

# Design as 2<sup>nd</sup> Nature

Patrik Schumacher, London 2018

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The slogan 'design as second nature' can serve as suggestive pointer or shorthand for many decisive features that together characterize the essential innovations of the work of Zaha Hadid Architects and indeed of parametricism<sup>1</sup> in general. The implied analogy with nature operates on many levels and invites many interesting productive elaborations. Our work aspires to give our artificial built environments the complex differentiated order, beauty and legibility we find in natural environments.



The work of Zaha Hadid Architects operates across all design disciplines and scales from urbanism to product and fashion design. The organic, nature-like formal language that characterizes all ZHA designs unifies an otherwise very diverse spectrum of morphologies. This essay demonstrates the rationality potentials of this architectural style.

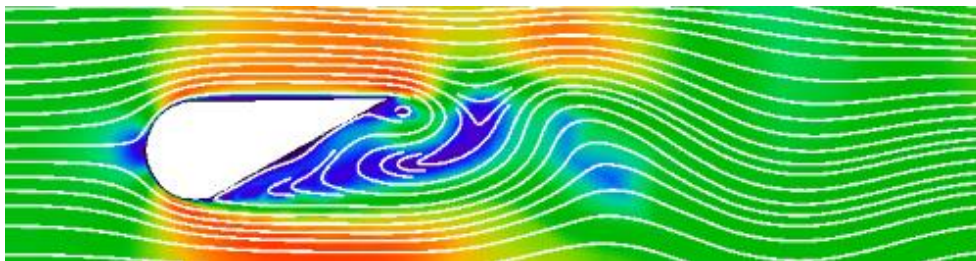
Architecture, since its self-conscious inception as innovative design discipline in distinction to tradition-bound building in the Renaissance, has always aspired to be nature-like, i.e. the idea of architecture as 2<sup>nd</sup> nature is as old as the discipline itself.

What has changed is the conception of nature that underlies this nature analogy. Originally key compositional features like symmetry and proportion were the primary features elaborating the analogy. The idea of the organism also demanded rigid building types with a fixed set of parts in a determinate arrangement. In Alberti's treatise this idea establishes the classical ideal of beauty: "Beauty is that reasoned harmony of all the parts within a body, so

<sup>1</sup> Patrik Schumacher. **Parametricism** - A New Global Style for Architecture and Urban Design, published in: *AD Architectural Design - Digital Cities*, Vol 79, No 4, July/August 2009

that nothing may be added, taken away, or altered, but for the worse.”<sup>2</sup> Alberti further insists that “The mistake is [to be] avoided of making the building appear like a monster with uneven shoulders and sides.”<sup>3</sup> Alberti continues: “Every body consists entirely of parts that are fixed and individual; if these are removed, enlarged, reduced, or transferred somewhere inappropriate, the very composition will be spoiled that gives the body its seemingly appearance.”<sup>4</sup> This concept of an organic whole, with symmetry and strict rules of proportion, with a state of completeness or perfection that tolerates neither additions nor subtractions, remained in force throughout the Renaissance, Baroque and Neo-Classicism. The rationality of this rigid notion of order relies on the uniformity and fixity of institutions. It started to be challenged only in the 19th century, in the Neo-Gothic style, within Eclecticism, and then Art Nouveau. It was fully and finally abandoned only with Modernism where open, asymmetric compositions became possible, and all classical proportions were abandoned.

Since the late 20<sup>th</sup> century chaos theory and attendant computational simulation tools made much more complex and dynamic natural formations tractable. These tools were feeding into architecture either directly or via the discipline of computer graphics. It is this new understanding of natural formations as self-organizing dynamic systems that inspires our current understanding of architecture as 2<sup>nd</sup> nature.



Computational Fluid Dynamics (CFD) is a simulation tool used in many engineering contexts.  
Xi Engineering Consultants, Edinburgh

## Bio-mimetics and Vernacular-mimetics

The architecture-nature analogy operates on many levels. The research programme of bio-mimetics is one of the levels that has been very productive for the development of parametricism in recent years. Frei Otto pioneered a similar research paradigm - the research paradigm of natural constructions - based on inorganic processes of

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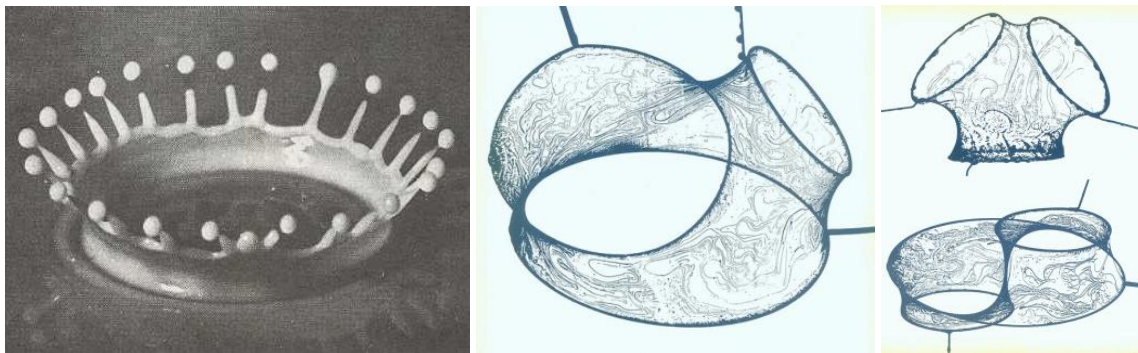
<sup>2</sup> Alberti, *On the Art of Building in Ten Books*, p 156

<sup>3</sup> Alberti, *On the Art of Building in Ten Books*, p. 199

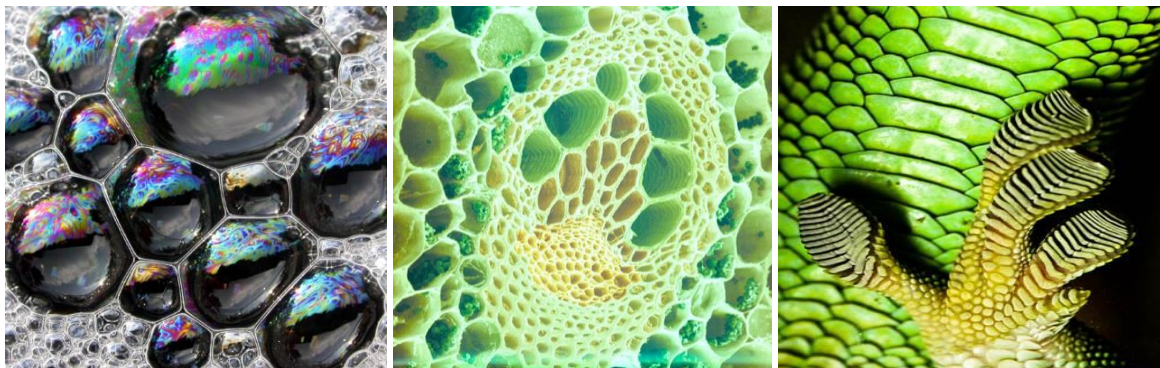
<sup>4</sup> Alberti, *On the Art of Building in Ten Books*, p. 199

morphogenesis. We at Zaha Hadid Architects have absorbed the lessons of Frei Otto and continue to work hard to apply his insights and models wherever opportunities to do so arise.

The inorganic, spontaneous processes of material self-organisation investigated by Frei Otto also underlie all organic forms, as was first shown by D'Arcy Thompson<sup>5</sup> and then further emphasized by Stuart Kauffman<sup>6</sup>. Such processes of material self-organisation - 'form finding' as Frei Otto called them to distinguish them from form invention which is always vulnerable to fail under attempts of their realisation – by necessity deliver forms that are coherent with material capacities under the given constellation of forces.



Morphogenesis via Material Self-organisation: Photo of a milk splash from D'Arcy Thompson's 'On Growth and Form' & Frei Otto, Soap film experiments delivering Minimal Surfaces, Institute for Lightweight Structures (ILEK)



Inorganic self-organisation processes furnish the base patterns upon which selective-adaptive organic evolution operates via genetic, differential reproduction in accordance with fitness criteria

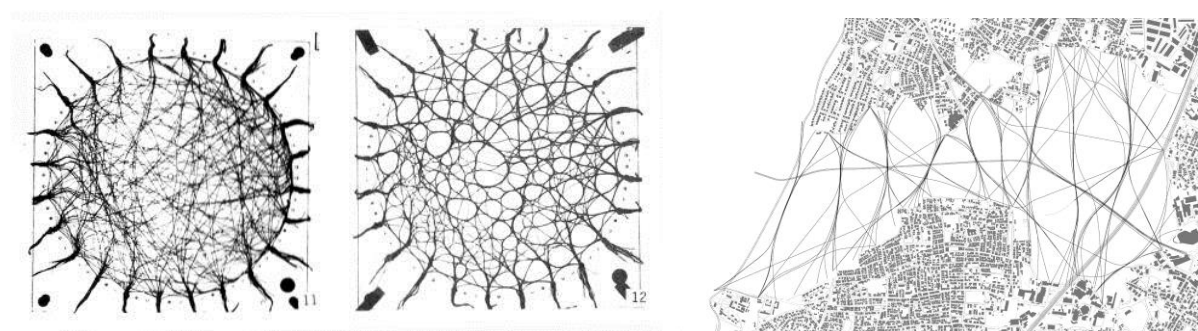
Organic evolution is of further interest as problem solving and performance according to more demanding fitness criteria than mere existence, as well as evolutionary optimisation processes come into play. Bio-mimetic research is guiding innovations in all arenas of engineering, not only building engineering. Classical examples include the invention of Velcro inspired by the tiny hooks on bur fruits and the development of dirt- and water-

<sup>5</sup> D'Arcy Wentworth Thompson, *On Growth and Form*, Cambridge University Press 1961

<sup>6</sup> Stuart A. Kauffman, *The Origins of Order: Self-Organization and Selection in Evolution*, Oxford University Press, 1993

repellent paint coating from the observation that nothing sticks to the surface of the lotus flower plant.

However, bio-mimetics indeed inspires engineering solutions rather than architectural solutions for two reasons: First, the scale of a building's macro-morphology is so large in comparison to most organic structures that the performative effectiveness of analogical transference often breaks down. Second, the performance criteria that buildings or building components share with organic structures are technical rather than social. However, technical functionality is engineering business while architecture's *sui generis* concern is with social functionality. An interesting parallel (as yet tentative) research programme<sup>7</sup> has been opened up with respect to indigenous, vernacular building traditions that over many centuries of gradual trial-and-error piecemeal improvements discovered and evolved impressive adaptive performative rationalities and economies with respect to given material constraints and local climate conditions. Here too technical rather than social transference potentials dominate due to the fact that the social processes that architects have to address today are mostly far removed from the pre-modern live processes sustained by the vernacular traditions. However, there are some fundamental, universal, invariant social-functional exigencies and problems that concern all human settlements and that thus allow for and invite the analogical transference of solutions on a sufficiently abstract level. For instance, Frei Otto<sup>8</sup> discovered that unplanned vernacular settlement structures often evolved minimal path systems as well minimized detour systems that optimize the trade-off between total system length and average detour imposition and he used material systems like the Wool-thread model to reproduce or simulate the optimisation process.<sup>9</sup> We used these insights and processes in some of our large scale urban design proposals.



The path system for Zaha Hadid Architects' Kartal-Pendik (Istanbul) Masterplan uses the optimisation strategy developed in Frei Otto's Institute for Lightweight Structures (ILEK) by Marek Kolodziejczyk. The Wool-thread

<sup>7</sup> I first came across this approach in the work of Michael Hensel and Achim Menges

<sup>8</sup> Frei Otto, *Occupying and Connecting: Thoughts on Territories and Spheres of Influence with Particular Reference to Human Settlement*, Edition Axel Menges, Stuttgart 2009

<sup>9</sup> Bill Hillier offered similar rational reconstructions of various typical vernacular settlements patterns. See: Hillier & Hanson, *The Social Logic of Space*, Cambridge University Press, 1984

model computes an optimised detour path networks similar to the path system we often encounter in unplanned cities.

## Bio-morphism and Geo-morphism

Proponents of bio-mimetic research in architecture have often emphasized the distinction between bio-mimetics and bio-morphism, rejecting the latter as superficial and meaningless in contrast to the performative achievements of bio-mimetics. This judgement makes sense from an engineering perspective that demands physical performance in relation to a given technical demand. However, within architecture this dismissive judgement is fallacious. It misses the essential point that architecture is concerned with social performance and that social performance of the built environment strongly relies on its visual performance in terms of maintaining legibility in the face of urban complexity, and I shall argue that bio-morphism can potentially perform better on this count than e.g. minimalism, post-modernism, or deconstructivism.

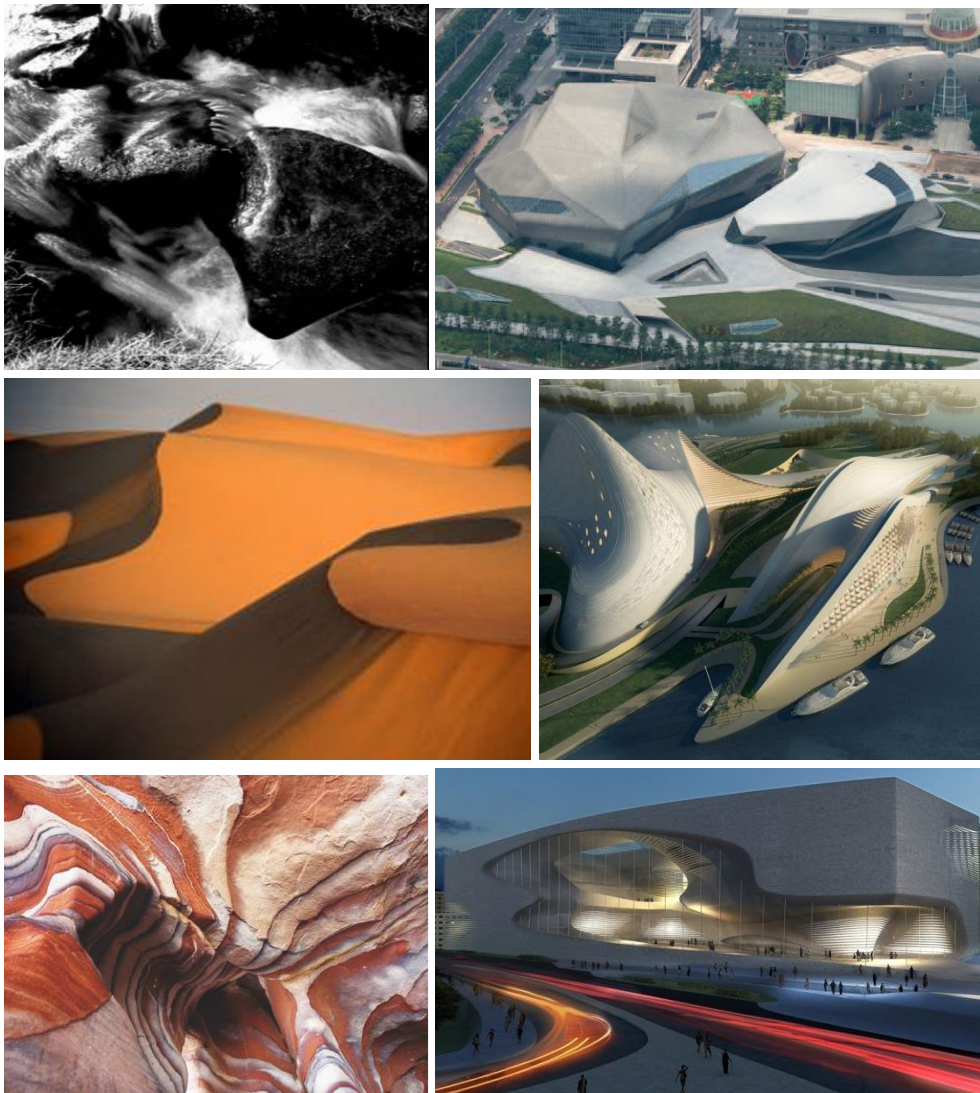
Also, in judging bio-morphism - here understood as the attempt to develop a formal repertoire or 'design language' inspired by the general formal characteristics of natural and organic forms - we must indeed take the broad perspective of appraising alternative styles as formal rule systems and general design resources, rather than focussing on individual designs with their particular biological inspiration. The rationality of bio-morphism cannot be discerned in the particular choice of a particular organic model which is indeed mostly arbitrary. Many models might have served equally well. What we must pay attention to are the general characteristics of models drawn from nature in distinction to traditional architectural models. What comes to light in such a general comparative characterisation are typical characteristics like the following:

- The pliability and subtle parametric variation of forms relative to contextual conditions, in contrast with the rigid forms and the strict repetition of elements in classical and modern architecture
- The gradients and smooth transitions between zones or patterns we find in natural landscapes or skins of animals in contrast with the hard edges and sharp dividing lines that characterise classical and modern architecture
- Affiliations and resonances between radically diverse forms and correlations between diverse and internally differentiated subsystems or strata, i.e. rule-based interdependencies, imply that the diverse elements and buildings that comprise the urban environment, in contrast to current urban clusters, never remain unmediated, unrelated, or randomly juxtaposed and agglomerated. All compositional actions induce or require corresponding reactions in the network of interdependencies. There are no limits imposed on the creative invention of the rules of reaction or dependency other than insuring that the established correlations are legible.

These general principles for a productive bio-morphism match up with the 'formal heuristics' of parametricism as first formulated in the author's 2009 paper 'Parametricism -



A New Global Style for Architecture and Urban Design’, although this paper does not explicitly refer to bio-morphism. Concerning the work of Zaha Hadid Architects it should be noted that for most of the studio’s life the landscape analogy was much more prevalent than the analogy between architecture and living organisms. We might therefore speak of **geo-morphism** rather than bio-morphism in relation to the work of Zaha Hadid and Zaha Hadid Architects.



Three examples of geo-morphism from Zaha Hadid Architects:  
Guang zhou Opera House 2006, Dubai Opera House 2008, Amman Grand Theatre 2010

These general characteristics are shared by all natural and biological models that fuel the bio-morphic and geo-morphic design imagination. Indeed, bio-morphism does not at all rely on working from specific inspirational models but can work with the general characteristics directly. Either way, what is most important is that these general characteristics offer momentous advantages in the context of architectural design problem solving, in comparison with classical or modern architectural rule systems and formal repertoires.

Formal design repertoires are indeed problem solving repertoires, and need to be appraised as such. The advantage a style or design language offers is the advantage of a better toolset that offers a greater chance to create a superior design, potentially beyond the reach of somebody competing with an inferior tool set. However, there is no guarantee that each design created within the superior style is indeed superior to the designs created within an inferior style. This depends on the particular care and intelligence brought to bear by the designer in the particular deployment of the styles formal resources in relation to the particular design problems posed by the respective project. This means that the appearance of the building which identifies it as of a superior style might be deceiving in that we might expect a superior design. Well, some of us might be able to fine tune their aesthetic sensors and sensibilities sufficiently to learn to distinguish carefully elaborated high performance versions from superficial low performance versions. Aesthetic sensibilities should ideally condition us for the intuitive identification of what is good for us, i.e. the high performing morphologies should intuitively appeal to us as beautiful while what is bad for us should appear ugly and repulsive to us.<sup>10</sup>

Incidentally, and significantly, many of the results of bio-mimetic research will also display the cited general characteristics organic form and therefore potentially be made to partake in the organisational and compositional-articulatory advantages of this new bio-morphically inspired language and style of architecture the author has successfully termed parametricism. Bio-morphism - the organic look - thus comes along, as it were for free, with the bio-mimetically inspired “organic” functioning.

Furthermore, not only bio-mimetically inspired engineering solutions, but most, if not all of the most sophisticated contemporary engineering-led morphologies, are organisationally and visually congenial with the paradigm and style of (bio-morphic) parametricism. This is significant, and a great advantage for parametricism. Also, this is hardly accidental.

Parametricism is the only architectural style that is systematically investing in the computational empowerment of its design processes, thus trying to make the most of the opportunity afforded by the computational intelligence that also empowers all the engineering advances that architectural design should ideally incorporate in its considerations and design decisions. The architectural utilisation of the new characteristic morphologies delivered by recent, computationally empowered engineering and fabrication advances leads to a new subsidiary style within the overarching epochal style of parametricism: Tectonism.

What emerges here is a truly ‘second’ nature, a brand new quasi-nature that evolves radically new morphologies according to evolutionary discovery and optimisation processes

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<sup>10</sup> This theory of beauty also implies that aesthetic revolutions are required whenever the morphological urban and architectural conditions of the vital and good life change, as indeed they have in recent decades.

that operate nature-like, but are appear as artificial, and are as novel and unpredictable as our contemporary fauna would have appeared in comparison to e.g. the era of pre-vertebrae creatures.

## **Tectonism: From Engineering to Style**

Recent advances in numerically controlled fabrication technologies increasingly feed back into the formal repertoires prevalent in avant-garde architectural design, product design and fashion design. This feedback is actively and strategically pursued by the current protagonists of parametricism who are experimenting with new digital fabrication technologies, not so much to empower their prior design sensibilities and intentions but in order to discover new sensibilities and repertoires in the new rather particular sets of affordances and constraints that come with the different fabrication technologies explored. On the basis of industrial robots as generic fabrication infrastructure, the specific technologies explored are developed within the experimental architectural studios themselves - mostly within and around schools of architecture - rather than being delivered ready-made from outside. While the manifest explicit agenda is the rational utilisation of the new productivity enhancing technologies, i.e. the designers are manifestly invested in technical functionality, I argue that the latent, implicit agenda is the expansion of architecture's design repertoire and morphology. The pragmatic promise of fabrication efficiency is an attractive premise for designers but not the most important motivation here: What attracts designers to the new technologies is their promise of new creative and expressive powers.

We indeed witness an intense new investment in architecture's stylistic resources. We are witnessing the formation of a new style: ***Tectonism***.

***Tectonism*** implies the stylistic heightening of engineering- and fabrication-based form-finding and optimization processes.

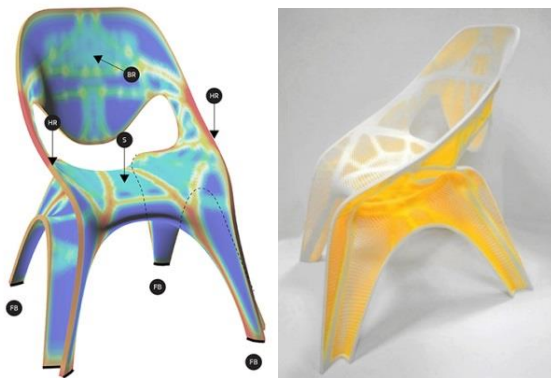
However, this style does not spell a departure from parametricism. Rather, tectonism is the currently most prevalent and promising ***subsidiary style*** (sub-style) within the overarching paradigm and epochal style of parametricism. In retrospect we might distinguish tectonism from earlier phases of parametricism like *foldism* and *blobism*. These older sub-styles are still practiced, just as during the era of Modernism the earlier white Bauhaus style continued in parallel with the later Brutalism. In contrast to these earlier sub-styles tectonism is embedding a series of technical rationalities that secure both greater efficiency as well as greater morphological rigour, while maintaining sufficient degrees of design freedom to



address programmatic and contextual contingencies. Since the principles tectonism utilizes are inherently plural and open ended, this additional rigour comes along with additional tectonic variety and thereby offers a new reservoir of morphological physiognomies. This empowers designers to give a unique, recognisable identity to individual projects. Tectonism delivers much more expressive variety than foldism or blobism, without descending into arbitrary form invention.

While the overarching general design agenda remains parametricism's pursuit of adaptive versatility and complexity, tectonism pursues these with a much richer set of parametric drivers and constraints than earlier versions of parametricism. These drivers originate in sophisticated computationally empowered engineering logics that are now available to architects at early design stages via structural form-finding tools like RhinoVAULT (for complex compression-only shells) and physics engines like 'kangaroo' for 'grasshopper' (to approximate shell or tensile structures), via analytic tools like Principle Stress Lines analysis in 'Karamba' that can also be turned generative, and via optimisation tools like structural topology optimisation (e.g. available in 'millipede'). Various fabrication- and materially based geometry constraints can also be embedded in generative design processes that are then set free to search the characteristic solution space delimited by the constraints. At ZHA CODE we are developing a lot of our own custom tools to model the particular constraints of particular fabrication processes.

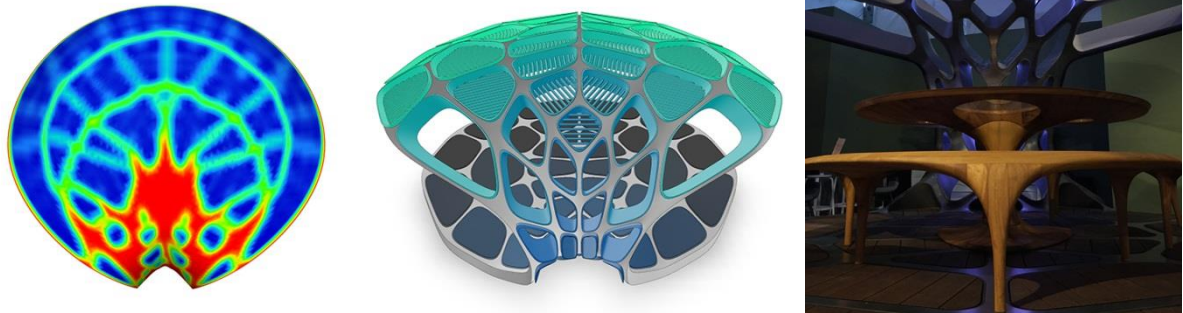
All this leads to uniquely characteristic morphologies and features that nevertheless all remain recognizable as variants of tectonism and indeed parametricism because all these techniques follow the overarching methodology of parametricism favouring parametric malleability. In earlier writings I had identified Frei Otto as the only true precursor of parametricism. This identification and honour also applies in relation to tectonism: Frei Otto and the legacy of his research institute are a huge inspiration to the protagonists of tectonism.



**ACADIA 3D Printed Chair**, ZHA CODE, printed by Stratasys, presented at ACADIA 2014

The design exploits the nearly limitless geometric complexity and fineness of manufacture afforded by high-resolution 3D-printing technologies. The design emerged from several successive optimization processes: After the outer edge line was modelled, the surface was generated via mesh relaxation with Kangaroo. This surface

was then the input for a structural topology optimisation to generate a pattern of reinforcement lines via iterative subtraction. The pattern was then interpreted via two gradient geometric manipulations: first by thinning/thickening the surface depth, and secondly by increasing the perforation between the lines of the emergent ribbing network.



**Volu Garden Pavilion**, ZHA CODE, for Design Miami 2015

This project was developed with the same design methodology via several optimisation steps: First: The global shell form optimization via Kangaroo. Second: The reticulation was evolved via topology optimization. Third: A series of geometric rationalisation algorithms were developed and applied to deliver towards fabrication constraints like a torsion-free network of ribs and developable surfaces for sheet material for the loops.

Tectonism delivers both new technical rationalities as well as new articulatory riches that emerge from the new probing attempts to invent and utilize new forms of robotic manufacturing, including various forms of robotic 3D printing. It is important to note that tectonism - like the earlier stages within parametricism's development – is already operating across the various design disciplines, although architecture remains its heartland.

Many of the best current protagonists of parametricism might be classified as belonging to tectonism as defined here, including the following architects who were featured in the recent AD issue 'Parametricism 2.0': Achim Menges, Marc Fornes, Gramazio/Kohler, Philippe Block, Mark Burry, among many others<sup>11</sup>. Such a classification does not necessarily require self-identification by the protagonists themselves, some of which might remain sceptical with respect to the very concept of style(s) and might resist to being subsumed under any classification. Some of the recent work of Zaha Hadid Architects where structural and environmental engineering logics as well as fabrication logics play an increasingly

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<sup>11</sup> See: AD Parametricism 2.0 – Rethinking Architecture's Agenda for the 21st Century  
Editor: H. Castle, Guest-edited by Patrik Schumacher, AD Profile #240, March/April 2016

formative role in the morphology and tectonic articulation of the design can also be classified as tectonism.



**ARUM**, Zaha Hadid Architects/ZH CODE, with Buro Happold and Robofold, Venice Biennale 2012

This self-supporting, multi-panel shell uses curved-crease folding to generate curved surfaces that can be manufactured from sheet material. The manufacturing process involved the robotic cutting, scoring and folding of 1.5mm aluminium sheets to create the sculpted components that were then bolted together to form the complex double-curved shell that emerged from the patterning without mold.

In particular the various experimental installations developed within ZHA CODE belong to tectonism, but also projects like the Serpentine Sackler Gallery, the 1000 Museum tower, the recently completed King Abdullah Petroleum Studies and Research Center, as well as various projects in planning at the moment: projects using reticulated concrete shells, tensile structures, exo-skeletons, articulated timber structures etc. Further we can include some of Nike's best products like their *Flyknit* shoes or some of ODLO's best sportswear. Here fabric tailoring and unusual knitting textures are driven by engineering concerns like temperature management, moisture management and movement management via various directions and degrees of elasticity, with gradient ribbing and perforation patterns etc. These innovations and their aesthetic expression inspired my own forays into fashion design.



***Parametric Dinner Jacket***, Patrik Schumacher with Vasilija Zivanic, London/New York 2013

This jacket is made from neoprene fabric which is super light, warm, and elastic. The elasticity allows the tailoring to follow the body shape closely without compromising movement and comfort. Zippers substitute for buttons everywhere. Laser cut perforation patterns allow for ventilation where needed and also enhance elasticity, as well as delivering an additional substrate for ornamental/semiological expression. The idea is to offer an elegant formal evening jacket perfect to go jogging right after the event.

In a recent exhibition entitled “Meta-Utopia - Between Process and Poetry” hosted by the Zaha Hadid Design Gallery in London, we displayed a diverse range of experiments in robotic fabrication, including large scale multi-material 3D printing, robotic plastic extrusion capable of printing lines into space without molds, concrete printing, robotic component assembly, robotic hot-wire cutting, as well as robotic curved folding of sheet materials. Each of these fabrication techniques imprints its unique, unmistakable character onto its products, including the shape-range of the overall form as well as the materiality and texture. This means that the concept of “faktura” is well alive in our era of robotics. (Faktura is the visual trace of the fabrication process in the artefact or work of art. It is seen as a positive, character sponsoring quality of the artefact or artwork. The concept emerged in the context of the Russian avant-garde art and design during the early Soviet Union.)

This new diversity of form making potentials and aesthetic expressions affords a welcome expansion of parametricism’s repertoire beyond the smooth nurb surfaces that had been prevalent previously. This fuels both programmatic invention as well as semiological articulation. According to my theory of architectural autopoiesis<sup>12</sup> new styles manifest both new formal concepts as well as a new conception of programme or social function, both connected with the opportunities afforded by new technologies.

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<sup>12</sup> Patrik Schumacher, *The Autopoiesis of Architecture*, Volume 1 & 2, John Wiley & Sons, 2010/2012





**Puddle Chair**, ZH Design with AI Build, presented at Meta-Utopia, ZHD Gallery, London 2017

This chair was designed specifically to be manufactured via free-form, multi-colour (black & blue) robotic 3D printing. The sofa's space frame is optimized for lightness, material robustness and structural integrity, and its intricate design is layered as with an artificial cloth to transform it into a comfortable seating surface with a stimulating ripple surface texture.



**Cirratus** - 3D printed concrete vase, ZH CODE, fabrication by XtreeE, London/Paris 2017

The design is an interpretation of a classic vase by architect Alvar Aalto. A bespoke algorithm produces complex double curvature geometry that adheres to and exploits the specific concrete printing manufacturing constraints and expresses the additive, layer-by-layer process of its making.

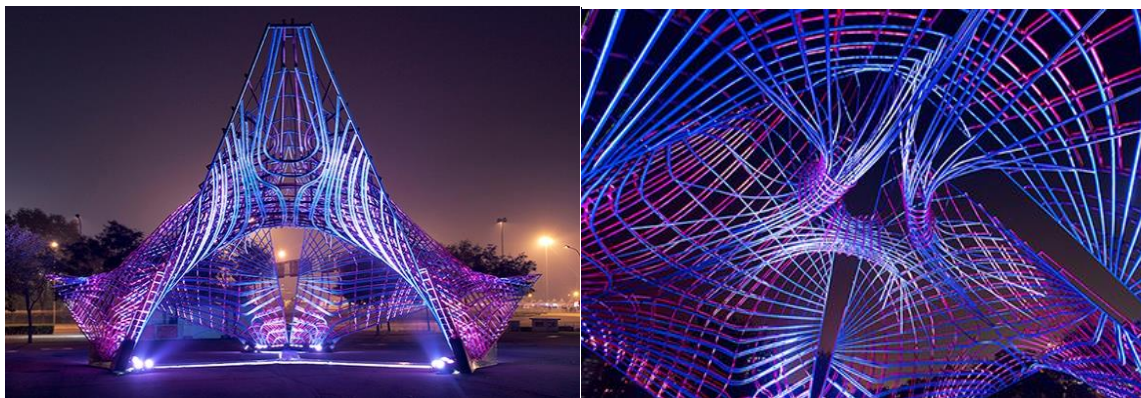
As Lei Zheng, the curator of our Meta-utopia show noted in the catalogue: "New aesthetic sensibilities are here as much tested as are technological feasibilities, rendering a possible future viscerally tangible, and querying its desirability." These works query "technological, aesthetic and anthropological innovations. Fabrication technology experimentation becomes here an engine of both spatio-formal invention as well as socio-programmatic invention."<sup>13</sup>

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<sup>13</sup> Lei Zheng, *Meta Utopia – Between Process and Poetry*, Meta-Utopia Catalogue, Zaha Hadid Design Gallery, London 2017



While many current design experiments focus on exploring new technologies and architects/designers are inevitably drawn into engineering problematics and thus become proto-engineers, stirring and steering real engineers to come on board, it is important to keep track of the fundamental disciplinary difference between design (including architecture) and the engineering disciplines. The demarcation between design and engineering is based on the distinction of the social functioning of the built environment from its technical functioning. The clear demarcation of competencies and responsibilities is the more important the closer the collaboration must become with respect to the complex ambitions we pursue in our built environments. While the technical functioning considers the physical integrity, constructability and physical performance of the building, architecture and design must take into consideration that a building's social function, i.e. its function to order social processes, succeeds via visual legibility. The core competency of architecture/design is thus the task of articulation. However, according to the style and thesis of tectonism, it is the new engineering and fabrication logics that deliver the expressive repertoire of articulation to architecture and design. This double burdening of form selection – where technical and communicative performance must be considered simultaneously – becomes possible only due to the expansive proliferation of technically viable options so that an additional selection criterion that selects and composes an orchestrated subset of all technically feasible forms according to compositional/legibility concerns can be accommodated.



***Candela Revisited***, ZHA CODE with Bollinger-Grohmann, Beijing International Architecture Biennale 2013. Like Felix Candela's Capilla San Vicente de Paul (Mexico City) this structure comprises three Hyperbolic Paraboloids with their tips meeting high in the air. Our take works with a broken rather than perfect symmetry. In contrast to Candela's smooth shell, our shell is a layered grid shell whereby the reticulation pattern follows the principal stress-lines analysed via structural analysis software 'Karamba'.

The relationship between the technical and the articulatory dimension of the build environment leads to the concepts of tectonics, or more precisely *tectonic articulation*<sup>14</sup>, here understood as the architectural selection and utilization of technically motivated, engineered forms and details for the sake of a legible articulation that aims at an information-rich, communicative spatial morphology, for the sake of visual or tactile communication.

It was Neil Leach who first used the concept of tectonics in connection with the digitally based design movement I later termed Parametricism in an anthology entitled *Designing for a Digital World*<sup>15</sup>, and then in a follow up anthology entitled *Digital Tectonics*<sup>16</sup>. According to Neil Leach the title was intended as a strategic re-appropriation of the term 'tectonics' from the more conservative - and seemingly moralising - way that Frampton had used it in his *Studies in Tectonic Culture*<sup>17</sup>.

I welcome this general re-appropriation as a basis for my much more specific concept of tectonics that implies the capacity (if not always the explicit agenda) of communication.

The concept of tectonic articulation applies to all design disciplines from architecture to product design and fashion, and so does the distinction between design and engineering implied in the distinction between technical and social functionality. Within our complex information/network society the built environment and the world of artefacts have to share in the task of information processing and communication: they become an important source of information helping us to navigate and orient within our increasingly complex social world. Thus the social functionality of a designed space or artefact crucially depends on its communicative capacity. All design – across all design disciplines – is to an important extent communication design. In fashion design this is often more obvious than in architecture or product design, but it applies universally across all design disciplines. The designed environment together with the world of designed artefacts – effectively the totality of the phenomenal world that surrounds us – functions as an interface of communication. This includes graphic and web design as well. Therefore all human interactions - whether face to face or mediated - depend on being framed and facilitated by designed spaces and artefacts which should take this crucial function into account.

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<sup>14</sup> This so defined concept of 'tectonic articulation', defined with reference to semiology, was first introduced by the author in: Patrik Schumacher, ***Tectonics - The Differentiation and Collaboration of Architecture and Engineering***, Contribution to the catalogue/book 'Stefan Polonyi – Bearing Lines – Bearing Surfaces', published by MAI - Museum für Architektur und Ingenieurkunst, Ed. Ursula Kleefisch-Jobst et al., Edition Axel Menges, Stuttgart/London 2012.

<sup>15</sup> *Designing for a Digital World*, Neal Leach (Ed), Wiley Academy, 2002.

<sup>16</sup> *Digital Tectonics*, Neal Leach, David Turnbull, Chris Williams (Eds), Wiley Academy, 2004.

<sup>17</sup> Kenneth Frampton, *Studies in Tectonic Culture*, MIT Press, 1995

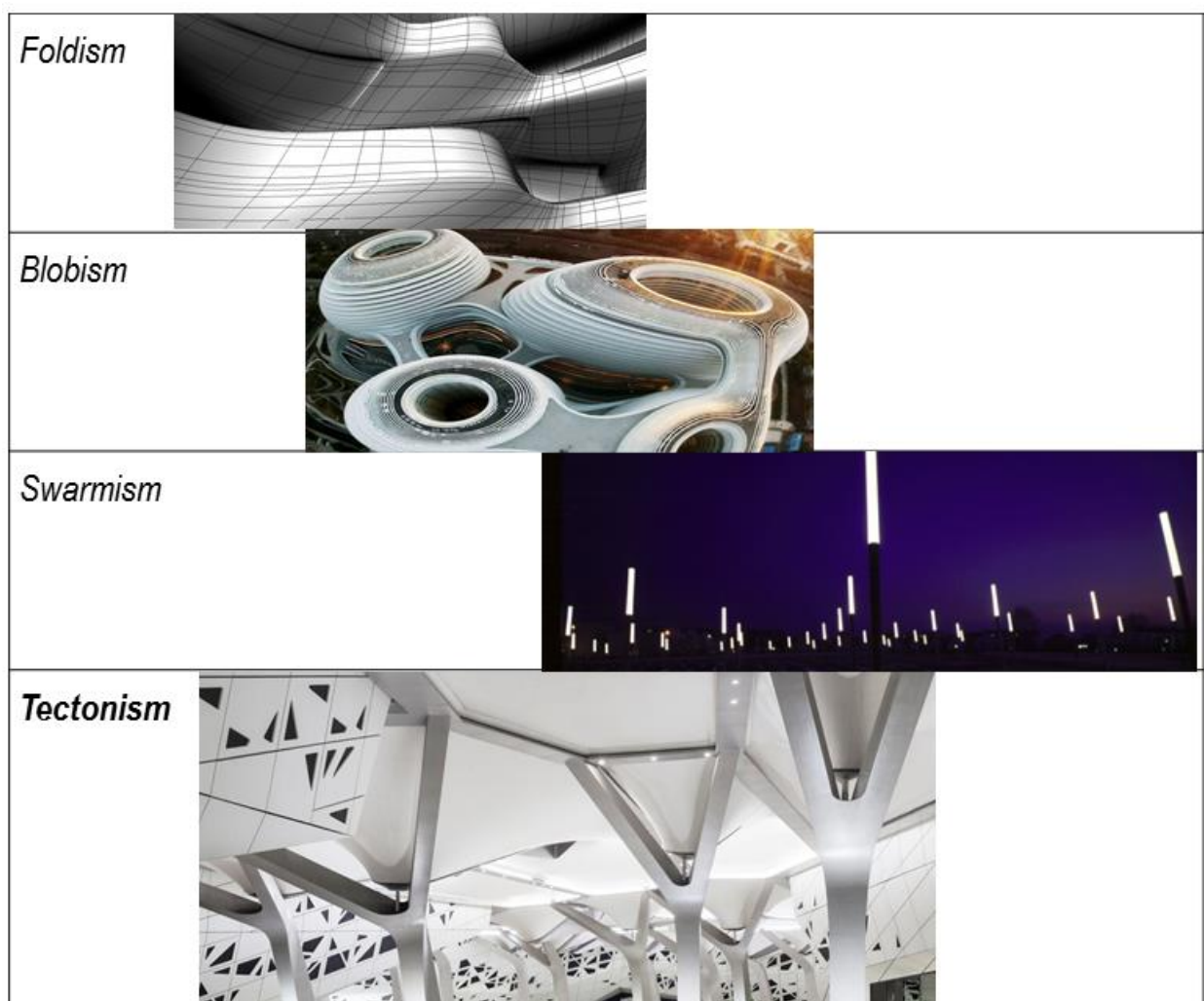
The history of architecture abounds with examples where architectural elements and features with technical functions become the object of articulatory or “ornamental” endeavours. However, we need to understand the instrumentality of ornament, i.e. we need to grasp ornament not in contrast to performance but as a special type of performance: communicative performance. A technically efficient morphology might thus also assume an articulatory, communicative function. The articulatory integration of the morphological consequences of technical requirements is always the more elegant solution than the attempt to fight and deny them by covering them up with a separate communicative surface. This latter stance would require the invention of additional communicative features because social distinctions desire and require expression. However, the utilization of the initially technically motivated morphological features for the characterization of spaces is not only more economical but leads to a higher level of credibility of the communication because the morphological feature that is now to become a signifier is often already an index of the intended meaning rather than a merely arbitrary symbol. In the terminology of the founder of semiotics, Charles Peirce<sup>18</sup>, tectonic articulation thus transforms “indexical signs” into “symbolic signs”. This process too gives degrees of freedom to the designer in the selection of the indexical features that might be heightened and systematized to become elements of a semiological system of signification. In order for architects to pursue tectonic articulation they need to guide and orchestrate the engineering investigations and then select the engineering options that most suit their primary task, namely to fulfil the posed social functions via spatio-morphological communications. The adaptive differentiation of load bearing structures as well as the adaptive differentiation of volumes and envelopes according to the building’s environmental performance (with respect to its exposure to sun, wind, rain etc.) as well as differentiations that stem from fabrication logics (e.g. tessellations, tool path patterns etc.) afford many opportunities for differential tectonic articulation. A thus lawfully differentiated built environment would be much more legible and navigable than Modernism’s mute, isotropic order of repetition or the visual chaos of post-modernist collage.

With the development of sophisticated computational design tools - within architecture, within the engineering disciplines, and within the construction industry - the scope for nuanced tectonic articulation has much increased. The realization of this potential requires an intensified collaboration between innovative architects, engineers and fabricators.

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<sup>18</sup> Charles S. Peirce, *The Essential Peirce: Selected Philosophical Writings 1893-1913*, Chapter 2: What is a sign?, Indiana University Press, 1998

Although there can be no doubt that architecture remains a discourse that is distinct from engineering and construction, a close collaboration with these discipline's as well as the acquisition of reliable intuitions about their respective logics are increasingly important conditions for the design of contemporary high performance built environments. These intuitions can be more reliably acquired if architects and designers engage in amateur proto-engineering by using the various physics engines cited above and experiment with fabrication processes. Tectonism is committed to such practises that demand additional skills and knowledge, and that deliver a new, rich formal repertoire of articulation. These new articulatory powers can be employed in a design agenda of communication made explicit: Design is communication.



Stages and Subsidiary Styles of the Epochal Style of Parametricism illustrated via some works by Zaha Hadid Architects: Guangzhou Opera House, Beijing Soho Galaxy, Strasbourg Parking, Riyadh Research Centre.

## Urban Identity and Legibility

We are witnessing a sustained drive towards urban concentration in global hub cities like London, New York, Tokyo, Shanghai, Sao Paulo etc. Within contemporary network society one's productivity depends on being plugged into urban professional and cultural networks that exist only in the big cities. What each of us is doing needs to be continuously re-calibrated with what everybody else is doing. That's what all further productivity gains depend on. This requires a new level of communicative density that is only available in the metropolis. This underlies what economists measure as 'agglomeration economies'. In the provinces you are cut off and thus unproductive. We all feel this and that's why we rightly pile into the city, and the more central we can locate, the better. Since the neat division into work and leisure has disappeared and we feel the vital urge to remain plugged into the network 24/7 it is as important for us to live in the city as it is inevitable for us to work in the city. Everything presses into the centre, the more the better. This spells a new desire for an unprecedented degree of urban intensification and mixity, a desire which is currently frustrated by outmoded planning restrictions. This new urban dynamic is not only a fascinating challenge and task for architects but first of all requires new degrees of freedom for urban entrepreneurs who need this freedom to experiment, discover and create the best ways to weave the new urban texture and to garner the potential synergies through new intricate programmatic juxtapositions. Only an unhampered market process can be such a discovery process and has the information processing capacity and agility to weave a viable complex variegated urban programmatic order for this new dynamic societal context. The planning brakes had to be released in terms of land use and density restrictions. The power of urban planning and control has been eroded accordingly. If we take a global glance at our big cities it is amazing that there should be any planning systems in place at all. The amorphous urban agglomerations our cities have become certainly don't allow us to see any trace of these regulatory efforts. Planning fights a losing rear-guard battle. The thesis elaborated in this paper not only accepts this fact but moreover extrapolates to municipal urban planning's final demise as logical and desirable culmination of the current socio-economic trend towards what we might call Post-fordist Network Society. Cities are our civilisation's the 'super brains' continuously brainstorming and elaborating innovations that lead to the continuous re-programming of the manufacturing and agricultural production robots churning out our means of life in emptied out production landscapes (which are then sorted in robotic warehouses and shipped back to us city dwellers). The most crucial information processing and ideation in the 'super brain' is happening in face-to-face communications. The myriad ordered spaces of the city operate as an integrated system of



communication interfaces that needs to be browsed and navigated by all to maximise interaction density and relevancy, generating more productivity enhancing 'brain power'. This network cannot be planned. It must be given plenty of freedom to evolve via negative and positive feedback loops. Plasticity is here as much a precondition of learning and intelligence upgrading as in the case of our brains proper. Cities are our civilization's 'super brains', continuously brainstorming and elaborating innovations that lead to the ongoing re-programming of the manufacturing and agricultural production robots churning out our means of life in 'inhuman' production landscapes. (The products are then sorted in robotic warehouses and shipped back to us city dwellers). The most crucial information processing and ideation in the 'super brain' is happening in face-to-face communications. The myriad ordered spaces of the city operate as an integrated system of communication interfaces that needs to be browsed and navigated by all to maximise interaction density and relevancy, generating more productivity enhancing 'brain power'. This network cannot be planned. It must be given plenty of freedom to evolve via negative and positive feedback loops. Plasticity is here as much a precondition of learning and intelligence upgrading as in the case of our brains proper. (It's only the big cities that evolve brain power and brain-drain all else.)

Large scale city planning first started to recede during the 1970s and since then urbanism as a discourse, discipline, and profession has all but disappeared. The disappearance of urbanism coincides with the crisis of Modernism which can be interpreted as the way in which the crisis of the Fordist planned economy manifested itself within architecture. The 50 core years of architectural modernism (1925 – 1975) were also the golden era of urbanism. During this period the advanced industrial nations urbanized on a massive scale. This was also the era of Fordism, i.e. the era of mechanical mass production and the era of the planned/mixed economy. The state dominated much of the city building via big public investments in infrastructure, social housing, schools, hospitals, universities etc. This made large scale, long term physical planning possible. In Western Europe energy, utilities, broadcasting, railways, as well as many large scale industries had been nationalized. This further enhanced the feasibility of large scale, long term urban planning. The most congenial societal context for modernist urbanism existed within the socialist block with its centrally planned economy. Socialism delivered the logical conclusion of the tendencies of the era, rolling out the technological achievements of the era in a predictable, centrally planned manner, literally delivering the uniform consumption standard made possible by Fordist mass production to every member of society. Consequently, we find the fullest expression of modernist urbanism in the Eastern Block. Civilization evolved further. The crisis of

Fordism, Post-fordist restructuring, the neo-liberal turn in economic policy (privatization, deregulation), and the collapse of the Eastern Block system all coincide with the crisis of modernism in architecture and urbanism. The bankruptcy of Modernist planning gave way everywhere to the same visual chaos of laissez faire urban expansion and agglomeration under the auspices of stylistic pluralism and the anti-method of collage. Our contemporary cities exude vitality but they are no longer symbols of order, but rather poised to tip over into a menacing disorder.



**City of London: Communication density becomes physically manifest.**

London is paradigmatic exemplar of the urban concentration process in global hub cities. As more and more large iconic structures pile into the financial district the urban scape becomes more and more chaotic, an unintentional bricolage. The planning process is evidently failing to stem the visual chaos and unable to establish any semblance of urban order.



Shanghai



Moscow City

In contrast to the visual chaos of the contemporary city, Renaissance, Baroque as well as planned modernist cities like Brasilia delivered recognisable paradigms of order. The Baroque used primary and secondary axes and ever ramifying symmetries as new ordering structures. Modernism added the principles of separation, specialization and repetition. Brasilia was perhaps the last sizeable city or urban district that projects a clear visual urban order: the last beautiful city development.



Renaissance Ideal City built



Baroque Ideal City built



Brasilia: Modernist "Ideal City" - simple order based on separation, specialisation, repetition

Symmetry has been made the norm in Classical architecture. Conceptual symmetries inform all Classical conceptual formalisms within science and philosophy up to the end of the 18th century: for instance the Kantian table of categories is marked by an insistence upon symmetric order – signifying completeness. This insistence on symmetry, which was for Kant an unreflected a priori of his theory, strikes us today as an irrational formalism. Modernism had since established the possibility of designing architectural orders without symmetry, but was still based on orthogonal grids and seriality. Relations of exclusion, inclusion, subsumption and subdivision, as well as lists and sequences, are operating in all modernist architectural and urban orders. These ordering devices are ubiquitous in modern civilization. These abstracted architectural tropes have recycled back from thinking to building, i.e. to concrete architectural construction, thus perpetuating their hold over our conceptual, social and spatial order. Deconstructivism was trying to cut this loop. It was the vehicle by which philosophy returned to its roots in architecture in an effort to break this circle of repetition through direct action in space. Deconstructivism did indeed violate longstanding conceptions of clear and distinct order. Initially this work was limited to the creative destruction of order, producing gestures of disruption and disorder. However, a new

repertoire of ordering principles emerged that was able to increase the capacity of architecture to organize and articulate the more complex life-processes and social institutions that had started to emerge. For instance, Deconstructivism elaborated a capacity for spatial overlap and interpenetration of domains. This capacity recognizes a salient trend in contemporary social institutions whereby conditions of multivalency become more and more widespread. The main point here is to increase the repertoire of both conceptual and spatial ordering principles and to upgrade their capacity to structure complexity. The contemporary style of Parametricism is well prepared to continue the Deconstructivist project of expanding architecture's repertoire of conceptual and spatial ordering way beyond the capacity of Deconstructivism or any prior style.

All urbanisation at since 1980 has produced “ugly”, amorphous urban agglomerations without recognisable order and identity. However, if real estate and rental markets are able to deliver synergetic programme mixes, i.e. programmatic order, then the hypothesis might be ventured that the disorder we perceive in our contemporary urban agglomerations is only apparent, only visual. The urban morphological cacophony obscures the underlying programmatic order, i.e. the evolved urban system of interaction offerings. This obscurity is not only due to the disarticulation produced by the prevalent pluralism of styles but also partly due to our limited conceptual repertoire of recognizing more complex systems of order.

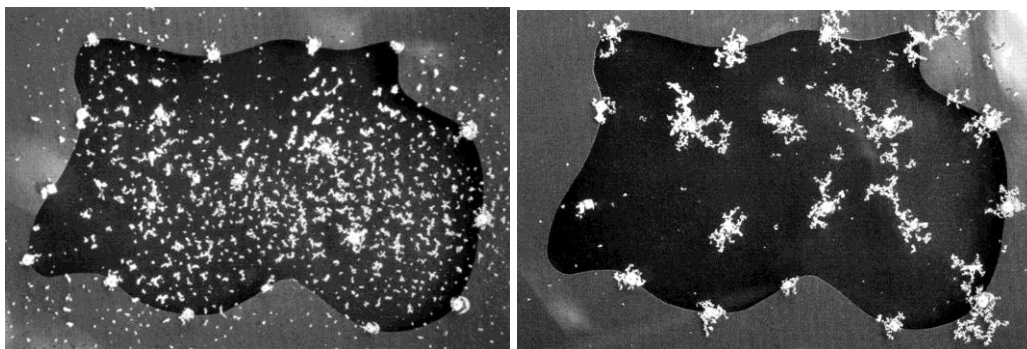
Le Corbusier insists that: ‘the house, the street, the town ... should be ordered; ... if they are not ordered, they oppose themselves to us.’<sup>19</sup> Le Corbusier's limitation is not his insistence upon order but his limited concept of order in terms of Classical geometry. Complexity theory (or chaos theory) in general, and the research of Frei Otto in particular, have since taught us to recognize, measure and simulate the complex patterns of order that emerge from processes of self-organization. Phenomena like the ‘donkey's path’ and the urban patterns resulting from unplanned settlement processes can now be analysed and appreciated in terms of their underlying logic and rationality, i.e. in terms of their hidden regularity and related performative power that result from the consistent constraining pressures that have been underlying their process of formation. Le Corbusier realized that although ‘nature presents itself to us as a chaos ... the spirit which animates nature is a spirit of order’.<sup>20</sup> However, his understanding of nature's order was limited by the science of his day. He lacked the concepts and computational tools that can now reveal the complex order

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<sup>19</sup> Le Corbusier, *The City of Tomorrow and its Planning*, Dover Publications (New York), 1987, translated from French original *Urbanisme*, Editions Crès & Cie (Paris), 1925, p.15; 1<sup>st</sup> English publication Payson & Clarke, New York 1929

<sup>20</sup> *Ibid*, p.18

of those apparently chaotic patterns by means of simulating their lawful 'material computation'. Parametricist sensibility gives more credit to the 'pack-donkey's path' as a form of adaptive material computation than to the simplicity of clear geometries that can be imposed in one sweeping move. Frei Otto's pioneering work on natural structures included work on settlement patterns. His starting point was the distinction and interplay of occupying and connecting as the two fundamental processes that are involved in all processes of urbanization.<sup>21</sup> His mapping of existing patterns and their geometric analyses was paralleled by physical experiments that were conceived as analogues modelling crucial features of the settlement process. In terms of occupation, he distinguished distancing and attractive occupations. For distancing occupation he used magnets floating in water and for attractive occupation he used floating polystyrene chips. A more complex model integrates both distancing and attractive occupation whereby the polystyrene chips cluster around the floating magnetic needles that maintain distance among themselves.<sup>22</sup> The result closely resembles the typical settlement patterns found in real urban landscapes.



**Frei Otto, Occupation with simultaneous distancing and attracting forces, Institute for Lightweight Structures (ILEK), Stuttgart, Germany, 1992** Analogue models for the material computation of structural building forms (form-finding) are the hallmark of Frei Otto's research institute. The same methodology has been applied to his urban simulation work. The model shown integrates both distancing and attractive occupations by using polystyrene chips that cluster around the floating magnetic needles that maintain distance among themselves.

This suggests that there are potentially discernible patterns in the apparent visual chaos of contemporary urban agglomerations. The assumption here is that these patterns can be clarified and accentuated by architectural articulation. There are underlying rules – economic rules – which guide individual decisions that form the (so far mostly obscure) patterns. The proposition put forward here is that these economic-programmatic rules should be aligned with rules of architectural translation that make the intricately ordered complexity of the urban life processes visually legible and avoid the visual pollution and obfuscation that stems from the current, unprincipled cacophony of disparate architectural

<sup>21</sup> Frei Otto, *Occupying and Connecting – Thoughts on Territories and Spheres of Influence with Particular Reference to Human Settlement*, Edition Axel Menges (Stuttgart/London), 2009.

<sup>22</sup> *Ibid*, p 45.



translations. The processes of architectural translation do not need to follow a uniform script as if conducted by a single hand, but could be delivered on the basis of multiple authors working within a shared language, with the shared ethos of making and maintaining connections, resonances and continuities across a field of diverse urban riches.

What is beauty, including urban beauty? Whatever appeals at first sight. Being impressed by beauty is a gut reaction, triggered by a perceptual encounter. This immediate gut reaction operates according to an underlying rationality. The recognition of beauty within a built environment is the recognition of the vitality of this environment, on the basis of its mere appearance, prior to a more in-depth experience and verification of its functionality. This works due to the extent to which subjects are conditioned by prior experience. However, as society evolves what was once vital might have become dysfunctional. Aesthetic sensibilities have to be adapted via aesthetic revolutions. New vital societal processes might be unduly constrained by the established order of beauty. They break out of this order and the environments they find or bring forth appear ugly. Their aesthetic rejection becomes a fetter on their further progress. A contradiction develops that can only be solved by an aesthetic revolution.

Sensibilities need to be (periodically) brought in line with the morphological conditions of the most vital social life-processes. In this sense beauty keeps changing its physiognomy. But is the category of beauty really devoid of any features that persist across its different, concrete historical manifestations? If this were so we would not be able to see the beauty of earlier styles. However, contemporary society – inclusive of contemporary architects – is still touched by the beauty (filigree order) of the Gothic, by the beauty (simple elegance) of the Renaissance, by the beauty (intense plasticity) of the Baroque etc. Contemporary architects recognize the beauty of past eras (although they would not find it appropriate to use any of these older styles to frame contemporary institutions). Is it possible to identify an invariant characteristic, a universally applicable condition that must be met by all environments, and even by all phenomena, that is recognized as beautiful? Yes, there is an invariant aspect that guides all discriminations of beauty versus ugliness: the sensation of beauty is always bound to a sense of order as distinct from chaos. Order as the universal and invariant aspect of beauty has been alluded to by many classical definitions of beauty. For instance Leon Battista Alberti's famous definition of beauty quoted at the beginning of this essay references order via the phrase 'harmony of all the parts' and insists that nothing can be added or taken away from a composition that manifests beauty. However, his insistence on completeness, is specific to Classical architecture and can no longer be considered a universal and invariant feature of beauty. In contrast to Alberti's concept of an organic

whole, as cited above, with symmetry and strict rules of proportion, with a state of completeness or perfection that tolerates neither additions nor subtractions, the formal heuristics of Parametricism call for order via lawful differentiation and correlation. These concepts are implemented via rule-based (algorithmic) design processes. A sense of order as distinct from chaos is maintained in all historical concretizations of the code of beauty. Order vs chaos is thus the invariant criterion of beauty. However, the criterion of order vs chaos is insufficient to give an operational definition of beauty that could fully guide the concrete application of the code values beautiful vs ugly. The order vs chaos criterion is still too abstract and leaves too many possibilities open. There can be many different forms of ordering, of relating non-arbitrarily. Order is a necessary but not a sufficient condition of beauty. Being attracted to order and repulsed by chaos might be a biologically hardwired response, i.e. the rationality of this response might be based on biological evolution rather than on cultural evolution or on conditioning on the basis of individual experience. Chaos, the absence of any perceived order, is disorienting and thus threatening, especially if the whole environment lacks order. If the environment is partially ordered and partially configured randomly, then it makes sense that attention is drawn towards the ordered aspects, ignoring the less ordered or accidental configurations. The probability that a random configuration of entities constitutes an interrelated, functioning assemblage is very low. Where entities are configured into an order, the presumption is justified that these entities somehow add up to a unit of interaction. Ordered configurations are thus more likely to constitute a force than random configurations, a force that should be reckoned with. Complex order inspires curiosity and awe, random configurations – like a heap of garbage or the disarticulated agglomerations of suburbia – are usually taken no notice of, except negatively for their ugliness and thus absence of interest. All natural systems are ordered in some way. However, the complexity of many natural phenomena prevented the recognition of their order and beauty in earlier times. Animal forms (and animal formations like flocks) are more organized than plant forms. Attention to animals is of higher evolutionary importance than attention to plants. Cultural evolution further confirmed the privileging of order over disorder. The more ordered appearance of the early city-based civilizations (Babylon, Maya Civilization etc.), compared with village-based clan societies, correlates with the superiority of these civilizations. The effort to give order to the built environment has been a constant feature of the process of civilization.

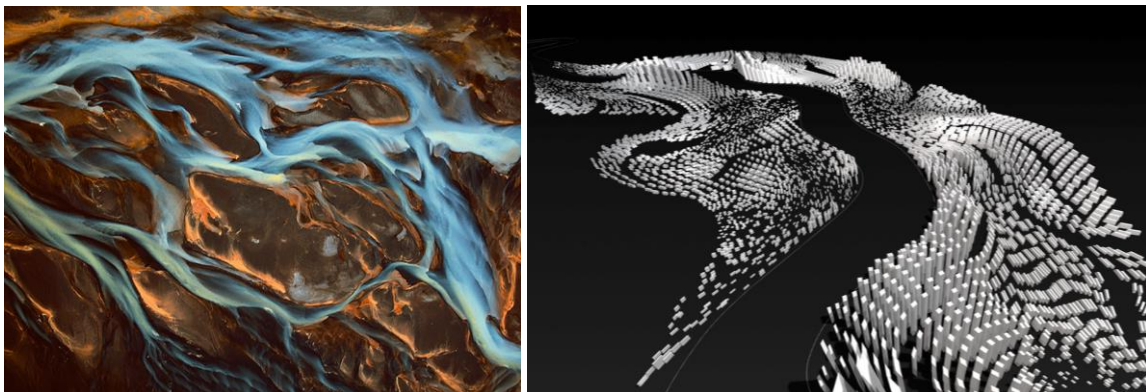
However, it seems that our current civilisation has lost its will to form and order, or at least it has lost the capacity to give order to the space it inhabits. Visual chaos and lack of identity abounds. If we look at contemporary city scapes they appear like gigantic garbage spills. It is therefore pertinent to speak of 'garbage spill urbanisation'.



The similarity between the seemingly random urban agglomerations of contemporary cities like Tokyo with garbage spills is rather uncanny. The unsystematic and unconstrained differences in building forms, materials and colours tell us nothing and paradoxically generate a sense of disorienting sameness.



**London's shapeless expansion :** Like all urban agglomerations, London expands without bounds and without shape. Only the river and other natural landscape features offer orientation.

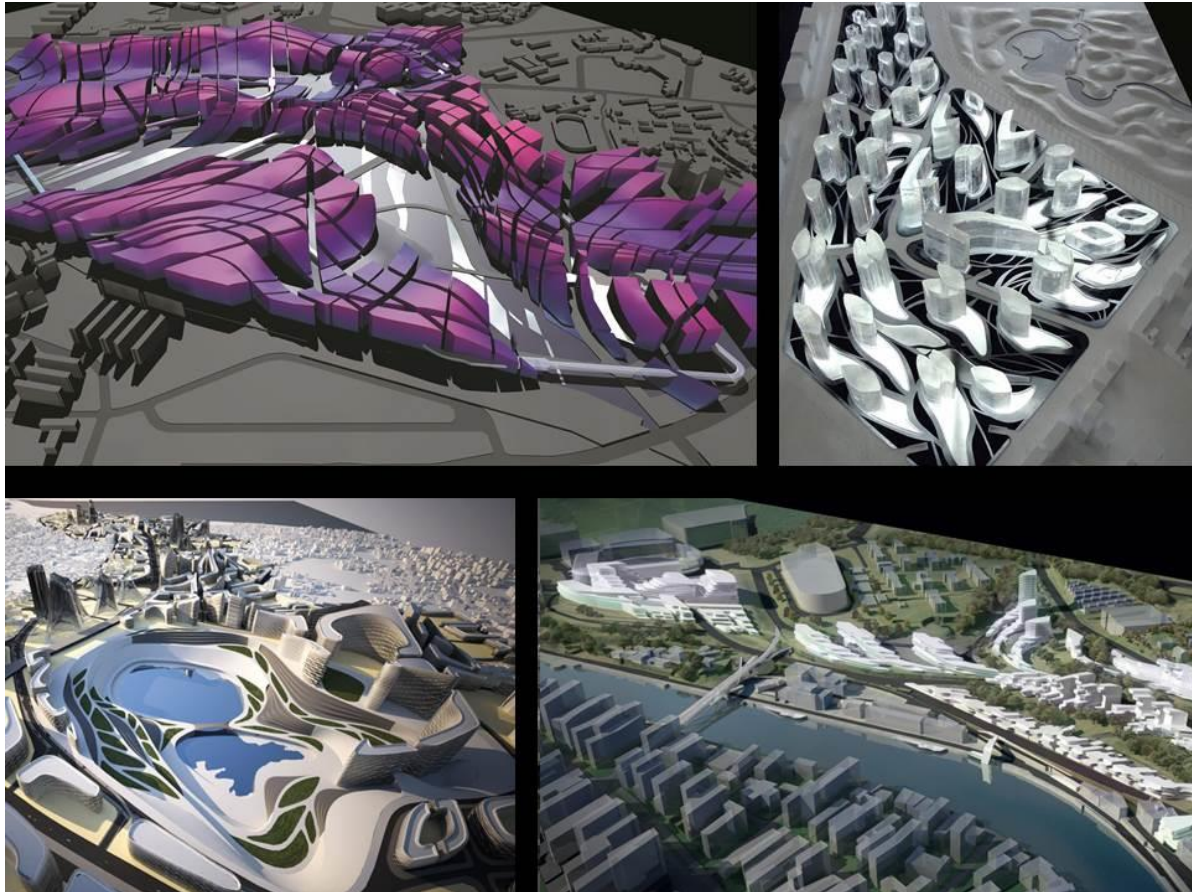


Parametric Urbanism uses the landscape analogy to give a complex, variegated order to urban formations. The rule-based processes of adaptive and correlative differentiation are able to maintain legibility in the face of considerable complexity.

The only features that give our otherwise amorphous contemporary mega-cities a recognisable shape and a viable orienting armature are natural landscape features like rivers, hills and valleys etc. It therefore seems to make sense to look at nature-like morphogenetic principles as models for an urban patterning. Thus the complex variegated order we find in nature, where rule-based adaptive variation allows us to remain flexible in the face of contingencies while simultaneously offering the chance to maintain legibility in the



face of a new, unprecedented complexity that is mandated by the complexity of our social order and by the versatility and dynamism of our contemporary social processes.



Parametric Urbanism: The application of bio- and geo-morphism, to urban design, exemplified here via four urban masterplan projects by Zaha Hadid Architects: One North for Singapore 2004, Soho City for Beijing 2005, Kartal-Pendik for Istanbul 2007, Zorrozaure for Bilbao 2007.

These considerations lead us to the concept of parametric urbanism which applies parametricism, i.e. the general characteristics of bio- and geo-morphism, to urban design. However, in the first iteration of parametric urbanism as applied in the masterplans of Zaha Hadid Architects depicted above, it seemed as if this approach requires a new but historically unavailable degree of overarching planning power to give the desired shape to the urbanisation process. Our experience was indeed that this level of control is not compatible with the neo-liberal turn towards market processes as primary drivers of urbanisation. Therefore this single author imposition of a specific, anticipated formal outcome of the urban development process had to be abandoned. The question was thus posed squarely: Can there be a free-market urbanism? Can there be a legible, market-based urban order? My answer is that a hegemonic parametricism could deliver a market-based

urban order bootom up, i.e. without the imposition of overriding planning powers. Indeed this conception is positively premised on a maximal freedom of both developers and their architects. This freedom is required to let the developers find the synergy potentials at each site and each new juncture and to allow the designers to creatively absorb the unavoidable contingencies that the innovative development process continuously throws up. The premise here is that the formal repertoire and ordering means of parametricism are rich and versatile enough - like the endless forms of nature - and that the internal discursive pressures of a converging discipline delivers the discursive guidance and motivation to pull this off. What can emerge under these premises are unpredictable, path-dependent urban identities that are as unique, as unpredictable, and nevertheless also as legibly ordered as the diverse natural landscapes of our planet. These landscapes tow evolved without masterplan or top-down control.

The market process is an evolutionary process that operates via mutation (trial and error), selection and reproduction. It is self-correcting, self-regulation, leading to a self-organized order. Thus we might presume that the land use allocation and thus the programmatic dimension of the urban and architectural order is to be determined by architecture's private clients within a market process that allocates land resources to the most valued uses. However, in the absence of stylistic and methodological coherence we cannot expect the underlying programmatic order to become legible as a spatio-morphological order. For this to happen we must presume a hegemonic stylistic and methodological paradigm that has the versatility and ordering capacity to translate the social order into a complex variegated spatial order. A shared paradigm offers the prospect of coherence across multiple authors working for multiple clients. No controlling hand needs to be presupposed.

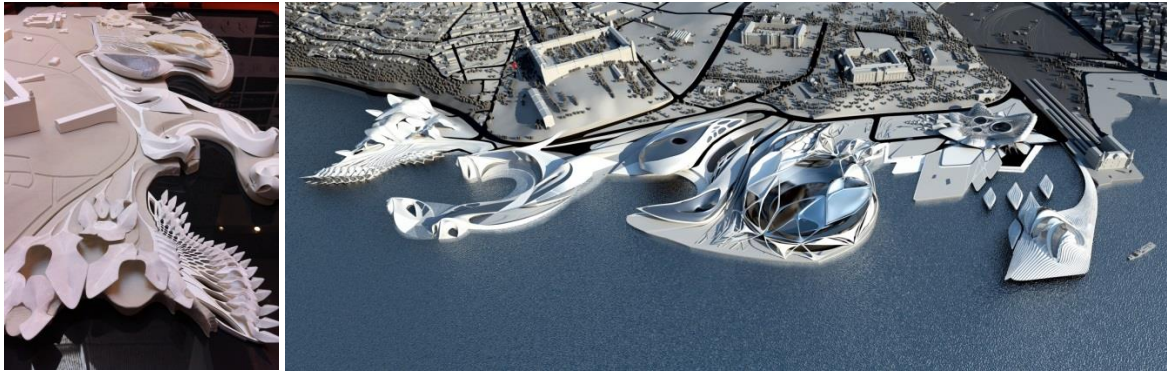
The thesis presented here proposes the analogy of an unplanned multi-author parametric urbanism with a multi-species ecology. Consider the way the various features and creatures within a natural environment coalesce to create a complex variegated order on the basis of rules - in turn based on the complex interaction of multiple laws of nature - that establish systematic correlations between the various organic and anorganic subsystems that make up a natural landscape. The topography correlates with the path of the river, the river together with topography and sun orientation differentiate the flora and the differentiation of the flora - together with river and topography - shape the differentiation and distribution of the fauna, which in turn impacts back on the fauna and thus often also on rivers and even the topography. While thus causality is complex and not easy to unravel, correlations and thus inference potentials are being established in all directions, and give information to those who want to navigate such a landscape. The key here is the build-up of correlations



and associations (irrespective of the underlying causality). Each new species of plant or animal proliferates according to its own rules of adaptation and survival. For instance, the moss grows differentially on the terraced rock surface in certain shaded slopes, i.e. depending on surface pattern, sun orientation, self-shading rock formation etc. A population of a certain species of birds then might settle on these slopes accordingly etc. In the same way parametricism envisions the build-up of a densely layered urban environment via differentiated, rule-based architectural interventions, that are designed via scripts that form the new architectural sub-systems, just like a new species settles into a natural environment. This process delivers rich diversity, yet fully correlated, if designed according to the heuristics of parametricism. Each new architect/author can be uniquely creative in inventing and designing the rules/scripts of his/her project and participate in its own unique way in the build-up of a variegated, information-rich urban order. The analogy also extends to the navigation in rule-based environments: the urbanite's intuitive orientation within a parametric urban environment functions analogous to animal cognition/navigation in a natural environment.



Landscapes as Multi-species Ecologies become a model for an evolving multi-author urban order.



**Complex Variegated Order via multi-author coherence, Istanbul Cultural District, Studio Hadid/Schumacher, Yale University, 2013**

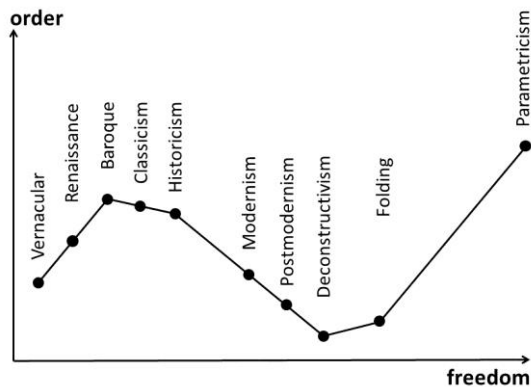
This design experiment in un-planned multi-author urban order demonstrates how coherence, interarticulation and resonance can emerge if independent authors work from within the shared paradigm of parametricism that enables and calls for mutually adaptive, affiliative and resonate design moves.

The only viable candidate for the next hegemonic epochal style is parametricism. Neither a hegemonic Postmodernism, nor a hegemonic Deconstructivism could overcome the visual chaos that allows the proliferation of differences to collapse into global sameness (white noise). Both Postmodernism and Deconstructivism operate via collage, i.e. via the unconstrained agglomeration of differences. Deconstructivism can be looked at as the aesthetic sublimation of the urban process of “garbage spill” collage. Only Parametricism has the capacity to combine an increase in complexity with a simultaneous increase in order, via the principles of lawful differentiation and multi-system correlation. Only parametricism can overcome the visual chaos and white noise sameness that laissez faire urbanisation produces everywhere. Parametricism holds out the possibility of a free market urbanism that produces an emergent order and local identity in a bottom up process, i.e. without relying on political or bureaucratic power. The values and methodological principles of parametricism are prone to produce path-dependent, self-amplifying local identities, starting with the given natural features and settlements. Its ethos of contextual affiliation and ambition to establish or reinforce continuities allows for the development of unique urban identities on the basis of local contexts, topography, climate etc.

Parametricist order does not rely on the uniform repetition of patterns as Modernist urbanism does. In contrast to Baroque or Beaux Arts master-plans, Parametricist compositions are inherently open ended (incomplete) compositions. Their order is relational rather than geometric. They establish order and orientation via the lawful differentiation of fields, via vectors of transformation, as well as via contextual affiliations and subsystem correlations. This neither requires the completion of a figure, nor - in contrast to Modernist master-plans - the uniform repetition of a pattern. There are always many (in principle infinitely many) creative ways to transform, to affiliate, to correlate. A unique, unpredictable, but recognisable and legible order (which allows for orienting inferences) will emerge, as long as all architects acquire the required skills and create within the parametricist paradigm and ethos that calls for continuities and affiliations, under the critical eye and peer

pressure of each other. A hegemonic parametricism thus holds out the prospect of a free market urban order.

Progression of Styles



Progression of Styles: Freedom vs Order, graph by Patrik Schumacher

Parametricism achieves an inversion of architecture's entropy law. Freedom must be bought by giving up **order** until the techniques of parametricism give a new, powerful ordering capacity to the discipline of architecture, a capacity that delivers a simultaneous enhancement of freedom and order.

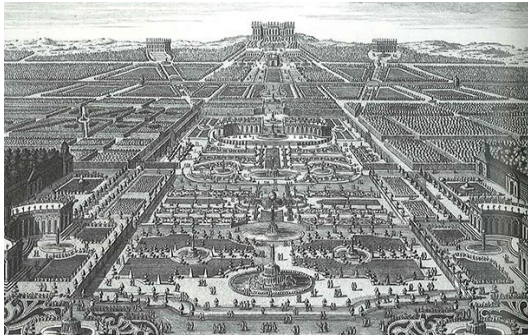
If we look at the historical progression of styles we find that the last 300 years established what we might call architecture's entropy law: all gains in terms of design freedom and versatility have been achieved at the expense of urban and architectural order, i.e. increases in versatility had to be bought by a progressive degeneration of architecture's ordering capacity. The increase of the designer's degrees of freedom was established via the enrichment of architecture's formal-compositional repertoire. This increase in freedom/versatility was the paramount criterion of progress in architecture's pursuit of matching the requisite variety of societal complexity. Like the move from classical architecture to modernism, the move from modernism via postmodernism to deconstructivism delivered an expansion of degrees of freedom and versatility (to accommodate a more complex society) that was paid for by a relaxation or rejection of rules of composition, i.e. of means of ordering, and thus a resultant degeneration of the visual order.

Order was progressively eroded. This long trend of a negative correlation of freedom and order can be reversed under the auspices of parametricism. Parametricism offers the simultaneous increase in freedom and order and thus inaugurates a new phase of architectural neg-entropy. Parametricism thus delivers urban neg-entropy.

Parametricism's radical ontological and methodological innovation translates into a massive leap in both dimensions of architectural progress considered here, i.e. it entails an unprecedented expansion of architecture's compositional freedom and an unprecedented

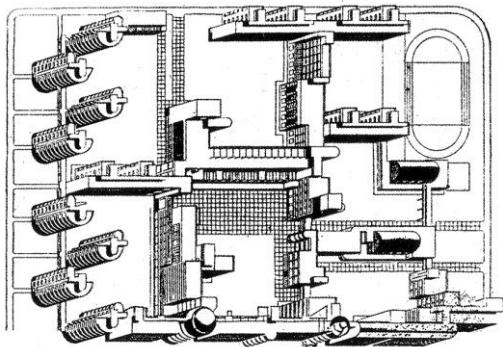


leap in architecture's ordering capacity through the deployment of algorithms and associative logics. Parametricism is the first style that delivers further degrees of freedom and versatility in conjunction with a simultaneous increase in its ordering capacity via new compositional rules like affiliations, gradients and associative logics. In principle all design moves are now rule based and thus with the potential to enhance the visual order and thus legibility of the built environment in the face of an increased complexity.



**Classicism: High Level of Order – Limited Degrees of Freedom, Architectura Civilis, Paulus Decker 1711**

The ordering principles of symmetry and proportion gave classical architecture the capacity to compose potent unities by ordering the city around the institutional ensemble of church and palace.



**Modernism: Increased Degrees of Freedom – Lower level of Order, Nicolai Kusmin, Miners Housing 1930**

Modernism did let go of the constraints of symmetry and proportion and gained the freedom of radical abstraction. It maintained orthogonality and worked with the ordering principles of separation, specialisation and limitless repetition.



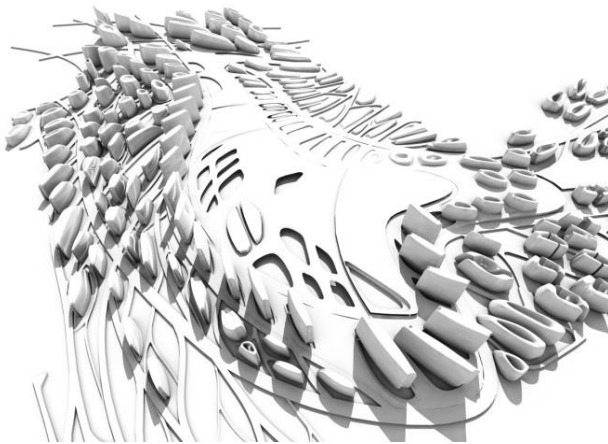
**Postmodernism: Further Increases in Degrees of Freedom – Further Loss of Order, OMA, 1976**

Postmodernism rejected the monotony of modernist separation and repetition and opened itself up for an unconstrained juxtaposition and collage of architectural forms and motifs from all other periods of architecture



**Deconstructivism: Further Degrees of Freedom - Further Degeneration of Order, Zaha Hadid 1986**

Deconstructivism abandons orthogonality and all historical motifs to regain the freedom of abstraction and intensifies the principle of collage by allowing superimposition and interpenetration as much as juxtaposition.



**Parametricism: Pronounced Increase in Freedom - Sharp Increase in Order, Zaha Hadid Architects, Masterplans for Appur.**

Parametricism expands the repertoire and thus freedom with spline/nurb based curvilinearity as well as gradient swarm formations. Parametricism hugely expanded architecture's ordering capacity via the scripting or agent-based emergence of associative logics.

Parametricism is by now manifestly superior to all other styles that are still pandered and pursued. This implies that parametricism should sweep the market and put an end to the current pluralism of styles (that resulted from modernism's crisis and) that has been going on for far too long due to ideological inertia. The plurality of styles must make way for a sweeping, universal, i.e. *hegemonic* parametricism, to allow architecture to finally make once more a vital, decisive, transformative impact on the built environment, the way modernism had done in the 20th century.

End.