

The Future of Form: The Location of Meaning in Data-driven Architecture

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"Meaning is bankrupt."

---Greg Lynn, 1991 lecture at the AA

INTRODUCTION

The plethora of recent architectural work exploring new digital tools and processes can be broadly categorized in terms of purpose as productive or generative. The first, productive, is focused on enabling an architect to visualize, achieve or refine an architectural concept which has already been formally predetermined. The second category of use concerns the generation of architectural form from data-inputs (referred to generally as parametric design). This paper compares these two major uses of computational innovation in architecture, production and generation, in terms of their aims and impact on the creative process and modes of meaning-generation.

Both categories involve new technology including point-cloud scanners, BIM, CNC mills, laser cutters, 3D printers, 3D modeling software, algorithms, parametrics, scripts, and other computational software. The key difference is in the way in which the digital processes are engaged creatively and the ultimate representational intent of the architect. While both categories are at the leading edge of architectural innovation today, the second can be taken to a more radical extreme in that conventional idioms and thematics of representation and architectural meaning (poetic, metaphysical, etc) are rejected or displaced.

This paper investigates the relationship of the new material processes to representation and meaning in architecture. To do so, first the paper situates these new phenomena within a brief history of architecture and architectural 'meaning' leading

up to the contemporary trend towards 'parametric' design. By putting them in a broader historical context it shows that what now appears to be a radical paradigm reversal is actually one step in a continuous trajectory or series of steps moving away from the symbolic representation of a transcendent metaphysics towards ever more instrumentalized processes and immanentized 'meaning'. It argues that the shifts are socially constructed but technologically or materially conditioned: there is a negotiation between the two domains.

It looks at Gehry as an example of how the new technological hardware/tools can be harnessed to preserve subjective and stylistic nuances and gestures from an "old-school" creative paradigm (that of the romantic genius turned starchitect creating his masterpiece) and argues that the tools do not determine anything, in themselves, but offer new creative and instrumental opportunities as well as limitations.

It then examines what is new and radical in the parametric (ie parametric, algorithmic, and scripting) design paradigm more closely, particularly what it rejects and embraces in traditional paradigms of authorship and creativity, and how it is aligned with the domination of information, media, technology as thematics, not just as tools. The generative use of computer processes challenges the old paradigm.

The paper then specifically focuses on meaning (theoretical justifications or models) in new explicitly data-driven generative processes. Three new theories or justifications are examined: firstly, performative standards; secondly the morphogenetic model – ie: mimesis of a biological or other 'meta-order' model (such as Emergence

Theory); and finally datascapes—which map data directly into form, positing information as the new meaning. In the case of the work justified by the biological model, despite the intention to jettison all metaphysical baggage, this theory still retains some residuum by virtue of its reference to an ultimate if immanent and emergent Order. The current multiplicity of theories demonstrates the social construction of meaning: as a subject of such debate between three different reference points, 'meaning' cannot be determined by the material processes, only conditioned by them.

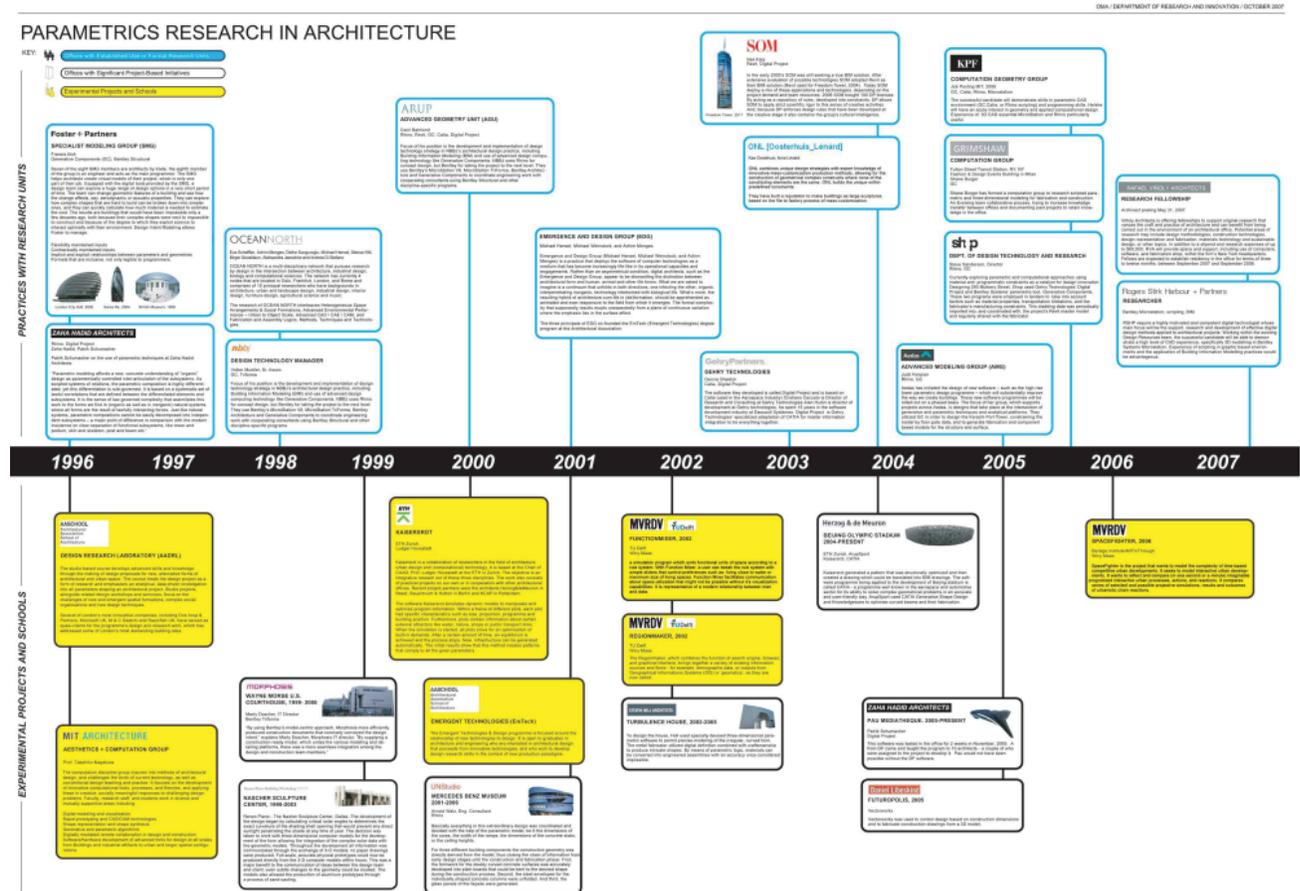
The idea of an ultimate meaning and its artistic expression has been challenged before in movements such as functionalism, dadaism, surrealism. We are now in an era of multiple paradigms where expressionism and the representation of "anti-meaning" can both be seen as relevant responses to our cultural confusion. While new generative processes can refer to a bankruptcy of tra-

ditionally transcendent or romantic meaning they can also refer to one which is emergent and even more immanentized than the romantic subject.

HISTORICAL BACKGROUND

"A bicycle shed is a building; Lincoln Cathedral is a piece of architecture." -Nikolaus Pevsner, An Outline of European Architecture

The presumption has always been that architecture is more than 'mere building': Architecture is supposed to carry meaning. Traditionally this meaning has been of the highest (ie metaphysical) order: the embodiment of the 'ultimate order' behind nature, with its plenitude and fecundity. For example, this connection was specifically developed in ancient Greece through the mystical relationship of mathematics (harmonic relationships found in music) to the divine through platonic geometry, which was the basic ordering system used for the ancient temples.



Digital Research Groups formed since 1996

The history of western architecture shows that cultural ideas about this Order are constructed socially, while continually integrating new scientific and technological understandings and possibilities. Advances in technology do not determine meaning (interpretation), but rather undermine existing interpretations while setting up new frameworks of possible understanding and (re-)interpretations. This is, for instance, what happened when the traditional metaphysical connections with architecture were cut off in the Enlightenment. The symbolic and metaphysical understanding of mathematics which had been carried forward via Renaissance Neo-Platonism was undermined by the new scientific processes including the development of calculus: this discovery instrumentalized the traditional geometrical representation of the infinite (the infinitely divisible line) which can be traced back to Pythagorean geometry. With calculus it was now possible to calculate by way of algorithms what had previously been the assumed infinity of points contained within any line: that symbolic infinity was suddenly intellectually graspable. This led to many debates about the role of science versus tradition, the nature of infinity and ultimate meaning.

In the context of bankrupt belief systems and the resultant cultural disorder, a new understanding and interpretation was needed. Rationalistic and aesthetic approaches to architecture and science developed, which could explain some things well but could not explain everything: one result of increasing mathematical precision was that the creative process and the symbolic 'wholeness' of the world seemed relatively mysterious and not well articulated: the *je ne sais quoi* discussed in many European texts of the 17th century. 'Reason' therefore gave rise to its apparent opposite, Romanticism, which was in fact its complement.

Romanticism involved a cultural/social immanentization and relocation of symbolic wholeness and nature's fecundity (conceived in terms of metaphysics as the divine or infinite) in the evolving paradigm of the romantic artistic genius as the source of inexhaustible creativity. As a parallel development to rationalism, the romantic subjective expressiveness (the personal style, nuances, gestures) of the artist became more and more highly valued in the production of the masterpiece. This dichotomy has prevailed right through the mod-

ern period and continues today. The split is well-illustrated by the simultaneous theories of functionalism (rational) and primitivism (romantic) in the work of Le Corbusier, for example.

More recently, the postmodern period was characterized by a theoretical preoccupation with meaning (what should be represented and how is meaning constructed) which drew on ideas from the post-structuralists and neo-rationalists amongst other schools. The other recent phenomenon of the last 20 years with great impact on architectural culture is the rise of media/information culture. The two trends intersect in a mediatised version of the romantic genius exemplified by the celebrity 'starchitect', whose personal style and genius creates icons. This leads to a contradiction. On the one hand each icon is a 'meaningful' representation somehow drawing on divine genius. But at the same time the plethora of individual expressions seem to add up to little more than a landscape of personal expressions of ego.

The intense focus on theory and meaning-generation in the 70s and 80s was ultimately exhausted by the 1990s. The debate about the construction of meaning had not resulted in agreement about a stable and meaningful object of representation. Consequently, a theoretical void opened up in architectural circles which coincided with the rise of digital computer technologies. Architectural theorists had recently explored--via Walter Benjamin's work-- how material (technological) processes change the nature of artistic production: the conceptual path was open to consider how digitalization could be part of architecture. Elite archi-



Skyline of Egos, Collage by OMA

tectural schools (AA, Columbia, etc) and theorists like Greg Lynn began to explore computer tools while architects like Rem Koolhaas experimented with data-forms (but not using the computer to generate them) in projects like the Whitney and Seattle Public Library.

I. DIGITAL PRODUCTION AND THE ROMANTIC PARADIGM

The vast majority of digital tools and techniques usage today is engaged on the productive level, ie after the Author/Architect conceptualizes the form in a 'traditional' way using a mode of meaning such as metaphor, concept, etc. Production takes several forms. 3D modeling digital processes are used to represent and refine the form. Models for study and presentation purposes are then made quickly to accurate dimensions using laser cutters and 3d printers. BIM software gives precision and control to the documentation and development process of a building. On the level of construction fabrication, linking the 3D model directly to CNC mills for example streamlines the production process, eliminates the potential for craftsman's error, and enhances feasibility of variety by making custom and unique elements cheaper.

New material productive processes by themselves do not necessarily work against the traditional romantic genius paradigm with its emphasis on personal style and nuance of form but in fact can enhance an Author's repertoire and the realization of personal aesthetics. Because final architectural form is already distanced from the initial conception---usually planned, developed, and documented in a long process after the concept is formed and before the construction begins-- the immediacy of expressionistic marks which indicates authenticity and value in sketches or paintings for example in the art world is not normally part of the architect's product --only in the proverbial napkin or concept sketch. This sketch—the initial idea put down notationally and expressionistically in a 'eureka' moment by the architect which sets the design intention and general outlines of the building idea—is normally mediated and developed traditionally through drafting and modeling processes into a documented set of instructions for the contractor to execute. Digital processes engaged on the productive level can, with greater control and precision and often in a

shorter period of time, simply replace and reconfigure the manual labor traditionally used to draft, model and document the developing design from the concept sketch onwards towards the fabrication of the final work.

In addition to digitalizing and streamlining later parts of the developmental process, new tools and operations for form-generation make new formal techniques, aesthetics, and built forms possible, thereby increasing the formal repertoire of the subjective Author/Architect, for instance by enabling the articulation of complex and fluid geometries. The greater precision possible in digitization also enables their personal aesthetics to be even more faithfully reproduced in the built work. For example, in Gehry's case the digital processes make it possible to very accurately document and translate into built form extremely subjective stylistic nuances that retain all the playfulness of the hand-built models which he uses to work out initial concept sketches he draws by hand. Gehry works like a sculptor on these physical models. To preserve his signature nuances the models are digitally scanned to create point clouds that are transformed into digitized forms. For this the sophisticated 3D modeling software CATIA (and now its architectural customized descendent Digital Project) is used because it is able to carry and preserve Gehry's signature complex organic shell forms. Further the parametric and BIM ability of Digital Project is used for repetitive parts of buildings (e.g.floor plates) in order to refine the shape of the building and calculate cost quickly. Finally the BIM qualities of the Digital Project software are used to contractually document the design as a



Guggenheim Museum in Bilbao © Frank Dellaert

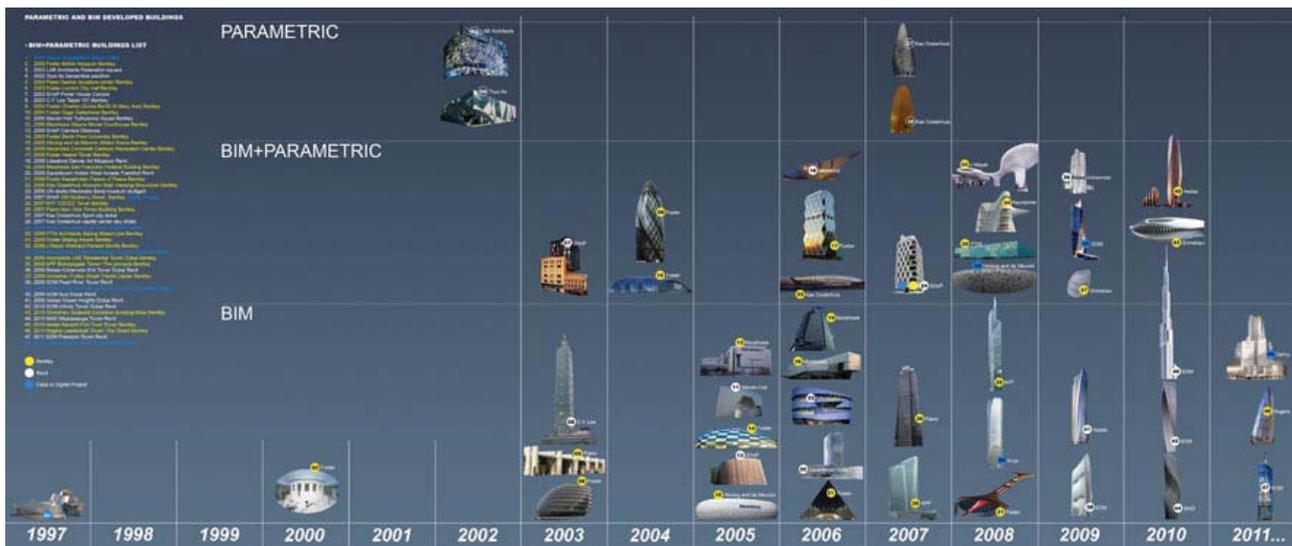
digital 3D model (replacing conventional 2D drawings). The software allows architects to work out complex geometrical nodes like corners in 3D to avoid construction problems later. This is an advantage over traditional 'plans and sections' representation that allow only static 2D views and not a 3D view. This precision and comprehension of Gehry's 3D documentation controls quality and cost because contractors have more precise material and geometric information with which to calculate price: they don't have to 'pad' their prices to cover unknown factors. Gehry requires his sub-consultants to use his software, thereby controlling the process virtually to the end built product.

The vast majority of new digital activity in architecture today involves similar productive processes—most of all 3D modeling as a replacement for traditional drafting but also including 'back-end' processes like BIM, laser-cutters, etc to refine and document the design. This kind of activity still fits without conflict within the traditional paradigm of the romantic genius who retains all the prerogatives of creative conceptualization, form-giving, and stylistic expression. This type of innovation and engagement of digital processes does not change the fundamental creative paradigm, it does not displace meaning or relocate the position of the author. The representational intent (ie the object of meaning) of the architect (rather than the material process) is key: are they using the processes mainly to help them achieve a preconceptualized form?

II. NEW GENERATIVE PROCESSES AND THE INFORMATIONAL PARADIGM

As happened with calculus in the 17th century and the relationship between mathematics and metaphysics, material processes can instrumentalize what were fundamentally poetic modes and processes, necessitating a rethinking and new formulations of order/meaning. While material processes do not construct meaning in a determinant sense (as seen with Gehry's example), there is a tension and relationship between social and material aspects--the construction of meaning is negotiated and mediated, with each aspect having an effect on the other, neither determining totally. Material processes have the most impact when there is a corresponding weakness in the social construction of meaning. One such material process to have an effect on meaning-construction would be computer scripting with data-input for the generation of form. The contemporary failure of traditional objects of symbolization to convince (Lynn's statement that 'meaning is bankrupt') and the recent collapse of theory created a vacuum for the new (social) construction of architectural meaning.

Far fewer projects currently engage new technologies for generative purposes than for productive purposes. These projects are loosely labelled 'parametric design' and utilize scripting functions with parametric possibilities, generative algorithms, and other computations (requiring data-input). The engagement with digital processes on a gen-



Productive vs. Generative: Projects since 1997

erative, creative level is exemplified by boutique offices and individuals such as Kas Oosthuis, MVRDV, COA, SHoP, the Kaisersrot project, Ocean North, Greg Lynn FORM, Marcos Novak, as well as the experimental research being carried out in elite architectural schools such as the AA, Columbia University, SCI-Arc, and more recently U Penn. Many of these boutique firms also take advantage of the fabrication and rapid-prototyping potentials of digital tools to create new effects quickly.

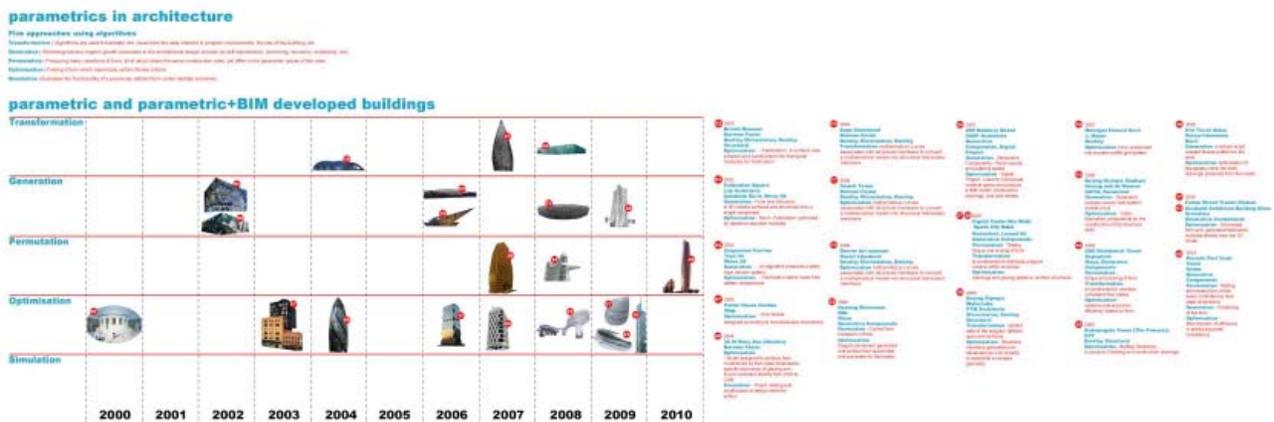
Scripting technologies essentially automate part of the creative process of form-giving formerly part of the author's domain. They generate vast combinations of possibilities with minute differences between them, producing a series of formal options systematically within a set of parameters (a range between constraints). In terms of the creative process, this dislodges traditional notions of the role and prerogatives of the Author. It amounts to a paradigm shift, but only in a partial way that relocates the nexus of creativity away from the (romantic) subject to the raw and externalized process of combining, producing and selecting--- much like DNA works in the genetic model. The Author is therefore distanced but not severed from the work: they still must set up a design intention in terms of determining or writing the program and to what ends (what the script does or tries to achieve--for instance some performative criteria)-- and must also set the range or constraints in which the automatic generation of options occurs. This means that an Author's traditional romantic 'eureka' moment of inspired form in terms of metaphor or some other symbolism

as well as the 'art marks' of subjective expression are no longer part of the creative process, and no longer important to the authenticity of the work. In this way the new processes can be seen as anti-author and anti-style.

This new automatic generative process can be applied at different scales to parts of a building or the whole building, and the degree to which the entire architectural object is generated through computational processes determines which paradigm of creativity within which it falls. If the generative script is applied to only a part of the building like a façade pattern, for example, as opposed to the basic shape and massing of the entire building, it is still possible for the work to generally reside in the traditional paradigm---form given by (and meaning determined by) the Author.

III. MEANING IN GENERATIVE PROCESSES

In the absence of convincing metaphysical systems for geometrical representation such as was the case through the Renaissance, the theoretical legitimacy (ie meaning) of 'parametric' design is usually based on one of three sources: either deriving from its production of performative effects (claims to 'build in' and optimize the site constraints or other performative criteria) or secondly in terms of process: mirroring generative processes from either emergence theory or more specifically the biological model of genetic (DNA) combinatories (morphogenesis), or thirdly from references to broader cultural phenomenon



Five approaches to design using algorithms

in terms of mapping data-sets (as is the case with datascares).

This multiplicity of possible meaning-justifications illustrates the fact that meaning is socially determined. While all fall within the new constraints and possibilities of interpretation posed by new digital processes of generation, they rely on different models or theories for legitimization. These theories are a source of debate but each also carries inherent problems, highlighting the ultimately unstable nature of meaning. These problems range from being dangerously close to collapsing into a discredited hyper-functionalism to becoming hooked into a cycle of meaning/anti-meaning to failing to jettison metaphysical baggage yet claiming so.

PERFORMATIVE MODEL

In this type of generative project the 'author' sets design intent according to performance criteria: for instance degree of sunshading, maximizing certain view, obtaining a particular programmatic mix. They write the script and sets parameters accordingly. Iterative algorithms are often used to generate a relevant range of options and selections are then made according to optimization of the performance criteria (in conjunction with other pertinent criteria). Performative criteria privilege architecture's utilitarian or functional aspect over its representational one, even eliminating the representational or symbolic dimension altogether: therefore a major problem is the obvious potential of a collapse into a hyperrational or hyperfunctional determinism: what is at stake in eliminating the symbol or metaphor as a meaning-generating device and using instead fitness criteria and judging the value of the architecture on whether it is

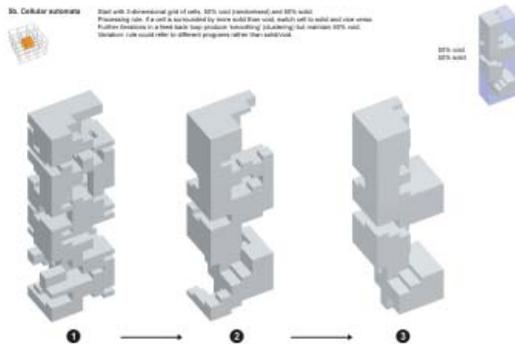
performative? Does the work become too seemingly mundane, self-referential and disconnected from the many dimensions of life by eliminating a higher or external, 'poetic' reference?

BIOLOGICAL MODEL/ EMERGENCE THEORY

With the biological or Emergence Theory models, which are contemporary scientific theories about an informational meta-order that organizes our world, the use of genetic algorithms are justified in terms of a mimesis of natural processes on the micro-level: a constant production of new combinations of raw 'DNA' or the microcosm logic of fractal geometry. This is in one way the most conservative theoretical justification of new generative processes: meaning is displaced away from an object of reference (a visual symbol or metaphor) and located in the process but some residuum of the metaphysical remains in this process. Architecture still is aspiring to some over-arching idea of natural order (albeit a process), and in this way still aligning itself with an authoritative and transcendent meta-order and ultimately still referencing a notion of plenitude and infinity, but one which has become almost completely immanentized. Like the performative model, this type of project often utilizes a sort of architectural Darwinism in which the fittest survive (are chosen according to fitness criteria).

DATASCAPES

Datascares are projects that explicitly 'map' data in their form, generally resulting in eccentric, unusual shapes which escape traditional aesthetic ideas and eliminate the humanist idea of artistic expression (nuance, gesture, art-marks, style and personality). This type of approach was pioneered by Rem Koolhaas/OMA using non-digital means in, for example, the Seattle Public Library and the Whitney Project. But what is new currently is how this type of project has evolved and is now being generated computationally with more sophisticated and complex use of data-inputs (for instance by MVRDV or Asymptote). Key to the issue of meaning in datascares is what data is used or mapped. If only functional data is materialized into form it becomes highly instrumentalized and also has the danger of falling into hyper-functionalism. Other datascares reference outside material: random data sets or culturally significant markers like financial information, or other significant statistics. In those instances there is an external reference



to a broader culture but still avoiding poetic metaphor or symbolism. Data or information as itself the object of representation --rather than a constraint to be taken into consideration and either made a design feature or woven unobtrusively into a design 'about' something else and hushed over—is the point and makes a statement about the status of meaning and representation today: meaning has been replaced by information: information is the only meaning, one could say a type of anti-meaning.

CONCLUSION

In terms of both artistic process and general cultural order we currently live in a time of transformation and change: today there coexist more than one paradigm of creation and meaning. After the crisis of meaning in the Enlightenment, the cult of the romantic genius who possesses immanent (divine) creative power arose and this paradigm remains relevant up to the current day in the person of the celebrity starchitect.

In the last fifteen years or more, radically new digital tools have been developed and are being used in the service of this old paradigm. Frank Gehry's creative process demonstrates that these tools can enhance and extend the creative prerogatives of the designer/starchitect through providing new formal possibilities, preserving the nuances of the designer's signature style, and making the building documentation precise enough to control the cost of constructing innovative geometries—and therefore making them buildable. But the same digital tools, engaged in a more creative way, are being used to challenge old paradigms and open up possibilities for new paradigms. By using digital processes to creatively generate formal possibilities through data-input, the notion of the romantic genius is undermined and loses its supremacy. The role of the Author is distanced from the creative process: they are now more a technocrat setting up the machine by determining an intent and a range of exploration: they are no longer a romantic genius expressing their divine talent.

Digital generative processes also imply that the poetic or conceptual meaning generated by the romantic genius loses power to convince and further that the new object of meaning is subject to debate: three different 'justifications' (ie

architectural theories) based on the new digital processes have currency today. The fact of a multiplicity of possible meaning-justifications and the current debate about them illustrate that meaning is not technologically or materially determined: new material processes create new frameworks of possibility for interpretation, and thereby set new conditions for meaning, but the possible meanings are still debated and socially constructed. Meaning is not determined by new material processes, but is constructed out of the possibilities provided by them.

If, as Greg Lynn said, today traditional meaning is bankrupt, the only logical substitute in the Information Age is informational, an 'anti-meaning' – a 'meaningful' recognition that traditional objects, devices and modes no longer convince. While new paradigms attempt to jettison architecture's metaphysical baggage once and for all, the morphogenetic model seems to reaffirm an emergent yet immanentized meta-order. While a morphogenetic model appears to be a radical stance, it is only the latest step in a series of immanentizations of ultimate meaning/order and instrumentalizations of the processes of architectural 'making,' that stretch back at least as far to the Enlightenment. The severing of mathematics and metaphysics at that time opened up a void at the heart of architectural thinking, yet, as the biological model shows, somehow architecture still seems unable to completely let go of its metaphysical roots. Today the leading edge of architecture navigates the between hyper-functionalism and residual metaphysics.

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