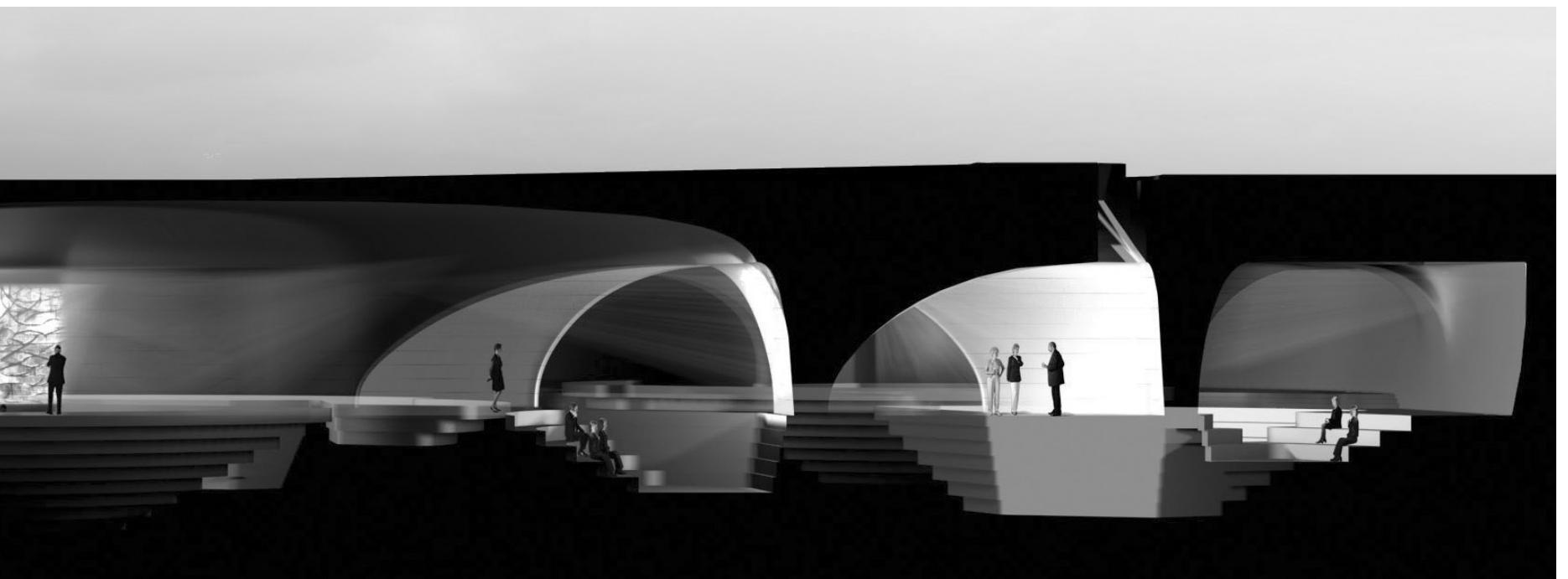
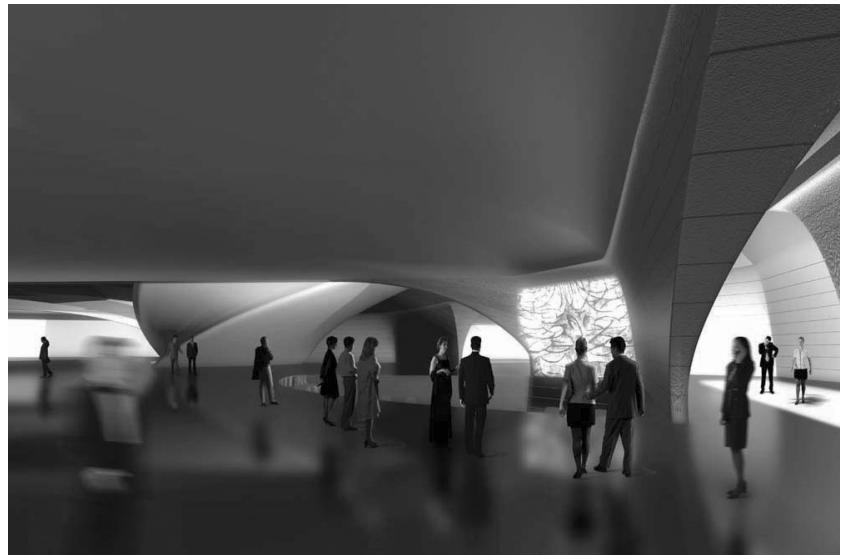
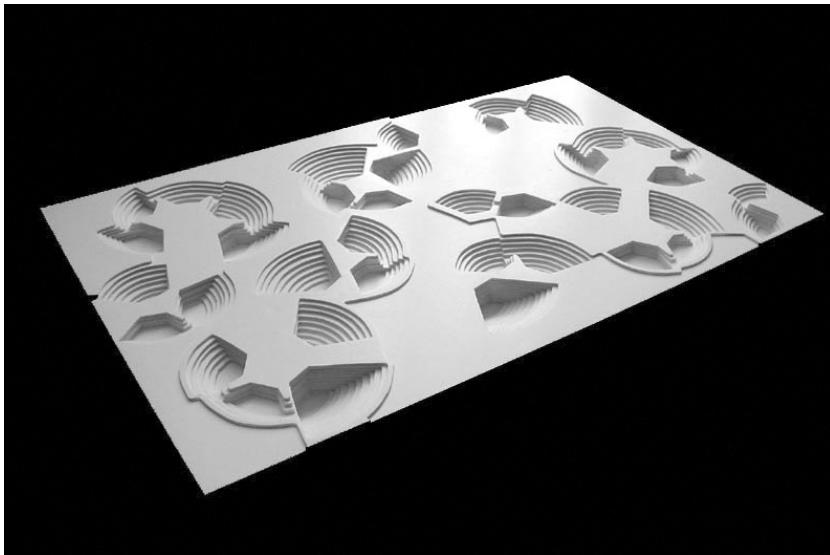
The layout of the museum is designed in relation to time zones controlled by the schedule of the film projections. This allows the generation of flexible museum visit patterns with a synchronization of architectural sequence and the experience of time-based artworks. In plan, two to six theaters are combined together creating clusters. These are adjusted and rotated to allow the

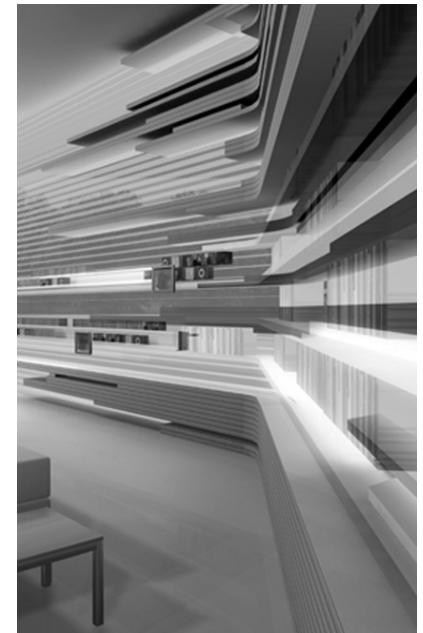
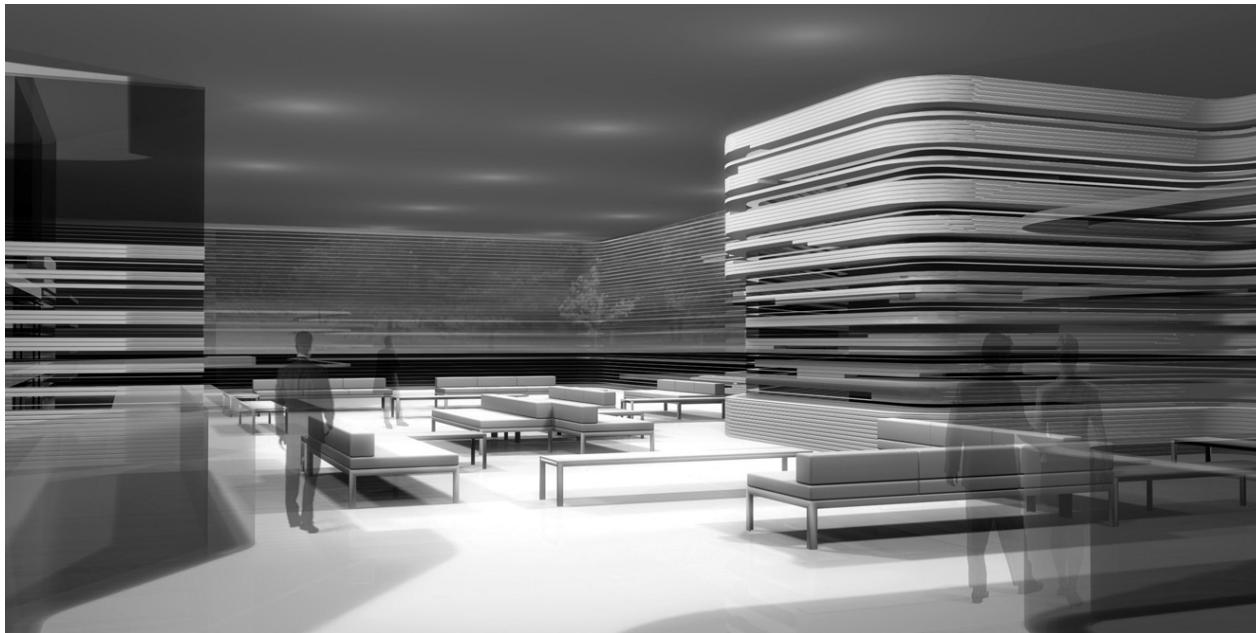
alignment of the structure above and to facilitate the circulation from one cluster to another. In the interior space, the profile of the screen is an inverted profile of the seating area creating a continuous movement between them. New audio technology and video projection systems have been utilized to free the museum spaces from the conventional acoustical limitation of the projection room and to remove the spatial enclosure of the traditional film theater. By using wireless headsets triggered by proximity sensors the visitor can only hear the sound of the movie he or she is watching without any interference. The projection spaces

can therefore blend one into another along the continuous wall and ceiling surface.

The roof, at the street level is at the same time a portal and a public ground extending museum activities to the city with open-air theaters for special events and night projections. The existing ground of the site will be carved out to accommodate the volume of the theaters.







### **Mediatheque of Proximity: France**

The French Ministry of Culture invited dZO to propose ideas for a new type of library called “Mediatheque of proximity,” which would accommodate a collection of books, CD ROMs, and DVDs for a number of remote cities in France.

Instead of celebrating a forthcoming disappearance of the book, our project blends traditional ways of storing information: books and digital storage/retrieval of information. The walls of the building are conceived both as the storage space for the information (books and digital media) and a stacking of glass and stone blocks that defines an uncertain boundary between interior

spaces and the landscape outside. The glass shelves, for the new media support, and the stone shelves for the books, are stacked along the walls creating a pattern that is defined by the content of the library.

Five hundred linear meters of storage of books and information support have been compressed inside of the mediatheque and by a process of folding and splitting to generate the reading, working, and reception spaces. This strip defines zones of interaction containing books, CD ROMs, DVDs, and electronic devices to interact with them and offers a great flexibility in the interior spaces. The stacking of the stone and glass blocks of the load-bearing

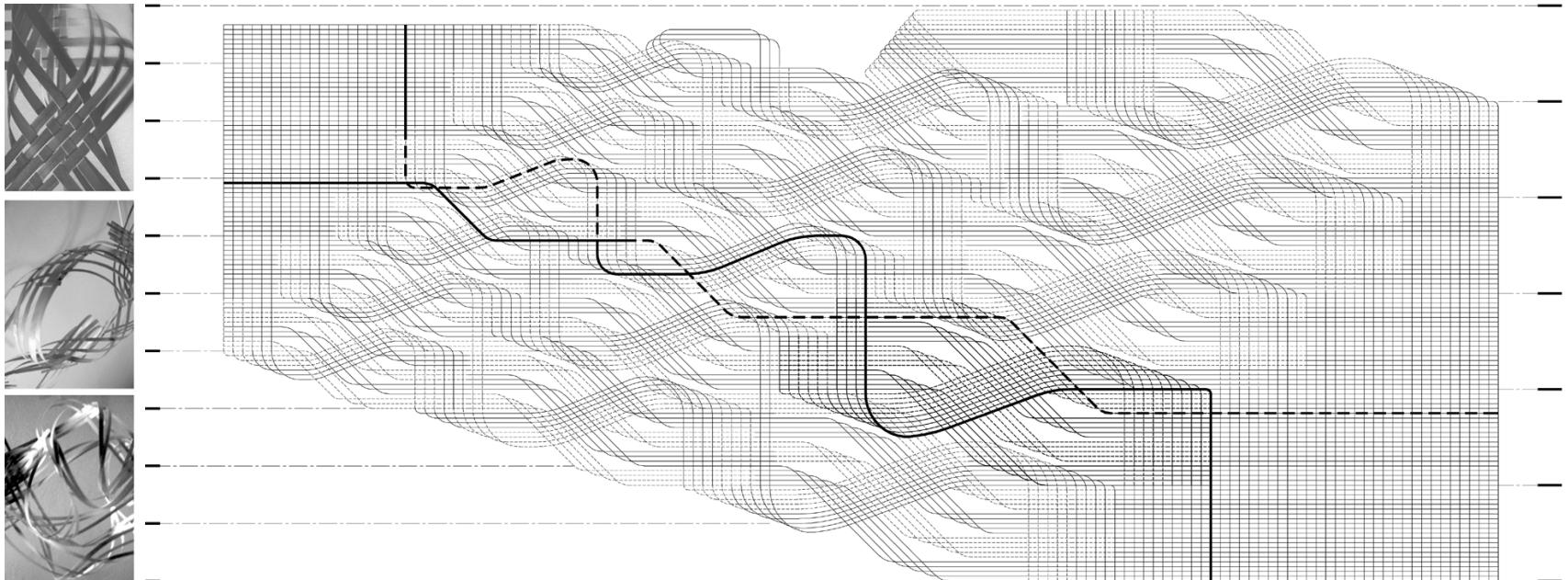
wall extends to the inside of the space to become shelves and support and integrates the tectonic dimension with the ornamental. The transparency of the wall/support of mediatheque constantly varies depending on the type and amount of information that it contains and frames as well as blurring the limit of the interior spaces with the landscape.

### **Ghost Track: Eighth Venice Biennial**

Our installation for the eighth Venice Biennial focused on designing an envelope that creates its own environment as much as it is flexible to other environments. We worked on the weaving technique, which

attracted us because of its complex fabrication process and the difficulty necessary to codify it. Nevertheless it represents the oldest way to create volumes—with surfaces—and it is a powerful technique to blend structural with ornamental patterns.

Beyond numerically controlled fabrication, our attempt in this project was to integrate digital modeling with artisanal weaving technique. It is easier to create a digital model of verbal knowledge (such as “teaching” a machine to play chess, for example) than to model a “savoir-faire” or know-how, a technique of manual elaboration that implies irregularity, hesitation, trial and error, and internal logics of



compensation, in an attempt to keep the surface as a whole together. The technique of braiding evokes this kind of complexity where the hands interact with the form in each of the knots. It points to the power and product of a transformative intelligence, which is a mental and material process shared by any kind of technique.

The art of braiding, knotting, twisting and curling motifs, the oscillation of the thread around the fabric generate an incessant inversed and reversed figure as they are dreams of spaces without seams, where the weave loses in its density of the surface the linearity of its contour. Like a carpet covered with ornamental patterns, the woven

surface uses a simple movement, which repetition and recurrence precede by gradual complication in time and in space. The woven surface tends toward the loss of its figure, an internal pulsation of the surface, which is both graphic and structural, and blurs the legibility of its surface.

As we know, the principle of the textile essence of architecture, as stated by Semper in “Prinzip der Bekleidung,” addresses the shell and its texture as primordial, preceding the structure. Architecture begins with and in ornament, or rather, in the woven mat; not with its capacity to provide shelter or put up an enclosure, but with its actual fibrous quality. The interior

is not defined by a continuous enclosure of walls but by the folds, twists, and turns in an often-discontinuous ornamental surface. The ornamental destiny of the twisted surface begins the process of superposition of form and structure. Strictly speaking, it is only the ornament that is structural. What matters, in the woven surface, is the coincidence of graphic and structural, the textile pattern that determines its own internal tension and physical behavior. From this differential process of the constitution of the surface we can, we believe, draw out structural and formal issues that go well beyond the form/structure debate.

