THE AUTOPOIESIS AND MIMESIS OF ARCHITECTURE

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Abstract. The use of digital technology in architecture has proven to be more assertive than originally thought: it has reconditioned the nature of the design process, and established new practices and techniques of fabrication. The 21st century began with the technology of art. There is a new responsiveness to the reading and understanding of digital space, which is characterized by complexity and the uncanny. Recent applications in digital technology show inquisitiveness in the contentious subject Genetic Algorithms. This new architectural process is characterized by two main shifts: from poiesis (or poetry) to autopoiesis, and from authenticity to mimesis. Since evolutionary simulations give rise to new forms rather than design them, architects should now be artists and operators of both Inventive and Systematic design. Inventive design: The digital media should bring about poiesis (poetry). Digital spaces reveal and visualize the unconscious desires of urban spaces and bring forth new dreamscapes, mysterious and surreal. This implies a Freudian spatial unconscious, which can be subjected to analysis and interpretation. "Space may be the projection or the extension of the physical apparatus", Freud noted[1]. Space is never universal, but subjective. A space would be a result of introjection or projection – which is to say, a product of the thinking and sensing subject as opposed to the universal and stable entity envisaged since the Enlighten. There is a spatial unconscious, susceptible to analysis and interpretation. Systematic Design: Digital media should bring about an autopoiesis. This approach calls into question traditional methods of architectural design – which replace the hierarchical processes of production known as "cause and effect" - and proposes a design process where the architect becomes a constructor of formal systems. Will the evolutionary simulation replace design? Is metric space dead? Is it replaced by the new definition of space, that of topology? The new algorithmic evolutionary conditions give architecture an autopoiesis, similar to biological dynamics. The use of algorithms in design and fabrication has shifted the role of the architect from design to

programming. Parametric design has introduced another dimension: that of variation and topological evolution, breaking the authentic into the reused. Architecture now is about topology than typology, variation than authenticity, it is mimetic than original, uncanny and subconscious than merely generic. In a parallel universe, which is both algorithmic and metaphysical, the modeling machine creates a new abstraction, the morphogenesis of the "new hybrid condition". The emphasis of the exploration is on morphological complexity. Architecture may become – paradoxically - rigorous yet more uncanny and introverted.

1. Digital Uncanny

I would argue that from its inception, digital media were considered a discipline external to architecture. By definition the digital in architecture does not exist. Despite this, architecture seems to truly lend itself to digital exploration. It creates a topology of symbolic forms as digital constructs. More importantly, it manifests itself in the most ambiguous element – space – within which any projection moves freely and without fixed boundaries. The new technology of the digital media has managed to unravel the repressed condition and abandoned projects of 20th c architecture (Futurists and Surrealists), and to challenge the only ideology that created it: modernism and its associated technology. One may talk about the relationship between the digital uncanny and introjections.

In architectural terms, the search for modernism's repressed condition was concentrated in the domain that the modernists had clearly and polemically identified as the basis of their attack on tradition: the irrational, the decorative and the uncanny. A good example is Tzara's indictment of modern architecture as a "complete negation of the image of the dwelling." "Modern architecture," Tzara argued, "as hygienic and stripped of ornaments as it wants to appear, has no chance of living…because it is the complete negation of the image of the dwelling" (Tzara, 1933).

In the modernists' tradition, the line between nature and machine, between the organic and the inorganic seemed clear; organicism was a metaphor, not reality. But for the current digital media, the boundaries between organic and inorganic are blurred; the body itself, invaded and reshaped by technology, in turn invades and permeates the space outside, even as this space takes on dimensions that themselves confuse the inner an the outer, visually and physically. As Walter Benjamin (1982) presciently observed, "The work of Le Corbusier seems to arise when the 'house' as mythological configuration approaches its end." Digital technology attempts to reincarnate these "mythological configurations," repressed by modernism, with the monstrous and anamorphic merging of animal and house as an

oneiric machine, a machine for dreaming. After all, there is no architecture without dream, myth or fantasy.

Figure 1. The blurring of lines between the mental and the physical. House interior project by author

The blurring of lines between the mental and physical (Figure 1), the organic and inorganic was transformed by the surrealists, especially Dali, into a formulation that stressed the intersection of the biological and the constructional, building and psyche, architecture and hysteria, in order to produce the ultimate object of desire, or its reification at least. Characterized by its mimesis of the digestible, it was an architecture that, in Dali's words "verified that urgent "function," so necessary for the amorous imagination: to be able in the most literal way possible to eat the object of desire." Walter Benjamin (1982) stated that the intersection of technology and nature was represented by the displacement of symbols from Romanticism to Modernism. Here we may begin to trace the affiliations of Surrealism and modernism on the level of technique - affiliates that were stated by Benjamin in the aphorism: "The reactionary attempt that seeks to detach the forms imposed by technique from their functional context and to make natural constants out of them – that is to say, to stylize them…" In Benjamin's terms, the structure that unified the two was fetishism. For fetishism, in its multiple displacements, "suppresses the barriers which separate the organic from the inorganic world." It is as "at home in a world of the inert as in the world of the modern mechanization of the dwelling in its mission of repression against the bric-a-brac of the nineteen century."

2. Mimesis

What happens, then, when the fusion between the organic and the inorganic takes form? Mimesis? A mimesis that has a multiple interpretation. Digital technology is mimicking architectural space so much that it becomes believable and "real," that organic and inorganic matter, animate and inanimate forms become indistinguishable. Form becomes malleable and changeable and interactive, as though it imitates its occupants. The body fuses with its surroundings.

According to Walter Benjamin and Theodor Adorno's biologically determined model, mimesis is posited as an adaptive behavior that allows humans to make themselves similar to their surrounding environments through assimilation (Adorno, 1984). Through physical and bodily acts of mimesis (i.e. the chameleon blending in with its environment), the distinction between the self and other becomes porous and flexible. Rather than dominating nature, mimesis as mimicry opens up a tactile experience of the world in which the Cartesian coordinates of subject and object are not firm, but rather malleable.

Figure 2. The act of mimesis as a means for survival

Adorno's discussion of mimesis originates in a biological context in which mimicry (a mediator between life and death) is a zoological predecessor to mimesis. Animals are seen as genealogically perfecting mimicry (adaptation to their surroundings with the intent to deceive or delude their pursuer) as a means of survival (Figure 2). Survival, the attempt to guarantee life, is thus dependant upon the identification with something external. The manner in which mimesis is viewed, as a correlative behavior in which a subject actively engages in "making *oneself* similar to an Other", dissociates it from its definition as merely imitation (Adorno, 1984).

According to Adorno (1984), "by means of the mimetic impulse, the living being equates himself with objects in his surroundings." This surely holds the key to exploring the question of how human beings situate themselves within their environment, and points to an area in which the domain of psychoanalysis may offer crucial insights into the mechanism by which humans relate to their habitat. It begins to suggest, for example, that the way in which humans progressively feel 'at home' in a particular building, is through a process of symbolic identification with that building. They may come to identify with technological objects. This symbolic attachment is something that does not come into operation automatically; it occurs gradually. Mimesis in Adorno, and in Walter Benjamin, is a psychoanalytic term - taken from Freud - that refers to a creative engagement with an object. Mimesis is a term, as Freud himself predicted, of great potential significance for aesthetics.

To understand the meaning of mimesis in Adorno we must recognize its origin in the process of modeling, of 'making a copy of'. In essence it refers to an interpretative process that relates not just to the creation of a model, but also to the engagement with that model. In mimesis imagination is at work, and serves to reconcile the subject with the object. This imagination operates at the level of fantasy, which mediates between the unconscious and the conscious, dream and reality.

It is important to recognize here the question of temporality. Symbolic significance may shift, often dramatically, over a period of time. What was once shockingly alien may eventually appear reassuringly familiar. The way in which we engage with architecture must therefore be seen not as a static condition, but as a dynamic process.

Mimesis for Benjamin offers a way of finding meaning in the world, through the discovery of similarities. These similarities become absorbed and then rearticulated in language, no less than in dance or other art forms.

Architecture along with the other visual arts can therefore be viewed as a potential reservoir for the operation of mimesis. In the very design of buildings the architect may articulate the relational correspondence with the world that is embodied in the concept of mimesis. These forms may be interpreted in a similar fashion by those who experience the building, in that the mechanism by which human beings begin to feel at home in the built environment can also be seen as a mimetic one.

Mimesis, then, may help explain how we identify progressively with our surroundings. In effect, we read ourselves in our surroundings, without being fully conscious of it. "By means of the mimetic impulse," as Adorno comments, "the living being equates himself with objects in his surroundings." The aim throughout is to forge a creative relationship with our environment. When we see our values 'reflected' in our surroundings,

this feeds our narcissistic urge, and breaks down the subject/object divide. It is as though - to use Walter Benjamin's use of the term mimesis - in the flash of the mimetic moment, the fragmentary is recognized as part of the whole, and the individual is inserted within a harmonic totality. It is within the new digital spaces that the act of mimesis happens (Benjamin, 1986).

3. Algorithms and the Breeding of Digital Forms

One technique by which mimesis is be constructed is by Algorithms. Algorithms may be defined as a detailed sequence of procedures to solve a problem. As such algorithms may be programmed to execute a series of mimetic tasks. Genetic algorithms constitute a class of search algorithms especially suited to solving complex optimization problems. In addition to parametric optimization, genetic algorithms are used in creative design, such as combining components in a novel and inventive way and ultimately creating a new complexity of language and form. Genetic algorithms transpose the notions of evolution in nature to computers by imitating natural evolution (Figure 3 and Figure 4). They find solutions to a problem by maintaining a population of possibilities according to the 'survival of the fittest' principle. Because of this ability to "search" algorithmic scripts or codes generate form, which is precise and complex and which would be impossible to have conceived using the basic software interface and tools. Inevitably, a new universe of formal and compositional possibilities opens up and techniques for digital form-finding.
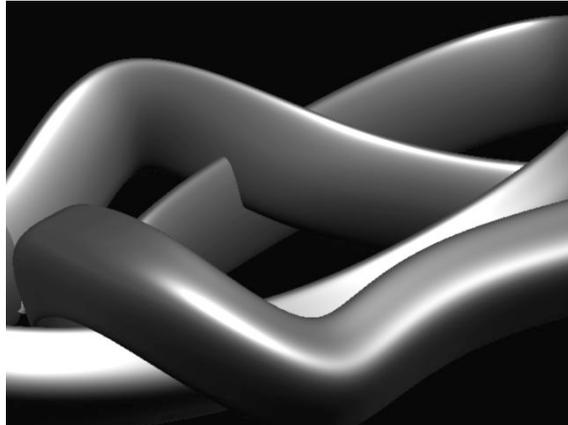
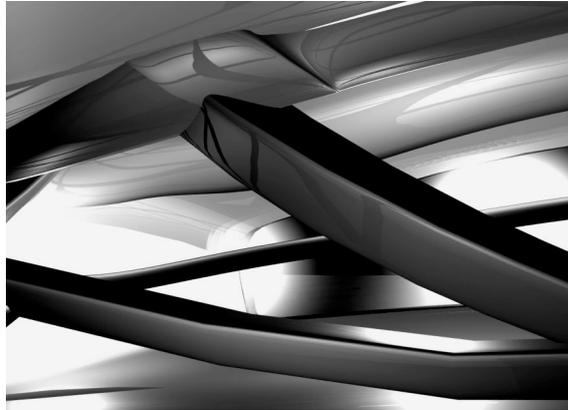*Figure 3*. Evolutionary forms. Project by author

Figure 4. Algorithmic digital form. Project by author

A common approach is to define a building envelope in terms of a series of parametrically defined elements such as the structural ribs. Some forms are curvilinear, non-planar and irregularly shaped, yet precise. Furthermore, some approaches that involve rule structures seek to generate designs via various forms of growth and/or repetition algorithms. Additionally, there are approaches that seemingly abandon any kind of formal approach to shape generation but that seek to allow designers to "discover" meaningful shapes that exist within more complex geometrical patterns. Most of the approaches using formal shape-identification algorithms require specially written computational algorithms. Architects can now use advanced software to breed new forms rather than specifically design them. As De Landa (2001) notes, " …only if what results shocks or at least surprises, can genetic algorithms be considered useful visualization tools."

Algorithms are based on non-linear wave function that through parametric differentiation organizers vectors of density. Can we then talk about fabricating of dense and large cityscapes, employing poly-directional structural networks?

On another level, the role of design has now been transformed into that of breeding fit and beautiful forms. There is clearly is an aesthetic component: the "sculpting" of beauty and the development of a personal artistic style. As with any socio-technological revolution throughout history, architecture inevitably invents a new formal language.

Ultimately, if traditional architectural representation has been based in resembling and describing the appearance of the architectural object, through its use the algorithm architectural notation has become operational; to design the choreographing of the transformation process. The architectural object is transformed into event and performance, either by understanding

architecture as the dynamics of spatial conditions, or by the object being understood as the actualization of built-up potentials.

4. Genetic Algorithms: Intuitive vs. Systematic

Through this highly refined algorithmic process, both intuitive and logical form-making processes are necessary. A grid-like structure transforms gradually into a convoluted scheme with numerous overlapping coils or folds revealing complex patterns. As the new architectural forms become complex, interconnected nodes and parameters change and, in a chain reaction, affect the outcome. Algorithms offer a degree of rationality therefore allow the designer to become a free form maker.

One assumes the role of the artist, not of computer programmer. The outcome requires being visual, and it is about inventing form than about solving problems in a systematic way. The resulting exuberance of formal composition should be judged as any architectural proposal, i.e. first on its visual impact, and the potential to become a building.

Architects may start thinking less in terms of typology and more about topology and variations. One way to introduce this thinking process is by contrasting the results. More variations are necessary in order to keep the "search" exciting. One of the design goals of the generative process is not only to support both the "designer's" (intuitive) view and the "programmer's" (formal) view, but also to reconcile these two views and create appropriate mechanisms as an interchange between them.
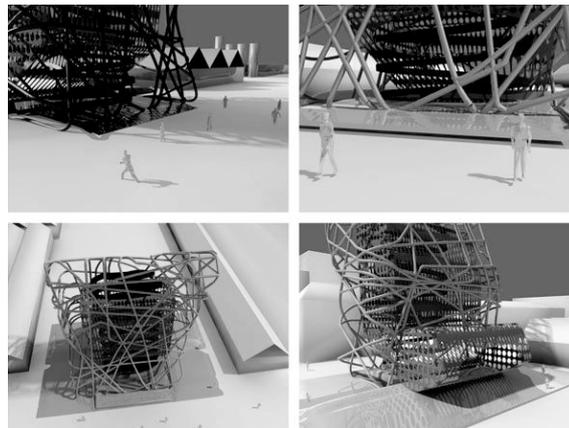

Figure 5. Composite algorithmic forms. Project by author

New possibilities may be the introduction of a new kind, a heterogeneous structure, as layers of form generated by different codes. Complex behavior

comes from the interaction of simple parts (Figure 5). The basic principle of Generic Algorithms is searching for optimum balance, and the eventual survival of the fittest. Evolutionary Algorithms can be both a structural making device and a search mechanism. The structurally oriented form-finding approach becomes a useful tool for composing space through repetition. Structural members define both the surface and the volume of forms.
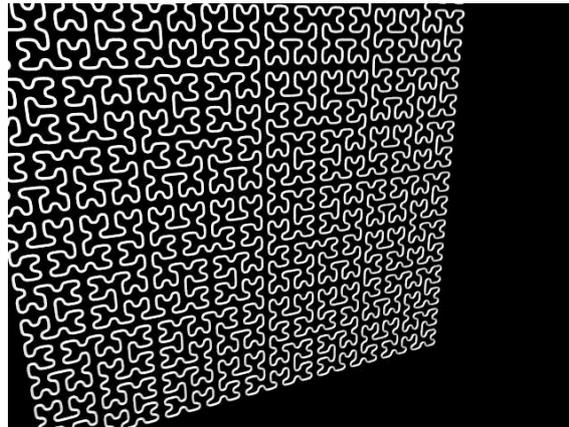
Figure 6. This image was created by placing the algorithm onto a unit sized NURBS plane

The new digital approach to architectural design is based on computational concepts such as topological space, isomorphic surfaces and parametric design. Architecture is recasting itself, becoming - in part - an experimental investigation of topological geometries. Digital media is employed not as a representational tool for visualization, but as a generative tool for the derivation of form and its transformation – the digital morphogenesis. It explores the possibilities of "finding form". Topological space opens up a universe where essentially curvilinear forms are not stable but may undergo variations, giving rise to new possibilities, i.e., the emergent form (Figure 6).

In the task of designing rich search spaces, certain philosophical ideas, which may be traced to the work of Gilles Deleuze (1993), play a very important role. Though not invented by Deleuze, he was the one who brought them together for the first time, making the basis for a brand new conception of the genesis of form. According to Manuel De Landa (2001) in his essay "Deleuze and the Use of the Genetic Algorithm in Architecture," the productive use of generic algorithmic implies the deployment of three forms of philosophical thinking:
    1. Populational thinking: The sequence of operations points at

spontaneous and multiple mutations.

2. Intensive thinking: Without the structural engineering and distributions of stress, a virtual building will not evolve as a building.

3. Topological thinking: The obtained with the genetic algorithm must demonstrate an incredible combinatorial productivity like in natural forms, with thousands possibilities.

The employment of the genetic design strategies develops autonomous architectural concepts, which replace the traditional hierarchical processes of production known as "cause and effect": new organizational patterns and weavings and performative morphologies that can modulate and differentiate the environment. This morphogenetic process includes pattern, repetition and permutations.

The tendency towards architectural autonomy might be understood as a moment of overall societal process of differentiation. Traditionally, architecture and good design were inseparably connected with society and harmony. The new algorithmic evolutionary conditions give architecture an autopoiesis. The autopoietic system as a complex, historically evolving system always uses time and involves series of events in its "responses," so that simple and predictable one-to-one correlations between environmental impacts and system responses are out of the question. Recent developments in digital technology expose a degree of autonomy that architectural discourse has established by differentiating itself from the immediacy of everyday talk about buildings, and thus the complexity of the discursive detour, which mediates a particular impact/response, should grow with the overall complexity of society (Figure 7).
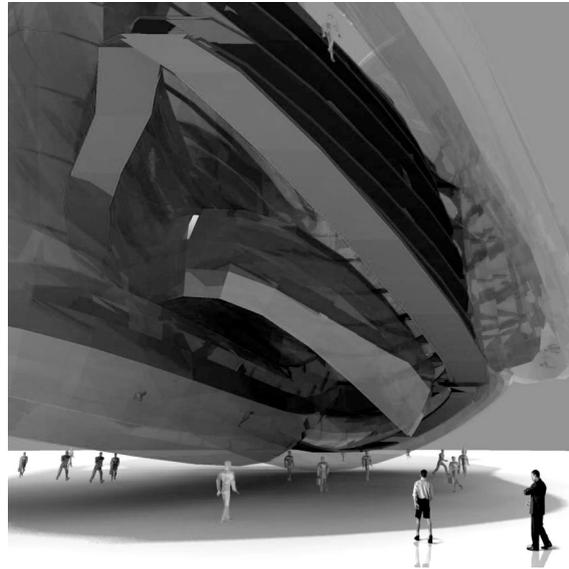
Figure 7. Controlled Complexity. Project by author

Current experimental work focuses on issues of organizational complexity (layering, interpenetration of domains), on the production of diversity (iteration vs. repetition), on the spatial recognition of fuzzy social logics (smooth vs. striated space), on ways of coping with uncertainty (virtuality vs. actuality), and on engagement with new production technologies.

What is important about the morphogenetic model is the degree to which it allows for a coexistence of various forces, engendering an autogenetic, autopoietic and mimetic system. Autopoietic systems produce theories of complex self-organization that nevertheless can become problematic. Self-organization or autopoiesis is thus impossible without the necessary random influx of external forces. This is precisely Felix Guattari's point when he talks about the machine and its arrangement that a machinic arrangement of heterogeneous forces and heterogeneous autopoietic processes are much more interesting than simple models of poiesis (Deleuze and Guattari, 1993).

Moving beyond the design of an envelope alone, only spatial relationships may incorporate another layer, that of interiority, by "weaving" in one (enclosure) into the other (interior). There are two levels of complexity: that of weaving of the skin and that of the volume.

In weaving, the linear fluidity of wrapped objects creates exciting visual forms. A repeated line gives the forms an organic and often mystical quality. Because of the predictability of a wrapped surface, their generation lends

itself to scripting and procedural methods using wrapping algorithm. One can imagine a solid shape being "mummified" or wrapped at various layers.

This dual process is what it is known as the "exogenous" and "endogenous" control of plant development. Diffusion-limited aggregation and cellular automata provide models of *exogenous* mechanisms of branching pattern formation. In this case, components of the growing structure communicate through the surrounding space, in contrast to the *endogenous* control mechanisms, which rely on information flow within the developing structure. In nature, endogenous and exogenous control mechanisms are often combined. For example, the development of a tree is affected by the genetically controlled formation of meristems (apices), the flow of water, nutrients, and phytohormones through the branching structure, and the plant response to environmental factors, such as the shading and crowding of branches. *Environmentally sensitive* systems represent one of the approaches proposed to create comprehensive models integrating endogenous and exogenous phenomena. Architectural design, as well as fabrication, can now employ and imitate these operations.
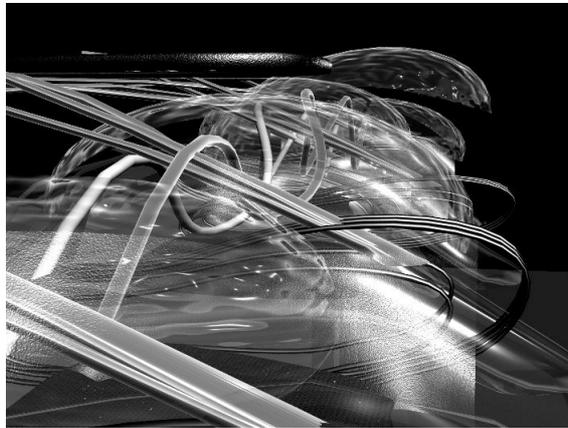
5. Programmed Morphology

Figure 8. Space vs. structure. Project by author

The new apace is the outcome of the synthesis between space-oriented and structure-oriented models, developing self-regulatory patterns in which potentialities are regulated by the developing structure itself (Figure 8). These techniques result in the simulation of evolutionary and environment based three-dimensional structures and surfaces. The new research in

architecture involves structural morphology and generative modeling of architectural form. The design process now has even now turned from the mimetic into one of growth, based on given data (directions or restrictions). Algorithmic structure represents abstract patterns that are not necessarily associated with experience or perception. Algorithmic processes result from events that are often neither observable nor predictable and seem to be highly intuitive. In this sense, algorithmic processes become a vehicle for exploration that extends beyond the limits of perception.
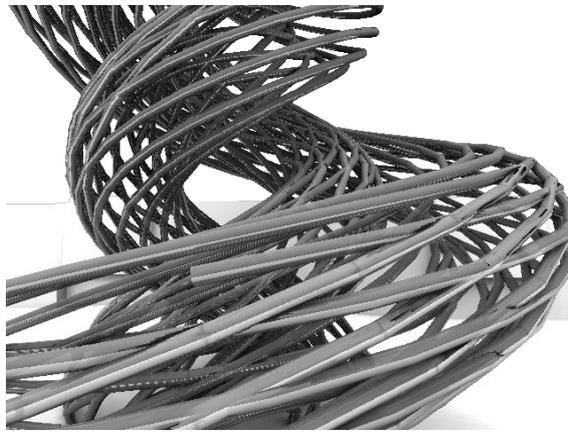
Figure 9. Double weaving. Project by author

```
proc pipe()
{
    string $inputCurve[];
    float $posB[];
    float $posA[];
    vector $pointA;
    vector $pointB;
    vector $norm;
    float $normal[];
    string $selectedObjects[];
    $inputCurve = `ls -sl`;
    string $selectionString = $inputCurve[0] + ".u[0.5]";
    select -r $selectionString;
    $posB = `pointPosition`;
    $selectionString = $inputCurve[0] + ".u[0.0]";
    select -r $selectionString;
    $posA = `pointPosition`;


    // create the approximate normal for the curve at 0,0
    $pointA = <<$posA[0], $posA[1], $posA[2]>>;
    $pointB = <<$posB[0], $posB[1], $posB[2]>>;
    $norm = unit($pointB - $pointA);
    $normal[0] = $norm.x;
    $normal[1] = $norm.y;
    $normal[2] = $norm.z;

    // create the circle and extrude it
    circle -c $posA[0] $posA[1] $posA[2] -r 0.1 -nr $normal[0] $normal[1] $normal[2];
    CenterPivot;
    select -tgl $inputCurve[0];
    $selectedObjects = `ls -sl`;
    extrude -ch true -rn false -po 0 -et 2 -ucp 1 -fpt 1 -upn 1 -rotation 0 -scale 1 -rsp 1 $selectedObjects[0]
$selectedObjects[1];

}
```

Figure 10. Example of a script to pipe curves

Algorithmic Architecture employs methods for creating new architectural morphologies (Figure 9 and Figure 10). By using scripting languages and working with codes it is possible to create forms through methods analogous to the evolution of intelligent life: emergent behavior and self-organizing systems. It pursues various methods through which the role of the designer can shift from "space programming" to "programming space". What the new scripts and codes can achieve is conceptual broad gestures at the beginning, and precision later on, only when the underlying geometric relationships have been defined and tested. This is an ideal process in any design, starting form broad ideas and gestures and which then are developed in more detail. Beyond CAD tools and the interface of even advanced modeling software, this requires new methods. These new tools should be open-ended and programmable. As parameters change so do the variety and topological permutations. Well-established and used scripts are those that generate what is called weaves and braids. Given the specific surface or volume, they achieve an interconnectedness of elements for bracing and strength, like continuous materials. Structurally, both tension and compression are in a new set of relationship; more a network of structural matrix. Weaves are

based on parameters for surface topology description, density, and number of strands or threads. They can adopt a helicoidal or crosshatch pattern.

The applications of this new emerging technology are numerous. This paper attempts to look into the future a mention needs to be made of the article "The New Paradigm in Architecture" by Charles Jencks. Although almost impossible to categorize Jencks has identified five approaches that broadly represent the range of current digital architecture: Organi-Tech, Fractal Architecture, Blobitecture, Enigmatic Signifier and Landform.

The architectural process is evolutionary and intuitive. As if re-enacting Surrealism in a new form, the modernist repressed condition may have been liberated, replaced by the uncanny and the myth and the new autopoiesis of architecture.

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