ARCHITECTURE IN FORMATION

ON THE NATURE OF INFORMATION IN DIGITAL ARCHITECTURE

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Edited by Pablo Lorenzo-Eiroa and Aaron Sprecher

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Architecture in Formation,
On the Nature of Information in Digital Architecture

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Routledge, Taylor and Francis, New York

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INTRODUCTION

Architecture in Formation comprises a dialog among architectural theorists, historians, and experimental architects based on the many and complex relationships between information processing and its representation. This collection of historical examinations, critical essays, and design projects provides a cross analysis that aims to re-conceptualize the current state of the discipline of architecture as it has become, of late, increasingly structured around advances in computation.

We follow the trajectory of a critical, alternative axis deviating from the way digital technology has usually been understood since its widespread adoption in the 1990s. While previous trajectories privileged a visual logic, thus repressing digital architecture to a merely representational role, we emphasize the architectural specificity of a disciplinary potential, which recognizes the role of computation in actually processing the relational capacity of systems and structures. Our ambition is to produce both a historical venture against the mere actualization of technology and an intellectual understanding of the digital project through the more generalized notion of *Information*. However, we are not proposing to dismiss visual and formal logic. Rather, we hope to foster the integration of these levels of cognition and representation with deeper, usually inaccessible, relational structures.

An architecture of information implies the constitution of a critical, intermediary, and abstract interface-space that is capable of transforming the discipline by mediating the relationships among cognitive structures, codes, information processing, and form. The associated disciplinary shift drives a general movement toward engaging an emergent, formal aesthetic that is based upon profound structuring relationships. In particular, due to the increasing ease of writing and manipulating computer programming codes, the architecture community recently began to question the hidden, form-giving roles of software developers, thereby precipitating a new "deconstruction" of software structures to produce novel, unexpected modes of architectural design. Yet, this questioning also provoked the emergence of a form of structuralism, one that would have to be displaced in order to avoid the idealistic dimension of the architectural object – even as the object itself becomes invisibly embedded into reactive and dynamic systems. Such an object-system, then, would necessarily consider architectural design in terms of latent possibilities.

In this volume, the architectural questions inferred by information structures and interfaces have been framed through our combined dialectical and editorial voices, the result of which necessarily redefines both the limits and nature of the discipline. Specifically, our dialectical positions address the intrinsic, disciplinary notions of representation, information standardization, and formal autonomy, as well as extrinsic notions regarding the boundaries of the discipline. This dialectical approach is investigated in four forms: interviews, curated essays, project essays and experimental projects, the summation of which generates the necessary conflicts, contradictions, and continuities capable of reorganizing certain fundamentals of the discipline as it continues to expand through computation.

With regards to current, alternative scenarios, this collection of essays and projects also aims to critique the current dialectical reasoning that has emerged with the pervasive use of computer codes and information processing. Rather than presenting a counter argument, however, we have sought to organize discourses relative to deeper conceptual and perceptual structures without privileging one for the other, the result of which is the integration of different arguments into a more complex spectrum of architectural performance. In response, *Architecture in Formation* proposes addressing both of these perspectives with the objective of achieving a potential synergy between the two, especially with respect to the experimental projects featured in this book. Considering this collection of projects and essays, one may well question whether the architecture of these experimental practitioners actually indexes technological or cultural questions relative to architecture. For us, the more interesting problem has been that all of the participants in this book deal with technology in such a way that for any decision they made, there was an associated aesthetic appreciation dependent upon these topological levels. For instance, architects working with visual logic tend to dismiss the underlying structuring of form, which is also structured by technology through representation, while architects merely dealing with relational logic tend to dismiss the autonomy of form once it is constituted, thereby dismissing the quality of the constituted object and its capacity to affect reality.

This book consists of six chapters. Each chapter begins with an interview and ends with an extended critical essay. Together, they frame the chapter's specific discourse inquiring the nature of information. By specifically fostering a progression from conceptual to perceptual structures, each chapter reveals a particular cartography of influences and cross relationships of the featured theorists, historians, and practitioners. This cartography takes the form of a crowdsourcing diagram depicting the informational content of each chapter, thereby offering alternative, formal readings of the chapter. The six chapters are:

Chapter 1, *Structuring Information,* introduces the historical, theoretical, and conceptual backgrounds underlying current architectural explorations of various information systems, codes, and cognitive structures. In this chapter, architectural historians, theoreticians, and experimental practitioners question the multi-layered role of information in architecture – all the way from its most abstract layers to the most concrete ones relating to bodily affection, by reflecting upon the many and complex relationships between information processes and architecture. The resulting discussion forms an initial topological level, which is used to organize the overall structure of the remaining chapters.

Chapter 2, *Information Interfaces,* explores the nature of abstract systems that process data and induce information. This chapter includes an overview of relational systems in architecture – in particular, the mathematical principles and protocols that layer information, even as they simultaneously question the generative capacity of interfaces to translate, mediate, and induce relationships within the architectural project. Primarily concerned with information visualization and representation, this chapter features projects dealing with issues ranging from the multiplicity of interfaces to the manipulation of representational information across various computational platforms. In order to expose the deepest topological levels of this exploration, we have chosen to highlight the works of practitioners who are recognized for their innovation at the level of the architectural interface, i.e. – the system of representation structuring the way we conceive space, by experimenting with the structuring of form relative to emergent representational strategies. These strategies come together to establish a second topological level that apprehends the computer codes and mathematical logic inherent to computational architecture, thereby enhancing our understanding of its relational logic.

Chapter 3, *Responsive Information,* investigates interactive systems in the context of the contemporary production of spaces and environments. This third topological level features experimental projects and essays expressing the potential of responsive systems in terms of their spatial and programmatic organizations.

Chapter 4, *Evolutionary Information,* addresses questions regarding both the use of evolutionary protocols in architecture and the innovations arising out of evolutionary, time-based architectural systems and topologies. In this chapter, we feature experimental practitioners who work with minimal expression in spatial organization in order to redefine novel typological relationships that recognize the presence of the body in order to induce affection. This fourth topological level therefore addresses the architectural conformation of synthetic solutions in order to activate a critical disciplinary displacement relative to both artificial evolutionary processes and architectural systems.

Chapter 5, *Extensive Information,* focuses on the extensive aspects of information systems through an investigation of the various processing logics derived from forces acting upon materials – even as these systems challenge categories and intuitive assumptions. Together, considerations of material actualization and digital fabrication mark a movement away from merely speculating upon the physicality of objects, and toward exploring the informational systems acting at the core of material formation. As part of the discourse of this fifth topological level, the notion of material physicality is considered in the context of organizational structures – some of which resist the separation between deeper levels of content and their material expression, and some of which activate a higher level of abstraction by resisting the linear understanding of forces, organizations, and materials.

Chapter 6, *Information Affect,* extends the preceding discourse on materiality, while also scrutinizing the role of deep structures – both relative to the output of information, and within the context of spatial perception. This sixth and final topological level features architectural experiments founded upon the many connections between information and affect, i.e. – between the architectural object and its influence upon the subject. Accordingly, considerations of relational structures are displaced in order to privilege the performative aspects of form – maybe even motivating formal excess.

Each of the above chapters comprises multiple topological levels of discourse. Together, the six chapters develop a series of progressive layers modeled upon Gregory Bateson's and Michel Serres' understanding of reality, which considers reality in terms of multiple topological levels of information. Thus, this book is organized according to a series of categories that extend, enrich, and redefine the relationships among information processing, image and non-image, form and system on multiple, but incremental, topological levels. These levels are organized to critically structure the way architecture deals with information by presuming to build up a body of knowledge, which temporarily reconfigures the limits of the discipline. The resulting topological levels can then question more conventional architecture strategies in wide-ranging ways – from deep structures concerned with concepts, to structures concerned with perception; from the structuring of information relative to systems of representation and the structuring of relationships, to bodily affection; and from even deeper structures dealing with the constitution of an autonomy that transcends the mere linear indexing of information, to the crossing of information that explicitly recognizes transdisciplinarity in adaptive architectural solutions. Additionally, the topological levels of each chapter sometimes coincide across various essays and projects, and sometimes overlap across chapters, thus putting into question the nature of digital architecture in terms of its similarities and differences among the many practices and critical positions shaping the field today. Fostering a progression from conceptual to perceptual structures, the structure of this collection reveals a cartography of influences and cross relationships among the featured essays, projects, theorists, and practitioners. This cartography activates formal problems that go beyond the initial assumptions established by the chapter divisions.

With respect to establishing a specific, ideological position, this book attempts to develop a critical questioning of form and information through its collection of interestingly heterogeneous voices. As a result, some essays and projects developed themes we had suggested, while others explicitly problematized these themes. We hope the reader finds the resulting book to be effective at productively juxtaposing the work of the world's leading architectural practitioners, theorists, and researchers, who are undertaking today's most innovative design research and experiments.

fig 1
Parametric negative-dialectic information exchange between a natural pseudo-Cartesian rock formation and an artificial topo-logos. Groundscraper for Punta del Este, Uruguay. Eiroa Architects-BA, Pablo Lorenzo-Eiroa 2009-2011.

FORM:IN:FORM ON THE RELATIONSHIP BETWEEN DIGITAL SIGNIFIERS AND FORMAL AUTONOMY

— PABLO LORENZO-EIROA

Architecture in Formation aims to consolidate, reorganize, and critique what has constituted a revolution in the discipline over the past ten years. This revolution is based on a growing recognition to acknowledge deeper structures in architecture. Information technologies presented a new paradigm to architectural representation through the possibility to work directly with deeper relational structures such as computer codes. This revolution is reacting against late post-structuralisms that rely only on visual judgment without acknowledging deeper relational structures. This transformation is built from a renewed advancement in digital architecture representation and architecture organization, motivating a fully integrated systemic approach ranging from bits, to codes to the structuring of relationships. Although, this cultural transformation seems to be propelled once more from a historical cyclical purge reacting consistently between two opposing forces.

Media communications have advanced a sensibility and education based on the understanding of a visual logic that was highly beneficial to architecture – a visual arts discipline based on formal logic. Media has separated visual appeal and affection from the underlying protocols engineered to manipulate mass behavior. Therefore the visual is no longer a paradigm for reference, as underlying codes have now become referential. Instead of replacing visual logic for a new relational logic, an alternative axis must depart from understanding of critical relationships across perceptual structures and deeper conceptual structures. Late post-structuralist tendencies have progressively hidden *conceptual* structures in favor of *perceptual* structures rather than focusing on syntactical organizational problems that investigate alternative displacements of disciplinary fundamentals. Disciplinary fundamentals of architecture, including both representational structures and syntactical structures that organize space, must be acknowledged and then displaced. If architects do not recognize the underlying logic of the interfaces and displace the given source codes of algorithms to create their own, their work is trapped by a predetermined set of ideas, cultural projections, and aesthetic agendas contained within those interfaces. Similarly at the architectural level of the project, if architects do not displace the logic of systems from which they work, and further do not recognize implicit emerging spatial typologies or underlying relational structures, their work becomes trapped by predetermination.

However, before explaining this new structuralist movement promoted by information technologies, it is interesting to first question its emergence relative to a historical cycle. It seems necessary to critique the historical cyclical pendulum between contrasted positions predestined to continuously renew the discipline. Any reactionary force is equally problematic and presents a temporary balance without critiquing the problems that provoked such reaction. The content and structure of this book addresses a criticism of this historical cultural cyclical reaction. Therefore this emerging new structuralism is understood as a revolution, but is also aimed to attack deeper levels of this assumed historical process.

A New Structuralism as a Continuity from Post-Structuralism

The pendulum reactionary force of post-structuralism emerged in the late 1950s against the previous abstraction and predetermination of structuralism. Since the 1990s it has been deviating from deconstruction's conceptual premise of 1968: to develop a full decomposition of any assumed disciplinary fundamentals. Disciplinary fundamentals have been progressively disregarded instead of being revolutionized. This necessity to acknowledge deeper fundamentals correlates with the emerging new structuralism manifested by the possibility to work directly with computer codes.

Structures are transcendental common relationships among cultural objects and constitute the basis of occidental culture. Structuralism has been criticized for generating *categories* that reference conventions, which obscure real differences. This is the first problem to identify in information technologies, since the processing of information enhances an emerging structuralism that has to be acknowledged but also resisted. In Deleuze's idea of *difference without concept* (Deleuze G. 1994) differentials are understood as real differences, as he notes the value of the curvature in itself, independent from other assumed referential categories. Intellectuals like Foucault argued for both structuralist and post-structuralist theories, and each discipline would have to address the tendency of known *types*, that if not frontally displaced, continue to prescribe order.

Post-structuralism initially emerged as a reaction to the homogenizing quality of structures, but also defined experience negating relational logic. Alois Riegl establishes the conceptual categories "optic" as psychological and "tactile" as empiric that synthesizes as haptic (Riegl A. 1901). The concept of haptic relates to the idea of *affection,*[1] a post-structuralist concept that for Deleuze is independent of the subject, an apperceptive experience of the body (Deleuze G. 1970). There is no argument against such a position that relies on the reality of the object independent from intellectual interpretation. But induced by media, architecture is eroding its disciplinary knowledge and its capacity to stimulate experience as a physical spatial affection that is de-sensitized due to the disjunction between subject and place.

This position is critical of inconsistent late post-structuralist formalisms that disregard deeper relational logics without accounting the indexing of systems that constitute form, problematically ensuring stability at deeper levels. But this position is also critical of what a new structuralism is activating, understanding information visualization as a process of representation of external content, which does not recognize the autonomy of form once it is constituted – negating any artistic empowerment. This position defines an architecturally based formal expression aimed to work with structuring relationships but also to recognize an empowerment that leads to affection. Therefore, achieving higher levels of architectural performance by thinking of this emerging new structuralism as a continuity from the previous series of post-structuralist displacements. This concept presents a background for the first manifesto:

There is a necessity to rethink the relationship between post-structuralism as a critique of determination and a new structuralism as a continuity, disclosing deep structures to the foreground addressing their role in qualifying affection.

[1] Affection (*affectio*) is said directly from the body, while the affect (*affectus*) refers to the mind. Concept used by Spinoza and Deleuze as an empowerment, an external body that acts over our body and not a simple modification. *Aesthetics* has been often referred to merely questions of perception but such artistic fundament has been integral to conceptual questions in the work of many artists.

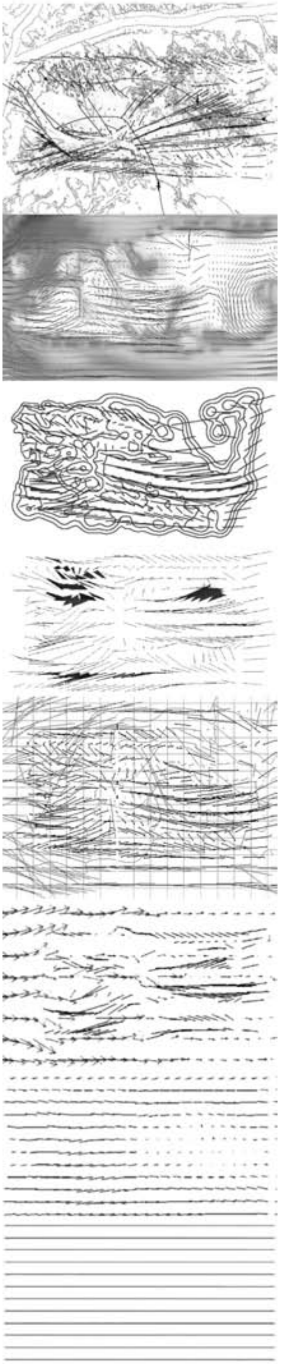
Form:In:Form

Information technologies enable the communication between computer interfaces. According to von Bayer, information theory bridges all forms of knowledge through binary translation (von Bayer H.C. 2003). Information theory investigates this form of communication through mathematics. Computer interfaces calculate, organize, and transfer sets of data that communicate a message that, translated through interfaces, conveys information. A bit is the minimum unit of data signal. Signs organized through code sequences represent the content, message, or information. Even if a code may change the signal remains the same, as the relational logic of the code acquires importance and relevance over the binary sign. Architecture form, and as a consequence architectural space, is standardized, homogenized, and parameterized through information processing. As a result of the possibilities of information technologies, architecture is now an integrated informed organic system: a responsive interface that organizes information forming spaces-environments.

Any language mediates reality, and determines the way that we think. Wittgenstein's *Tractatus Logico-Philosophicus* (Wittgenstein L. 1921) reveals the problematic relationship between language and the world, demonstrating the limits of representation. For Husserl, mathematics as a formal ontology replaces reality, thereby constructing a set of independent conditions (Husserl E. 1929). Charles Sanders Pierce's linguistic representation can be understood through his triadic signs: Icon (likeness), Symbol (convention), and Index (actual connection) (Pierce, C.S. 1893–1913). Pierce understood logic as formal semiotics. Ferdinand de Saussure defines the Sign (the basic unit of language) as the relationship between the Signifier (sound-image) and the signified (the referent, the meaning) (De Saussure F. 1916). Jacques Derrida's critique of Saussure's equation is that structuralism disseminates categorical thought, since for Derrida a sign is understood as the creation of signifiers, an artificial construction independent from what it is being named (Derrida J. 1982). Georges Teyssot's recent understanding of Saussure's sign qualifies the slash that prescribes the relationship between Signifier and the signified as a curve, a topological relationship in the algorithm "sign=S/s" conveying a bond for signification, as in poetry (Teyssot G. 2010). Roland Barthes declared the end of authorship when he defined language as a system of predetermination of content (Barthes R. 1977). Alain Badiou questioned any existing information outside a system, since there is no language that is complete (Badiou A. 2005). And the problem is that even though Chomsky's linguistics influenced the way architects understand formal systems (Chomsky N. 1957), from the relevance of syntax that open up semantics, his ideas did not enter representation relative to information processing. Conrad Fiedler opposed the Kantian idea that art was a lower form of cognition, since artistic form constitutes an autonomous logical system which its purpose is not to mean through translation or representation (Fiedler C. 1949).

A vectorial line drawn in the computer screen is not a line. It is rather a series of computed codes that simulate a three-dimensional beam of light projected into a two-dimensional screen. The image of this line is therefore a representation of an external binary calculation from its means of constitution. Since there is no information without representation, the reduction into codes results in a structuralism that replaces architecture. While interfaces process information, at the same time they re-structure extrinsic content to fit its medium, activating a topological loop that in the end informs reality. Computer Signs (binary codes) represent information that is actualized through Interfaces (computer languages are mediums that activate symbolic form) that inform Form (index), activating a responsive loop between information and representation where interfaces as signifiers induce form through binary codes, activating the topology: *form:in:form*. But the actualized signifier acquires a certain autonomy independent from the indexed set of codes, inducing further relationships.

fig 2
Infrastructure proposal that affects environmental forces to induce landscape opportunities in an ecology of natural feedback, exchanging information and energy. Mississippi River Delta 2006, ARC 177 Students Elan Fresler and Cooper Mack, the Cooper Union and parametric diagrams by Professor Pablo Lorenzo-Eiroa.



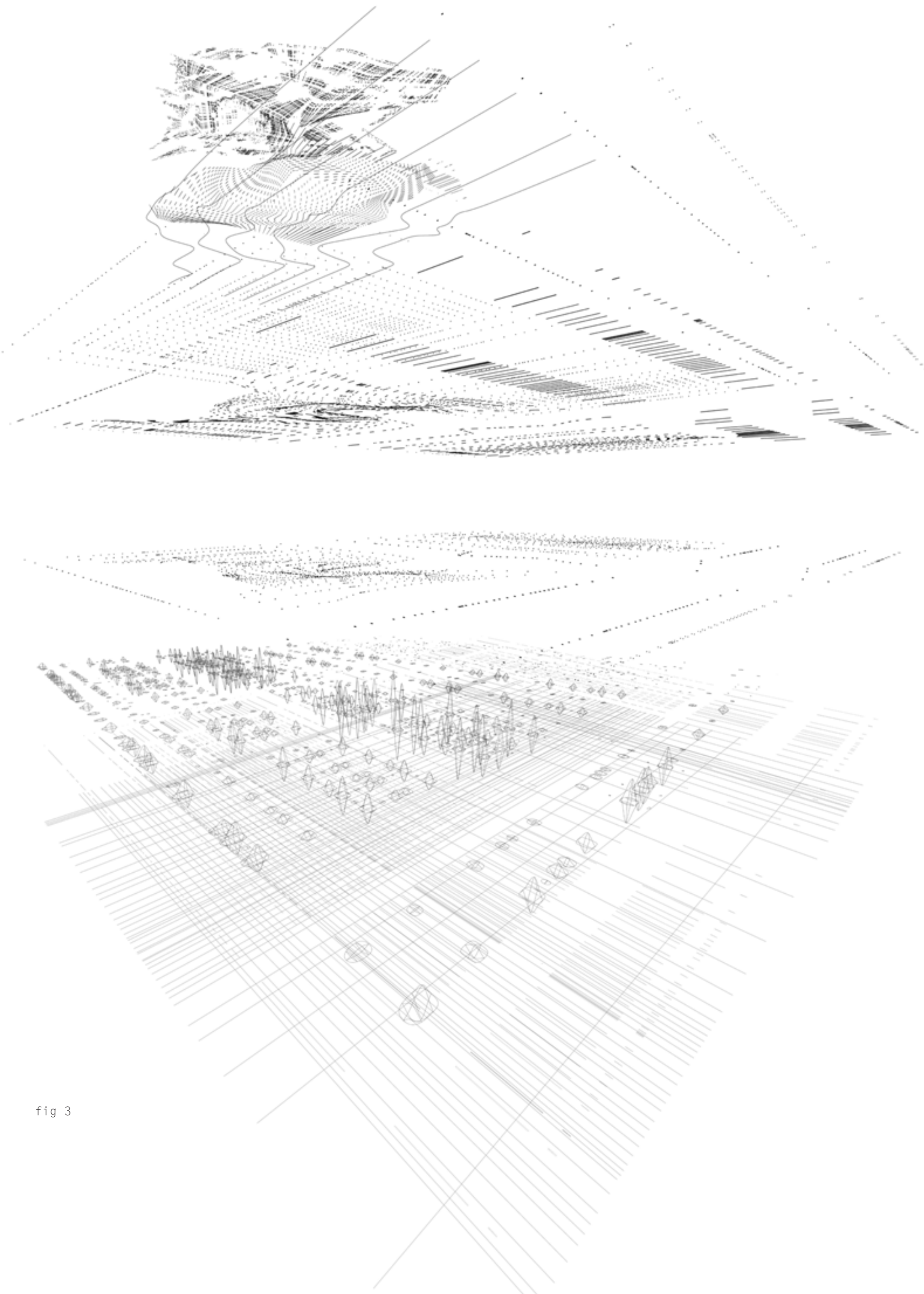


fig 3

fig 3
Each interface builds topographies of information intended to be addressed within the logic of the project. Artificial ecology of natural sedimentation that promotes landscape interventions to connect Buenos Aires and Colonia. Ecoinduction for the Rio de la Plata, Buenos Aires, Eiroa Architects-BA, Pablo Lorenzo-Eiroa 1999-2011.

fig 4
Representational structures, interfaces, and organizational types. From left to right and top to bottom: binary code, genetic diagram, radial organization, bypassed radial organization, network structure. Mathematical scripting, flow diagram-algorithm, grasshopper visual algorithm, bifurcating structure, lattice structure. Parametric script, perspective-interface diagram, grid, striation, logarithmic grid. Diagrams by Pablo Lorenzo-Eiroa.

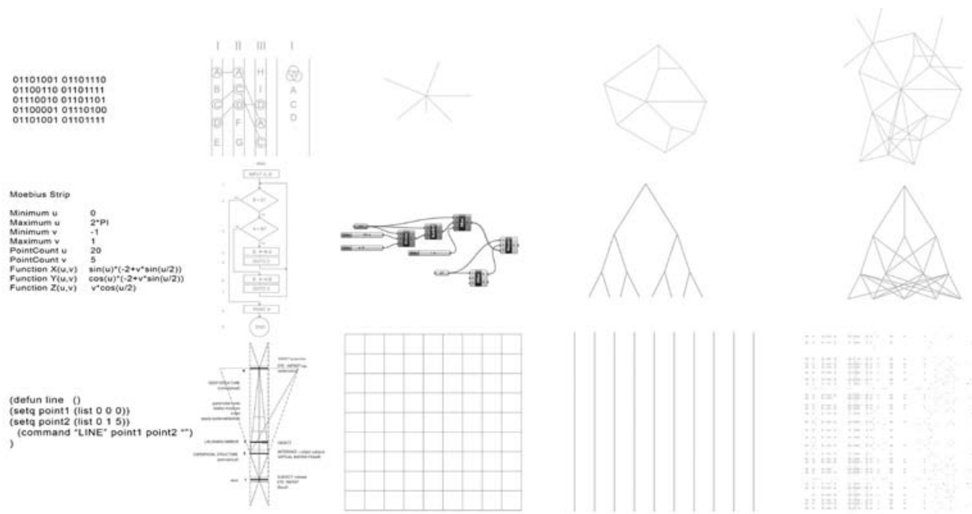


fig 4

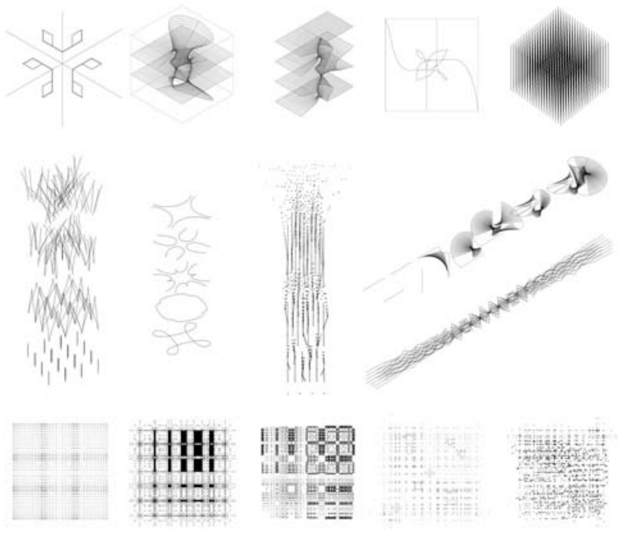


fig 5

fig 5
Topological displacements overcome the predetermination of implicit representational structures and organizational structures. Cartesian departing structure and representational system transcended by inducing continuity among the three axes. A departing nine square grid structure is displaced by progressive non-determination, activating spatial affection. Design II students Che Perez, Henry Barrett, Johae Song, Phong Nguyen, Kristinn Vidarsson, Binham Li and Cory Hall, The Cooper Union, Head Professor and Coordinator Pablo Lorenzo-Eiroa, with Assistant Professors James Lowder, Lydia Kallipoliti and instructor Katerina Kuourkuola 2010-2011. Graduate and Undergraduate computation design seminar students Harry Murzyn and David Varon, The Cooper Union, Professor Pablo Lorenzo-Eiroa.

The implementation of structuralism expands a technological-mathematical paradigm diminishing artistic philosophy and aesthetic theory. One of the fundamental innovations in art was the abandonment of abstracted representation in favor of concrete art. In this form of art, content is not seen as extrinsic but rather as generated by coordinating the set of conditions that index its formal logic, thereby opening up cultural problems and inducing relationships once it is constituted. In this sense, there is a unique art intrinsic to each medium, material, communication, technique, reality, context, frame that is only possible at a certain moment in time. Computation eliminated this dimension in art, and the current digital revolution is contingent upon this recognition. In information visualization and information mapping, formal strategies often are conceived independently from the data they are representing. In this reversible paradigm, form is unmotivated from its capacity to induce cultural change. These representational strategies have yet not accounted for the fact that a map is a deterritorialization machine that by describing a territory implicitly recreates it.

Architecture has motivated a self-referential modern consciousness since the Renaissance, problematizing representation. Algorithms are now critiqued for predetermining form, but historically speaking, perspective has been striating Western modern space since the Renaissance with similar consequences (Panofsky E. 1924–1925). Brunelleschi's perspective produced a parametric space and was critiqued by many architects. Andrea Palladio critiqued perspective's artificiality, proposing a frontal layered space that interrupted its cone effect. Panofsky's perspective analysis identifies the ambition for a structuring of space and objects through mathematics, as the tiles in the floor in Ambrogio Lorenzetti's *Annunciation* of 1344 diminish parametrically. Lorenzetti brings the deep structure of the interface, perspective, to perform at the same level of the narrative of the painting. The vanishing point indexes the presence of God mediating between the Angel and Mary, coordinating multiple

fig 6
Cartopological space:
typological Cartesian variations
through relative topological
displacements. House IIa, Eiroa
Architects NY 2011.

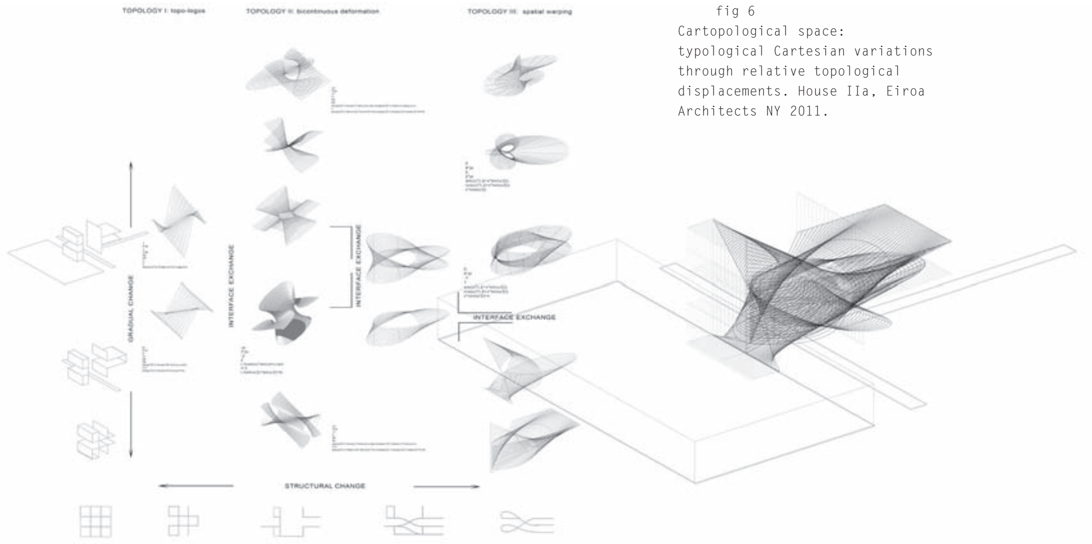


fig 6

topological levels and therefore achieves a higher artistic signification. E01
Las Meninas by Velazquez of 1656 paradoxically displaces the linearity of perspective by the artist placing himself inside the painting, building up a topological space with the viewer. Modernist architects used axonometric projection to resist perspective subjectivity, and proposed a parametric mathematical projection model where XYZ induce a universal machinic object-space. John Hejduk displaced this homogenizing parameterization in axonometric projection as a main generator in the logic of his diamond houses. These works recognized how reality is artificially structured by representation. Thus by displacing the structure of the medium, these artist and architects creatively proposed a cultural project questioning representation and any linear implementation of the dominant technological paradigm. Digital representation created a revolution in architecture comparable with perspective in the Renaissance but its structuralism has not been displaced, neither has it been questioned culturally within the discipline.

Opposingly, computation induced several displacements to the discipline that were not culturally questioned. Dynamic digital representation produced a vectorial isotropic space and a dynamic architectural object, negating gravity and as a consequence the ground condition was progressively displaced and recently has been ignored in architecture. Site-specific interventions motivated different architectural relationships with the ground surface searching for a topo-logos of spatial differentiation. Surface modeling extended this disciplinary cultural process into the progressive autonomy of the surface from the ground. Nurbs-based geometry enabled the possibility to work with calculus and degree curvature, which then facilitated the manipulation of complex topological surfaces that ultimately informed spatial topology.

The interdisciplinary incorporation of animation-based software enabled the possibility of manipulating form in relation to its topological history. But these capacities also provoked problems, as anthropomorphic architecture has been informed by elastic geometry tools for character animation.

The computer screen has shifted the horizontal surface of the drafting table defined by XY and Z as extrusion, to the vertical. The computer displaced the tectonics of the floor plan, activating XY as a picture plane and Z as depth, assimilating architecture with cinema in which depth and not vertical extrusion defines space. This new relationship promoted a late-post-structuralism based on a perceptive-visual iconographic logic that replaced structural reasoning. Contrarily, algorithms are now breaking with the visual logic, bringing back a mental pensiveness across the parametric project based on structuring relationships. Visual algorithms were successful in developing interfaces to mediate between abstract computer codes, bridging scripting and the relational logic implicit in algorithms. This process brought computation a step closer to a formal logic by visually structuring relationships by layering information.

Computation, mathematics, and form have independent cognitive principles but are based on common metaphysical organizational structures including bifurcations, grids, networks, and other relational typologies. Formal invention must deal with the mechanisms of information processing in order to displace the prescriptive logic of interfaces and to activate a cultural discourse intrinsic to architecture.

Computation and Authorship[2]

Software interfaces and codes constitute implicit frames where artistic expression begins. If the mediums of representation have such a power to regulate the work, then *interfaces* are spaces of differentiation. As such, interfaces can activate a performative aspect in the work, triggering a formal *generative* capacity. Part of this problem is how a project starts, as the first sign in a project may already be structured by systems of representation.

It is quite clear that if architects do not break or displace the given source codes in order to create their own, then their work is trapped by the predetermination of a set of ideas contained within those interfaces. While many architects try to address non-determination, formal excess and “random” computing processes present a trap for the activation of personal aesthetics. While the underlying logic of the interface remains untouched, the designer confuses visual noise with predetermined organization. This statement questions authorship in the design process – if structure is predetermined by the interface, the designer is merely interpreting a variation that completes the implicit combinations that the metaphysical project of the interface proposes, placing the programmer as the author. It seems that this trend will eventually affect legal authorship as certain programmers may claim copyrights over the geometry produced within interfaces, thereby opening up a full set of issues for the practice of the discipline that will become increasingly problematic in generations to come.

This problem of predetermination can be *explicit* or *implicit*. Predetermiation has become increasingly significant as architects have changed models of drawing *through* software in favor of computational algorithms. When computing algorithms, scripts, or connections in relational software a predetermination is *explicit* as the designer edits given codes or creates his/her own codes addressing means to organize information and processes that compose the form of the project. This explicit structure must be challenged for the design to acquire autonomy independent from its initial parameters. Architects that develop their own script partially resolve some of these questions, as far as they are able to distinguish what is computable from what is not and if they are able to displace the reversible logic of algorithms linearly structured through bifurcations.

However, when an architect draws “freely” using computer interfaces, this predetermination is *implicit* in the way the interface prescribes parameters. Subjective aesthetic agendas are filtered through the

2 Authorship relative to computation was one of the first problems the author raised in the ACADIA 2010 conference at the Cooper Union that he co-chaired. Mario Carpo’s *The Alphabet and the Algorithm* published in 2011 refers to similar problems.

parameterization of tools, visualization, interaction, and the form of the interface. Although, a posteriori visual judgment is always necessary for a critical displacement, and this cannot be computed in advance, giving relevance to drawing. Reversible logic is part of computation's deterministic project, however, architectural form acquires a relative autonomy independent from this processing of information. Once form is constituted it acquires a set of syntactical relationships, and at this point it is necessary to address a post-deterministic process aimed to surpass the initial machinic parameters, engaging a non-reversible logic.

This recognition can enable solutions that open up possibilities for new forms of representations. By progressively displacing the structure of the interface, these interfaces can revolutionize into new paradigms of representation, activating the second manifesto:

In order to avoid any semantic representation of extrinsic content, it is imminent to activate a topological loop between representation and actualization, acknowledging the parameterization of the interfaces that striate the logic of what constitutes the work.

Architecture, in its fullness, may be possible at that time when the interface operates at the same conceptual level as the architecture that it structures, building up an autonomy, a single reality, only possible within the framework of the discipline – specific to its intrinsic knowledge. This autonomy has not yet entered the digital.

The Role of Relative Displacement

The predetermination of interfaces can also be related to the predetermination of typological organizational structures that prescribe space. Topology has become the most critical project against the predetermination of linear structures. For Nietzsche, topology implies a genealogy, a displacement of "relative forces" and the typological, a variation in absolutes values (Deleuze G. 1962).

Typological organizational structures such as bifurcations, networks, grids and other common organizations need to be displaced and transcended for new models to emerge, avoiding the totalitarism of categorical types that if not acknowledged remain implicitly untouched. Any formal process should overcome the arbitrariness of the point of departure. Therefore, progressive topological displacements must seek for that break in a conceptual differentiation, aiming for a structural change typologically significant to transcend the simple variation of the form of their initial implicit or explicit structures. This reading proposes a series of implied conclusions for a critical understanding of the relationship between typology and topology and the possibility of a criticism to overcome their predetermination. Eisenman's formal methods in the 1970s developed an increasingly complex diagram from basic displacements, however the origin, or the first organizational structure while it is being displaced, it is not transcended throughout the process. Alejandro Zaera-Polo described Eisenman's process as a machinic diagram (Zaera Polo A. 1997) where computed solutions open up non-critical relationships like those emerging in the Berlin Memorial. Gregg Lynn's animate form theorizes relative topological variations claiming that any solution in the series is equally valuable (Lynn G. 1999). Preston Scott Cohen's Tel Aviv museum overcomes aleatory *machinic* variations by the displacement of generic structures in the building, since its topological transformation arrives to an indexed Lightfall which recognizes the presence of the subject.

This solution attempts to resolve the implicit project in the implementation of the relative, which its ultimate aim is to displace absolute values. This is the argument for the third manifesto:

The implicit project in parametric variations is to resolve within relative topological displacements such a structural typological change that is able to critique and transcend the departing implicit or explicit organizational structure.

Revolution or Progress? Technology as Culture

There are many unresolved questions in contemporary digital architecture that are the result of a linear implementation of information technologies without a cultural dimension.

Architecture as a cultural discipline has based its advancement on a continuous state of revolution. Heinrich Wölfflin described the group of architects that reacted to the Renaissance as Baroque, defining a historical oppositional structure which would cyclically repeat from one revolution to the other (Wölfflin H. 1888, 1929). This relationship differentiates artistic disciplines from science, which base their advancement on continuous progress. Today, in redefining the digital project, architects working directly with information codes must first identify this contradiction in the current digital architecture revolution. Digital architecture has been redefining its *project* as a progressive infinite continuous force, asserting a continuous actualization of architecture's avant-garde by indexing the most recent technological innovation. Digital architecture is aiming for a certain stability in this process, providing a false idea of continuous revolution replaced with a sense of progress, where cultural values, such as aesthetics, became equally informed and exchangeable with technological innovation. This provides the initial argument to the fourth manifesto:

Architecture must stop defining its avant-garde renewing itself cyclically by actualizing technology. Architecture must invert this relationship to actively inform technology from a cultural position.

In:Formed Ahistoric Architecture

Architecture has relegated its cultural *project* to technology. There are several consequences and the main one relates to the role of the history of the discipline. Recent generations may consider architectural history irrelevant. This is quite verifiable in the current state of architecture discourse, where innovation is referenced by an advancement over previous digital form generation or digital representation techniques without addressing a cultural displacement that would activate content in the work. The implicit condition is that computation has induced an *ahistoric architecture*.

If architectural canons can be related to cultural constructions that become active by formal logic then this implies the possibility of an incorporation and accumulation of meta-architecture history implicit within computation. What is implied for architecture knowledge is that if computation is successful in incorporating all possible strategies, techniques and philosophies of form within architecture history, these would be implicit in the structuring of form programmed in the latest release of computer software. This assumption is the implied fundamental that is manifested in current technologically informed avant-gardes: there would be no need for a historic precedent since the departing structure of the software would have these characteristics implicit in the interface.

Several architectural canons were informed by representational techniques. Architecture cannot be tested solely by addressing formal principles through computation, and canons were also informed by other questions. Algorithms are informing architecture, but computation is often more useful rather as a catalyst to guarantee the calculation of a consistent systematic formal logic across a project. This machinic logic ensures systematic order and the un-motivation of the designer's personal socio-cultural projection that is often seen as a constraint to emerging conditions intrinsic to the architecture of the project. If there is any relationship between formal advancement, representation, and architectural canons it has been through digital representation during the last twenty years, setting up precedents for an *ahistoric* architecture.

The issue is whether computation will catch up with implicit cultural demands. This dilemma may present a possibility that inverts the equation and places culture as an implicit force informing technology

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by sensing and anticipating cultural challenges. Computation not only informs implicit formal processes, but classifies and creates signifiers – re-defining architecture. Software then becomes a meta-ahistorical de-territorialization machine that encompasses the discipline by finding novel means to constitute form.

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An organism is a system. (...) It is a river that flows and yet remains stable in the continual collapse of its banks and the irreversible erosion of the mountains around it. One always swims in the same river; one never sits down on the same bank. The fluvial basin is stable in its flux and the passage of its chreodes; as a system open to evaporation, rain, and clouds, it always – but stochastically – brings back the same water. What is slowly destroyed is the solid basin. The fluid is stable; the solid which wears away is unstable – Heraclitus and Parmenides were both right. Hence, the notion of homeorrhesis. The living system is homeorrhetic.

Michel Serres on the organism as an information system, Hermes, 1982

ARCHITECTURE IN FORMATION: ON THE AFFLUENCE, INFLUENCE, AND CONFLUENCE OF INFORMATION

— AARON SPRECHER

Toward an Informed Architecture

With the advent of modern science and the perception of natural phenomena in terms of uncertainties, the discipline of architecture has undergone a similar shift – from a stable, idealistic expression of the real world, to the unleashing of performative systems that reflect its instabilities (Blackmore J. 1995). This perennial interest to transform the fixity of the architectural model into a system of potentialities has generated many theoretical assumptions that often referred to the nature of living organisms as a source of information processing (Wiener N. 1954). Just to name a few, Patrick Geddes' "Life-conserving Principles" (1915); Frederick Kiesler's "Correalism and Biotechniques" (1939); Richard Neutra's "Survival Through Design" (1954); Superstudio's "Microevent/Microenvironment" (1972) and Markos Novak's "Transarchitecture" (1995).

Their theoretical assumptions share a conception of architectural performance seen in terms of the capacity to reflect and draw from the complexity of the natural organism. While they have emerged in different contexts of knowledge, these assumptions have in fact generated an approach to architecture that is intricately associated with its capacity to stream and generate information. The affluence, influence and confluence of information are three notions associated with the exponential role of technology in today's architectural production. Their respective attributes have generated an anxiety that no longer arouses from the will to represent our reality but from the desire to literally generate it. It is here proposed to review some arguments about the reasons why architecture always cared to integrate the spheres of information.

As the French philosopher Michel Serres asserts, the living organism acts similarly to an open system that can only be assessed rather than defined because of its recombinant qualities (Serres M. 1982). It renders a reactive system in quasi-equilibrium where the intense affluence of information, influence of systemic parameters and confluence of knowledge incessantly erode, reform, and transform its existence. This consideration of the living organism as an information system provided a breeding ground, almost literally, for visionary researchers who did not hesitate to assess the architectural object as a responsive, reactive and mutative organism. In the past 30 years, architects such as Greg Lynn, Karl Chu, and more recently Francois Roche provided the research community with remarkable results on the potential to embed evolutionary principles at the core of the object. At the same time, critical theorists such as Georges Teyssot, Antoine Picon, and Mario Carpo engaged with defining the consequences of the increasing influence of information technologies on the

fig 1

discipline of architecture. The visionary work of these practitioners and theorists prefigured the digital euphoria of the 21st century.

Now that the digital savvy milieu of architects has lived on the ecstasy of the first days, it is time to look again on the nature of information that propels today's *informed architecture*. Here, the term "informed" suggests that architecture is more than ever sensitive to the affluence, influence and confluence of information as defined by Michel Serres. These three conditions are indeed prevailing in the mutation of the architectural object into something that increasingly resembles a techno-engineered organism. An organism profoundly influenced by the inherent intensity, instability and transdisciplinarity of technology.

Affluence

With the accelerated "informatization" of the human society and economy in the postwar period, architecture has engaged in an exponential integration of information technologies (Nora S. and Minc A. 1981). One of the consequences of this condition has been the emergence of an architectural production increasingly preoccupied with reaching a critical degree of morphological, structural and material precision. Such precision reflects the ability for information to intensify its presence into the deepest structure of matter. More importantly, this intensification of information affluences has augmented the symbiotic relation between the form and its function. Such a system is indeed increasingly specialized due to the selective processing of information that continuously modifies its very own nature and accelerates its evolution (Atlan H. et al. 2004). The architectural system thus conceived is endowed with an exponential capacity to absorb information assets while relentlessly combining them in order to guarantee its functional performance.

Yet, such an architectural system is far more than a Petri dish of information bits. It foremost operates as an open system of influences that continuously reinvents itself. (fig 1)

fig 1
Information Affluence: I-grid is a design performance by Open Source Architecture located at the corner of Sunset Boulevard and Olive Drive in West Hollywood, California. Its computational protocol expresses the transformation of an existing billboard into manifold morphologies. Initially based on an incremental grid, an evolutionary algorithm produces a series of iterated mutations that index the affluence of information assets. The 50-foot-high I-grid expresses the notion of instability inherent to its info-engineered nature. The resulting composite image is based on a collection of vectors that aim at emphasizing the movement from the idealistic model to the statistic object. The final image was produced on the basis of a color code where each and every iteration could be identified while composing the overall system. I-grid features a new form of interactivity stimulated by information streams that are intensified (data compression) across multiple virtual computing grids and extended (data decompression) on the physical surface. Information here becomes a unique vector that blurs the conventional dialectics between private and public realms, computers and the city. Instead, it suggests the formation of a system that proposes nothing more than abstraction, an abstract space of information.
(Photo Credits: Open Source Architecture, Los Angeles, 2008).

Influence

Considering the exponential capabilities offered by the information technologies, architecture has been engaged into redefining its modes of production and the nature of its expression. Following Michel Serres' assertion, the architectural object increasingly resembles an organism that is responsive to its own internal nature and the external conditions of its surrounding. In this hyper-mediated environment, what used to be the collective gives way to the connective, the rigid structure to the open system, the condition of causality to non-linearity. Such an environment is generated by a wide range of information influences that render a reality in constant mutation; a reality shaped by potentialities, instabilities, and probabilities. Considering architecture as an expression of the human environment, the idea of a world shaped by probabilities is crucial because it implies that the architectural organism evolves in a non-linear fashion. In other words, its existence does not reflect a structure of cause and effect but rather induces complex evolutionary processes. In recent years, this consideration has triggered new modes of design thinking that share a similar objective, namely increasing the capability to reflect on a wide variety of generative influences. These new modes of design thinking include automated processes such as structural shape annealing mechanisms, genetic algorithms, and cellular automata. While considerably augmenting our perception of the real, the architectural organism renders a world of evolving phenomena shaped by unstable influences.

The architectural organism thus conceived does not simply imply that new modes of production have emerged. It foremost implies that the discipline of architecture has marked an epistemological shift prompted by the current technological confluence of knowledge. (fig 2)

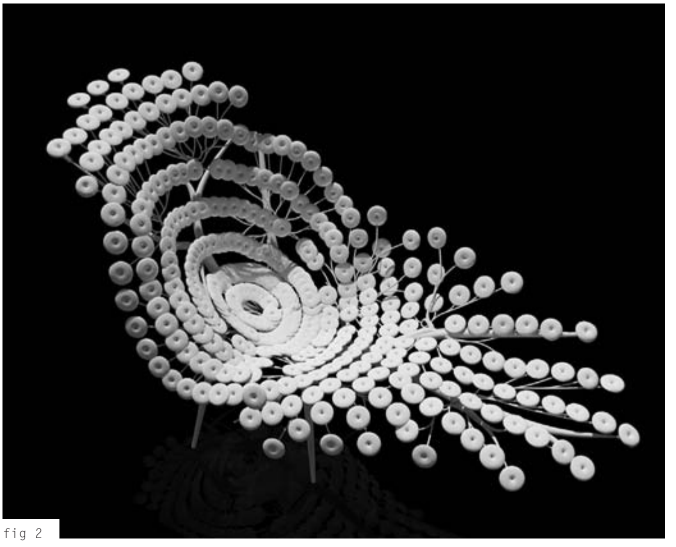

fig 2

Confluence

This continuum has radically transformed the nature of the practice. By embracing a great diversity of information and technologies, the architectural entity went from a static to a dynamic condition in the past 30 years. It now resembles an energetic system, meaning that its existence depends on the addition and association of parameters, each representing a potential condition for the reconfiguration of its intrinsic nature. Above all, technology has exponentially increased its ability to add parameters, therefore producing models that are, too often idealistically, qualified as “emergent.” This notion of emergence is often used to describe an architectural entity that expresses a formal complexity produced by increasingly blurred computational operations. And yet, the redundant use of this notion is not surprising in view of a contemporary reality that appears more and more unstable and mutable.

In today’s architecture studio, designers continuously acquire terms and languages that are borrowed from the sciences. This change in practice does not imply that architecture has turned into a new science, but rather that its tools have become increasingly scientific. These scientific procedures have gradually transformed the deceiving nature of diagrams into computational codes that stem from the confluence of a wide range of disciplines. Associating the notion of confluence of knowledge to the design activity suggests that architecture can no longer remain an autonomous discipline. It now embraces the immensity of information networks. One of the consequences of this transdisciplinary condition is expressed by the current proliferation of new design activities in fields such as material and fabrication research, interactive and immersive media, and most noticeably, biologically inspired modeling (Linder M. 2005). In other words, the expansion of information assets implies that architecture is increasingly influenced by other fields of knowledge. Its concerns are no longer constrained to a particular dimension but instead

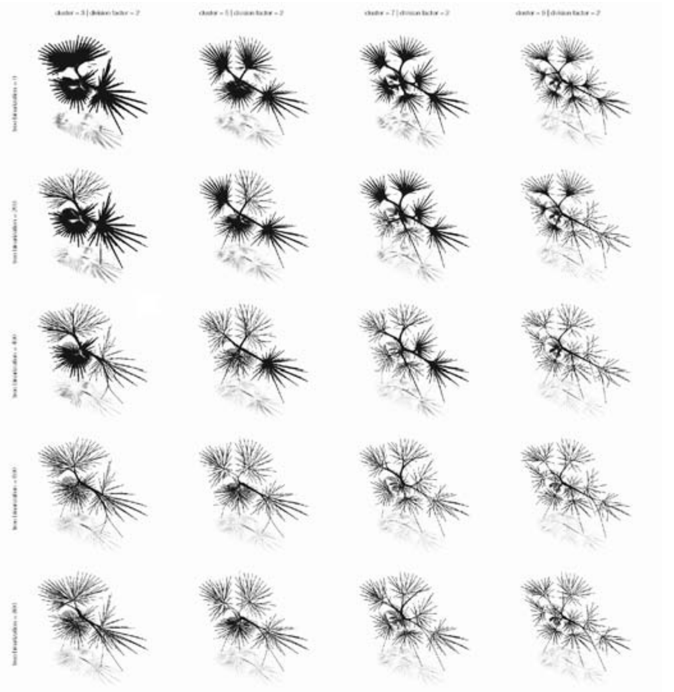

fig 2a

fig 2
Information Influence: C-Chair by Open Source Architecture exemplifies the role of information as an influential factor in the formation of the object. The model emerges out of inanimate objects such as points, lines, and surfaces. These objects, by themselves, are empty containers which act as memorizers of information. Once they are placed within the context of a spatial and temporal axis, they are imparted with information, such as location, direction, and connections. As these basic building blocks are established and well defined, a gradient switch responds to areas where the human body comes into contact with the chair surface. C-chair associates two distinct topological systems, the tree and the rhizome. Since both systems are built from common building blocks, an interface between the two is natural. The interface becomes a point cloud of densities which define zones of structural support. The rhizome proliferates by growing homologous strands, and genetic switches regulate the stochastic drift of speed, direction and density. A clustering technique regulates the hierarchical structure of the tree. One by one, points are moved from one cluster to another until the system stabilizes to form a minimal overall Euclidean distance. The more complex organism, the tree, inherits the established knowledge of the less complex organism, the rhizome, and this knowledge is encapsulated as an object-oriented machine. Some methods are reused and others are augmented or overridden. This analogy of architectural codification to living organisms is not a coincidence. In comparing genetic encoding with software encoding, we find striking similarities between the theory of evolutionary development in biology and software techniques such as object-oriented design (Carrol, 2005). (Image Credits: Open Source Architecture, 2009).

fig 2a
C-Chair. Sequence of Cluster Formation and Binarization

extend at all scales simultaneously, from the intrinsic structures of material to the macro-scale of environmental phenomena. Architecture stands now at the confluence of informational streams that generate a continuum of knowledge across all disciplines. (fig 3)

Informed Architecture: Sensitive Organism

From Frederick Kiesler's topological surfaces to Greg Lynn's curvilinear shapes, architecture is offered the possibility of perceiving our reality in terms of behavioral and responsive architectural mechanisms rather than shallow images of reality.

Described in his seminal article "A Home is not a House" the proliferation and specialization of building systems prompted Reyner Banham to describe the house as a "baroque ensemble of domestic gadgetry [that] epitomizes the intestinal complexity of gracious living" (Banham R. 1965). This analogy of mechanical and electrical services to systems regulating the living organism is striking because it suggests that the accumulation of energetic functions, as diverse as climatic, wireless and grid-based, implies the disappearance of the form, image, and representation of architecture as we know it.

In this article, François Dallegret's drawings for Banham are a tribute to this conglomeration of mechanical, electrical, and structural systems, with their associated requisites and interactions (Banham R. 1965). This vision of the house as an exhilarating skeleton marks the advent of a design paradigm of performance for architecture of life, energy and (de)regulated behaviors. Similar to a living organism, Banham's architectural object emerges out of energetic streams, organic veins forming a unitary system of interwoven and interacting sub-systems which combine effectively toward the whole. Banham and Dallegret's mechanical systems are characterized, indeed defined by their behaviors, capabilities, sets of innate and imparted knowledge.

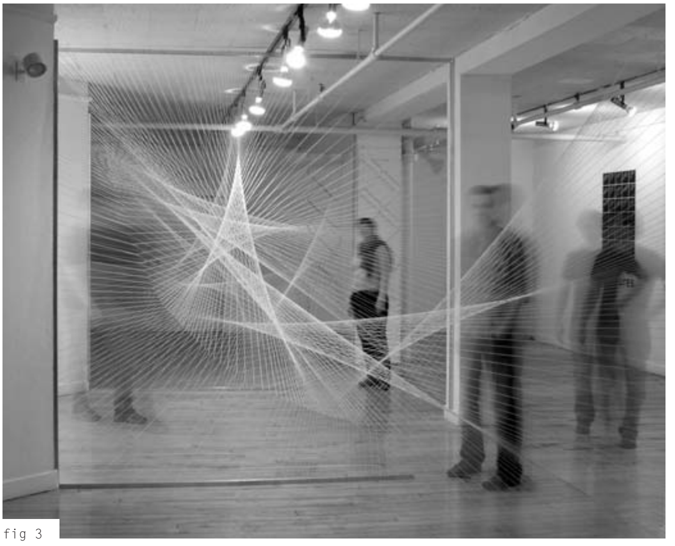

fig 3

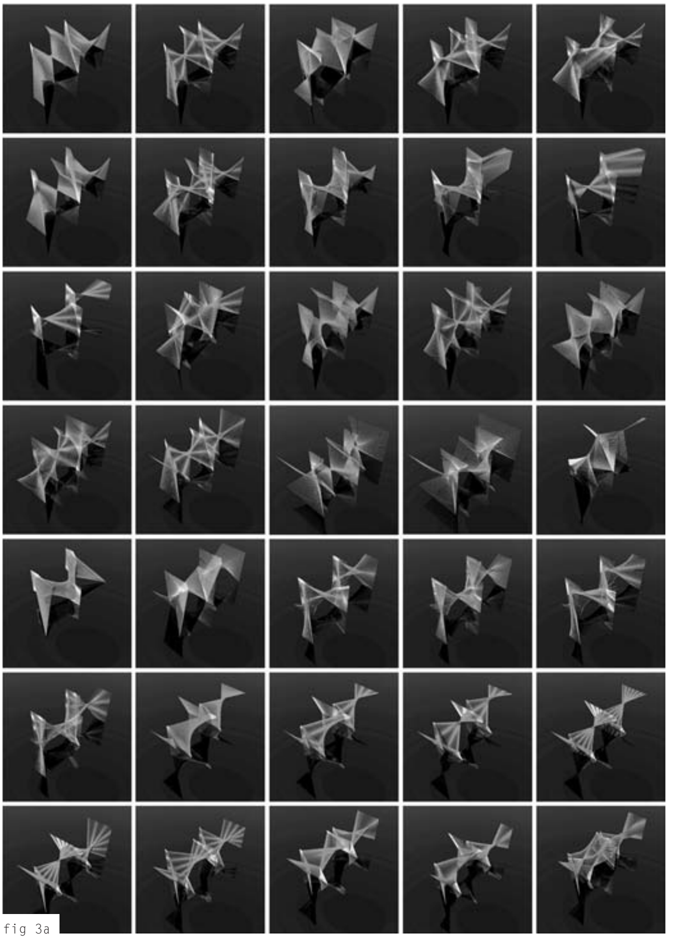

fig 3a

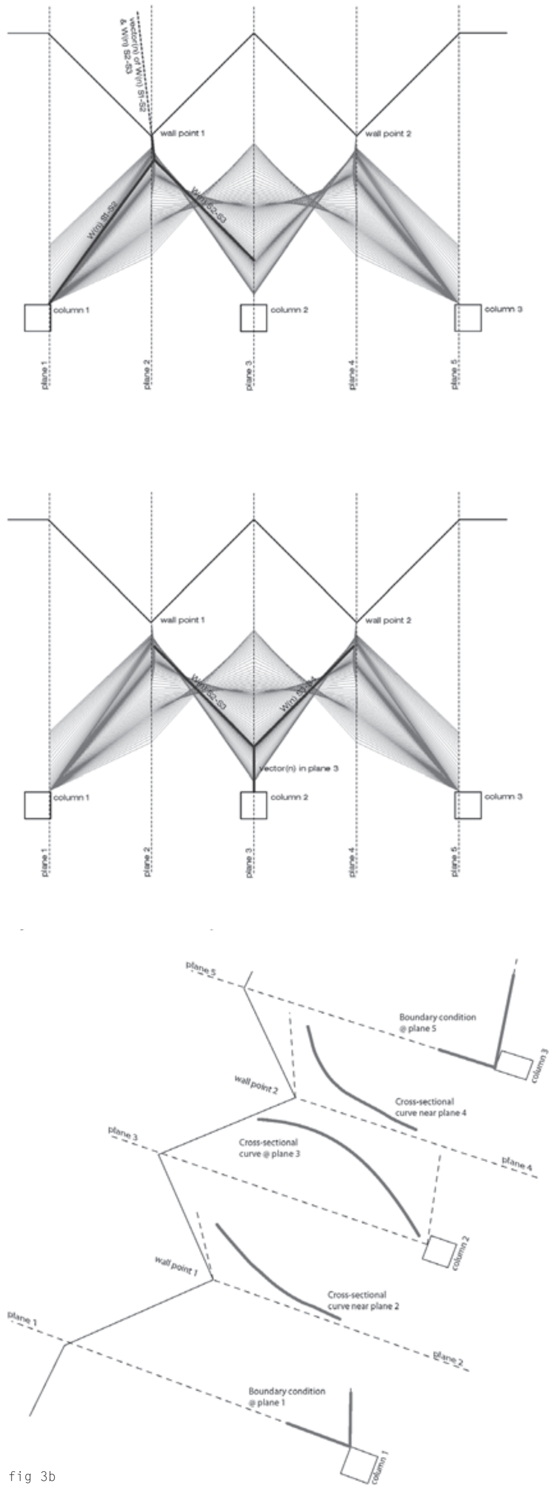

fig 3b

fig 3
Information Confluence: n-Natures is a fiber-based prototype developed at the crossing of multiple computational platforms (Mathematica© and McNeel Rhinoceros©). Such an engineered prototype epitomizes the current confluence of knowledge between multiple disciplines; in this case, mathematics (Dr. Edward Mosteig, Loyola Marymount University), computational design, material research, and digital fabrication (Open Source Architecture and John Bohn Associates). Pressured by computational tools that were primarily developed in other domains of knowledge, today's architectural production is no longer autonomous but depends instead on a wide range of research domains. The expansion of information and its associated technologies implies that design is increasingly porous to other fields of knowledge. The discipline is consequently confronted with a large amount of parameters that are relayed, processed, and re-sampled by sophisticated computational protocols. Investigating the diversity of information assets associated with the architectural object, This experiment consists of generating a fiber-based material system that reveals the three-dimensional spatial nature of the Riemann-Zeta mathematical function. The main trait of n-Natures rests on the fusion of the deterministic nature of the mathematical function, the empirical information regarding the unique geometry of the gallery space, and the physical requirements of the tensile material system. As such, determinism and empiricism are two distinctive approaches that the team members defined at the inception of this project. (Photo Credits: Kevin Deabler, Rhode Island School of Architecture, Providence, 2009).

fig 3a
n-Natures. Models determined by variations in cross-sectional curves and hull line densities.

fig 3b
n-Natures. Top: Asymmetric conditions produce vectors out of plane (planes 2 & 4) each pair of W lines produces unique vector forced to resolve at wall point 1 (or 2); Middle: Symmetric conditions on plane 3; Bottom: Axonometric of boundary conditions and cross-sectional curves at planes 1 to 5.

fig 4

All projects by
**Open Source Architecture
(Chandler Ahrens, Eran Neuman,
and Aaron Sprecher).**

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Today, with Dallegret's mechanical systems turning into operational sets, the former diagram has turned into an operational code. With the ever-increasing integration of computational capability, it is now largely accepted that the architectural object is generated out of operational processes that are often inspired by other disciplinary fields such as biology and genetics. Like the DNA of living organisms, architectural reality as codified rather than diagrammed implies that it has become energetic. Its codes are dynamic and reactive to the ever changing modalities of the external environment and internal capabilities of the architectural model. Architecture, as nature, induces vital mechanisms of manifold information streams, simultaneously memorizing, associating, and connecting parameters that regulate the living and evolving designed organisms.

In the past 50 years, roughly since the advent of information sciences and technologies, architecture has undergone a profound transformation of its status. And yet, from Dallegret's *Environment-Bubble* and Superstudio's *Microevent/Microenvironment* to today's morphogenetic desires, architecture remains fascinated with life, nature, and the complexity of our human reality. The intensive affluence of information, the evolving influence of environmental conditions and the transdisciplinary confluence of knowledge are three prevailing conditions to the existence of current architectural productions. These conditions act in the most profound structures of today's informed architecture. They have gradually transformed the object into a sensitive organism that has the potential of being mutative to its own existence and environment. The architectural organism thus conceived is now ready to embrace the "ambient spheres" of life (Sloterdijk P. 2000). (fig 4)

fig 4
Architecture as Nature: ParaSolar by Open Source Architecture is a phototaxic installation featuring 80 proposals on the future of Tel Aviv. Its inflated components negotiate and react to parameters related to solar exposure. (Photo Credits: Yaron Kanor for Open Source Architecture, Center for Performing Arts, Tel Aviv, 2009).

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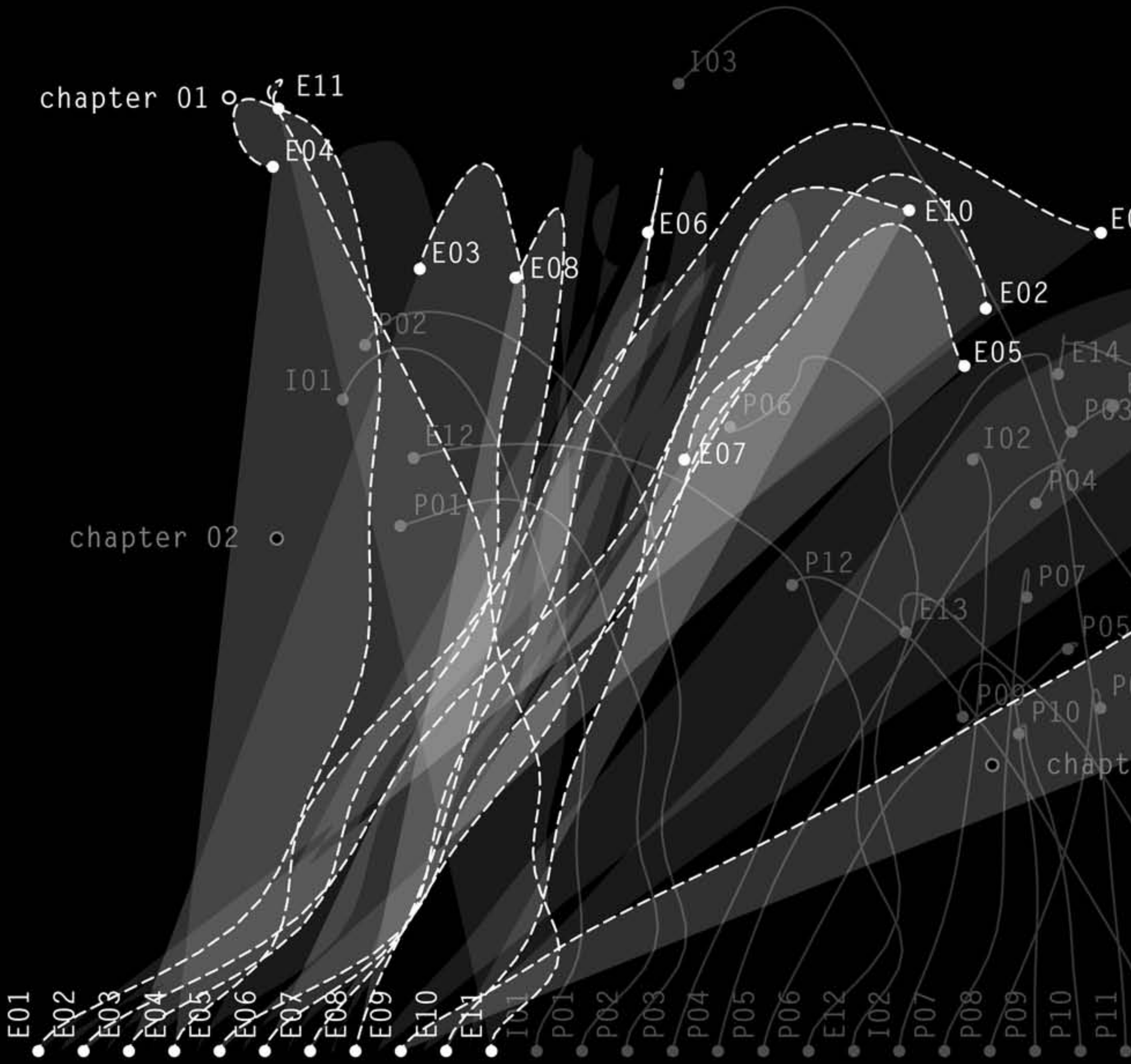
Wiener N. (1954), *The Human Use of Human Being*, New York: Double Day & Company, p.17. We follow here Norbert Wiener's definition of information that is "the content of what is exchanged with the outer world as we adjust to it, and make our adjustment felt upon it."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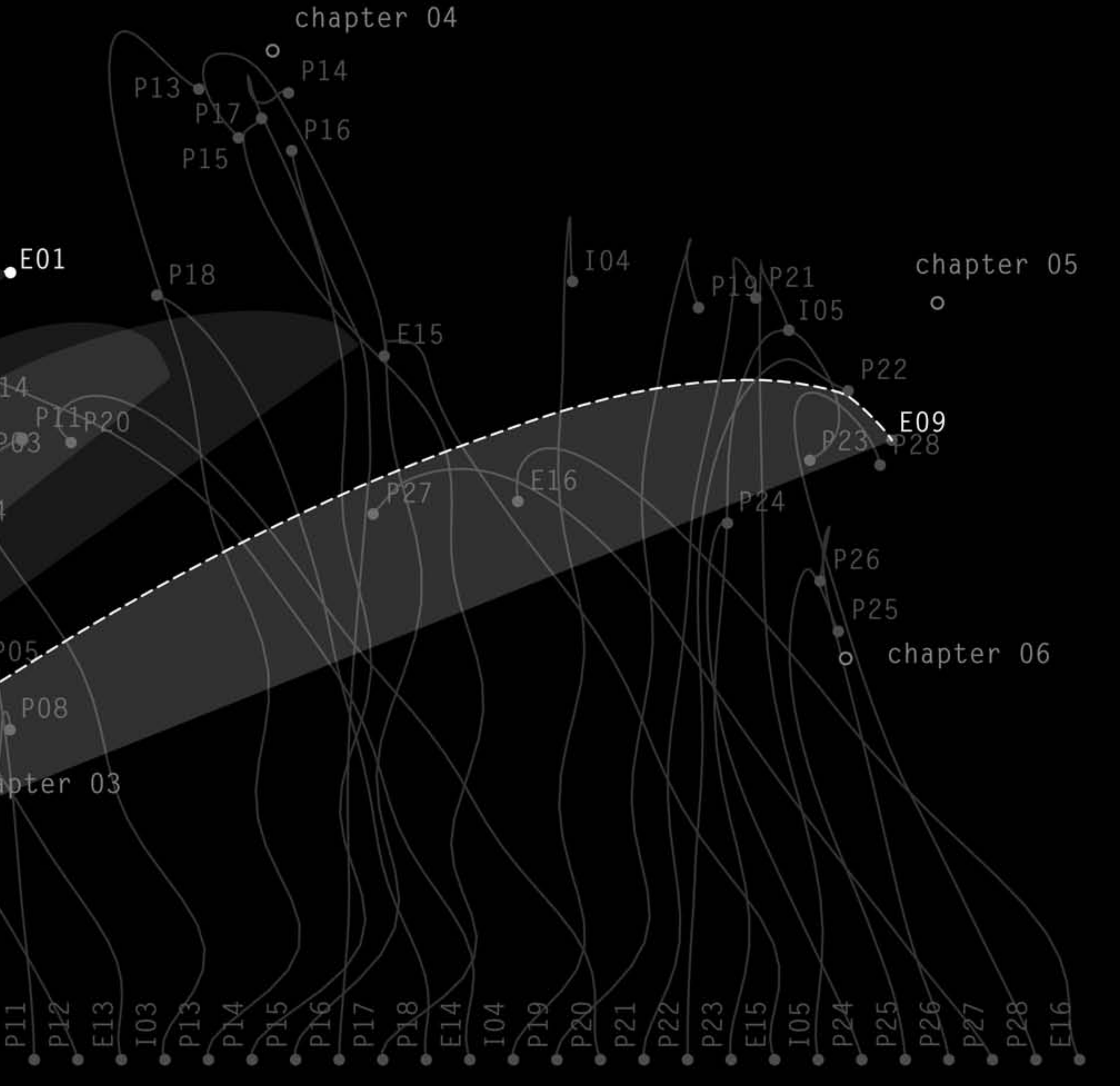
01
STRUCTURING INFORMATION:
— TOWARDS AN ARCHITECTURE OF INFORMATION



*"Topology becomes
the dominant … discipline."*

Reyner Banham, "The New Brutalism," (1955).[1]

"Infolding: imagine working through into depths with the help of a media that provides instantaneous feedback and thereby allows infolding with time, memory, energy, relation… A topology that uses rhythms intermingling and flowing around and through each other would let us build walls secondarily, rather than as categorical dividers. TV networks do not have walls…"

Warren Brodey, "Biotopology 1972," 1971. [2]

1
Reyner Banham, "The New Brutalism," *The Architectural Review*, 118 (December 1955), 354-61, quote 361; reprinted in Banham, *A Critic Writes: Essays by Reyner Banham*, ed. Mary Banham et al. (Berkeley: University of California Press, 1996), 7-15.

2
Warren Brodey, MD, "Biotopology 1972," *Radical Software*, v. 1, n° 4, (Summer 1971), 4-7, accessed April 2012, http://www.radicalsoftware.org/volume1nr4/pdf/VOLUME1NR4_art02.pdf

AN ENFOLDED MEMBRANE

— GEORGES TEYSSOT

Our starting point is a well-known story. During the 1990s, while many American architects were reading the English translation of Gilles Deleuze's study *The Fold: Leibniz and the Baroque* (1993), Greg Lynn edited an issue of *Architectural Design* (1993) on the topic of Folding in Architecture. In his introduction, "Architecture Curvilinearity: The Folded, the Pliant, and the Supple," Lynn called for curvilinear forms.[3] This invocation led to the provisional assertion of a "blob" architecture, the official birth of which seems to be marked by Lynn's subsequent article in *ANY* magazine (1996), where he argued that tectonics was "out" and obsolete, while topology was "in" and sexy.[4] Lynn also thumbed his nose at a series of personalities who were fighting rearguard battles, defending what remained of the idea of Semperian tectonics. Moreover, during the 1990s, new tools for 3-D modeling offered by numerous computer applications (Maya, Form*Z, Rhino) made it possible for architects to literally multiply the folds in their projects.

The Monad's Window

One might ask what architects discovered in reading Deleuze's interpretation of Leibniz, the most important aspect of which was the monad. In the *Monadology* (1714), Leibniz gives the name monad to the simple substance.[5] This singular individuality, a folded membrane, carries all actions and thoughts that will unfold over time. Each monad collects and reflects the whole world, and operates as "a perpetual living mirror of the universe."[6] Michel Serres, in his famous thesis on Leibniz, and more recently, Bernard Cache, have argued that Girard Desargues' mathematics provided a model for Leibniz's monad.[7] Inventor of infinitesimal calculus, Leibniz could easily have consulted Desargues' work. An architect, engineer, and mathematician, Desargues was a founder of projective geometry, which offers a mathematical model for the intuitive notions of perspective and horizon by studying what remains invariable in projections. Outlining the concept of the "invariant," he gives his name to the "Desargues theorem," focusing on homological triangles. His disciple was the engraver Abraham Bosse, author of a *Treatise on Projections and Perspective* (1665), who later taught linear perspective to stonecutters, carpenters, engravers, manufacturers of instruments and, less successfully, to painters.[8] The perspective that Bosse teaches implicitly introduces the idea of infinity, in that he uses parallel lines with an infinitely extending vanishing point to construct perspective. Moreover, permeated by the knowledge of Desargues, Bosse develops a method for tracing shadows, which was inspired by his master.[9] (figs 1, 2)

3
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4
Greg Lynn, "(Blobs) or Why Tectonics is Square and Topology is Groovy," *ANY*, 14, (May 1996): 58-61.

5
Gottfried Wilhelm Leibniz, *The Monadology*, [1714], trans. Robert Latta (1999), [access date June 2011], http://www.rbjones.com/rbjpub/philos/classics/leibniz/monad.htm.

6
Leibniz, *Monadology*, [1714], §56.

7
Michel Serres, *Le Système de Leibniz et ses modèles mathématiques: étoiles, schémas, points*, (Paris: Presses Universitaires de France, 1968), 166-167; 3rd ed. (Paris: Presses Universitaires de Presses, 1990); Bernard Cache, "Desargues and Leibniz, in the Black Box. A Mathematical Model of Leibnizian Monad," *Architectural Design*, "Mathematics of Space", George L. Legendre, ed. vol. 81, 4, (July / August 2011), 90-99.

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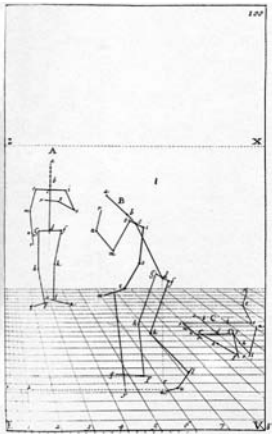

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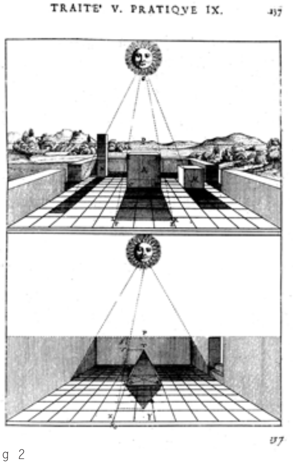

fig 2

fig 1
Abraham Bosse, *Manière universelle de M. Desargues, pour pratiquer la perspective* par petit-pied... (Paris: P. Deshayes, 1648), p. 100. Courtesy Werner Nekes Collection, Mülheim/Ruhr, Germany.

fig 2
Jean Dubreuil, *La perspective pratique, nécessaire à tous peintres, graveurs, architectes, brodeurs, sculpteurs*, 2nd edition (Paris: Chez Jean Du Puis, 1664). Courtesy Bibliothèque de l'Institut de France, Institut de France, Paris, France. Photo: Réunion des Musées Nationaux (RMN) / Art Resource, NY.

It remains to succinctly describe *The Monadology*, which is a synthesis of the Leibniz's thought. A monad is "a simple substance ... that has no parts," for monads constitute "the true atoms of Nature".[10] Natural changes and transformations in a monad occur as a result of "an internal force, which one might call an active force."[11] A monad is the site of changes in "what we call perception."[12] To describe monads, Leibniz introduces the Aristotelian notion of *Entelechies*, actuality, from *entelekheia* – active, effective energy. For Aristotle, the soul is the entelechy of the body. It is where the sources of the body's internal activities reside, guaranteeing them a certain perfection, assuring them an autonomous existence (autarcheia), and allowing them to act like "immaterial automata."[13] Nature has given highly effective perceptions to animals that correspond to each of the five senses, as well as other senses that man does not comprehend. Animals are provided with sense organs and "what happens in the soul represents what goes on in those organs."[14] The lower animals possess empirical knowledge every bit as much as man does, but man is endowed with Reason, and can acquire Science, for we are dealing here with what is called a "'rational soul' or 'mind' in us."[15] Atoms, which are all different, come together to create the whole array of bodies found in nature, whose movements God orders so as to produce the best of all possible worlds.[16] It follows that "this interconnection, or this adapting of all created things to each one ... brings it about that each simple substance has relational properties that express all the others, so that each monad is a perpetual living mirror of the universe."[17]

To explain the paradox of the diversity of worlds, where each monad represents the universe, only differently, Leibniz uses the example of point of view: "Just as the same town when seen from different sides will seem quite different – as though it were multiplied perspectivally – the same thing happens here: because of the infinite multitude of simple substances it's as though there were that many different universes; but

10
Monadology, §3, online translation.

11
Ibid., §11 ("active force" was crossed out in the original); Leibniz's emphasis.

12
Ibid., §14.

13
Ibid., §18

14
Ibid., §25

15
Ibid., §28 & 29

16
Ibid., §55

17
Ibid., §56

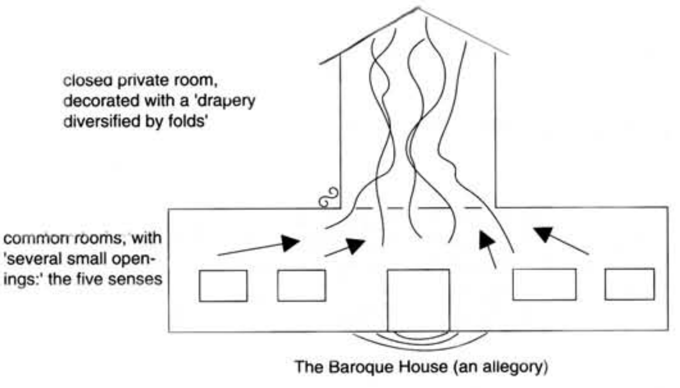

fig 3

fig 3
Allegory of the Baroque House, in Gilles Deleuze, *The Fold: Leibniz and the Baroque*, trans. Tom Conley, [1988], (Minneapolis: University of Minnesota Press, 1993), 5. Courtesy of University of Minnesota Press.

they are all perspectives on the same one, differing according to the different points of view of the monads."[18] This is, of course, an allusion to anamorphoses, curiosities typical of the baroque, defined by the play of perspective obtained by a reflection in a curved mirror or through a mathematical procedure, that only reveal a drawing's subject when the viewer stands in a particular spot. "Each body feels the effects of everything that happens in the universe," and this, everywhere, whether in the past or the present, extends to "what is distant both in space and in time," writes Leibniz.[19] Hippocrates liked to say that there is one common flow, one common breathing, and all things were in sympathy: "But a soul can read within itself only what is represented there distinctly; it could never bring out all at once everything that is folded into it, because its folds go on to infinity," writes Leibniz.[20] Bodies are folded substances every bit as much as souls are; but, like a hyperbola, the fold of souls goes on toward infinity. "Thus, although each created monad represents the whole universe, it represents more distinctly the body that is exclusively assigned to it."[21] The monad – and this is the paradox – is a living mirror of the universe, but it also possesses an "organized body," a kind of "divine machine or natural automaton."[22] The monad is alive and is endowed with a capacity for internal action, capable of representing the world from its particular point of view. As a "Living Mirror," it is regulated by harmonic relations, and ordered like the universe. For Leibniz, substance being in a "perpetual state of flux," the monad acts as a medium.[23] Yet, monads have no causal interactions among themselves, nor do they interact directly with real phenomena, perceived jointly with the other monads. Hence the paradox: "perception" provides the very substance of the monad, but without any external influence.[24] Like automatons moved by a spring, all created monads have internal perfection, which ensures their autonomy. They are self-sufficient.

18 Ibid., §57

19 *Monadology*, §61.

20 Ibid.

21 Ibid., §62.

22 Ibid., §64.

23 Ibid., §71.

24 Ibid., §14.

fig 5

fig 5
View of a curiosities cabinet (*Wunderkammer*) from: "A series of illustrations...of Levin Vincent's collection", in Levin Vincent, *Wondertooneel der nature* [*Marvels of Nature*] (Haarlem: Sumptibus Auctoris, 1719). Photo: Snark / Art Resource, NY.

During the seventeenth century, with René Descartes and Blaise Pascal, geometry is one of the most innovative aspects of science, and it governs the spirits. As Michel Serres explains in *Le système de Leibniz* (*The System of Leibniz*, 1968), amongst geometry's applications are perspective and its inverse – the tracing of shadows, which was useful for painters, engravers, and architects. Leibniz seeks to connect with an assortment of encyclopedic knowledge, at the center of which one discovers the epistemology of Desargues' work. Leibniz's terminology reflects Desargues' principles – while at the same time drawing upon his own philosophical language, which allows one to ask if Desargues' principles are indeed the models of Leibniz's categories. This questioning would indicate one of the sources of the Leibnizian system. As Serres wrote:

"One knows how to 'concretize' a point of view*, a place and a* situation*, an* elevation *(figure and situation of an object), the determination of a correspondence, the relation of appearance between an objective point and a prospective point, the character of representation of this appearance, and so on. Everything happens as if the* reasons and principles of perspective ... were epistemologically expressible *in a language that is* none other than the philosophical language of the Monadology.*"*[25]

Serres warns, however, that there isn't a single model: "This does not imply that *The Monadology* is *only* a metaphysical translation of Desargues' epistemology.... [T]here are also other translations; the perspective template is just one model among others. From this model to the structure of *The Monadology*, there isn't a one-to-one relation, but a one-to-multiple relation."[26] For Cache, it is not sufficient to merely affirm that the monad is a viewpoint on the world; one must provide a geometric construction that implements a principle internal to the monad's closed box, in accordance with Alberti's perspective, which presented the capacity to connect objects and subjects in space.[27] For Leibniz, in their complete-

25
Serres, *Le Système de Leibniz*…, 166-167, our translation; the italics are in the original.

26
Ibid., 167, n. 1, our translation.

27
Bernard Cache maintains that "Desargues does it in two ways: through perspective and by projective geometry, which are two very different approaches (even if they present a unity for "contemplative" persons); in Cache, op. cit.

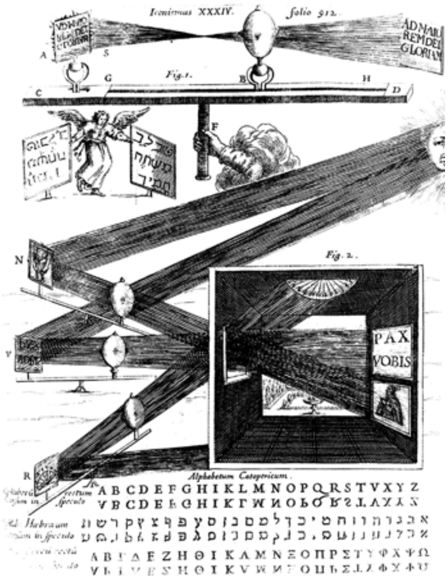
fig 6

fig 6
Projecting inscriptions through a set of lenses; in Athanasius Kircher, *Ars magna lucis et umbrae* (Rome: H. Scheus, 1646), 912, p. 34. Courtesy Werner Nekes Collection, Mülheim/Ruhr, Germany.

ness, "monads have no windows, through which anything could come in or go out"[28] – although Horst Bredekamp challenges this assertion in his book, *The Window of the Monad* (2008).[29] The first stage of Leibniz's monad, described in a drawing of 1663, represents the relations between soul and body with the shape of a Pythagorean pentagram.[30]

As Deleuze writes in *The Logic of Sense* (1969), "This surface topology, these impersonal and preindividual nomadic singularities constitute the real transcendental field."[31] For Leibniz, "the individual monad expresses a world according to the relation of other bodies with its own, as much as it expresses this relation according to the relation of the parts of its own body [between themselves]."[32] This expresses the harmonic relationship of parts (of the body) to the whole. Deleuze goes on to write: "[This relationship] presupposes the distribution of pure singularities according to the rules of convergence and divergence. These rules belong to a logic of sense and the event.... Leibniz went very far in this first stage of the genesis. He thought of the constitution of the individual as the center of an envelopment, as enveloping singularities inside a world and on its own body."[33] The monad is a folded membrane, a receiver organ for picking up the world. But, it is also an enveloping substance, a sort of skin.

Plica ex plica

Deleuze's research on topological singularities continues in *The Fold*. Deleuze himself draws the monad in the form of a two-storey, baroque house.[34] On the ground floor are common rooms, with five openings (one door and four windows) representing the five senses plugged into the world. However, the upper floor has no window: there is a dark room, lined with "stretched canvas 'diversified by folds'," which represent innate forms of knowledge, as well as receive "vibrations or oscillations" conveyed from the lower floor.[35] The closed cabinet is an allegory of baroque space, which projects into infinity, but moves along two distinct branches,

28
Leibniz, *Monadology*, [1714], §7.

29
Horst Bredekamp, *Die Fenster der Monade: Gottfried Wilhem Leibniz' Theater der Natur und Kunst*, (Berlin: Akad.-Verl., 2008), 2nd edition.

30
Gottfried Wilhelm Leibniz, "Leib-Seele-Pentagramm," [1663], in Hubertus Busche, *Leibniz' Weg ins perspektivische Universum: eine Harmonie im Zeitalter der Berechnung* (Hamburg: Meiner, 1997), 59; and in Horst Bredekamp, Die Fenster der Monade, 18.

31
Gilles Deleuze, *The Logic of Sense*, trans. Mark Lester with Charles Stivel (New York: Columbia University Press, 1990), 109.

32
Deleuze, *The Logic of Sense*, 110.

33
Deleuze, ibid., 111.

34
Gilles Deleuze, *The Fold: Leibniz and the Baroque*, trans. Tom Conley (Minneapolis: University of Minnesota Press, 1993), 5.

35
Deleuze, *The Fold*, 4.

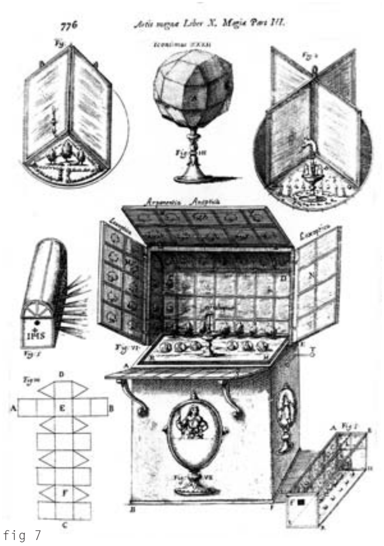
fig 7

fig 7
“Theatrum catoptricum,” engraving, in Athanasius Kircher, *Ars magna lucis et umbrae*, in X. libros digesta....(Amsterdam: Apud Joannem Janssonium à Waesberge & haeredes Elizaei Weyerstraet, 1671), 2nd augmented edition, 776. Courtesy Werner Nekes Collection, Mülheim/Ruhr, Germany.

“as if infinity were composed of two stages or floors: the pleats of matter, and the folds in the soul.”[36] The lower floor is pierced with windows, while the upper floor is blind and closed, with the ability to resonate, “as if it were a musical salon translating the visible movements below into sounds up above.”[37] (fig 3)

Serres and Deleuze make clear that Leibniz’s theory of an intelligent membrane is made possible by discoveries such as the fluidity of matter, the elasticity of the body, and spring mechanism.[38] In a flexible body, the elasticity of the parts forms a succession of coherent folds, infinitely dividing into increasingly smaller components, as they subdivide into bending movements. As Leibniz outlined: “The division of the continuous must not be taken as of sand dividing into grains, but as that of a sheet of paper or of a tunic in folds, in such a way that an infinite number of folds can be produced, some smaller than others, but without the body ever dissolving into points or minima.”[39] Deleuze adds: “the model for the sciences of matter is the ‘origami’ ... or the art of folding paper.”[40] He could have mentioned also a treatise on “How to Fold Napkins,” such as the one published by the German Master-Cook, Mattia Giegher, published in Padua in 1639.[41] (fig 4)

The monad is two stories, the one at the bottom made of organic matter, “an organism ... defined by endogenous folds.”[42] For Deleuze, folding and unfolding does not mean simply a tension-release, like in a spring, or the contraction-dilation that occurs in a liquid, but leads to phases of enveloping-developing, or involution-evolution. He writes, “The organism is defined by its ability to fold its own parts and to unfold them, not to infinity, but to a degree of development assigned to each species.”[43] Quoting the work of the Belgian biologist Albert Dalcq, Deleuze reveals that his own particular reading of Leibniz approaches the field of epigenesis.[44] He also mentions D’Arcy Thompson’s book on morphogenesis.[45] Of course, the seventeenth-century theory of preformation and duplication is distant from the theory of twentieth-century epigenetics, but in both

36
Ibid., 3.

37
Ibid.

38
Ibid., 4; Serres is mentioned by Deleuze on page 9, n. 18.

39
Leibniz’s dialogue, *Pacidius Philalethi*, [1676], C, 614-615; quoted by Deleuze, *The Fold*, 6.

40
Deleuze, *The Fold*, 6.

41
Mattia Giegher (Matthias Jäger), *Li Tre trattati* (Padua: P. Frambotto, 1639), 3 parts in 1 vol.

42
Deleuze, *The Fold*, 7.

43
Ibid., 8.

44
Deleuze mentions to: Albert Dalcq, L’œuf et son dynamisme organisateur (Paris: Albin Michel, 1941); Deleuze, *The Fold*, 164, n. 24.

45
« D’Arcy Thomson » [sic], Deleuze, Le pli: Leibniz et le baroque (Paris: Éditions de Minuit, 1988), 138. D’Arcy Wentworth Thompson, *On Growth and Form*, [1917, abbreviated ed. 1942], ed. John Tyler Bonner, (Cambridge: Cambridge University Press, 1995; 1961).

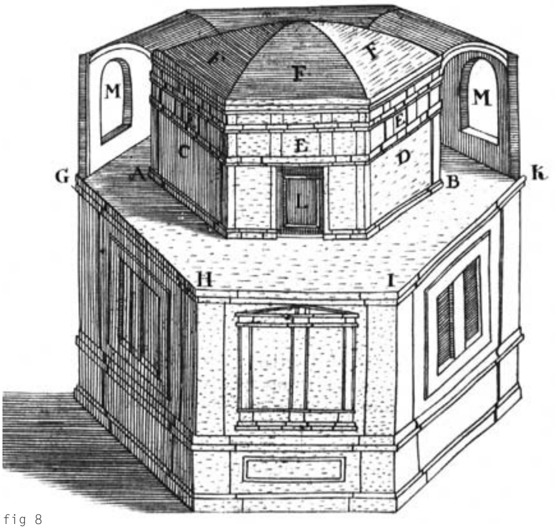

fig 8

fig 8
"Conclave Catoptricum," in Johannes Zahn, *Oculus artificialis telediooptricus: sive Telescopium* (Nuremberg: sumptibus J. C. Lochneri; Bibliopolae: typis johannis Ernesti Adelbulneri, 1702), 2nd edition. Courtesy of ETH-Bau Library.

of these conceptions the organism is considered. Deleuze writes, "as a fold, an originary folding or creasing, (and biology has never rejected this determination of living matter, as shown nowadays with the fundamental pleating of globular protein)...."[46] With preformism, "an organic fold always ensues from another fold, at least on the inside from a same type of organization: every fold originates from a fold, *plica ex plica*."[47] Thus, in the monad, bodies are downstairs (perception, feelings) and the soul is upstairs. An elevation, or an exaltation, has occurred: "a change of theater, of rule, of level or of floors. The theater of matter gives way to that of spirits," or that of souls.[48] There is a staircase between the two planes, because floors are like folds, "not a fold in two – since every fold can only be thus – but a 'fold-of-two,' an entre-deux, something 'between' in the sense that a difference is being differentiated."[49] Therefore, "any localization of the soul in an area of the body ... amounts rather to a *projection* from the top to the bottom ... in conformity with Desargues's geometry, that develop from a Baroque perspective."[50]

Without openings, monads are the perfect "black box"[51] of the baroque age. "Essential to the monad is its *dark background*: everything is drawn out of it, and nothing goes out or comes in from the outside."[52] The baroque monad must be compared to a series of places and devices typical of that period, that is, "a cell, a sacristy, a crypt, a church, a theater, a study, or a print room,"[53] to which one could add a cabinet for exhibiting a collection of natural or exotic items (*Wunderkammer*). Alternatively, one could include the camera obscura, with its small aperture through which light passes and is reflected off two mirrors, projecting an image on a sheet or a screen. In Deleuze's list of baroque contraptions, there are also transformational decors, painted skies, *trompe l'œil* adorning the walls, glass cabinets (*Spiegelkabinette*), an infinite alignment of mirrors (*glaces à répétition*), and so on.[54] Subsequently, Deleuze describes the architecture of the monad (fig 5):

46
Deleuze, *The Fold*, 10.

47
Ibid., 10.

48
Ibid., 11.

49
Ibid., 10.

50
Ibid., 12.

51
As described in: Norbert Wiener, *Cybernetics: Or the Control and Communication in the Animal and the Machine*, (Cambridge, MA: MIT Press, 1961), xi.

52
Deleuze, *The Fold*, 27.

53
Ibid., 27-28.

54
Hans-Dieter Lohneis, *Die deutschen Spiegelkabinette: Studien zu den Räumen des späten 17. und des frühen 18. Jahrhunderts*, München, Tuduv, 1985.

fig 9

fig 9
A public demonstration by Bell Laboratories of their new video telephone, August 1956. Photo: Snark / Art Resource, NY / Art Resource, NY.

"The architectural ideal is a room in black marble, in which light enters only through orifices so well bent that nothing from the outside can be seen through them, yet they illuminate or color the decor of a pure inside.... The Leibnizian monad and its system of light-mirror-point of view-inner decor cannot be understood if they are not compared to Baroque architecture. The architecture erects chapels and rooms where a crushing light comes from openings invisible to their very inhabitants."[55]

The monad represents the autonomy of a pure inside, "an inside without outside. [But] it has as its correlative the independence of the façade, an outside without an inside."[56] There is a severing between an outside (the facade) and a totally enclosed inside, lined with wall-mirrors, as in the catoptric boxes from that period. These include a "Drawing Machine" that projects an image on transparent paper, a "Catoptric Theater" in the form of a mirror-lined box that multiplies anything in it to infinity, and a "Magic Lantern" that reveals a soul in purgatory – the set of projectors designed and presented by the Jesuit Athanasius Kircher in the two editions of his monumental *Ars magna Lucis et Umbrae* (*The Great Art of Light and Shadow*), the first published in 1646, the second in 1671.[57] (figs 6, 7)

In this regard, one could mention the closed cabinet, or "Conclave Catoptricum," a near-perfect illustration of a Leibnizian monad on two floors that appears in Johannes Zahn's volume, titled *Oculus artificialis teledioptricus* (1702).[58] On the ground floor, a hexagonal room opens out to the world through five windows (the sixth side presumably occupied by a flight of stairs). On the upper floor, a peripheral corridor leads to a door opening on a closed cabinet, lined by eighteen mirrors and receiving indirect light through translucent, alabaster-lined openings. The cabinet's flooring is covered with marble, while its vault is decorated either with mirrors or painting. Zahn's conclave offers a good

55
Deleuze, *The Fold*, 28.

56
Ibid.

57
Anthanasii Kircheri, *Ars magna lucis et umbrae, in decem libros digesta*, (Rome: H. Scheuz, 1646); *Ars magna lucis et umbrae*, 2nd edition (Amsterdam: J. Janssonium at Waesberge, 1671). See Joscelyn Goodwin, *Athanasius Kircher's Theatre of the World* (London: Thames & Hudson, 2009).

58
"Conclave Catoptricum," in Johannes Zahn, *Oculus artificialis teledioptricus: sive Telesopium*, […], (Nuremberg: Lochner, 1702).

illustration to Deleuze's drawing of Leibniz's monad, in which "the upper level is closed, as a pure inside without an outside, a weightless, closed interiority, its walls hung with spontaneous folds that are now only those of a soul or a mind."[59] (fig 8) The folds of the brain's circumvolutions are baroque works of art and the monad is organized according to two vectors, one deepening down and the other rising as a thrust toward the upper region.[60] The two vectors, one metaphysical, the other physical, comprise a similar world: they live "in a similar house."[61] If the monad exists as an absolute interiority and, like the mirrors in Zahn's conclave, materializes as an inner surface with only one side, it nonetheless presents another. Actually, for Deleuze, the monad has "a minimum of outside, a strictly complementary form of outside."[62] In other words, topology can resolve the apparent contradiction as a partition, a supple and adherent membrane forming a fold, a torsion that provides "the exterior or outside of its own interiority."[63]

Hybrid Form

Today, as Deleuze suggested, one issue remains: the question of how to live in the world. The "topological" condition of contemporary living does not allow the difference between inside and outside to survive. It has erased, or at least shifted, the limits between private and public: "what has changed now is the organization of the home and its nature."[64] In his conclusion to *The Fold*, Deleuze points out that, in the future, we will need "to overtake monadology with a 'nomadology'."[65] This paradoxical situation – one in which a closed space restores to us the outside of our interiority – describes the condition of our screens, those catoptric boxes that are now part of our ever more interactive environment. Confronted by what Gilles Lipovetsky and Jean Serroy define as the "global screen,"[66] what appears on our screens today forms what we might call a virtual space of ghostliness.[67] Crisscrossed by hundreds of streams and constantly thought about from outside, the topological space of the network "is never in things or in people, but in the impossible verisimilitude of what lies between them: encounters, the proximity of what is most distant, the absolute dissimulation in our very midst."[68] In Michel Foucault's words, such a fictive space therefore "consists not in showing the invisible, but in showing the extent to which the invisibility of the visible is invisible."[69] As universal tools of work, but also as devices supporting percepts and affects, the screens that populate our dwellings and houses only function by means of the topological torsion of a virtual space, whose closure allows contact with an absolute exteriority acting like infinite folds – successive interlockings that can't help but unfold, allowing us to plug in, not to the outside itself, but to the outside of any proper interiority. Between the two stages of the monad, which are folded twice (body and soul), there is a between-fold, a folding, a zone that acts like a hinge, surface, interface, crease, or seam.[70] (fig 9)

Criticism of the substantial subject (the "me" of psychology and the "I" of metaphysics) occurred through exploration of new impersonal individuations, those pre-individual singularities that Deleuze effectively discovered in Gilbert Simondon's main doctoral thesis, defended in 1957 and published in part in 1964 as *L'Individu et sa genèse physico-biologique* (*Individuation and its Physical-Biological Genesis*).[71] For Deleuze, Simondon's essay offered the first rationalized theory of impersonal and pre-individual singularities. Breaking with stable ontologies of substance, Simondon formulates a philosophy of individuation in becoming, at the center of which the human subject occupies only a limited place.[72] The pre-individual is "a being who is more than a unit." Simondon writes: "*The pre-individual being is a being in whom there are no phases*; a being in whose center individuation takes place is a being in whom a resolution appears through the being's distribution into phases, thus putting everything in a state of becoming."[73] After Friedrich Nietzsche, Henri Bergson, Gaston Bachelard and Georges Canguilhem, Simondon was to

59 Deleuze, *The Fold*, 29.

60 Ibid.

61 Ibid.

62 Ibid., 111.

63 Ibid., 111.

64 Ibid., p.158.

65 Ibid., 158.

66 Gilles Lipovetsky and Jean Serroy, *L'Écran globale: culture-médias et cinéma à l'âge hypermoderne*, (Paris: Seuil, 2007).

67 Jacques Derrida, *The Specters of Marx: The State of the Debt, the Work of Mourning and the New Internationale*, trans. Peggy Kamuf (London: Routledge, 1994), 3-8.

68 Michel Foucault, *Maurice Blanchot: The Thought from Outside*, trans. Jeffrey Mehlman and Brian Massumi (New York: Zone Books, 1987), 23-24; first published as "La Pensée du dehors", *Critique*, no. 229, (June 1966): 521-546.

69 Foucault, *Maurice Blanchot*, 24.

70 Deleuze, *The Fold*, 120.

71 See the new edition of Simondon's main thesis: Gilbert Simondon, *L'Individuation à la lumière des notions de forme et d'information* (Grenoble: Millon, 2005). This edition combines *L'Individu et sa genèse physico-biologique* (Paris: Presses Universitaires de France, 1964) and *L'Individuation psychique et collective*, published in 1989; the text is Simondon's reworked doctoral thesis defended in 1957.

72 Anne Sauvagnargues, *Deleuze. L'empirisme transcendental* (Paris: Presses Universitaires de France, 2009), 26-27.

contribute to an undermining of the paradigm of the individual being by re-posing the problem in terms of the whole set of processes, the forging and emergence of the real, that lead to individuation. "Individuation is the operation itself of the pre-individual; it is the pre-individual itself in operation."[74] To describe this phenomenon, one must be able to reconstitute pre-individual nature as the source of all existence, the principle of genesis, which places nature before things and individuals – the source of their begetting.[75] To the question, "What is an individual?" Simondon replies: "One cannot, strictly speaking, talk about an individual, but only about individuation; we need to go back to the activity, to the genesis, instead of trying to apprehend the fully-formed being in order to discover the criteria by which we know whether he is an individual or not. The individual is not a being but an act, and a being is an individual as an agent of this act of individualization by which he manifests himself and exists."[76]

What Simondon is asking us to do is to consider nature not as *a priori*, but as a construction-in-becoming. Pre-individual nature has to be constructed to take account of all processes. The transition from nature to the individual can be constructed by broadening the concept of nature to the whole set of realities prior to individuation, whatever the level of complexity, and by managing to define unbalanced systems, known as "metastable" systems. The notion of "metastability" was taken from the notion of entropy, specific to the cyberneticist Norbert Wiener.[77] Metastability is the concept Simondon creates to describe the phenomena of entropy specific to thermodynamics, to Wiener's cybernetics, and to the theory of information, and which represents a system that has not yet exhausted its potential difference by increasing order or information (like Erwin Schrödinger's negative entropy or Léon Brillouin's negentropy).[78]

One needs to see nature as "the reality of the possible"[79] – that is, as what is likely to cause something to exist. This reality of the possible corresponds to a "real potential" that distinguishes it from both the possible and the virtual, suggesting that the notion of virtuality be replaced by the notion of "the metastability of a system".[80] Simondon makes clear in his complementary thesis of 1958, *Du mode d'existence des objets techniques* (*On the mode of existence of technical objects*), that "the potential is one of the forms of the real, as completely as the actual is. The potentials of a system constitute its power of becoming without deteriorating," by resisting the phenomenon of thermodynamic entropy.[81] These potentials "are not the simple virtuality of future states, but a reality that drives them to be. Becoming is not the actualization of a virtuality ... but the operation of a system having potentials in its reality."[82] Simondon consequently establishes an important distinction between the possible, the actual and the virtual: the possible doesn't "contain" the actual already, just as nature does not include all beings virtually, and the latter are not the realization of a given nature. As mentioned before, the possible does not already contain the actual before emerging, for every individual is an event.

In Deleuze, that which affects the passage of the virtual into the actual is the intensity (or intensive quality) whose essential activity is that of individuation.[83] His intensity is best understood after considering the concept of individuation, which Deleuze takes from Simondon. Simondon uses information theory to describe individuation in physical and biological systems, showing that traditional distinctions between form and matter, individual and milieu, animate and inanimate, must be reconceived in terms of information in order to take account of the reality of the process of individuation.[84] Moreover, Simondon proposes to stretch individuation beyond the individual being, and to extend it to a broader nature – to whose identity it contributes. Thus, Simondon speaks of individual-milieu, a hybrid form, loaded with potentialities and singularities: "The individual, arising from a situation of genesis, seems to be finally just a kind of crease, a fold that, while unfolding, would unfurl the whole nature."[85]

73
Simondon, *L'Individuation*, 67, our translation; see Jean-Yves Chateau, *Le Vocabulaire de Simondon*, (Paris: Ellipses, 2008), 48.

74
Chateau, *Le Vocabulaire de Simondon*, 49, our translation.

75
Didier Debaise, "Qu'est-ce qu'une pensée relationnelle?," *Multitudes* (5 May 2005), online: http://multitudes.samizdat.net/Qu-est-ce-qu-une-pensee (accessed June 2011).

76
Simondon, *L'Individuation*, 191, our translation. Jean-Hugues Barthélémy, *Simondon ou l'Encyclopédisme génétique* (Paris: Presses Universitaires de France, 2008), 18-19.77 Barthélémy, Simondon, 20.

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Barthélémy, *Simondon*, 20.

78
Sauvanargues, *Deleuze*, 243.

79
Simondon, *L'Individuation*, 305, our translation.

80
Ibid., 313, our translation; Barthélémy, *Simondon*, 21.

81
Gilbert Simondon, *Du mode d'existence des objets techniques* (Paris: Aubier, 1958); repr. with an added preface by John Hart and a postface by Yves Deforge (Paris: Aubier, 1989, 2001), 155-156, our translation.

82
Ibid., our translation.

83
Gilbert Simondon, "The Genesis of the Individual," in Jonathan Crary & Sanford Kwinter, eds., *Incorporations* (New York: Zone Books, 1992), 297-319; Gilbert Simondon, "Technical Mentality," trans. Arne De Boever, *Parrhesia* 7 (2009): 7-27.

84
Ronald Bogue, *Deleuze and Guattari* (London and New York: Routledge, 1989), 61.

85
Debaise, "Qu'est-ce qu'une pensée relationnelle?," our translation.

Chrono-topology

To view milieu, itself the result of individuation, one is obliged to consider the individual and its environment. In *Individuation and its Physical-Biological Genesis*, in the chapter on "Individuation and information," there is a section focused on "Topology and ontogenesis," where Simondon exposes "the topological condition ... paramount in the living condition for life."[86] Contemporary, biological studies of the cell's permeability allowed Simondon to formulate hypotheses on a chrono-topology: "The living membrane ... is characterized ... by what separates an interior state ... from an exterior region."[87] While filtering what passes through, and preventing the access to other bodies or substances, the membrane is polarized. Therefore, milieu takes the specific sense of a third biological term, neither inside nor outside, placed halfway in the middle.[88] Deleuze was inspired by Simondon's theory of the membrane, while attempting to construe his assumptions about pre-individual singularities.[89] In *The Logic of Sense* (1969), Deleuze notes that "membranes are no less important, for they carry potentials and regenerate polarities.... The internal and the external, depth and height, have biological value only through this topological surface of contact."[90] This will lead to considerations about the folded surface of the cell, and allows Deleuze to assign a biological value to the famous sentence of Paul Valéry's famous statement: "The deepest is the skin." Then, Deleuze inserts a long quotation extracted from Simondon's thesis: "The characteristic polarity of life is at the level of the membrane.... The entire content of the internal space is topologically in contact with the content of external space at the limits of the living."[92] Simondon's conception presupposes the existence of a pre-individual reality, because "what appears in the individuation is not only the individual, but the couple individual-milieu."[93]

An example of individuation is the process of crystallization: the passage of a substance from a metastable, amorphous state to a stable, crystalline one. Individuation, therefore, precedes the individual. Simondon argues that the simple model of crystallization may be used to understand the process of individuation throughout physical and biological systems. The difference between animate and inanimate matter is that animate matter manages to sustain certain metastable states that allow a perpetual individuation in the organism. We perceive a distinction between matter and form, organism and environment, species and individual, but these are merely manifestations of a single process of becoming, metastable and pre-individual, which constitutes the real.[94] In Deleuze's terms, a metastable substance is a difference in itself, and individuation is a process in which difference differentiates itself.

Simondon will thus uncover and illuminate genetic principles, contemporary to real processes, by first investigating theories of matter (crystallization), and then theories of life (membrane).[95] He concludes his work with a theory of form: "A technical operation institutes an internal resonance while matter takes form, by means of energetic conditions and of topological conditions; topological conditions can be named form, and energetic conditions express the entire system."[96] In this view, topology and chronology coincide in the individuation of the living. They are not a *priori* forms, but the dimensionality of living while it is individualizing. For Simondon, they satisfy the very conditions for us to think about morphogenesis.[97] Indeed, it is his analysis of genetic processes – brick, membranes, or crystals, for example – that allows us to rethink spatial categories like inside and outside, depth and height, transparency and opacity, top and bottom, front and rear, light and heavy, mobile and immobile, fast and slow, smooth and striated, and so forth. Suddenly, basic architecture (basement and attic, wall and partition, floor and ceiling, passage and disruption, ground and roof) can see its meaning enter into baroque metamorphosis to transmute into a topological surface of contact.

86 Simondon, *L'individuation*, 225, our translation.

87 Ibid., our translation.

88 Victor Petit, "L'individuation du vivant …," *Cahiers Simondon*, no 1, ed. Jean-Hugues Barthélémy, (Paris: L'Harmattan, 2009), 47-75, see 57.

89 Gilles Deleuze, "On Gilbert Simondon," in Deleuze, *Desert Islands and Other Texts, 1953-1974* (Los Angeles & New York: Semiotext(e), 2004): 86-89; Sauvagnargues, *Deleuze*, 26-28.

90 Deleuze, *The Logic of Sense*, 103-104.

91 Paul Valéry, "L'Idée fixe," [1931], in Valéry, *Œuvres, II*, (Paris, Gallimard/La Pléiade, 1960), 215.

92 Gilbert Simondon, *L'individu et sa genèse physico biologique*, (Paris: PUF, 1964), 260-264; cited by Deleuze, *The Logic of Sense*, 104.

93 Simondon, *L'individuation […] forme et d'information*, 24-25, our translation; Barthélémy, *Simondon* ..., 41.

94 Ronald Bogue, *Deleuze and Guattari*, 62.

95 Sauvagnargues, *Deleuze*, 244.

96 Simondon, *L'individuation*, 45, our translation.

97 Ibid., 228.

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DIGITAL INDETERMINISM: THE NEW DIGITAL COMMONS AND THE DISSOLUTION OF ARCHITECTURAL AUTHORSHIP

— MARIO CARPO

All that is digital is variable, and all that is digitally variable is potentially open to interaction, communality and participation. In the course of the last ten years digital culture at large has enthusiastically albeit belatedly embraced all kinds of collaborative tools; this new emphasis on shared agency is a key aspect of what has been called the Web 2.0, and communal making is fast becoming a dominant technical and cultural paradigm of our age. With one significant exception: architecture. Architects have for the most part neglected or rejected the new digital commons, and digital design culture seem to have chosen its own peculiar way to liquidate humanistic and modern authorship – one which is not based on social bonds and communality, but on the quest for a new alliance among technology, complexity, indeterminacy, and the sometimes mysterious capacity that some natural and social systems have to self-organize and thrive against all odds.[1]

Mechanical machines make objects; digital machines don't. As the name suggests, digital machines, in the first instance, just produce numbers – sequences of numbers, also known as digital files. These numbers must eventually be converted into objects, or media objects (texts, images, or music, for example), but this conversion requires the subsequent intervention of actors, networks, and tools that are, in most cases, independent from the maker of the initial digital file. Users of digital tools have always been aware of this ontological difference between mechanical making and digital making. At the very beginning of the digital turn, Gilles Deleuze and Bernard Cache famously defined the new technical object of the digital age as a generic object – an open-ended mathematical notation designed for interaction and variability, which they called Objectile.[2] As in the Aristotelian theory of science, an Objectile is a class or family of object, but no object in particular. Scholastic thinkers held different views on this matter, but in the case of digital making, the class (genus) may become an event, or individual, through the addition of predicates, which today we often call specifications. A peculiar aspect of digital making is that the limits for the possible variations of some specifications, or parameters, can be set from the start, hence the term parametricism, which is today often used to denote this mode of design.

In the course of the last ten years, digital culture at large has enthusiastically, albeit belatedly, embraced all kinds of digital interactivity and collaborative tools. This new emphasis on shared agency is a key aspect of what has been called "Web 2.0", and has prompted a complete reinvention of the digital economy after the dotcom crash at the turn of the century. The reasons for this delayed surge of collaborative

1
The first part of this essay refers to arguments I developed in *The Alphabet and the Algorithm* (Cambridge, MA: The MIT Press, 2011), 4, "Epilogue: Split Agency," 123-128; and in "Digital Style," *Log* 23 (2011): 41-52. This essay was commissioned by the office of David Chipperfield for publication in the *Critical Reader* to accompany the 13th exhibition of architecture of Venice Biennale (2012), *Common Ground*. It was rejected by same after delivery.

2
Gilles Deleuze, *Le pli: Leibniz et le baroque* (Paris: Éditions de Minuit, 1988), 22-26; English translation: *The Fold: Leibniz and the Baroque*, trans. Tom Conley (Minneapolis, MN: University of Minnesota Press, 1993), 15-19.

making in the digital domain were probably technical as well as social. But, when it became clear that, on the Web, every consumer of data can be a data producer, and every user can be a maker – as well as an editor, self-appointed curator, and referee for any existing body of data, many users started to use the Web to do just that, with tremendous cultural, social, and economic consequences.

The interactive Web offers unlimited possibilities for tapping the wisdom of crowds, and for aggregating the opinions and knowledge of many. This goes well beyond the simple collecting and averaging of data. Particularly in the making of media objects, the old statistical ways of mean finding have been replaced by a new, open-ended mode of "aggregatory" versioning, where the collective knowledge of a community is garnered by inviting all agents to edit one another – in theory, *ad libitum atque ad infinitum*; in practice, under the stewardship of some form of curation. Against all odds, there is evidence that this unauthorized mode of making can be quite effective. Open-source software made collaboratively by many, but by none in particular, often works better than competing proprietary, commercial software. The authorial *Encyclopaedia Britannica* has recently stopped to exist in print, but collaborative Wikipedia is thriving. Based on the simple principle that more people know more, if there is a way of garnering their lore, Wikipedia's strategy of digital aggregation promises to convert the shortcomings of each into the wisdom of many – just like in Adam Smith's classical economics, the "invisible hand" of the market converts the egoism of each into the common good.

The success of Wikipedia, and of similar case studies, may seem anecdotal. Yet, interactive aggregation and participatory versioning are fast becoming a pervasive, and possibly dominant, technical and cultural paradigm of our age. Aspects of it occur, more or less conspicuously, whenever and wherever digital tools are used – which is to say, today, everywhere, and all the time. This is why we are – slowly – getting used to technical objects of all kinds that are never finished nor ever stable; which are designed for permanent evolution and variations, and seem to live forever in trial mode, always waiting for the next patch or fix – to some extent working most of the time, but never entirely or fully predictably. Alexandre Koyré famously saw precision, it all its forms, as the hallmark of modernity.[3] Just as industrial, mechanical modernity needed and fostered precision, it would appear that post-industrial, digital postmodernity is reviving an ancient techno-cultural paradigm of approximation, redundancy, and endless revisions – now carried out by electronic computation, not by manual craft. Lawyers and economists have already started to tackle the many paradoxes of electronic versioning and mass-collaboration. The old authorial notions of intellectual property, copyrights, and royalties, which, not coincidentally, rose in synch with mechanical printing technologies, are famously unusable and often meaningless in a digital collaborative environment.[4] Yet the aesthetic implications of this new digital "style of many hands"[5] have received little attention; among the design professions, almost none.

This is not by coincidence. Digital design theory spearheaded and pioneered the digital turn. In the 1990s, architects like Greg Lynn and Bernard Cache were at the forefront of technical and cultural innovation. But, in the 2000s, when digital culture went 2.0, architecture did not follow suit. With few exceptions, which will be discussed below, there has been no participatory turn for digital design. This may be partly due to technical factors: architectural notations must be frozen, at some point, in order to be built, and can seldom be open-ended. But the burden of heritage may have played an even bigger role. Architectural design is the brainchild of Renaissance humanism. Humanists, Leon Battista Alberti first and foremost, invented architecture as an art of drawing, and the notion of the modern architect as a new kind of humanist author – a thinker and a maker of drawings, not a craftsman and a maker of buildings. For better for worse, this early-modern cultural revolution made

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Alexandre Koyré, "Du monde de l''à peu près' à l'univers de la précision," *Critique* 28 (1948): 806-823; reprinted in Koyré *Etudes d'histoire de la pensée philosophique*, Cahiers des Annales, 19 (Paris: A. Colin, 1961), 311-329.

4
On "copylefting" and other digital alternatives to analog copyright laws see for example Lawrence Lessig, "Re-crafting a Public Domain," *Perspecta* 44, Domain, (2011): 177-189.

5
See Carpo, "Digital Style."

architecture what it still is: a high added-value intellectual profession. Most architects today still see themselves as authors in Albertian, humanist terms, and the Albertian, authorial definition of architectural design as an art of drawing – a notational art – is today enshrined by the laws, customs, and social practices of most countries around the world.[6]

Hence, it is not surprising that so many digital designers in recent times have been testing and trying, more or less deliberately, design strategies aimed at curtailing, taming, or effacing the participatory potentials of digital parametricism. The most common case in today's digital scene is that of an author that first designs an open-ended system (an Objectile, or generic notation), then finalizes it all alone, picking a limited number of perfectly finished design solutions of which she will be, in a sense, the double author: first as the inventor of a general parametric system, then as an end-user of the same. Without going to such extremes, the normal mode of use of today's parametricism allows for such a limited range of variations that all end-products of a given design environment tend to look the same, regardless of their degree of customization. As most offices working this way also happen to favor a legacy repertoire of curving lines and smooth surfaces derived from the spline-dominated design software of the 1990s, many of the objects they create also appear similar to one another, hence corroborating the claim, strongly restated of recent by Patrik Schumacher, of parametricism as a comprehensive theory, and of a spline-based visual environment as the ineluctable stylistic expression of digital making.[7]

But not all the cultural and technical reasons that prompted the rise of digital spline-making in the 1990s may last forever. Today's digital designers might conceivably choose to leave many more design options open to subsequent interactive or collaborative choices, increasing the degree of indeterminacy embedded in a parametric design system, or the share of authorial responsibility devolved to others. In this instance, similar to the initiator of an open-sourced software project, who writes the first code then monitors all its edits and changes, the primary designer would become, in a sense, the curator of an ongoing collaborative project, designing it at launch and then steering its course: watching, prodding, and occasionally censoring the interventions of all co-authors (or interactors) to follow. While many examples attest to the success of this collaborative design strategy in fields such as software development, and increasingly in the design development of physical objects, its instances in architectural design are rare. Some digital designers pride themselves on using open-source software, but few or none on authoring open-ended design – architectural notations that others could modify at will.[8]

In fact, the most radical Web 2.0 applications in architectural design have not been devised by designers, but by the building and construction industry. The family of software known as Building Information Modeling, originally a management tool used to facilitate costing and the exchange of information between architects and contractors, is fast becoming a fully-fledged design platform, and imposing its collaborative logic to all involved.[9] While the traditional design–bid–build process embodied the Albertian way of making by design and by notation, today's BIM model translates a new mode of building by collaborative leadership, which, in turn, resembles and almost reenacts the collaborative way of building that prevailed in most European building sites before the Humanist invention of the modern authorship. As the author that is now being done away with used to be called the architect, it stands to reason that not all architects may enthusiastically endorse this new technology. Indeed, designers often blame BIM software for its philistine, bureaucratic approach to architectural design.

Yet architects who resent, more or less overtly, the digital diminishment of their modern authorial privileges often seem more keen to envisage a lesser degree of design determination when it is to the benefit of a higher order of indeterminacy – one which many designers today

6 Carpo, *The Alphabet and the Algorithm*, esp. 71-80.

7 Patrik Schumacher, "Parametricism and the Autopoiesis of Architecture," *Log* 21 (2011): 63-79; see in particular p. 63. See also Schumacher, *The Autopoiesis of Architecture: A New Framework for Architecture*, Vol. I (London: Wiley, 2011); and *The Autopoiesis of Architecture: A New Agenda for Architecture*, Vol. II (London: Wiley, 2012)

8 Carpo, "The Craftsman and the Curator," *Perspecta* 44, Domain (2011): 86-91; Eric von Hippel, *Democratizing Innovation* (Cambridge, MA: MIT Press, 2005), esp. 103-105.

9 See Peggy Deamer and Phillip G. Bernstein, ed., *Building (in) The Future: Recasting Labor in Architecture* (New York: Princeton Architectural Press, 2010), esp. Bernstein's essay "Models for Practice: Past, Present, Future," 191-198; see also Bernstein, "A Way Forward? Integrated Project Delivery," *Harvard Design Magazine* 32 (2010), 74-77.

increasingly like to attribute to nature itself. The cultural roots of this new breed of digital naturalism are no less transparent than its technical premises, as various postmodern theories of chaos, complex, non-linear, and self-organizing systems have merged with a traditionally empirical approach to structural design, which architects always cherished, to give rise to a holistic practice of structural and material making often known as "form-finding," "design by making," or "emergence." [10]

All designers know that some structures and materials occasionally behave in unpredictable ways, and that under certain conditions, normal relations of cause and effect (stress to deformation, for example) do not seem to apply. Similar shortcomings of predictive sciences may have many rational explanations. Long before the rise of today's digital technologies for "big data" management, for example, scientists often found it convenient or expedient to follow statistical models rather than causal ones. Others, however, may equally conclude that as some behaviors of a given system in certain conditions cannot be causally predicted, the system must have a life of its own. Improbable as it may appear – in the etymological sense of being difficult to prove – this assumption may not be more difficult to prove than the opposite; and indeed, vitalism has a long and distinguished tradition in the history of Western thought.

The above explains, to some extent, the system of belief underpinning the frequent rejection of rational design, and of cause-and-effect analytical calculations, among many of today's digital designers. For the last twenty years, the technical continuity between computer-based design and computer-driven fabrication has mirrored, and at times re-enacted, aspects of traditional, one-to-one hand-making and bespoke craftsmanship. Today, a new generation of digital craftsmen are increasingly perceiving CAD-CAM technologies as an extension of the mind and hands of the designer, and many of them have embraced traditional, phenomenological, and esoteric interpretations of craftsmanship – as recently epitomized, for example, in the influential work of Richard Sennett.[11] The "tacit knowledge" of the craftsman cannot be verbalized because it derives from a mystical union between the body of the artisan and the materials he is crafting. The phenomenological craftsman does not analyze, quantify, calculate, predict, and design; rather, he just makes and feels, and finds form by trial and intuition. Likewise, today's theories of "design-by-making" – always popular among architects, and particularly among architectural educators, but today enhanced, promoted, and almost vindicated by the power of digital tools – often favor a silent and almost mystical or sensual experience of design without thinking. According to these theories, reason and speech are of little use to the maker sensing his making through his body and, increasingly, through the body's digitally mediated prosthetic extensions. Digital tools can be powerful allies of design-by-making, because digital simulations can make or break more models in an instant than a physical craftsman could in a lifetime. And when a model works, whether a physical model or its digital equivalent, there may be no need to understand why.

Digital technologies for data collection and information retrieval offer increasingly functional alternatives to the analytic, predictive approach of modern, positivistic sciences: what happened before, if retrievable, will simply happen again. For designers, digital simulations have an additional treat – the appearances of a holistic re-enactment of reality. Of course, digital simulations are based on analytical tools, and the data they feed on, causal, statistical, or other, must have been picked and ranked and their programs scripted, at some point, by someone. Yet in this instance, too, digital technologies and their use may curiously foster a wide swath of vitalistic beliefs; and the notion – sometimes the fantasy – of the computer as a non-linear machine has been a strong component of digital thinking from the very beginning. While traditional phenomenologists continue to abhor computers, which, with some reason, they perceive as machines, many digital theoreticians of the last twenty years have been phenomenologists *malgré eux*. From the proprioceptive science of the digital sensorium and of the digitally extended body in the 1990s to today's neoromantic theories of making by intuition and by computational simulation, digital phenomenology has been and remains to this day a surprisingly strong component of digital thinking, and an often hidden or even concealed source of inspiration for many digital makers.

So it will be seen, to sum up, that while digital culture at large has embraced the interactive and collaborative way of making which seems inherent in the technical logic of most digital tools, and has already developed a number of successful post-authorial strategies, in architecture and design the same digital pattern of devolution of agency has been mostly redirected from social participation to a new and daring partnership with what many perceive as the mysteries and indeterminacy of nature. The spirit of the game is in many ways similar, as social crowdsourcing, no less than material self-organization, may lead to forms of automated, evolutionary, and non-authorial making. In a current mode of web design known as A/B testing, design choices are made by trying out two versions of the same interface and comparing their performance via the automated feedback of user data. When a new version (the B version) of a website works better than the old one (the A version), for example because users stay longer on the page, or click on a link more often, the system automatically switches to the new version. Variations may have been introduced by actual designers, but they may also have been randomly generated.[12] In this case, the system self-organizes by accidental mutations and environmental feedback, or natural selection, as in Darwin's model of biological evolution. As in the parametric model mentioned above, the designer of the system may author some general aspects of each individual product, but individual variations result in this case from the anonymous aggregation of the choices of many (crowdsourcing).

Evidently, this is not design as we knew it. But the new streaks of vitalism, naturalism, and romantic irrationalism that are so pervasive among digital form-finders at the time of this writing (in the summer of 2012) also point to other, riskier developments. User-driven customization and the social devolution, distribution, or dissolution of design have long been a myth of modernity, before becoming a late-modern corporate strategy and an almost inevitable practice of digital post-modernity. Not surprisingly, participatory design can be declined in both a corporate and a socialist version (and it has been), as it has an undeniably democratic aura about it (majority rules, and majorities can better rule, particularly in design, if there is a way to aggregate their choices) – which some designers may resent as social determinism (if clients are always right, why should they not design for themselves? Well, with today's digital tools, they almost can). Likewise, co-designing with nature, negotiating with – even surrendering to – nature's whim are timeless human ambitions, more recently revived by nineteenth-century romanticism and by the various naturalisms and organicisms that followed in the course of the twentieth century. And one can certainly see many reasons why the quest for a renewed alliance with nature may be a popular theme today, given the ideological perceptions of the limits of human making and of the finiteness of the natural environment, which are now stronger than at any time in modern history.

In today's generative scripting, just like in the morphogenetic theories that have so powerfully inspired it, evolution emerges by natural selection (in the case of digital design, enacted by computational means). Digital Darwinism is indeed an implicit and often latent component of contemporary digital design culture, which may account for the often transparent political allegiances of today's digital phenomenology: a universe of forms where forms "just happen" is also a universe where, in the best Nietzschean tradition, the hero, the magician, the artist, or others, can and will capture, interpret, and perhaps tweak the spirit of nature – to the detriment of all others.

In this, today's digital irrationalism appears to be at odds with the more socially oriented inclination of mainstream digital culture. Perhaps digital design has chosen its own eigene Weg.[13] Perhaps designers are once again, as in the 1990s, anticipating more general trends and developments. Time will tell. One thing is for certain: whether in the social form of devolution of agency (the digital style of many hands), or in the naturalistic mode of dissolution of authorship (the digital style of chaos and nature), the visual forms that will result from the digital elimination of humanist authorship are likely to be a far cry from the polished smoothness, elegant curvilinearity, and delicate intricacy which authorial parametricism has engendered and nurtured so far. Social interaction creates a common ground of solidarity, collaboration, and community that romantic identification with nature often likes to break. A digital Sturm und Drang may not be around the corner, but there is thunder on the horizon, as well as dawn.[14]

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Unlike mathematicians, postmodern philosophers and architects often refer to "non-linearity" as a synonym for indeterminacy. The best account of architectural interpretations of "non-linearity" and their intellectual provenance is in Charles Jencks, *The Architecture of the Jumping Universe: A Polemic: How Complexity Science is Changing Architecture and Culture* (1995; second revised edition, London: Academy, 1997). See also AD 67 (1997), Profile 129, *New Science = New Architecture*, guest-edited by Charles Jencks. On the architecture of "emergence," see the works of members of the former Emergence and Design Group (Michael Hensel, Michael Weinstock, Achim Menges), starting with the seminal AD 74 (2004), Profile 169, *Emergence: Morphogenetic Design Strategies*, guest-edited by same. The Emergence and Design Group was a pioneer in the investigation of the mathematical and computational (rather than holistic and intuitive) design strategies deriving from the theories of self-organizing systems. The ambiguity inherent in the biological theories on the self-selective "emergence" of form and, more in general, in the postmodern discourse on indeterminacy, is particularly evident in their computational metaphors, which are sometimes part to analytic and scientific agendas, sometimes plied to corroborate mystic, vitalistic or irrationalist ideologies. In the recently published Log 25 (2012), *Reclaim Resi[lience]stance*, guest-edited by François Roche, the term "form-finding" is used in different contexts, including to denote recursive processes of mathematical optimization. (See, in particular, François Jouve, "Structural Optimization," 41–44, and Roland Snooks, "Volatile Formation," 55–62.)

11
Richard Sennett, *The Craftsman* (New Haven: Yale University Press, 2008).

12
Brian Christian, "Don't Trust the Designers, Trust the Audience," *Wired*, May 2012: 178–183.

13
Nietzsche, Morgenröte, V, 184.

14
Ruskin, *The Lamp of Obedience*, X, 2.

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PARAMETRIC SEMIOLOGY: THE DESIGN OF INFORMATION-RICH ENVIRONMENTS

— PATRIK SCHUMACHER

All design is communication design. The built environment, with its complex matrix of territorial distinctions, is a giant, navigable, information-rich interface of communication. Each territory is a communication. It gives potential social actors information about the communicative interactions to be expected within its bounds. It communicates an invitation to participate in the framed social situation. Designed spaces are spatial communications that *frame* and order further communications. They place the participants into specific constellations that are pertinent with respect to the anticipated communication situations. Like any communication, a spatial communication can be accepted or rejected, i.e. – the space can be entered or exited. Entry implies accepting the communication as the premise for all further communication taking place within its boundaries. Crossing a territorial threshold makes a difference in terms of behavioral dispositions. Entry implies submission to the specific rules of conduct that the type of social situation inscribed within the territory prescribes. In this way, the designed-built environment orders social processes. This spells the unique, societal function of architecture: to order and frame communicative interaction.[1]

1 Patrik Schumacher, *The Autopoiesis of Architecture, Volume 1: A New Framework for Architecture*. London: John Wiley & Sons Ltd., 2010. See *Part 5:The Societal Function of Architecture*. The same societal function applies to other design disciplines. All designed artifacts of everyday life (furniture, fashion) are involved in the structuration of communication/society.

The Built Environment as Societal Information Process

Society can only evolve with the simultaneous ordering of space. The elaboration of a built environment (however haphazard, precarious, and initially based on accident rather than purpose and intention) seems to be a necessary condition for the build-up of any stable social order. The gradual build-up of a social system must go hand in hand with the gradual build-up of an artificial spatial order; social order requires spatial order. The social process needs the built environment as a plane of inscription where it can leave traces that then serve to build-up and stabilize social structures, which in turn allow the further elaboration of more complex social processes. The evolution of society goes hand in hand with the evolution of its habitat – understood as an ordering frame. The spatial order of the human habitat is both an immediate physical organizing apparatus that separates and connects social actors and their activities, and a material substrate for the inscription of an external "societal memory." These "inscriptions" might at first be an unintended side effect of the various activities. Spatial arrangements are functionally adapted and elaborated. They are then marked and underlined by ornaments, which make them more conspicuous. The result is the gradual build-up of a spatio-morphological system of signification. Thus, a semantically charged built environment emerges that provides a differentiated system of settings to help social actors orient themselves with respect to the different communicative situations constituting the social life-process of society. The system of social settings, as a system of distinctions and relations, uses both the positional identification of places (spatial position) and the morphological identification of places (ornamental marking) as props for the societal information process. Compelling demonstrations for this formative nexus between social and spatial structure can be found within social anthropology, attesting to the crucial importance of cross-generationally stable spatio-morphological settings for the initial emergence and stabilization of all societies. Only on this basis, with this new material substrate upon which the evolutionary mechanisms of mutation, selection, and reproduction could operate, was the evolution of mankind out of the animal kingdom, and all further cultural evolution, possible. Thus, the built environment, as the cross-generationally stable, material substrate of the cultural evolution, acts functionally equivalent to the DNA as the material substrate of the biological evolution.

Increasing the Information Richness of the Built Environment

The importance of the built environment for ordering and framing society remains undiminished. However, what, in former times, was left to the slow evolutionary process of trial and error has, since the Renaissance, become more and more the domain of competency and responsibility of the specialized discourse and profession of the discipline of architecture. Now, more than ever, the critical issue for an ambitious architecture wanting to contribute to the next stage of our civilization is how a designed territory operates as sophisticated framing communication that gathers and orders relevant (socialized) participants for specific communicative interactions. Accordingly, I have grounded my theory of architecture in communication theory, with particular reference to Niklas Luhmann's social systems theory and theory of society. Communication-theory does, indeed, provide a parsimonious, productive framework for architecture's reflective self-description. The implication of embedding architectural theory within communication theory is that all architectural spaces are conceived and designed as communications.

A theory of society is a necessary framework for a comprehensive theory of architecture, starting with the explication of architecture's societal function. Luhmann, for instance, proposes to conceptualize the life process of society as a communication process rather than as a material reproduction process. This is, of course, a radical abstraction. However, I think this is a rather pertinent and powerful abstraction. All problems of society are problems of communication. Both the problems and the solutions of mankind have to do with society's self-generated complexity.

If all problems of society are problems of communication, then the focus on communication is a precondition for upgrading architecture's social efficacy. Especially within the post-Fordist network society (information society, knowledge economy), total social productivity increases with the density of communication. The life process of society is a communication process structured by an ever more complex and richly diversified matrix of institutions and communicative situations. A post-Fordist network society demands that we continuously browse and scan as much of the social world as possible in order to remain continuously connected and informed. We cannot afford to withdraw and beaver away in isolation when innovation accelerates all around. We must continuously recalibrate what we are doing in line with what everybody else is doing. We must be networked all the time, so as to continuously ascertain the relevancy of our own efforts. Telecommunication only via mobile devices may help, but it does not suffice. Rapid and effective face-to-face communication remains a crucial component of our daily productivity. The whole built environment must become an interface of multi-modal communication, as the ability to navigate dense and complex urban environments has become a crucial aspect of today's overall productivity.

Information Density via Parametric Design

Everything must resonate with everything else. This should result in an overall intensification of relations, which gives the urban field a performative density, informational richness, and cognitive coherence that makes for quick navigation and effective participation in a complex social arena. Our increasing ability to scan an ever-increasing simultaneity of events, and to move through a rapid succession of communicative encounters, constitutes the essential, contemporary form of cultural advancement. Further advancement of this vital capacity requires a new built environment with an unprecedented level of complexity, a complexity that is organized and articulated into a complex, variegated order of the kind we admire in natural, self-organized systems.

The more free and the more complex a society, the more it must spatially order and orient its participants via perceived thresholds and semiotic clues – rather than via physical barriers and channels. The city is a complex text and a permanent broadcast. Therefore, our ambition as architects and urban designers must be to spatially unfold more simultaneous choices of communicative situations in dense, perceptually palpable, and legible arrangements. The visual field must be dense with offerings and information about what lies behind the immediate field of vision. The parametricist logics of rule-based variation, differentiation, and correlation establish order within the built environment, giving those who must navigate it the crucial possibility of making inferences. Employing associative logics correlates the different urban and architectural subsystems in ways that make them representations of each other. Everything communicates with everything. This is not a metaphysical assertion about the world, but a heuristic principle for parametric design under the auspices of parametricism. The rule-based design processes that inform all forms on the basis of informational transcoding imply the possibility of information retrieval through the user, as long as human cognitive capacities are reflected.

Organisation, Articulation, Signification

The three terms of this section title spell out how architecture's societal function – the framing of communicative interaction – can be broken down and concretized into three related subtasks. Organization is based on the distribution of positions for spatial elements and their pattern of linkages. Articulation is based upon the constitution of morphological identities, similitudes, and differences across the architectural elements to be organized. Organization is instituted via the physical means of distancing, barring, and connecting via circulatory channelling. These physical mechanisms can, in theory, operate independently of all nuanced perception and comprehension, and can thus, in principle, succeed without the efforts of articulation. However, the restriction to mere organization without articulation, and without facilitating the participants' active navigation, severely constrains the level of complexity possible in the pattern of social communication thus framed. Articulation presupposes cognition. It enlists the participant's perception and comprehension, and thereby facilitates the participants' active orientation. The distinction of organization versus articulation is then based on the difference between handling passive bodies and enlisting active, *cognitive agents*. These two registers relate in this way: articulation builds upon, and reveals, organization. It makes the organization of functions[2] apparent. In so doing, it elevates organization into order.

The dimension of articulation includes two distinct sub-tasks: *phenomenological* and *semiological* articulation (signification). Their distinction is that between the enlistment of behavioral responses from cognitive

2 According to the functional heuristics of parametricism, the functions of spaces are conceived in terms of dynamic patterns of social interactions/communications, i.e. as parametrically variable, dynamic event scenarios, rather than static schedules of accommodation that list functional stereotypes. See: Patrik Schumacher, *The Autopoiesis of Architecture, Volume 2: A New Agenda for Architecture*. London: John Wiley & Sons Ltd, 2012. See Chapter 11.2.2:Operational Definition of Parametricism: The Defining Heuristics of Parametricism.

fig 1
Parametric Semiology: Semio-field, differentiation of public vs. private as parametric range.

fig 2
Parametric Semiology: Semio-field, master-plan with program distribution.

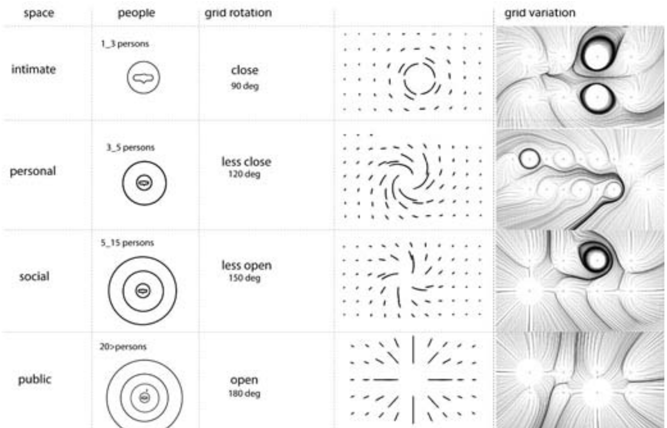

fig 1

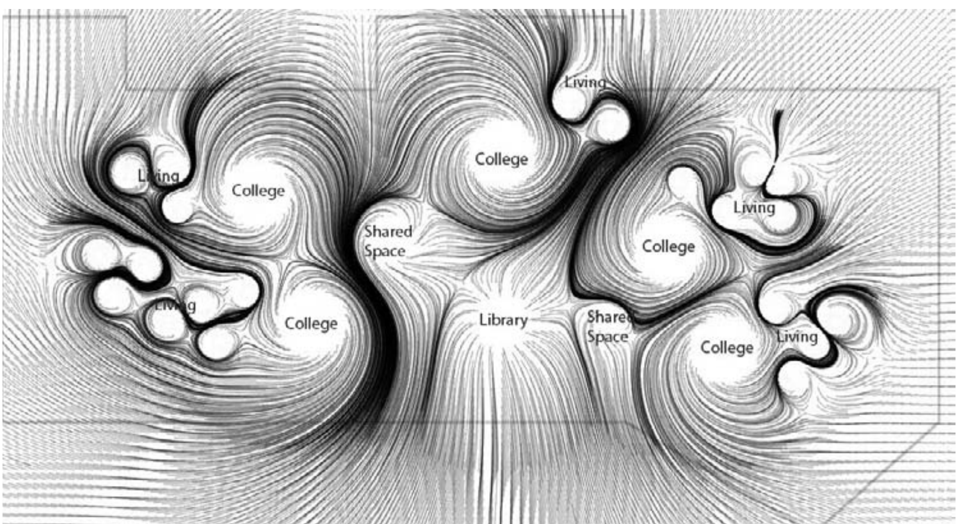

fig 2

agents, on the one hand, and the communicative engagement of *socialized actors*, on the other. The phenomenological project enlists users as cognitive agents, perceiving and decomposing their environment along the lines of the principles of pattern-recognition or Gestalt-perception. It makes organizational arrangements perceptually legible by making important points conspicuous, avoiding the visual overcrowding of the scene, and so on. This is a necessary precondition for all semiological encodings that can only attach to the visually discernible features of the environment. In other words, users can only read, interpret, or comprehend what they can discern. However, the comprehension of a social situation involves more than the distinction of conspicuous features. It is an act of interpretation that presupposes socialization. It is an act of reading a communication: namely, the reading of space as both framing communication and the premise for all further communications to be expected within its ambit. (These framing communications are attributed to the institutions hosting the respective communicative events, i.e. – they are attributed to the clients, rather than to the architects or designers.) Communication presupposes language, that is, a system of signification. The built environment spontaneously evolves into such a (more-or-less vague and unreliable) system of signification. The task of architectural semiology as design agenda, therefore, is to go beyond this spontaneous semiosis (that every talented designer navigates intuitively) and build up a more complex and precise system of signification. (figs 1-3)

fig 3
Vienna University of Applied Arts, Masterclass Hadid, Parametric Semiology: Semio-field. Project authors: Magda Smolinska, Marius Cernica, and Monir Karimi.

The Refoundation of Architectural Semiology within Parametricism

After the failed attempts of the 1970s and 1980s, architectural semiology can now be effectively theorized and operationalized as *parametric semiology*. It is important to note that a semiotic system can neither be reduced to syntax nor to semantics. This was the mistake of the attempts in the 1970s. Eisenman's work had no sematic dimension, and Jencks had no syntax. The postmodern architects tried to build on the spontaneous semiosis of architectural history, and were therefore restricted to the recycling of clichés and deprived of the chance to build up a more complex syntax. Instead, the re-foundation of architectural semiology being promoted here suggests a radical severance from all historical semiotic material, thereby making possible the construction of a new, artificial spatio-visual language – analogous to the creation of artificial programming languages, and thus able to take full advantage of the

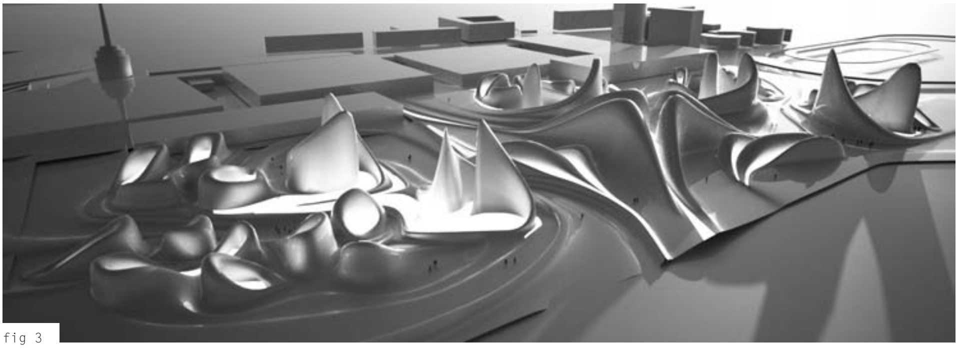

fig 3

radical arbitrariness of all languages. The construction of this language must proceed step by step, oscillating between syntactical and semantic advances. This is made possible via parametric agent-based modeling that realizes the signifying relations as associative functions systematically making agent behaviors dependent on architectural features. At the same time, the pragmatic layer is anticipated as the (never fully predictable) social appropriation process that commences when the design spaces are eventually utilized and re-utilized.[3]

In the second volume of my treatise, *The Autopoiesis of Architecture*,[4] a set of axioms and heuristic principles are formulated that outline strategies for semiological projects conceived as complex architectural designs – for instance, the design of a university campus, as the design of a coherent visual language or system of signification. The first axiom restricts the domain of architecture's signified to the social events that are expected to happen within the respective buildings or spaces, defined along the three dimensions of function type, social type, and location type. The second axiom states that the relevant unit of architectural communication, the architectural sign, is the designed/designated territory (just like the sentence is the minimal relevant unit of speech). Territorial thresholds mark differences that make a difference in terms

3
The computational information processing thus simulates the final users' information processing that occurs when users read their environment as clues for their actions and communicative interactions. The agent-based modeling also allows designers to anticipate how individual dispositions and reactions aggregate into emergent patterns of social interaction that are the final consciously recognized and expected signifieds that constitute the function designations of the respective designed spaces.

4
Patrik Schumacher, *The Autopoiesis of Architecture, Volume 2: A New Agenda for Architecture*. London: John Wiley & Sons Ltd., 2012.


fig 4

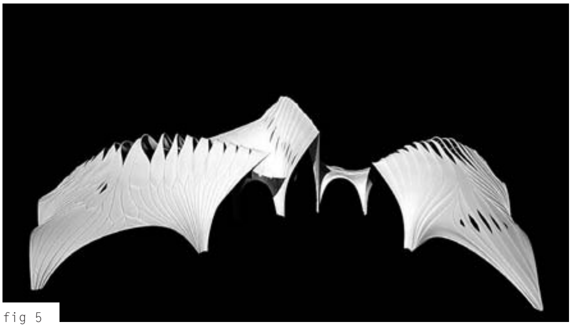
fig 5

fig 4
Dialectic Fields: Shell morphology as a semiological system of distinctions: smooth vs. creased vs. faceted.

fig 5
Dialectic Fields: Cluster of creased shells with semiologically distinctive surface articulation.

of social situation. The use of these differences constitutes the meaning of architectural signs/communications. (figs 4-6)

My most recent academic design-research, at the AADRL and elsewhere, shows how architectural semiology can be operationalized via agent-based crowd modeling. The scripting of the agents' specific behavioral dispositions, in relation to specific spatial and/or morphological features of the designed environment, allows designers to model and work on the signification relation. The domain of the signified – the patterns of social interaction expected within designed territories, can thus be brought into architecture's design medium as one more, but crucial, subsystem in the set of correlated subsystems constituting the parametric model. It becomes possible, therefore, for the first time in the history of architecture, to model this life-process and incorporate it into design speculation. This was made possible by the use of computational crowd modeling techniques, via agent-based models. General tools like "Processing," or specific tools like "MiArmy," "AI.implant" (available as plugins for Maya), and "Massive" now make behavioral modeling within designed environments accessible to architects. Agent modeling should not be limited to crowd circulation flows, but should encompass all patterns of occupation and social interaction in space. The agents' behavior might be scripted so as to correlate with the configurational and morphological features of the designed environment, i.e. – programmed agents responding to environmental clues. Such clues or triggers might include furniture configurations, as well as other artifacts. The idea, then, is to build dynamic action–artifact networks.

Morphological features, as well as colors and textures that, together with ambient parameters (lighting conditions), constitute and characterize a certain territory can now influence the behavioral mode of the agent. Since the 'meaning' of an architectural space is the (nuanced) type of event or social interaction to be expected within its territory,

fig 6

fig 6
AADRL 2012 Parametric Semiology: Dialectic Fields. University campus designed as a system of signification, by Ganesh Nimmala, Leonid Krykhtin, Kwanphil Cho, and SharanSundar.

these new tools allow for the re-foundation of architectural semiology as *parametric semiology*. The semiological project therefore implies that the design project systematizes all form-function correlations into a coherent system of signification. A system of signification, in turn, is a system of mappings (correlations) that map distinctions or manifolds, defined within the domain of the signified (here the domain of patterns of social interaction), onto the distinctions or manifolds, which are defined within the domain of the signifier (here, the domain of spatial positions and morphological features defining and characterizing a given territory) and vice-versa. This system of signification works if the programmed social agents consistently respond to the relevantly coded positional and morphological clues in such a way that expected behaviors can be read off the articulated environmental configuration. However, rather than modeling scenarios frame by frame, agent-based modeling works by defining the agents' behavioral dispositions and biases relative to environmental features. The event itself, then, becomes an emergent global pattern resulting from the local interactions of agents with each other inside the environment. If this succeeds, architecture will have done its job of ordering the event scenario. That is, the meaning of architecture, the prospective life processes it frames and sustains, will have been modeled and assessed within the design process as an object of direct creative speculation and cumulative design elaboration. In this way, architectural semiology can finally be operationalized; in this way, it will have a real chance of succeeding as a promising, rigorous design-research project.

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WILLIAM HOGARTH'S SERPENTINE LINE

— BERNARD CACHE

Book I of Albrecht Dürer's *Underweysung der Messung* (Instructions for Measurement), which focuses entirely on lines, concludes with the production of diagrams rather than with making an attempt at figuration with the serpentine lines drawn by an instrument. This absence of figures is all the more surprising, given the fact that the expression itself, "a serpentine line," already rose to exceptional notoriety and posterity in an essay by William Hogarth (1697–1764), *The Analysis of Beauty*. As its title suggests, for the English engraver, this book was intended to be a rational analysis of beauty, avoiding any use of woolly-minded statements by art connoisseurs who, simply by talking about the "je ne sais quoi," acted as the arbiters of good taste. For Hogarth, the very principle of beauty specifically resides in the serpentine line, which he introduces in his book by referring to Pliny's anecdote about Apelles' signature: "*If we suppose it to be a line of extraordinary quality, such as the serpentine line will appear to be, Apelles could not have left a more satisfactory signature of the compliment he had paid to Protogenes.*"[1] Hogarth further describes the line by referring to the line of flight of an animal chased by a hunter: "*This love of pursuit, merely as pursuit, is implanted in our natures and designed, no doubt, for necessary and useful purposes. Animals have it evidently by instinct.*"[2] Finally, he finds the line enchanting the eye in sinuous mountain paths or meandering rivers, and in all types of waving objects, up to the human silhouette at the top of the scale. The main characteristic of this serpentine line, this line of beauty, is that its continuous variations never allow the eye to rest.[3] It may be said, then, that the art of composing well is the art of varying well.[4]

Hogarth, in turn, faces the problem of describing this line,[5] but much more drastically than Dürer, because the English engraver refuses any theory of proportion to govern the mechanical generation of such a line. When he refers to the human figure, it is no longer to showcase the relationships of proportion between its different members. Rather, it is to illustrate how the skin and fat smooth the bumps drawn by the muscles on the bones. Commenting on three anatomical drawings of a human leg, Hogarth explains that the great beauty of the middle picture does not depend upon[6] the accuracy of the proportions of its parts, but in the more pleasant and intricate winding forms of its curves. A line, then, is more beautiful in Hogarth's eyes if it features gradual and imperceptible transitions between the variable curves.[7] At this point, Hogarth finds that he, too, is required to base himself on the experience of drawing such lines, whether it is a pencil drawing imitating wires, which would smooth the bumps of various anatomical reliefs of the human body, or

1
William Hogarth, *The Analysis of Beauty*, with the rejected passages from the manuscript drafts and autobiographical notes. Edited with an introduction by Joseph Burke. Oxford, Clarendon Press, 1955, page 17. All of the Hogarth quotes were taken from this book.

2
William Hogarth, *The Analysis of Beauty*, page 42.

3
"And the serpentine line, by its waving and winding at the same time different ways, leads the eye in a pleasing manner along the continuity of its variety, if I may be allowed." William Hogarth, *The Analysis of Beauty*, page 55.

4
"In a word, it may be said, the art of composing well is the art of varying well." William Hogarth, *The Analysis of Beauty*. page 57.

5
"The very great difficulty there is in describing this line, either in words or by the pencil, will make it necessary for me to proceed slowly." William Hogarth, *The Analysis of Beauty*. page 67.

6
"This tendency to beauty...is not owing to any greater degree of exactness in the proportions of its parts, but merely to the more pleasing turns, and intertwisting of the lines..." William Hogarth, *The Analysis of Beauty*. p. 74.

7
"...you will see how gradually the variations in its shape are produced; how imperceptibly the different curvatures run into each other, and how easily the eye glides along the varied wavings of its sweep." Page 77.

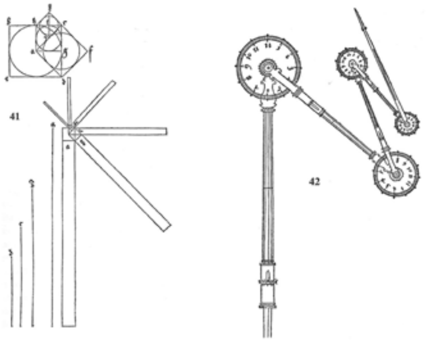

fig 1

fig 1
Dürer's instrument to generate serpentine lines
Underweysung der Messung, Book I, fig 41 & 42

else the finishing of a statue with a chisel. But, in the absence of any mechanical regulation, the reader will be led to understand that the real judge expects from a master's hand what the Italians call *il poco piu*, "a little more," which distinguishes between the original masterpieces and the best copies of them.[8]

Hogarth, who waged war on the *je ne sais quoi* of the connoisseurs, is thus finally reduced to referring to *il poco piu*, or the "little more," of the artist or sculptor. The modern mathematician will perhaps be tempted to interpret these two expressions in terms of differential geometry, or the calculation of small variations, which would allow one to specifically describe the variations in curvature and the particularities of a bent line. Hogarth wrote this work shortly after Leibniz and Newton, but the divide is now wide open. It is not only that the artists were no longer able to follow the mathematicians in their developments – and this divergence applies as much to projective geometry as to differential calculus. Rather, it was that Edmund Burke, who wrote in the wake of Hogarth, seized on the pretext that mathematicians abandoned the old theories of proportions, to definitively dispell any attempt to link art and mathematics.[9] Thus, Hogarth attempted to restrict the relevance of proportions as a beautiful spirit that cares only about the functional adaptation of *fitness*.[10] But this rational beauty is not anymore related to the beauty of the senses, which alone interest artists. Hogarth engages in a real process of neutralizing the esthetic value of proportions by mocking the weakness of artificial mechanisms versus the living machines of nature. According to him, proportions could only take into account the jerky movements of robots, such as those of a mechanical duck that had recently been imported from France to England.[11] It is noteworthy that the fluidity of the serpentine paths of Dürer's mechanical instrument escaped the English engraver's attention.

But Hogarth's argument also develops at a second level, though it is not always very clear. That is, if this natural machine that is the human body moves so fluidly and gracefully, as can be seen in dance, it is because nature has provided it with the best proportioned organs. Yet, the organs most appropriate for movement, muscles and bones, are buried inside the human body and covered with fat and skin – extra weight, one is tempted to say, while the surface is so complex that we cannot see any "practicable" proportions. As a result, not only can we not identify the relevant anatomic joints between which measurements could be taken, but muscle mass is subject to the variations of various body movements. Consequently, the body's general outline proportions, taken as a whole,

8
"He will soon be led to understand what it is the real judges expect from the hand of such a master, which the Italians call the little more, il poco piu, and which in reality distinguishes the original from the master pieces at Rome from even the best copies of them." William Hogarth, *The Analysis of Beauty*, page 77.

9
One only has to listen to everyone who, still today, under the guise of the type of geometry so unfortunately called non-Euclidean, disqualifies any use of classical geometry in the arts.

10
"How naturally, from these considerations, shall we fall into a judgment of fit proportion; which is one part of beauty to the mind though not always so to the eye." William Hogarth, *The Analysis of Beauty*, page 85.

11
"There was brought from France some years ago, a little clock-work machine, with a duck's head and legs fixed to it...: yet for the poorly performing of these few motions, this silly, but much extolled machine, being uncovered, appeared a most complicated, confused and disagreeable object" page 87.

fig 2

fig 2
William Hogarth:
The Five Orders of the Periwigs

are the only "practicable proportions," such as comparison of the skeleton's height to its width. As for the rest, Hogarth completely dismisses any proportion system that claims to take into account complex curved surfaces, whether or not it is related to anatomy, or even to hair, which resulted in the wonderful, satirical engravings of the five orders of the periwigs. Anyone who thinks this is an early satire of the globular architecture of our time is, without doubt, a malevolent spirit.

William Hogarth: The Five Orders of the Periwigs

In fact, it did not escape the attention of informed commentators that William Hogarth was more interested in surfaces with variable curves than in the lines crossing them.[12] Indeed, Hogarth totally missed how effective Dürer's diagrammatic approach was for generating such surfaces, i.e. – by controlling gradual variations in the instrument parameters determining these lines. It is actually quite difficult to "eyeball" or "draw by hand" a series of gradually changing curves in order to draw a surface giving the illusion of continually unfolding in three-dimensional space. Certainly, for engravers, such competency is essential to the art of line engraving. But this variation control is easier when one has access to parameters of the instrument to produce curves; one simply adjusts the parameters to make gradual variations, as illustrated by Dürer's diagrams.

Hogarth should have been extremely interested by Dürer's series of diagrams, which suggested it was possible to control the variation of lines by "proportioning" them on the drawing surface. However, to an engraver interested in illustrating, say, the steps in the downfall of a poor young girl who comes to the big city in The Harlot's Progress, the benefits of such a mathematical drawing might have seemed to be of limited importance. Indeed, Hogarth's considerations are more picturesque than formal, regardless of any concern he might have had for making more gradual variations in his lines of beauty. To draw a comparison with the design of engineering or architectural objects today, all that parametric software does is to automate and further push the regulation of variations that were the precisely the purpose of Dürer's constructive diagrams. Thus, today's digital design methods actually allow us to reconnect with a certain classical tradition by picking up the thread that had started to break with Hogarth's serpentine line – a thread we need to continue to examine in order to measure the extent to which Dürer's Underweysung stands out from other traditions that have occupied center stage for too long.

12
According to Joseph Burke in his introduction to *The Analysis of Beauty*. Clarendon Press, 1955.

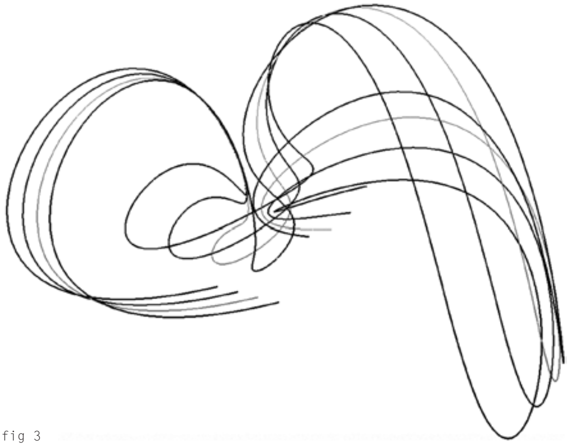

fig 3

fig 3
Variety of serpentine lines generated with Dürer's instruments shown in the 42nd figure of the Underweysung der Messung, Book I

It was precisely when Hogarth intended to get rid of any mathematical pattern other than these simple "praticable" proportions that the English engraver had in mind the treaty *On Human Proportions* by none other than . . . Albrecht Dürer, whose allegedly jumbled, impractical rules he had disparaged in his preface.[13] Hogarth was probably very familiar with the engraving work of his German predecessor. Ronald Paulson, for example, has been able to detect in five of the six engravings of the famous series, *A Harlot's Progress*, a somewhat subversive imitation of the images that Dürer had composed in his *Life of the Virgin*. Although Hogarth did not refer specifically to *Underweysung der Messung*, he made the serpentine line the main subject of *The Analysis of Beauty*. Would Hogarth have known about *On Human Proportion*s? If so, did he read it attentively? One wonders about these questions because, instead of being content to disparage the profusion and detail of Dürer's measurements towards ensuring an accurate depiction of nature, Hogarth likened the engraver's proportionality research to the establishment of a musical harmony system, which had not even been considered by the German artist.[14]

13
Whilst Albrecht Dürer, who drew mathematically, never so much as deviated into grace, which he must sometimes have done in copying life, if he had not been fettered with his own impractical rule of proportions.

14
Therefore I must not omit taking notice, that Albrecht Dürer, Lomazzo, (see two tasteless figures taken from their books of proportion [fig 55, plate 1]) and some others, have not only puzzled mankind with a heap of minute unnecessary divisions, but also with a strange notion that those divisions are governed by the laws of music. Page 91.

Edmund Burke's Gradual Variation

It is worthwhile to examine all the criticism against using the concept of proportion at this juncture in the eighteenth century, because it was after Hogarth's *The Analysis of Beauty* was published that Edmund Burke wrote *A Philosophical Enquiry into the Origin of our Ideas of the Sublime and the Beautiful*. One may even say that one of the outcomes of *The Enquiry* was to highlight a fundamental distinction between the two types of variations that Hogarth did not sufficiently clarify. In fact, Burke referred explicitly to *The Analysis of Beaut*y when he proposed making **gradual** variation the basic principle of beauty and making **accidental** variation an attribute of the sublime.

Edmund Burke: The Enquiry . . . III.15: Gradual Variation

But as perfectly beautiful bodies are not composed of angular parts, so their parts never continue long in the same right line. They vary their direction every moment, and they change under the eye by a deviation continually carrying on, but for whose beginning or end you will find it difficult to ascertain a point…

fig 4
Series of diagrams proposed by Dürer to make the serpentine line vary: U.I.43-50

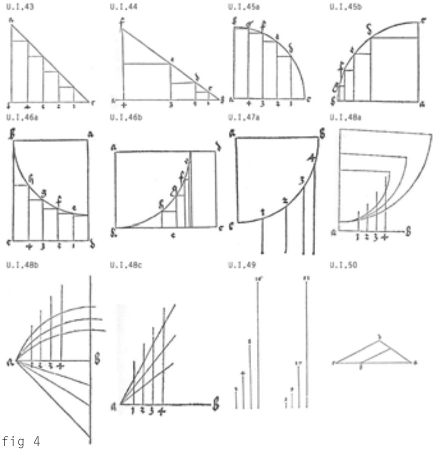

fig 4

Observe that part of a beautiful woman where she is perhaps the most beautiful, about the neck and the breast; the ***smoothness****; the softness; the easy and insensible swell; the variety of the surface, which is never for the smallest space the same; the deceitful maze, through which the unsteady eye slides giddily, without knowing where to fix, or whither it is carried. Is not this a demonstration of that variation of surface continual and yet hardly perceptible at any point which forms one of the great constituents of beauty.*

It gives me no small pleasure to find that I can strengthen my theory in this point, by the idea of the ingenious Mr ***Hogarth****; whose idea of the line of beauty I take in general extremely just. But the idea of variation, without attending so accurately to the* ***manner of the variation****, has led him to consider* ***angular figures*** *as beautiful; these figures, it is true, vary greatly; yet they are in a sudden and broken manner; and I do not find any natural objet which is angular, and at the same time beautiful. Indeed few natural objects are entirely angular. But I think those which approach the most nearly to it, are the ugliest.*

While Hogarth already noticed the distinction between gradual and accidental variation, Burke needed to focus on it in order to develop his own system of opposition between the beautiful and the sublime. For Burke, “the beautiful” springs from the love kindled by round and smooth globular bodies, whereas “the sublime” results from the creation of vast, dark spaces on a rugged background, evoking a feeling of terror in those observing from afar. For his own purposes, Burke borrowed the contemplation of the Lucretian image of a sinking ship from a garden, or from dry land. The contemporary reader will be surprised to learn that our modern era’s globular fluidity rhetoric can already be found in *The Enquiry*.

Edmund Burke: The Enquiry . . . IV.21: Sweetness in Nature

Nor is it only in the touch, that smooth bodies cause positive pleasure by relaxation . . .

Let us first consider the taste. Since it is most easy to enquire into the property of liquids, and since all things seem to want a ***fluid vehicle*** *to make them tasted at all, I intend rather to consider the liquid than the solid parts of our food. The vehicles of all tastes are water and oil . . .*

Water and oil simply considered are capable of giving some pleasure to the taste . . .


fig 5


fig 6

fig 5
Hogarth : A Harlot's Progress (1732) – Planche 1

fig 6
Dürer : Visitation (vers 1504)

*For as **fluidity** depends, according to the most general opinion, on the roundness, smoothness, and weak cohesion of the component part of any body; and as water acts merely as a simple fluide; it follows, that the cause of its fluidity is likewise the cause of its relaxing quality; namely the smoothness and slippery texture of its parts.*

The other fluid vehicle of tastes is oil . . .

*If you have tried how **smooth globular bodies**, as the marbles with which boys amuse themselves, have affected the touch when they are rolled backward and forward and over one another, you will easily conceive how sweetness, which consists in a salt of such nature, affects the taste.*

This contrast between the beautiful and the sublime was not limited to reproducing a type of modernized version of the Pythagorean table of ten oppositions, to which Aristotle referred, and which already contained the basic polarization of the "curve" and the "straight line." If this polarization of esthetic experience arose from Burke's shared background with Hogarth, it was only in categorical rejection that proportions might have had any relevance in art. This was because the entirety of *The Enquiry* was based on an analysis of the passions in which Burke distinguished not two, but three, emotional states: pain, pleasure, and . . . indifference. If beauty arose from pleasure and sublime arose from pain, then, proportion was considered to be a purely rational quality, which did not trigger any emotion other than indifference. Better still, Burke insisted upon the fact that aesthetic experience did not seek any assistance from reasoning, and that this experience had nothing to do with measurement, calculation, or geometry.[15] Here, his work was poles apart from *Instruction in Measurement*, although it was based on the same subject – namely, the serpentine line.

Taking the lead from Hogarth, Burke was intent on neutralizing the idea of proportion in order to inscribe measurement relationships in a smooth continuum, wherein fractions may take any value, indifferently. Better still, absolute indifference and tranquility would be the express condition that would allow proportions to be the subject of mathematical speculations.[16] In a full-scale attack against all the authors who apologized about using proportional systems in art, Burke argued that proportions were not the source of beauty in plants, animals, or even in humans.[17] By concentrating on animals, Burke, as later D'arcy Thompson, saw all species with identical members, but with different proportions according to their characteristic behaviors and environments. These specific proportions would have, in turn, specific variations for each individual,

15
Edmund Burke: The Enquiry ... III.2: "Beauty demands no assistance from our reasoning ...Surely beauty is no idea belonging to mensuration; nor has it anything to do with calculation and geometry.

16
Edmund Burke: The Enquiry ... III.2: "Proportion is the measure of relative quantity. Since all quantity is divisible, it is evident that every distinct part into which any quantity is divided must bear some relation to the other parts or to the whole. These relations give an origine to the idea of proportion. They are discovered by mensuration, and they are the objects of mathematical enquiry. But whatever any part of any determinate quantity be a 4th, or a 5th, or a 6th, or a moiety of the whole; or whether it be of equal length with any other part, or double its length, or but one half, is a matter merely indifferent to the mind; it stands neutral in the question: and it is from this absolute indifference and tranquillity of mind, that the mathematical speculations derive some of their most considerable advantages."

17
They are the consecutive titles of three chapters of the Enquiry: III.2 Proportion not the cause of Beauty in Vegetables; III.3 Proportion not the cause of Beauty in Animals; III.4 Proportion not the cause of Beauty in the Human Species.

depending on age, sex, and physiognomic features . . . as Dürer carefully examined in his *On Human Proportions*.

However, something happened between Dürer, on the one hand, and Hogarth and Burke, on the other, so that, using the same initial data, i.e. – the serpentine line and the variety of proportions, they drew radically different conclusions. Undoubtedly, progress in mathematics had contributed to disqualifying the idea of proportion and breaking the common contacts that artists and laymen had with scientific developments. For instance, although Burke cited Newton's work twice, he certainly did not notice that the mathematical principles of natural philosophy were deeply rooted in classical problems. Book 1, Proposition 1 of Newton's *Principia* reads as follows: "The areas which bodies made to move in orbits [under the action of a central force] describe by radii drawn to the center of forces lie in unmoving planes and are proportional to the times." With this equivalence of areas and proportionality, we have arrived at the heart of Greek geometry. Moreover, Newton even cited Euclid's work. There are reasons that must be analyzed elsewhere as to why Newton's entrenchment in the classical mathematics tradition, similar to that of Descartes, is rarely mentioned anymore. There are, for instance, such contributing factors as the language, rhetoric, and social strategy of mathematicians, as well as pure mathematic reasoning.

With regard to Burke, however, his rejection of studying proportions in art is surprising, especially since the English philosopher's major complaint against the French Revolution lay precisely in the rejection of any past heritage, as embodied in the abolition of the monarchy.[18] While the French Jacobins denied the existence of intermediate bodies between individuals and sovereigns, the English philosopher did not take into account the impact of the heritage of the theory of proportions in articulating aesthetics on technical practices and scientific theories. For Burke, proportions were only a rational, abstract discourse, devoid of historical depth, as neutral and inefficient as the arithmetic of universal suffrage in his view. It should be remembered that proportions have been at the origin of aesthetic discourse since the Canon of Polykleitos (450 BCE). This mathematical concept has so much historical depth that it contributed to the creation of a host of competing traditions. There is no universal mathematical reason, which can be deployed unequivocally, by imposing logic on other areas of knowledge and practices. Instead, we must emphasize the fact that there is a plethora of rational traditions, and historical or conflictual reasons, preventing us from contrasting "reason" and "tradition." Also, the outright rejection of the discourse of proportions is equivalent to abandoning the entire heritage of aesthetic traditions and their expressions, as well as other forms of knowledge, e.g. – mathematics and more practical, concrete forms like mechanics. For us, then, the whole issue is to know whether today, we will be able to develop new invariants to replace proportions, so that we may control the fluctuations of our time keeping on building a historical tradition.

18
Edmund Burke: Reflections on the Revolution in France in a letter addressed to a gentleman in Paris (1790).

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LITERAL DIGITAL

— MARK LINDER

Literal is a virtual synonym for digital. Despite the widespread association of digital media with everything ephemeral, elusive, and epiphenomenal, computer technology is the most intensive, elaborate, intricate, creative, and practical exploration of literalism in human history. Almost everyone is aware of the fact that computers are absolutely literal devices and software is comprised of absolutely literal code, but very few seem to consider this of any significance when using the seemingly magical technology. Typical users, especially designers, are concerned predominately with output and effect. Their desire (and for most, their intent) is to maintain the longstanding caricature of the computer as a miraculous black box. Few digital designers acknowledge the literal basis of their work. Even coders, scripters, and technical virtuosos, who are necessarily literalist in practice, apparently consider this to be of only practical importance. This aversion to literalism is nothing new or unique to architects or to computing. No matter the media or the moment in history, the predominant languages of design and speculation prefer to celebrate explanation and interpretation, and rarely betray precise attention to, or description of, the procedures, protocols, and operations of projects. But computers and computing offer staggeringly unprecedented, liberating, and projective possibilities for literalness, from the keystroke or mouse click, to the assembly and specification of complex physical artifacts. Their potential lies not in control, but in the precision and explicit opportunities to isolate decisions and pursue their implications. Acknowledgment and assertion of this *literal digital* can produce elegant, focused, and intriguing works of design and art. This is already a pursuit of a handful of artists, such as the self-described “literal artist” John Cayley and the visual artist Manfred Mohr. [1]

It may seem surprising that literal and digital share a common identity. Literal means (literally) “of the letter,” and a letter is a kind of digit. Of the many variants beyond these most-basic definitions, there are others that are specific to, or have particular resonance for, computing. In the archaic jargon of printing, a literal is a typographical error. Since the advent of keyboards, this has been transposed into the idiom “fat finger,” a wonderfully literal and figural affiliation of literal and digital. Closely related to the notion of mistake is negation: in mathematical logic a literal is an irreducible unit that has a perfect complement in its negative. Such a literal is “pure” if the formula that contains it does not also contain its negation. So, there is a weak, inverse analogy between the mistake that turns printing a letter into a literal, and the negative of a literal in logic that produces impurity. The latter, of course, connects

1
John Cayley is a poet and an assiduous theorist of “literal art,” which he associates with the materiality of language and what he calls “programmatology.” He rejects the term “digital” as a mere “placeholder” lacking adequate definition, despite seeming “far more exciting” than the “fairly flat term “ ‘literal’.” For Cayley, “literary cultural production in its material manifestation as writing has always already shared the defining qualities of the digital,” and he places himself in a lineage of literal artists “from Mallarmé, through Dada into the currency of total syntax and post-Concrete visual poetry….” See John Cayley, “Literal Art” at http://www.electronicbookreview.com/thread/firstperson/programmatology.

directly to the rudimentary basis of electronic computing: binary code begins with elemental literals, 0 and 1, that are mutual negatives. Thus, logically speaking, binary code is perfectly "impure." In a more technical sense, in any coding language, a literal is a particular kind of constant that represents itself and is not used to calculate, but only to appear or to be legible.[2] A more specific type of literal is a terminal symbol: an input or output that is irreducible and cannot be changed within the rules of a particular program or grammar.[3]

Generally speaking, where there are literals, there are issues of propriety, rules, and under-estimation of their robust potential.[4] Literalisms are identifiable, deep conventions that, as Marina Rakova has insisted, are much more pervasive and useful than is usually supposed. Her analysis of philosophical and linguistic attempts to distinguish between literal and metaphorical language revealed the mistaken "standard assumption" that literal meanings are basic and exceptional in comparison to figural usages. Instead, Rakova argues, "there is much more literalness in language than has traditionally been supposed.... I believe that the restrictive notion of literal meaning that underlies most discussions of metaphor and polysemy is not the notion of literal meaning that could help us understand why language is the way it is."[5] Thus, she shares Cayley's sense that literalism has been a more persistent and profound aspect of cultural practices than most are willing to admit, and has even offered a general theory supporting Cayley's call for reframing the digital as literal.

The call for increased awareness and explanation of the literal is directly applicable to digital design in architecture. All design operates on the basis of literalisms: line, surface, pattern, gradation of color or lightness, technical skill, and specifications are just a few examples of literalized elements of design practice. But, traditionally, design discourses have relied upon metaphor and representation to convey significance: a drawing or model is not a building, so it must be read and interpreted in prescribed, disciplined, or cultural ways to be understood as such. Today, with the ever-increasing power and complexity of computing, there is a potentially seamless and linear movement from digital production to actual construction, which makes the value of attending to the literal digital more obvious, easy, and useful. This movement also makes the habit of thinking that ideas motivate design that much easier to avoid. Instead, digital media make the operations and procedures of design available, repeatable, and explicit in direct and tangible ways.

It is crucial to remember that the irreducibility of literals does not imply reductiveness or banality; the opposite is closer to the actual potential of the literal digital. As Herman Goldstine has explained in his classic history of the computer, it is astounding that, from the earliest mechanical computers to the first electronic computers, mathematical and scientific inquiry was affirmed and advanced by efforts at radical literalization, whether the mechanism was digital or analog.[6] But, the digital computer literally turns all calculating and processing of "operations that are transcendental and definitions that are implicit as well as processes that are defined by infinite sequences "into sheer, indefatigable counting: the wonder of computing is that" all transcendental operations must be replaced by elementary ones...; all implicit definitions must be replaced by explicit ones involving finite and constructive procedures; and limiting processes must be truncated and replaced by finite sequences of elementary operations." Surely, the computer replaces "tedium" with "generality, accuracy and speed,"[7] but the more important, even crucial, subject for investigation is how its fundamental literalism constructs new levels or higher orders of disciplinary or techno-cultural literalism – that we might call the digital literal. This may be a mathematically complex operation like lofting, or a simple keystroke operation, menu toggle, or other interface convention that launches otherwise massively tedious sequences of calculation and converts them into basic, easily-repeatable and applied elements of design thinking. Perhaps, in the not too distant future, more of us will be keeping it literal.

2
In programming, a literal is "a value written exactly as it's meant to be interpreted." This can be contrasted with a constant, which is a "name that represents the same value throughout a program. But a literal is not a name – it is the value itself. A literal can be a number, a character, or a string." See http://www.webopedia.com/TERM/L/literal.html.

3
For a clear explanation of terminal symbols, see http://en.wikipedia.org/wiki/Terminal_and_nonterminal_symbols.

4
In ordinary usage, there are two pervasive misuses of the term literal. The first is the common criticism that something or someone is "too literal": such assertions are usually technically correct in understanding literalness as a direct, accurate description or utterance, but evaluatively wrong in assessing this kind of usage as simplistic or reductive. The second is simply wrong, and increasingly the subject of rants by bloggers and linguists: "literally" has become a synonym for the opposite, "figuratively."

5
Marina Rakova, *The Extent of the Literal: Metaphor, Polysemy, and Theories of Concepts*, London: Palgrave Macmillan, 2003, 15.

6
Herman Goldstine, *The Computer: From Pascal to von Neuman*, Princeton: Princeton University Press, 1972.

7
Goldstine, 140-143.

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OEDIPAL TIME: ARCHITECTURE, INFORMATION, RETRODICTION

— DAVID THEODORE

In 1961, British architect John Weeks confronted an information problem. Thanks to the ambition and charm of his partner, Richard Llewelyn-Davies, their firm had won the commission for Northwick Park Hospital in London (fig 1). The challenging task was to house a new institution that would combine, for the first time in Britain, both an immense district hospital and a national inpatient research facility.[1] The modern hospital, Weeks thought, demanded more than just modern architecture. He was not worried about what style he should build in; he worried whether it was wise to build at all. Weeks feared that postwar medical practice was changing so rapidly that by the time the hospital opened, roughly a decade later, the initial programming data and organizational diagrams would be outmoded. How might one design and build a hospital that could incorporate new information and requirements that arrived *after* construction?

This question provoked Weeks to reflect upon artistic theory, obsolescence, and the meaning of architectural form. His response came in two stages: he formulated several innovative architectural strategies, and then worked out ways to implement some of them in the actual design of the hospital, which admitted its first patients in 1970.[2] One of his striking proposals was to collaborate with his engineers to use computational algorithms to compose the façades, a remarkably early example of parametric design in which the building's appearance was "determined wholly as a result of a computer-orientated programme" (fig 2).[3] The pragmatic success of these strategies has obscured Weeks' attention to a more abstract characteristic of architectural thought that's highly useful in the information era, namely a concept I wish to call *Oedipal time*.

In Sophocles' telling, it is Oedipus' killing of his father and fornicating with his mother that caused his mother to abandon him as a child. In other words, it is Oedipus' actions in later life that make sense of his childhood, and not the other way around, as we moderns believe. In architecture, this sense of reverse causation, of later events creating earlier intentions, is latent in the design process. Indeed, Oedipal time may account for why the "napkin sketch" has become so important within design culture. Although many deride the making of a "preliminary" sketch *after* the design is finished and the building built, such sketches are legitimate as they *constitute* intentions *ex post facto*. The napkin sketch is a retroactive point of departure, created only after the design process is over. And so it was with Weeks' architecture.

In first thinking through the problem of the modern hospital, Weeks relied on up-to-date aesthetic theory. He was an active (if minor) member of the postwar British art movements around Reyner Banham and

1
John Weeks, "Hospitals," *A.D. Briefing 43*, no. 3 (1973): 436-443, 456-463.

2
On the design concepts, see John Weeks, "Indeterminate Architecture," *Transactions of the Bartlett Society* 2 (1963-1964): 83-106. On the hospital buildings, see Nigel Thompson, "Northwick Park Hospital," *The Arup Journal* 4, no. 3 (1969): 2-13.

3
John Weeks, "Indeterminate Dimensions in Architecture," in *Cybernetic Serendipity: The Computer and the Arts*, ed. Jasia Reichart (London: Studio International, 1968), 69. This catalogue, which accompanied a groundbreaking exhibition of computer art, included two line drawings of the elevations.

fig 1

fig 2

fig 1
Photograph of Northwick Park Hospital X-ray department, London, 2010 (courtesy of the author). For the façade of Northwick Park Hospital, the engineer (Nigel Thompson of Arup & Partners) used stress computations to group structural mullions at intervals in such a way that each mullion is equally stressed in accordance with local loading conditions.

fig 2
Photograph of Northwick Park Hospital, London, 2010 (courtesy of the author). In an earlier version of the envelope design shown here, the architects sought to compute mullion placement with an additional parameter, glare control.

the Independent Group.[4] He worried about the failings of formalism. He admired the notion in John Cage's music and Merce Cunningham's dance that form should be the mere fungible result, not the primary static goal, of creative processes. Moreover, he engaged with cybernetics, organicism, and functionalism. In 1965, for instance, Llewleyn-Davies and Weeks were consultant architects on a new printing house for the *Times*, a building grounded in time and motion analysis, and organized in plan and section in a factory-functionalist mode that optimized the efficient flow of copy into the composing room.[5] Yet for the modern hospital, in constant danger of obsolescence, these artistic methods were inadequate.

Postwar architects boosted the notion that all buildings need to be flexible. Flexibility, it was argued, would allow a building to adapt to inevitable changes in size and program. Louis Kahn promoted interstitial floor space for mechanical systems, notably in his laboratory work, and Eberhard Zeidler exploited it at the McMaster University Health Science Centre (a megastructure much beloved of Banham). Weeks himself invented and adapted several flexibility strategies during the design of Northwick Park, most of which are still with us. He promoted the use of an extensible interior street with plug-in program modules, fast-track construction, indeterminate form, and duffel coat planning, in which the

4
Reyner Banham, "A Clip-on Architecture," *Design Quarterly* 63 (1965): 3-30.

5
Richard Llewelyn-Davies and John Weeks, "Horizontal Flow of Copy," *The Times* 4 May, 1965, iv-v.

building fits the program loosely (like an overcoat) rather than exactly (like a bespoke suit).[6]

For Weeks, though, who had been steeped in the methods and results of medical research, the problem of the hospital went beyond flexibility. By 1961, he and Llewleyn-Davies had spent nearly a decade heading a team researching the design and construction of hospitals for the Nuffield Provincial Hospitals Trust.[7] They had concluded hospital buildings could be improved if based on information, on facts gathered through quantified collection techniques: time-motion studies, data surveys, and photographic and cinematic observation. They also built experimental hospital wards as "laboratories" to gather information about the acoustic properties of materials, the work habits of nurses, and the use of baffles to optimize glare-free lighting conditions.

In short, Weeks looked for a new relationship between data, designer, and time. The architecture itself was to be open to *retrodiction*: new information, coming at the end of the design and construction process, could be incorporated into the building in such a way that it *appeared* to be there at the beginning. In his vision, the designer would neither prescribe nor predict how the hospital functioned, nor what it looked like. Weeks wanted the actual building to retrodict intentions, not to use intentions to predict how the building would function in the future. The architecture would not only be flexible enough to make room for new data (the unlimited new information coming in from medical research), but would also help make sense of it by influencing information flows, instead of simply being shaped by them.

Such retrodiction in architecture works in Oedipal time: intention comes only in retrospect. The exigencies of national health planning demanded a building capable of symbolizing and manifesting physically an architectural intention, derived from health policy, which would not be known until later in time. Oedipal time thus allows architecture to highlight the difference between adapting to unanticipated *needs* – more space, a different organizational diagram – and adapting to unanticipated *meanings*. At Northwick Park, the buildings were architecturally flexible, but the architectural ambition went deeper, searching for ways to modulate and take stock of social change. In a future-oriented society, architecture holds the singular cultural responsibility to re-inform the past.

Ironically, today the research hospital is no longer subject to change due to information overload. The data produced by medical research has little impact on hospital architecture, which is instead overdetermined by technocratic constraints: safety codes, best practices, equipment specifications, economic models, and so on. The problem has been passed on to other buildings types in which the design is now primarily determined by questions of information rather than questions of program, typology, site, and or even budget. As Weeks discovered, it is helpful in these cases to remember architecture's retrodictive power. The fluid form produced can still result in determinate meanings, only they will be retroactively established *later*, in Oedipal time.

6
Jonathan Hughes, "The Indeterminate Building," in *Non-Plan*, ed. Jonathan Hughes and Simon Sadler (London: Architectural Press, 2000), 90-103.

7
Nuffield Provincial Hospitals Trust, *Studies in the Function and Design of Hospitals* (London, Oxford University Press, 1955).

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TEN EXALTATIONS FOR AN EXCITABLE PLANET

— EVAN DOUGLIS

In Search of Synthetic Immortality

With the rise of interest surrounding the use of emergent systems as the new organizational model for a planet undergoing continuous change, the opportunities to develop a more robust bio-mimetic approach in architecture are becoming increasingly more attractive. For the futurist at the turn of the 21st century, the once exotic and ineffable metamorphosis of the chameleon octopus, the otherworldly bioluminescence of the sea cucumber, and the strange gelatinous, reconfigurable anatomy of the comb jelly creature are no longer unobtainable effects underlying nature. Rather, the dazzling behavior of invertebrates is just one of many examples of the complex systems innate to living organisms currently being re-assessed on a computational level in order to extract the base code inherent to these uniquely divine creatures.

Re-conceptualizing the bridge between organic and inorganic systems as a transfer of essential, genetic information is not an entirely new proposition in the history of the world – if one considers the legacy of ancient and contemporary alchemists that have sought, through the transmutation of matter, to create a parallel, animistic universe. Conceived as an extension of our timeless desire to bring inanimate materials to life, this continuous chase for synthetic immortality has preoccupied our imagination for centuries.

Given our present predisposition for even greater control over an increasingly complex universe, the next generation of animate assemblies within the discipline of architecture will inevitably be comprised of more complex amalgamations of scripted equations capable of re-enacting the most spectacular effects. Harnessing the unlimited power of programming as a vast hereditary engine for emergent designs will soon let us see surface and behavioral variations on a level of intricacy and control unparalleled in the history of digital design.

In the dream of recombinant technology and biologically mimetic surfaces, ‘autogenic structures’ represent an alternative model of production seamlessly obedient to the process of modern strategy. Situated somewhere between an indeterminate topology and a strange vehicle of desire, this seemingly life-like fleet of new building components embody an entirely new synthetic ecology. Conceptualized as a new era of manufactured flesh, this architecture of the future will serve to highlight the endless algorithms of differences found in the indeterminacy of everyday life.

The Infra-Thin

The *Infra-Thin* at the turn of the century represents the "new" scale at which all emergent behavior (as we know it) will be re-conceptualized and unleashed back into the world with the aim of achieving a perfect future. Whether we're referring to the smallest increment of matter on a genomic level, or the underlying code regulating the building blocks of nano-technology, this is the new battleground in which a future "game of life" will be played. Given this radical leap to a 'deep interiority' as a means to re-assess the underlying structure of all things, the project of the Infra-Thin proposes an unprecedented, kaleidoscopic explosion of surface developments and material behaviors for the next generation of architectural building components.

Digital Alchemy

In an "era of information" where the dexterity of visual branding extends so effortlessly throughout the public domain (reaffirming the "messages of persuasion" of the capitalist agenda), *Digital Alchemy* represents "a project of resistance", wherein the computational power of the computer is skillfully mined and strategically aimed toward reaffirming the sustenance and memory of people and places, the claim for authenticity (as an ethical imperative), novel effects, and sentient surprise.

Mindful of the impressive legacy in the history of a world beholden to more spiritual and mystical conceptions of life, our current technological regime – with its ever-expanding digital design and manufacturing prowess, faces an extraordinary opportunity to re-assess the proper recombinatory relationships between structure and ornament at the turn of the 21st century. This is a compelling moment in architecture, where the cultural imprint of a civilization can slide seamlessly among meaning, memory, and matter.

Dazzle Topology

In appreciation of the "haptic" in architecture, *Dazzle Topology* represents an invaluable source of insight underlying the retinal effects of intricacy and surface complexity. Seeking to elevate the status of the "surface in architecture" as the new site of projected desire, Dazzle Topology explores the relational correspondence between "surface" and "seeing". This relationship is a critical area of inquiry for all those committed to maximizing the full effects of our new era of topological expression.

As an example: In the spirit of Hans Holbine's legendary anamorphosis painting, "The Ambassadors," one might re-assess (with our ever-increasing engine of computational power) the role of "illusory techniques" today as an opportunity to achieve greater control over conceptual and cinematic effects in architecture.

Excitable Matter

Common to Greek and Judaic mythology, early science-fiction novels, and writings on Magic Realism at the turn of the 21st century is the compelling desire to bring inanimate matter to life. This dream of synthetic immortality has preoccupied the imagination of countless civilizations. In this dream, the material world surrounding us obtains an air of excitability, self-determinism, and a range of performative attributes that radically challenge our otherwise-enduring sense of all living things as divine and absolute.

Given our current efforts in the disciplines of material science, bio-engineering, nano-technology, and robotics, the next generation of material behavior within architecture will assume a level of intelligence and sentience rivaling the most spectacular science-fiction novels.

Perpetual Desiring Machines

At a time when the "economy of desire" continues to globally assert pressure on the rapid distribution of goods based on the promise of novelty and surprise, 'mass-customization' in architecture represents an ideal response to reaffirm the heterogeneity of our multi-cultural planet at the turn of the 21st century. Analogous to a *Perpetual Desiring Machine*, the promise of "infinite variation" for a distributed model of interchangeable, modular construction represents the perfect counterpoint to the slow, yet determined, eradication of difference often uncovered in the wake of globalization.

Although fundamentally different in terms of their unique cultural practices, M.C. Escher and Hans Bellmer, for example, curiously shared a similar vision of a world based upon an anagrammatic assembly where the continuous rearrangement of similar parts perpetuated the illusion of infinity and erotic surprise.

Biological Mimesis

Often, the most extraordinary secrets concerning the laws of nature and our very own existence (as a species among many) can be found just by looking at the underlying behavior of the natural world as a complex ecology of seemingly indeterminate orbits of activity. At a time when we aspire to truly manifest emergent behavior – in order to respond more effectively to the cultural and environmental aspirations of the 21st century – learning more about the elegantly designed life-forms that share our planet represents an invaluable opportunity for the next generation of architects and bio-engineers. Offered as an infinite archive of analogical models, bio-mimicry represents a major paradigm shift with the capacity to revolutionize the history of architecture as we know it.

Intricacy

Complex macramé, ornate scrolls, full-body tattoos, Persian tiling and calligraphic manuscripts, Russian nesting dolls, old Italian wood inlay music boxes, the pointillism paintings of Seurat, Damien Hirst's Diamond Skull, M.C. Escher's drawings, Louis Sullivan's ornamental embellishments, and the strange and beautifully eerie portraits of "alternate realities" by Max Ernst: all subscribe to an obsession with surface exuberance at the most intimate scale. Seeking to imbue another level of chromatic and topological variation within the surfaces of real or imagined places is a timeless project – and one that has particular relevance for architecture in an era of digital and manufacturing control.

Conjoined Ideation

Given the demands of our profession to manage an increasing number of factors impacting design, environmental, economic, and technological considerations, the "autonomous model" of architectural education is no longer adequate to prepare our students to assume leadership roles in the resulting complex and highly-competitive job market.

Dealing with the daunting challenges we face at the turn of the century requires an interdisciplinary response, wherein multiplicities of knowledge and expertise (drawn from research streams beyond architecture) are brought together as the "conjoined ideation" of novel proposals. The distinct boundaries traditionally affirmed within architectural programs must be re-conceptualized as elastic constellations of collaborative arrangements – in order to mine the natural affinities within, and beyond, every academic institution.

Ethics + Aesthetics

Architecture is situated at a unique moment in history, when a convergence of global interests demands critical and innovative responses from our discipline. Faced with an ever-increasing focus on creating new forms of renewable energy, smart-grids and coastal-city solutions, sustainable and zero-carbon technology, and environmentally responsive buildings for the 21st century, we need to reaffirm the ethical imperative of responding to these serious environmental priorities – while also aggressively advocating for the invaluable role of design.


fig 1

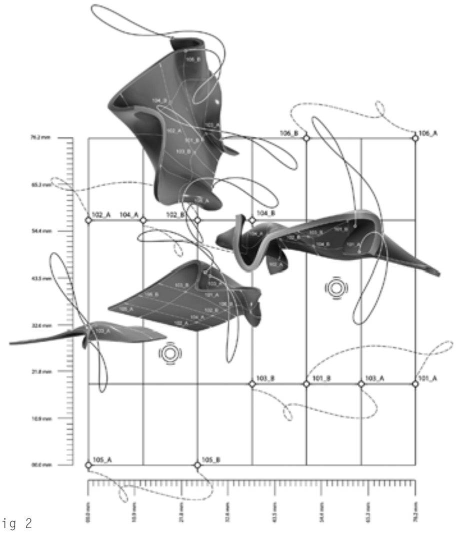

fig 2

Given the recent surge to politicize the debate over green buildings as being exclusively biased toward using quantifiable data as the sole criteria of measuring success, it is of enormous importance that our community of architects participates, on the most proactive level, in reasserting the inextricable bond between ethics and aesthetics. "Sustainability," when used as a mere slogan and detached from architectural production, threatens to over-simplify the larger challenge facing all of us at the turn of the century.

The "real project" calls for radical innovation, such that buildings of the future exemplify the full breadth of human creativity and ideation – and thereby celebrates, on the most benevolent level, the diverse ethos of cultures and communities on a planet undergoing continuous change.

The following projects are a selection of my practice.

Auto-Braids / Auto-Breeding

This project was an exhibition display-scape designed for a selection of seminal furniture and modular housing prototypes by Jean Prouvé. The work was originally exhibited at Columbia University, before traveling to the Pacific Design center at the MOCA museum in Los Angeles.

In the context of creating *desiring machines*, the idea that a single unit could contain the necessary intelligence to generate infinite diversity (like letters in an anagram) has fascinated me for many years now. Although it's not an entirely new concept, since one finds it explored as far back as the Persian Tiling systems of the 10th century, it has significant merit at this particular moment in time – given the recent rise of digital and manufacturing technology and the new wave of interest in modularity. (fig 1)

In favor of privileging the generative logic of the membrane's surface, the single digital unit was comprised of a simple fold, mirrored across

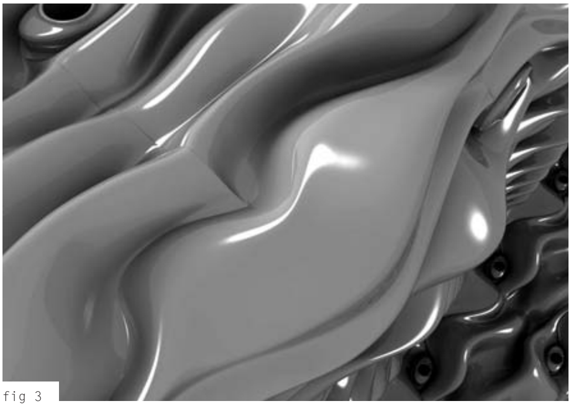
fig 3

a central axis. Seeking to introduce a sense of a visual moiré across the entire display-scape, the perpetual flux of the membrane stood in stark contrast to the stasis of the suspended artifacts. We were purposefully looking for a perceptual juxtaposition so the opposing speeds of flux and stillness would draw the spectator toward the main curatorial subject in the show. (fig 2)

By considering the audience as an inextricable participant in our theater of operations, the illusory intelligence of our surface was thoughtfully calibrated in relation to the perceptual changes experienced by spectators in the gallery. No longer inert and inanimate, the Auto-Braids display-scape membrane exhibited a multiplicity of topological variation as an index of a new world yet to come. (fig 3)

Helioscopes

Helioscopes was about envisioning a new world. If we consider the Greeks to have built their civilization from the bottom up based on the laws of gravity and a reverence for the ground plane as the origin point of all beginnings, what might the future of architecture look like in an alternate universe? Would it be like in a science-fiction novel, where the tentacles of the new city descend upon us from the sky in a gentle and benevolent embrace? Would these structures of the future have the capacity for flight, aerial flotation, or even endless drift (fig 4)? And what happens in this new era of synthetic flesh, when the indisputable boundary between the real and artificial is finally eclipsed after countless centuries of disbelief, and strange, gelatinous partners are working in tandem with us to rule the earth?

With this ambition in mind, we set out to make a single helioscope tail. Conceived as a prototype unit indicative of a much larger, immersive cloudscape, we selected the expression of the helix given its innate predisposition for swirling effects, spatial wrapping, and complex surface

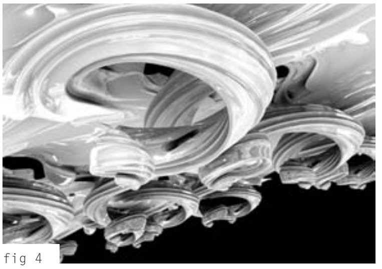
fig 4


fig 5


fig 6

transformations. Frozen in space as strange, amorphic vortices, each tail contained an LCD screen carefully situated at eye height within a hidden orifice. (fig 5)

Offered as an unexpected reward for the curious mind, the single occupant of the orifice assumes the role of voyeur as he or she is unexpectedly enveloped, upon arrival, by a shroud of desirability and erotic surprise. Emblematic of our contemporary world – obsessed as it is with novelty and endless difference, *Helioscopes* attempts to highlight the "project of desire" as a uniquely influential constellation of cultural, subliminal, and material considerations functioning in tandem below the surface of things. (fig 6)

Moon Jelly

More recently, I had the opportunity to extend my research with emergent systems to the diaphanous arena of glass. Fascinated by its seemingly illusive and random behavior, we developed a strategy of productive resistance that attempted to tame the formlessness of glass in favor of more spatially evolved expressions. We focused on blown glass as the preferred operative technique, given its innate growth properties, bulbous figuration, and capacity to be radically modified, under the right circumstances.

In response, we developed a series of restraining nets made out of aircraft cables and crimp hardware that functioned like a didactic corset. Calibrated to distribute alternating territories of restraint and release around the full circumference of the glass, we discovered, over time, the proper clues by which to unleash a latent interiority within the internal logic of the material. (fig 7)

The first generation of Moon Jelly vessels was developed as a series of one-of-a-kind chandeliers for the restaurant *Choice: Kitchens & Bakery* in Brooklyn, New York. In combination with the custom modular-ceiling system we created for the same project, our interest in generative systems was realized within the flesh of both real and illusory skins. Seeking to create a fantastic cloud of exuberant effects above one's head, the luminous glass units accessorized the modular surface as biological extensions and, in turn, proposed an other-worldly sensibility to the space. (fig 8)

The Moon Jelly ceiling system also offered us an ideal opportunity to test the application of our research with mass-produced tiles. Focusing on a system utilizing only two tiles, we devised a surface that deployed multi-directional vortices with hyperbolic peaks and valleys. We blurred the hexagonal boundary to produce the illusory effect of endless varia-


fig 7


fig 8

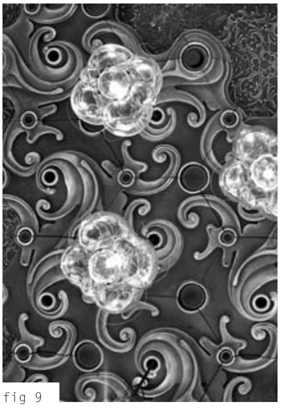
fig 9

tion by generating a series of “distraction” techniques across the surface that proved to be extremely effective. (fig 9)

Conclusion

The role of architecture has always been one of combining radical projection with a benevolent purpose. Beyond being a wonderfully creative, poetic, and exploratory endeavor, architecture has the capacity to go well beyond the single author and do great work within the public domain. Among the many ideas and potential lessons I have tried to convey in my manifesto and design research presentation today is my unwavering commitment to new forms of innovation, my call for a stronger reciprocity between virtual design and its manufactured avatar, and – given its ineffable value in architecture – the increased production of pleasure whenever possible.

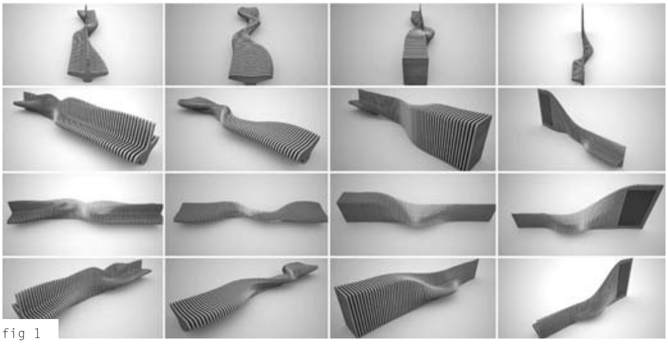

fig 1

fig 1
Bench Family
Urban Adapter, Hong Kong and
Shenzhen Biennale 2009

SERIAL MULTIPLICITIES

— ROCKER-LANGE ARCHITECTS

Do codes, as systematic sets of rules and regulations, inform all parts of life?

The use of the term code can be traced to the Latin term codex – documents carved onto wooden tablets by the Romans in order to distribute a set of regulations throughout the empire, and thereby enforcing behavior.[1] Michel Foucault's *The Order of Things* (1966) argues, in part, that all epochs possess underlying codes which, through discourse, actively constitute their *episteme* and circumscribe their respective potential expressions.[2]

Architecture and urbanism have always been constituted by codes. The Vitruvian system of orders and proportions provided an underlying code supporting architecture's conceptualization, production, and interpretation from the Renaissance into the late eighteenth century, when its regulations proved insensitive to growing social, political, and technological changes.[3] With the advent of industrialized mass-production, new codes became necessary for standardized production processes and material dimensions. In particular, both the Deutscher Werkbund (founded 1907) and, later, the Bauhaus (founded 1919) sought to integrate architecture and design with the coded logics of mass-production.

But it has only been with architecture's shift from mechanization to computation that architects have been able to expand the potential of the code. Developed during the Second World War by mathematicians and scientists carrying out computational experiments, code evolved into an abstract language designed for interpretation through authorship. Certainly, computer "code" is not the same as building code. Yet, through the increasing role of computation in defining and executing all sorts of building-related codes, one could suggest that we are seeing the increasing conflation of the two. At the very least, we can see an encoding of building codes through computer code.

The "source" and "machine" codes of computation are easily overlooked due to the widespread use of the computer in architectural design, wherein the visualization enabled by these codes is passively accepted by the user. Such an underestimation of computation's potential is heavily indebted to modern ideas of representation, which is based on the dualism between subject and object, subject and milieu.[4,5] Yet, code, when harnessed directly, is able to challenge traditional views of reality, subject-hood, and object-hood.[6]

The computer is a discrete, digital machine operating via continuous oscillations of 0/1, of absence/presence, where one part is what the other is not. This oscillation approximates a process that Gilles Deleuze has termed *different/citation*.[7] Citing Leibniz's differential calculus,

1 Colin H. Roberts and Theodore Cressy Skeat, *The Birth of the Codex* (New York: Oxford University Press, 1987), 18.

2 Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences* (New York: Vintage Books, 1994).

3 However, during the intervening four centuries, the system of orders and proportions being propagated by the tradition fostered a rich field for interpretation and innovation through its very code. Working with and within this code, architects have revealed unexpected potentials for architecture. For more on this shift, see Antoine Picon, "The Ghost of Architecture: The Project and Its Codification" *Perspecta* 35 (2004): 20-39.

4 This dualism, which traces its lineage to René Descartes' *cogito*, presupposes an entity as reducible to the sum of its parts. Only if an object is stable and space understood as its mere receptacle, may representation, or a coincidence between sign and signified, occur.

5 When computation is mined for its creation of surface effects or *virtual reality*, ideas of representation and a fixed reality have a guiding hand.

6 As Wolfram has demonstrated, code provides a mean for the reconception and reinvention of the given.

7 Gilles Deleuze, *Difference and Repetition*, trans. Paul Patton (New York City: Columbia University Press, 1994, originally published in French 1968).

fig 2
Conceptual diagrams
Urban Adapter, Hong Kong and
Shenzhen Biennale 2009

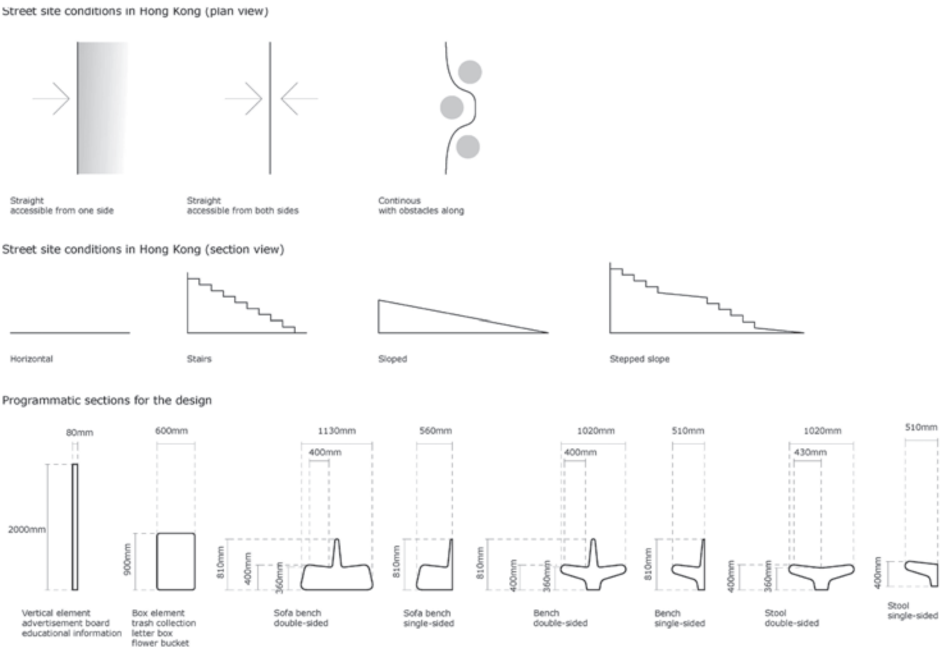

fig 2

the logics of which underlie most computational processes, Deleuze argues that any determination is always relational and, as such, is never truly determinable.[8,9] This results in a multiplicity, which relies on the reconceptualization of existence not as a fixed state of being, but as a state continuously constituted and reconstituted by its relationship to innumerable variables.

As the computer's processing constantly writes and rewrites, design becomes a constant process of becoming. Algorithms are essentially a representational use of code in the computer, wherein the result of the algorithm is essentially a type of image of what lies below it, unchallenged and uninvestigated: the machinic code. A concept, then, is no longer a transcendent model, which the design strives to reveal. Instead, design becomes a creative, form-finding act – an event linked with the design's literal in-formation. Any concept is, according to Deleuze, merely "self-referential, as it 'posits' itself and its object at the same time it is created."[10] Concept and design become and dissolve, rising and falling, and intrinsically connected as a single data-design. This process takes its cue from the aeronautic and automotive industries, where similar techniques are termed *versioning*.[11] Suggesting not only the convergence of projection and production, but also the altering of notions of professional expertise and authorship, versioning blurs the distinction between practice and theory, design and concept. Perhaps most drastically, computation, when pushed to its fullest by versioning, leaves behind the comprehension of architecture as a fixed being. As a result, the solid ground upon which architecture supposedly rests turns out to be devoid of stable references. Looking at architecture this way allows us to pose deep questions for the manufactured divisions between architecture and its milieu. The modernist ideal of modularity based on the *repetition of the same* is then replaced with the *repetition of difference*, whereby each iteration is just another becoming in the process of the versioning that

8
Ibid., 171.

9
This notion of *reciprocal determinability* reimagines multiplicity not as an aggregation of individual parts, but as an irreducible ontological condition.

10
Gilles Deleuze, *What is Philosophy?*, trans. Hugh Tomlinson and Graham Burchell (New York: Columbia University Press, 1996), 22.

11
See Ingeborg M. Rocker, "Versioning In-forming Architectures," *Versioning Evolutionary Techniques in Architecture, Architectural Design* 72 (Sep./Oct. 2002): 10 – 17.

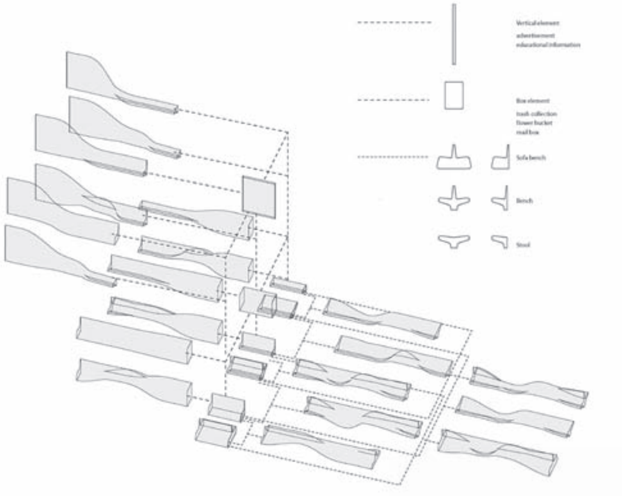

fig 3

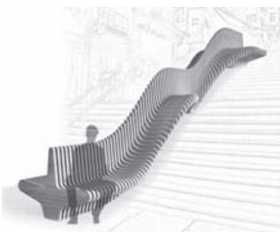

fig 4

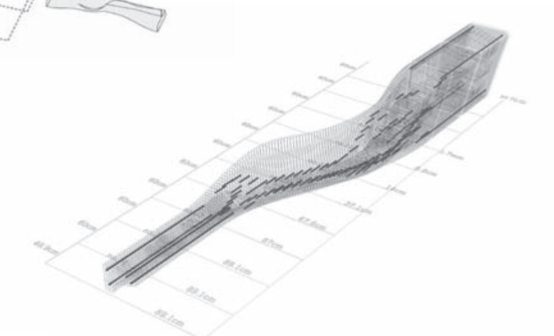

fig 5

fig 3
Bench Family
Urban Adapter, Hong Kong and Shenzhen Biennale 2009

fig 4
Public seating
Urban Adapter, Hong Kong and Shenzhen Biennale 2009

fig 5
Registrations of sections by metal cords
Urban Adapter, Hong Kong and Shenzhen Biennale 2009

is literally in-formed by preceding iterations and, in turn, in-forms the subsequent iterations. *Design versions*, therefore, are snapshots of an evolution in progress, wherein each iteration is identifiable only with respect to others of a series.

But, in algorithmic architecture, complex behavior is frequently exchanged for complex aesthetics. While incessant variations, complex folds, and the sweeping curves generated through parametric processes appear to address life's complexities, in fact, they merely produce a form-obsessed gesture towards them. Instead, the full potential of computation in architecture presents an opportunity for critical analysis and design synthesis. That is, rather than producing a normalizing restriction of architectural expression, or being a generator of its exuberance, code must be treated as a site for the re-coding of architecture's own codes.

Serial Systems: Hong Kong

The process of densification occurring in Hong Kong – building to an intense 6,300 people per square kilometer – has utilized industrial techniques to construct a hyper-coded and hyper-standardized urbanism. The density of sameness has transformed and differentiated the urban environment: the same principles motivating mass-produced urban products of industry cannot address a flexible public space. It is within this context of highly differentiated constraint and repetition that interventions of mass-differentiated systems are needed to adapt to different scales of the city and formulate a space for the public, from furniture to architecture to urbanism.

While Hong Kong is not short of recreational spaces with its adjacent country parks, the inner city ratio of building mass to open space has heavily decreased in recent decades, even as the number of shopping malls has increased drastically in the same period. However, shopping malls are privately owned and fall, therefore, under a different

fig 6
Close-up Tower Matrix 2
Serial Architecture - Systems of Multiplicities, Venice Biennale 2010

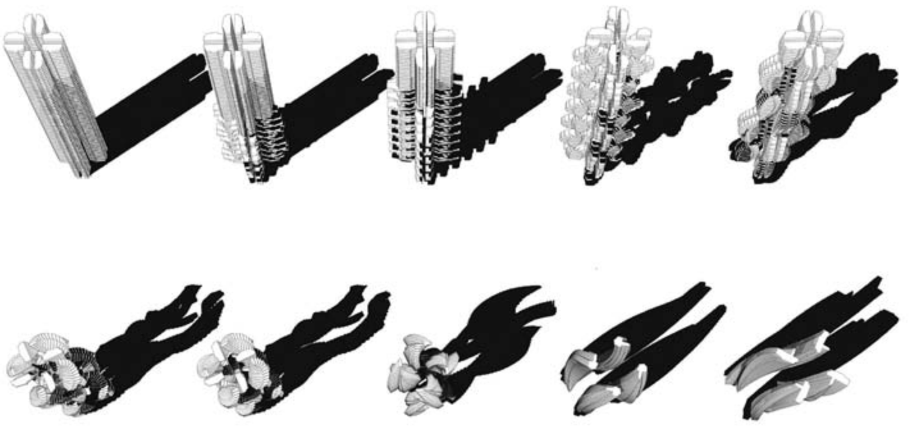

fig 6

jurisdiction than the public space of the street. It is perhaps not too far-fetched to suggest that the public domain in Hong Kong has been internalized over the last decade.

The interior of this cityscape is primarily packed inside the typology of the tower. Mainly mixed-use, the tower contains “public,” yet interiorized, streets linking vertically stacked shops, restaurants, and offices. Despite the diverse programmatic mix, the question of public space within the urban fabric of high-rise buildings has remained widely unaddressed. Only a few architects, like Rem Koolhaas, who analyzed Shibuya Station in Tokyo as a 24-hour vertical urban architecture, drew attention to this phenomenon in hyper-dense cities.

What can the relationship of public space to life be in rapidly growing Asian cities? How can architecture in Hong Kong, with its limited land resources and highly profit-driven urbanization concepts, reintroduce an open public space, in which society can develop culturally, politically, and socially? How can a system of multiple, truly public, exterior spaces continue to exist in an ever more compacted urban landscape?

Urban Adapter

Generic Hong Kong park benches provide, more or less, the same seating experience. They are single sided, most positioned with their back toward a fence, and are, to a certain extent, inflexible: they are applicable only to a single, specific site condition and provide limited user experiences and thus are a little unsuited to the challenges of Hong Kong’s hyper-dense public realm.

The Urban Adapter suggests multiple design solutions based on specific sites and program data, generating a family of bench furniture. Rather than a fixed form, members of the family would adapt to different site conditions and programmatic needs. While Hong Kong is not short of recreational spaces in its adjacent country parks, the inner-city

fig 7
Tower 2.1.4
Serial Architecture -
Systems of Multiplicities,
Venice Biennale 2010

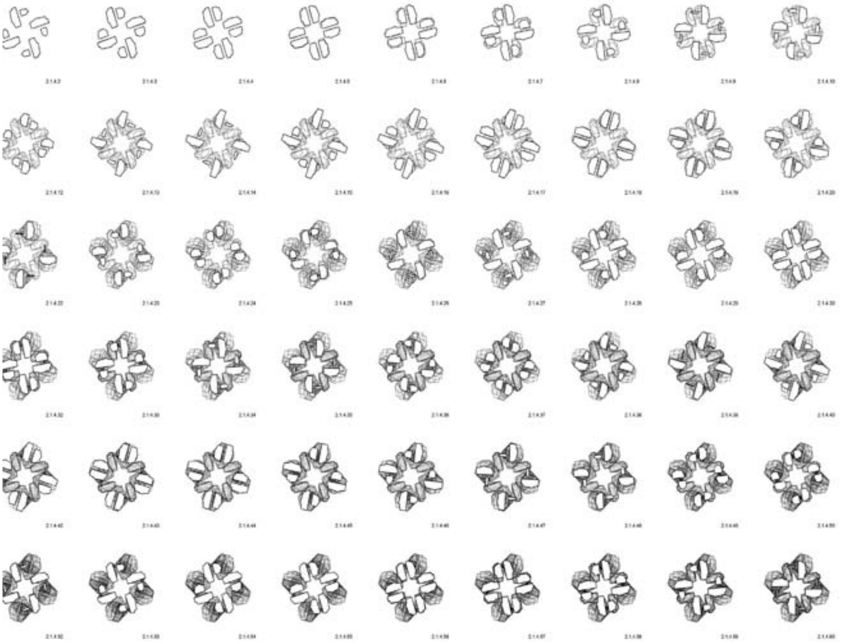

fig 7

ratio of building mass to open space has, in the last few decades, heavily decreased, while its number of shopping malls has increased. The Urban Adapter responds to the available exterior open space, which has been distorted in section and plan by the urban density.

Through the methodology of the section-cut assembly, this furniture is able to adapt to either sloping or stair configurations. As well, its seating adjusts, and even carries additional programmatic values such as garbage/recycling receptacle, flower buckets, and billboards for advertisements or educational purposes. The resulting functional surface invites users to undertake new seating and communication arrangements, perhaps even those that are unusual or rarely public. (figs 1-3)

Serial Architecture

The typical approach to the Hong Kong housing tower is to deploy a repetitive and reductive strategy of accessibility, lighting, egress, and utilities, with the goal of attaining maximum developer profit. The monotony of these developments is highly problematic, as the photography by Michael Wolf demonstrates.

A Serial Architecture interrogates the connection between the building type's form, as defined by the limits of its typological and urban source codes, and the introduction of social common spaces. Rather than an extruded form, models are developed that describe flexible spaces based on relationships between discrete elements. By constantly redefining and altering this model, we can author nearly infinite variations based on the input data.

Five matrixes, each of 25 towers, were generated while emphasizing different tower-families. All 125 towers have 60 floors; all towers are as much versions of one another as of the basis floor plan, which was developed in reference to the constraints of typical towers. While the principle of the highly space- and material-efficient plans was maintained, a semi-

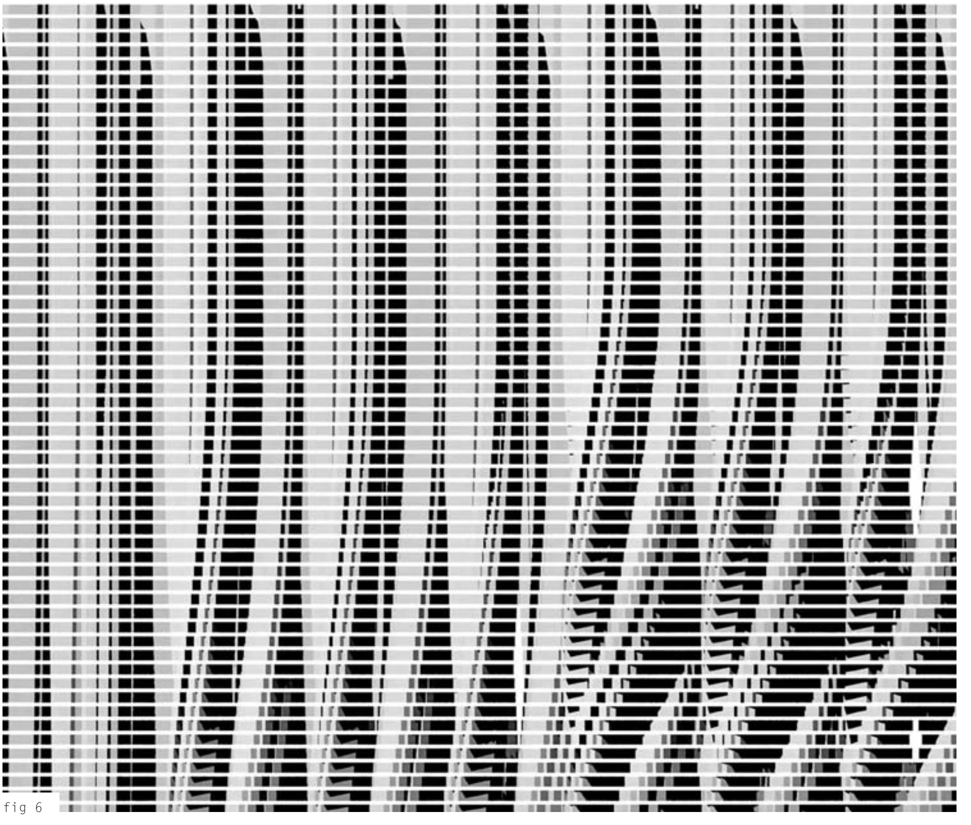

fig 6

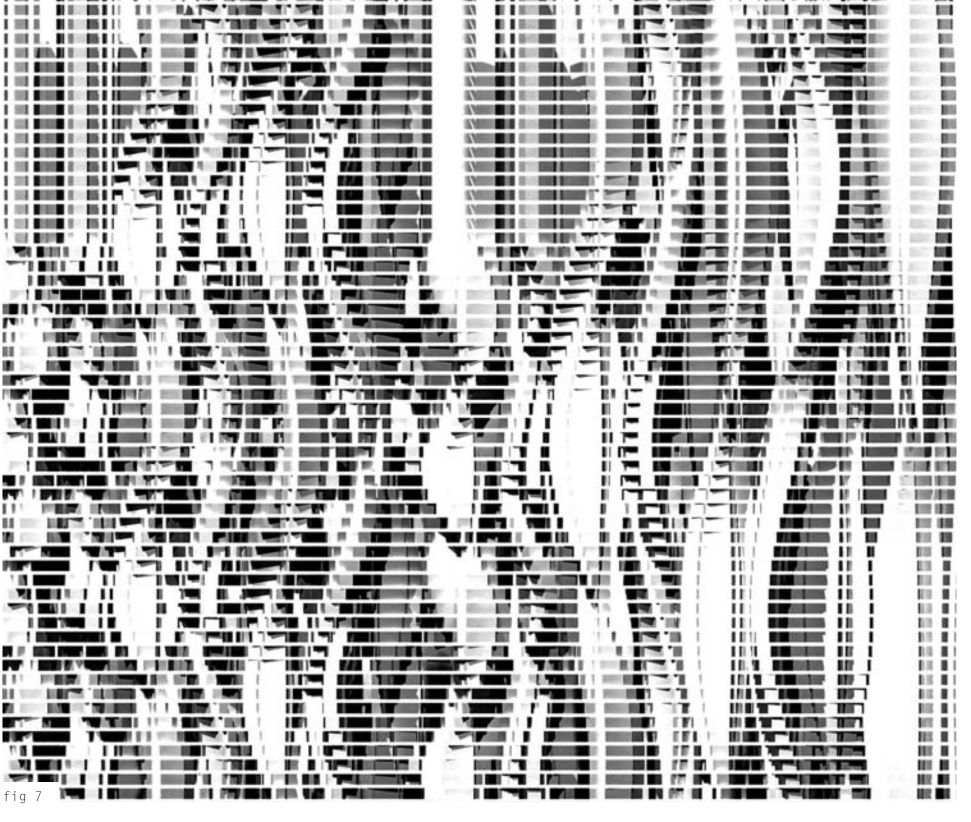

fig 7

fig 6
Elevation Matrix 1
Serial Architecture -
Systems of Multiplicities,
Venice Biennale 2010

fig 7
Elevation Matrix 2
Serial Architecture -
Systems of Multiplicities,
Venice Biennale 2010

fig 8
Tower Series B: envelope, circulation, open-air voids
Serial Architectural Urbanism -
Systems of Multiplicities,
Hong Kong and Shenzhen
Biennale 2012

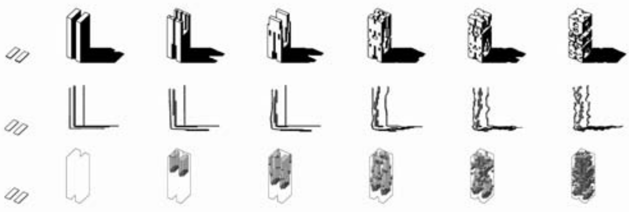

fig 8

public zone between elevator-core and apartments was introduced. As apartment sizes vary, so does the size of semi-public zones, which, depending on the size, can take on different public and social programs. (figs 4-7)

Serial Architectural Urbanism

The building envelope of the typical Hong Kong tower, usually expanding to the maximum boundary of the site, limits possible exterior public space. It could be argued that the gross floor area (GFA) for building plots is responsible for this dilemma. The common practice is to extrude the boundaries of the plot area to the very limit, in order to maximize the GFA. If these extrusions of coded limits are misused, the vitality of a dense city can suffer.

Instead of extruding the maximum boundary condition of the site, the model of Serial Architectural Urbanism incorporates a ratio of open space. At its core, there is a computational logic calculating the amount of open space relative to the interior space. When the GFA is interpreted through an alternative system of coding, different versions integrate public and open space into the building bulk. The resulting rule-based model can vary and adapt to different site and programmatic conditions. The spaces are distributed throughout the building bulk, with the consequence of creating a continuous, vertical organization connecting the public spaces. (fig 8)

Serial Synthesis

By interpreting Hong Kong's public space by way of computational processes, urban typologies and patterns of living – as structured by codes – are challenged. This interpretation has produced a project consisting of versioned series of alternatives to conventional towers, which critiques both the synthesis of urban codes within architecture and the coded algorithmic processes allowing for their critique. As such, our project further critiques the often grotesquely dysfunctional, uninhabitable, and continuously differentiating spaces of parametric architecture, which have often provided little more than rigorously generated forms. Thus, our project also stands as a critical commentary on the continuous-differentiation of an imagined continuity in architectural design, which has resulted in little more than an exhausting, and now exhausted, exuberance of form, and which seems to have finally found its end. Instead, we are compelled to suggest an alternative approach to parametric architecture, an approach that is grounded in the architectural discipline even as it revisits traditional architectural types.

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DIGITAL DESIGN BETWEEN ORGANIC AND COMPUTATIONAL TEMPTATIONS

— ANTOINE PICON

Attempts to theorize about digital design frequently refer to two themes that have had very little in common for many years. The first of these themes is the opportunity to use nature as a model, an opportunity fostered by the organic character, which the forms and processes serving as a basis for digital architecture seem to possess. Today, this theme is inseparable from the issue of calculation or, rather, calculability, considered a fundamental property of the physical world and a source of creative spontaneity.

Contrary to what many contemporary authors have written, this balance between the search for a certain organic quality and the computational dimension is not achieved easily. It raises some difficult questions about the general assumptions made in computer-aided design. Instead of being a decisive breakthrough, the current theoretical syncretism could mean a return to old, familiar ways of architectural thinking that it would be better to avoid. All is not necessarily new under the "digital sun." Its light casts many ancient shadows.

The Return Of Organicism

Organicism represents one of the oldest architectural "temptations." In her book on the subject, historian Caroline van Eyck identified the premises of organicism in the seminal work of Vitruvius and in the treaties of the Renaissance which required architecture to be based on the imitation of nature.[1] The organicist temptation goes far beyond the architectural field since it may be defined as the willingness to draw inspiration directly from nature by closely observing shapes, structures, and processes which nature creates before adapting them to the sphere of human activities and products. With this very general definition, organicism permeates a whole range of domains, from fine arts policy to economics and engineering. In many respects, economic and technological Darwinism appears to be a contemporary variation on this basic pattern.

The underlying goal of organicism lies in the desire to adopt some of the fundamental qualities of nature. Among these qualities, the key ones are the unity of plan and the efficiency of forms, structures, and natural processes, as well as their strength and profusion, which seem to have no equivalent in human creations. However, we can also list automatism, defined by Pierre Naville as one of the versions of the "general spontaneity that drives the universe," or else the ability to reconcile static and dynamic, structure and growth, which is actually the subject of D'Arcy Wentworth Thompson's book, *On Growth and Form*.[2] It should also be noted that potential variation is often based on quite simple premises,

1
Caroline Van Eck, *Organicism in Nineteenth Century Architecture. An Inquiry into its Theoretical and Philosophical Background*, Amsterdam, Architectura & Natura Press, 1994.

2
Pierre Naville, *Vers l'Automatisme social*, Paris, Gallimard, 1963, p. 228; D'arcy Thompson, *On Growth and Form*, Cambridge, Cambridge University Press, 1917.

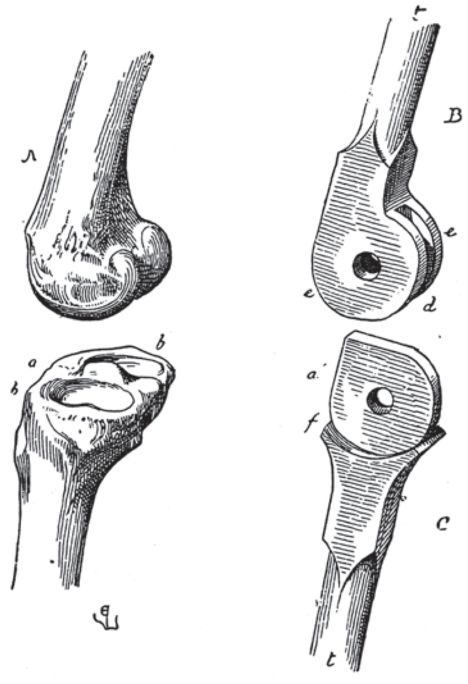


fig 1

fig 1
Viollet-le-Duc, “bone system applied to mechanics”, in “Histoire d’un Dessinateur”

whose potential is often referred to by the current proponents of “parametric” and non-standard design. The list of lessons learned from imitating nature is likely to continue to lengthen indefinitely.

Such lessons do not only apply to architecture, as mentioned above. Political and social organicism was present throughout the nineteenth century, as a break from the atomistic approach to political and social problems which had characterized the Enlightenment. Instead of conceiving society along the lines of a pact adopted for utilitarian reasons among individuals who were theoretically equal – Rousseau’s famous social contract – many thinkers of the industrial era, such as the members of the Saint-Simonian movement, interpreted it as a great body imparted with a life of its own, irreducible to the combinations of particular interests.[3] Given their desire to base sociology on biology, some of these thinkers chose to focus on race as an explanatory factor. The racism and eugenics of the totalitarian regimes of the twentieth century were rooted in that unfortunate choice.

Even though it followed its own path, the organicism movement that was part of nineteenth-century architectural theory should also be seen in a broader context. The emphasis on racial considerations by some of these key proponents, such as Eugène Emmanuel Viollet-le-Duc, is quite striking. Here again, the organicism “temptation” was combined with a biological determinism that presented dangerous implications.

Architectural organicism rarely proposes, at least in theory, to directly imitate the forms in nature. Instead, it goes back to principles that make these forms possible. Passive imitation must give way to an active understanding of these principles. This was the goal of Viollet-le-Duc when he studied the mechanism that was fundamental to the formation of the Alps.[4] That said, organicist projects rarely keep their promises. Despite his intellectual rigour, Viollet-le-Duc himself sometimes yields to the temptation of imitating the forms of nature rather than emulating the

3
Confer Antoine Picon, *Les Saint-Simoniens: Raison, imaginaire et utopie*, Paris, Berlin, 2002.

4
Pierre Frey (ed.), *E. Viollet-le-Duc et le massif du Mont-Blanc 1868-1879*, Lausanne, Payot, 1988.

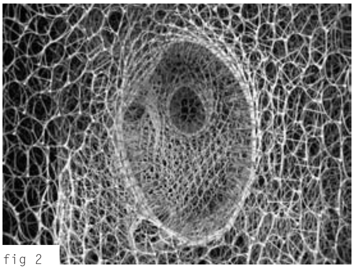


fig 2

fig 2
Jenny E. Sabin + Jones LabStudio, “Branching Morphogenesis,” 2008.

principles governing them. The foliage decoration on his lectern at Notre-Dame de Paris attests to this dichotomy, while at the same time demonstrating a special expressive force announcing the search for Art Nouveau.[5]

Contemporary digital architecture often seems to face the same type of dilemma. Containing an organicist component, it claims notions that are strongly influenced by the study of natural phenomena such as “emergence.” This inspiration is very obvious in Michael Weinstock’s book on this concept, which purports to refer to one of the most fundamental principles at work in nature.[6] At the same time, digital design is generally satisfied with mobilizing this design framework which justifies a vocabulary of forms inspired more directly by nature. Of course, flows and gradients have replaced nineteenth-century foliage. The smooth forms prevalent in many projects today do not reflect a less imitative approach. They often resemble marine organizations, including fish and cetaceans whose general lines are in unison with the liquid universe in which they live. In fact, today’s computer-generated architecture presents a distinctive liquid quality. The absence of articulations as clearly marked as those characterizing modern tectonics must definitely have an impact. Logic of continuous deformation seems to have replaced the assembly of parts, ceilings and floors, columns and beams. As Georges Legendre remarked, in digital design, parametric relations are replacing traditional architectural elements.[7]

The decline of the notions of parts and articulations obviously has something to do with the properties of computer-aided design programs. Another contributing factor is the ideal of continuous transition between an object and its opposite, of which digital architecture pioneers like Greg Lynn quickly became the proponents.[8]

Organicism does not necessarily refer to this type of approach, which leads to emphasizing plan unity, as well as an integrated and continuous

5
Cf. Martin Bressani, *Science, histoire et archéologie. Sources et généalogie de la pensée organiciste de Viollet-le-Duc*, history thesis defence at Université de Paris IV Sorbonne, 1997.

6
Michael Weinstock, *The Architecture of Emergence. The Evolution of Form in Nature and Civilisation*, Chichester, John Wiley & Sons, 2010.

7
Georges Legendre, *IJP: The Book of Surfaces*, London, Architectural Association, 2003.

8
Greg Lynn, “Architectural Curvilinearity: The Folded, the Pliant and the Supple,” in Greg Lynn (ed.), “Folding in Architecture”, *Architectural Design*, 1993, new edition, London, Wiley-Academy, 2004, pp. 2431.

fig 3

vision of living organisms and built forms that claim its principles. If such an approach has a neo-Aristotelian character, it is worth noting that the Stoics of Antiquity had developed a profoundly different interpretation of the living organism as assemblies of parties. Contemporary organicism is far from exhausting the potential for experiencing the diversity of nature.

A Paradoxal Reconciliation

Organicism, on the other hand, proposes a novel reconciliation between two directions that were long considered mutually exclusive of one another: the affirmation of the uniqueness of organic life and computational reductionism. Traditionally, the affirmation of the uniqueness of living organisms went hand in hand with the rejection of the application of mechanical models and, more generally of mathematics, to the understanding of life. During the eighteenth century, the vitalist school of thought, of which the Montpellier Faculty of Medicine was one of the bastions, refuted the mechanistic interpretation of Descartes and his followers. In many ways, nineteenth-century organicism inherited vitalism, even beyond the world of architecture. Some of its representatives oppose the application of quantitative methods to society because of its organic basis. This is the position of Auguste Comte, who believed that sociology must be founded on biology.[9] Political thought of the Enlightenment had made the opposite choice by assuming that you could calculate social phenomena by integrating individual behaviors. This led to the laying of the foundations of what would become economic theory.

Returning to architecture, the main representatives of organicism in the nineteenth century were relatively indifferent to calculability dimension, as if it was powerless to identify the heart of the design process. Viollet-le-Duc provides a striking example of this indifference. It is also revealing that the famous demonstration of the advantages of the use of

9
See for example, Jean-François Braunstein, *La Philosophie de la médecine d'Auguste Comte. Vaches carnivores, Vierge Mère et morts vivants*, Paris, PUF, 2009.

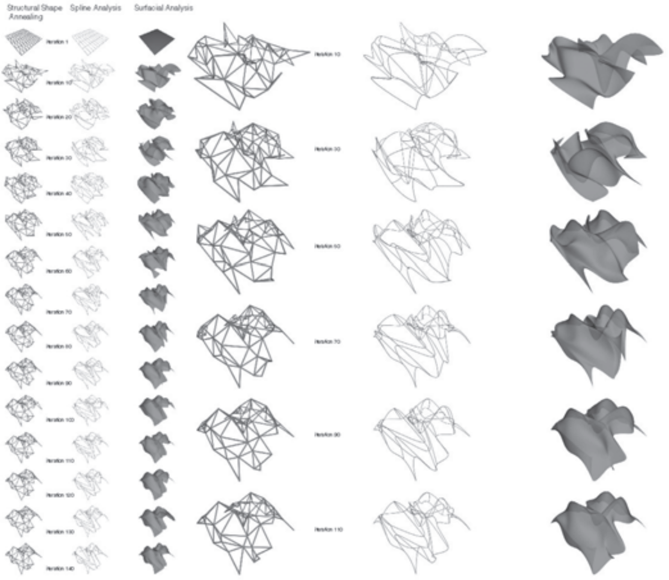


fig 4

fig 3
Open Source Architecture, The Hylomorphic Project, MAK Center, Los Angeles, 2006 (Photo credits: Joshua White)

fig 4
Open Source Architecture, The Hylomorphic Project: Structural Shape Annealing process on 140 iterations, MAK Center, Los Angeles, 2006 (courtesy: O-S-A)

cast iron in construction that he gives in *Les Entretiens sur l'architecture* stumbles by making a fairly basic mechanical error.

The situation prevailing today in the architectural field is quite different. The affirmation of the crucial importance of organic life is accompanied by the ambition to model it by means of calculations. Going a step further, designers like Karl Chu even tend to compare life to an algorithm. From this perspective, Chu even proposes a radical paradigm shift: instead of designing architecture similar to an artifact, why not consider it as a life-form in its own right as it is likely to use the same algorithms as living beings? Pushing computational ontology further, Chu states that the entire universe is only a vast calculation. Despite its radicalism, such an opinion is more widespread than it might appear among digital architecture supporters. The universe is a vast calculation using elementary particles and atoms as numbers or bits of information: how can one forget the famous passage which opens *L'Essai sur les Probabilités* (Essay on Probabilities) by Pierre-Simon Laplace, a veritable charter of modern determinism?

We ought then to regard the present state of the universe as the effect of its anterior state and as the cause of the one which is to follow. Given for one instant an intelligence which could comprehend all the forces by which nature is animated and the respective situation of the beings who compose it – an intelligence sufficiently vast to submit these data to analysis – it would embrace in the same formula the movements of the greatest bodies of the universe and those of the lightest atom; for it nothing would be uncertain and the future, as the past, would be present to its eyes.[10]

Since at least Laplace, determinism has been bound up with the issue of chance and probability. It is no coincidence that the random fascinates contemporary designers who mobilize creative resources

10
Pierre Simon, Laplace, *Essai philosophique sur les probabilités*, Paris: Veuve Courcier, 1814, p. 2, English translation by F. W. Truscott and F. L. Emory, New York, Dover, 1953.

through configurations such as Voronoi diagrams. But more than this alliance between determinism and randomness, it is the meeting or fusion of organicism and the computational perspective that deserves all of our attention.

It is easy to trace the source of this intensely closed meeting. It appears in fact as a consequence of the application of the concepts of information and code to life, an application that goes back to the seminal discovery of DNA by Francis Crick and James D. Watson in 1953. The power of algorithms to literally grow forms and structures supports computational reductionism. From evolutionary phenomena modeled using cellular automata to plant growth mechanisms that formal grammars derived from L-System by Aristid Lindenmayer simulate, we will endlessly continue to identify multiple points of contact between computer calculations and life. Like Christa Sommerer and Laurent Mignonneau, many artists have mobilized these resources in their work. With regard to architects, from Karl Chu to Neri Oxman or Jenny E. Sabin, there are many who are exploring leads that suggest a possible convergence between biology and algorithmics. "Gen(H)ome,"the title of an exhibition organized in 2006–2007 in Los Angeles by Chandler Ahrens, Eran Neuman, and Aaron Sprecher, provided a great summary of the underlying goals of these initiatives.[11]

The Limitations Of Organicism

Should we subscribe wholeheartedly to this perspective, however? This is debatable from a general stand point and risky when it is more specifically related to architecture. We now want to carry out a critique of contemporary organicist theory in its meeting with the issue of calculability. Without denying the heuristic fertility of such an approach, it seems necessary to keep in mind its limitations and risks.

In general, the convergence between biology and calculability appears as the result of a very particular context, that of the Cold War and science that hears the call of the cybernetic sirens and prospects for the control of human beings to which it leads. As demonstrated by Lily Kay, the interpretation of DNA in terms of information and codes must be placed within this framework.[12] At the same time, we should ask if contemporary reductionism does not remain an involuntary prisoner of a design of the living organism prepared in relation to the control concerns of the military–industrial complex for the years 1950–1960. The renewed fascination of the cybernetic project today makes it particularly necessary to conduct such a review.

While the concepts of information and code have led to highly successful applications in the field of genetic manipulation, other interpretations of the living organism are possible. We know now that, far from being reduced to a Turing machine tape, DNA involves extremely complex phenomena, some of which may well fall within the study of dynamic systems. Of course, none of it can reverse the assumption that life is nothing but a vast calculation. However, this calculation can be complicated and especially unpredictable to the extent that it may challenge the reductionist approach to life.

With regard to the field of architecture in particular, other arguments can be made in favor of the importance of distancing oneself from the ambient computational environment of organicism. The first is the blindness effect that it causes regarding the relationship between architecture and mathematics.[13] It is indeed striking to note to what extent algorithmic biologism, which currently dominates, tends to replace a reflection of a more epistemological nature on computation tools that are mobilized in this way, as if the architects who engage in it are directly manipulating the surrounding reality instead of partly creating this reality through the transactions in which they engage. One should examine the strange coexistence of continuous representations of nature with fundamentally discontinuous digital tools. Until now, the contrast between the continuous representations, with similarities to the intuitions of philosopher Gilles

11
Open Source Architecture (ed.), *The Gen(H)ome Project*, Los Angeles, MAK Center for Art and Architecture, 2006.

12
Lily Kay, *Who Wrote the Book of Life: A History of the Genetic Code*, Stanford, Stanford University Press, 2000.

13
We covered this theme previously in Antoine Picon, "Architecture and Mathematics: Between Hubris and Restraint," in *Architectural Design*, "Mathematics of Space," editor George L. Legendre, vol. 81, n°4, July-Aug. 2011, pp. 28-35.

Deleuze, and discretization procedures that accompany the transition to digital has only been paid attention in a distracted manner.

The major problem is still the impression of having a grip on reality, whether it is nature in the phenomenological sense or the substrate which enables its emergence. Because it manipulates powerful tools which seem to be able to recreate life or at least its appearance in the manner of Mary Shelley's Frankenstein, computational organicism is often accompanied by a naive realism that should be avoided by recognizing that one never has a good grip on reality, but rather grip on a mixture of physical reality and manipulations where there is always an element of symbolism.

The symbolic dimension is precisely one of the main aspects that is missing from the attempts to theorize about digital architecture. This absence is even called for by some designers as a necessary break from the mistakes of postmodernism.[14] Here again, the goal seems to adhere to the real laws of the physical world and of the production of affects, instead of venturing into the labyrinth of semiotics and perhaps illusions that divert architecture from what it must actually accomplish. But doesn't the illusion consist instead of imagining that one can get rid of symbolism? Wouldn't it be better to accept the contamination of the real by the symbolic? That seems to us to be one of the most urgent issues of the return to the ornament in the digital field of architecture.[15] Often presented from the production angle, contemporary ornamentation has a symbolic dimension that is important to recognize and theorize about.[16] The risk would otherwise fall into the worst form of symbolism, that which is hidden with unconscious associations of signs and ideas on which it rests.[17]

Returning to organicism, the goal here is not to condemn the search for sources of inspiration in nature, much less to reject the associations made between the living and the calculable. It just seems useful to maintain a tension between the two, constantly recreating a difference, even arbitrary, instead of accepting a fusion. This is in some ways the opposite position to that advocated by Bruno Latour in *Nous n'avons jamais été modernes* (We have never been modern) that we definitely want to defend.[18] Instead of insisting like Latour that nature and artifice have always been linked, it would be more interesting to establish a difference, as the moderns would do perhaps. Architecture is nourished by this difference. It simultaneously accepts its natural origins and an unbridgeable gap with nature. This was already the meaning of the fable of Father Laugier's primitive hut, the result of man's needs and natural instincts and the founding act that radically separated the beginnings of civilization and the state of nature by introducing the sphere of shared meaning. In a sense, contemporary organicism should not emphasize the question of nature and its identity through calculations, but rather ask how we can sustain the reign of humans in their continuum.

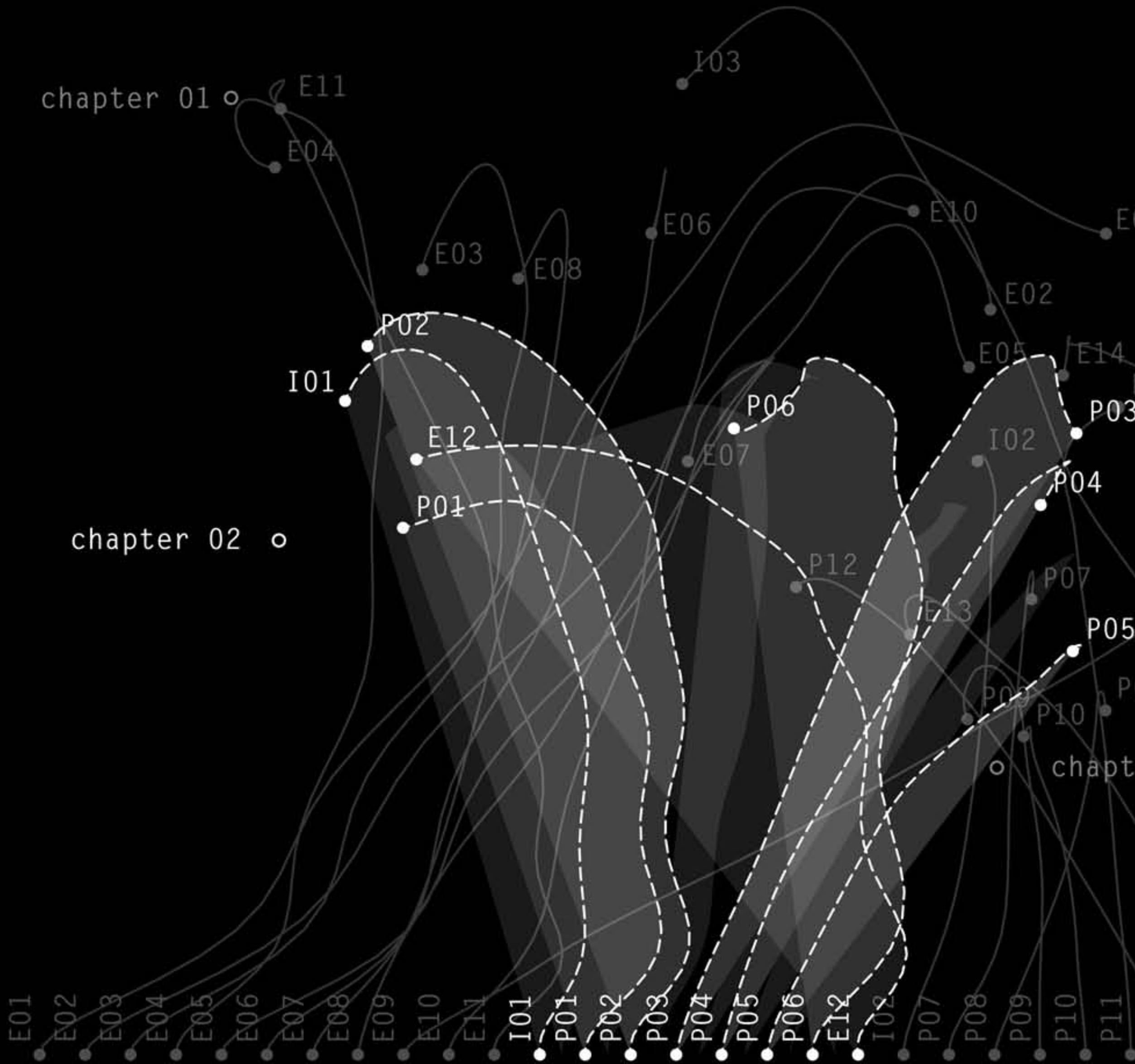
14
See for example Jesse Reiser, Nakano Umemoto, *Atlas of Novel Tectonics*, New York, Princeton Architectural Press, 2006.

15
It is one of the themes of our next book, *Ornament: The Politics of Architecture*, to be published in 2012 by Wiley.

16
Farshid Moussavi, Michael Kubo, *The Function of Ornament*, Barcelona, Actar, 2006.

17
Robert Levit, "Contemporary Ornament: The Return of the Symbolic Repressed," in *Harvard Design Magazine*, No. 28, spring-summer 2008, pp. 70-85

18
Bruno Latour, Nous *n'avons jamais été modernes. Essai d'anthropologie symétrique*, Paris, La Découverte, 1997.



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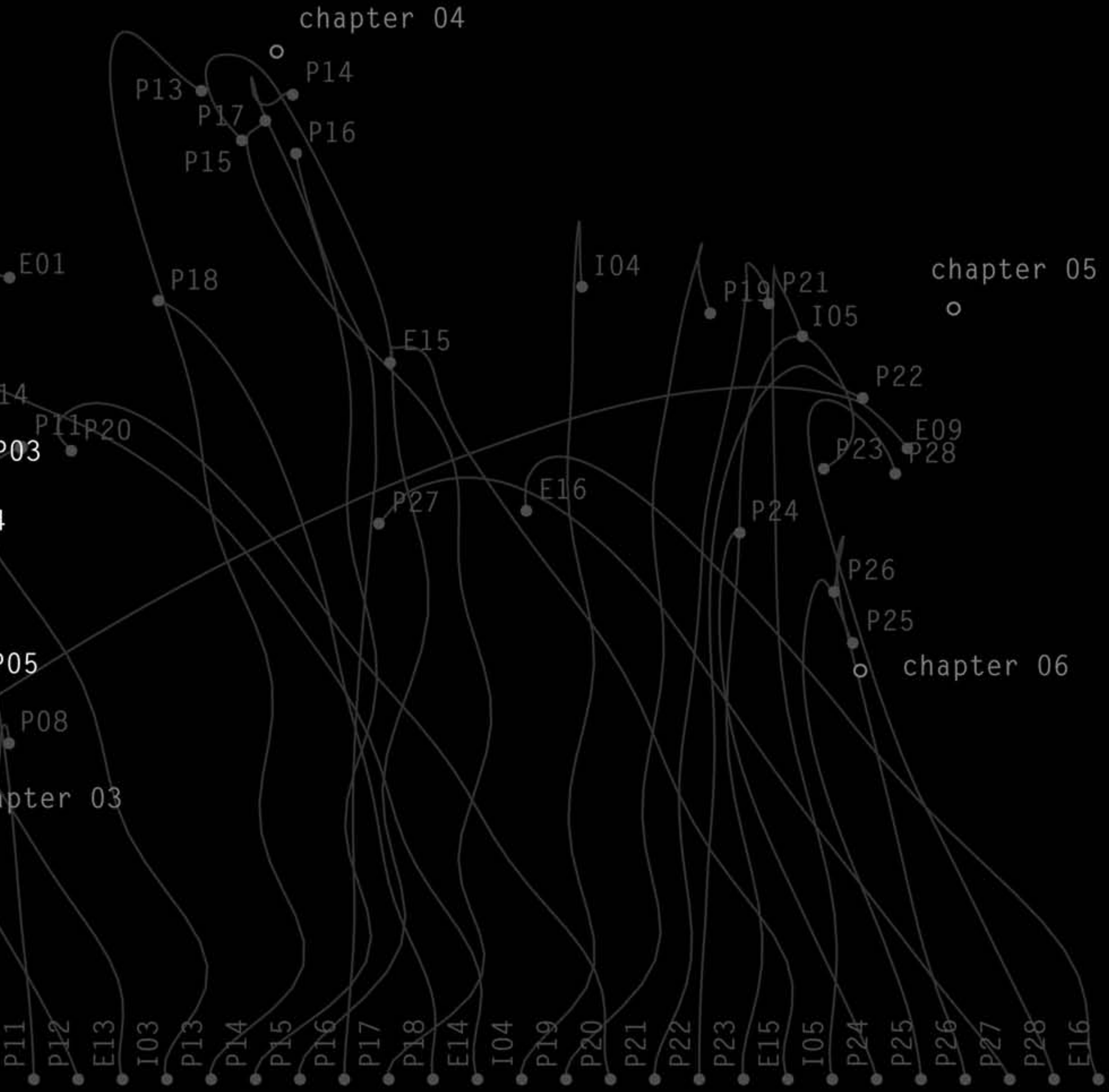
02

INFORMATION INTERFACES:

— DATA AND INFORMATION



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INTERVIEW: GEORGE L. LEGENDRE

— WITH PABLO LORENZO-EIROA AND AARON SPRECHER

01 *In trying to define a difference between data and information relative to architecture, we would like to ask you: How do you understand formal logic, once form is constituted? For instance, how do you understand the relationship between the constitution of form by external information and the qualities that form acquires once it is constituted, once it produces content that acquires a certain autonomy?*

Before starting, in your latest book "Pasta by Design," you referred to the search for geometric variables. You mentioned that there is thermodynamics involved in the formulation of pasta. Is there a separation between an organizational level that may be separated from its visual form and an organizational principle that may go beyond what you can actually perceive?

GEORGE L. LEGENDRE

Very early on we decided to analyze the multiple morphologies of pasta from a mathematical point of view. We considered complex mathematics, as well as other aspects of pasta culture, such as its material nature and the behavior attached to its making and consumption. As such, we considered the parametric nature of pasta morphology, as well as the mathematics of the non-representational, thermodynamic process of making and consuming it. I was, therefore, interested in the sensible mathematics of pasta – as well as the correlative operations of mixing, kneading, forming, drying, and packing, among many others.

During that phase I read a series of papers on food science, and more specifically on the enzyme-related processes involved in the production process. It soon became clear that it would be difficult to turn this into a critical project, because you cannot have a non-specialized argument about the impact synthesizing enzymes have on the quality of pasta, for instance. What is more, I also realized that there was no perceivable connection between the form of the extrusion dice and the resulting form of the pasta... In other words, if you look at something as simple as fusilli, a sort of corkscrew-shaped tube, it's actually coming out of a slit; which just does not seem physically possible. This apparent paradox is down to our thinking in terms of geometric description, whereas the process is, in fact, essentially thermodynamic. As such, the resulting form is determined by both the variable section of the bronze dye, differential pressure levels on either side of the extrusion dye, and the amount of dough channeled through.

02 *I would frame it in relationship to the question that the form is very difficult to describe, to index either the outcome or the process that generates it. So, maybe we can frame that in relationship to the difference of how you define your work, the relationship between that and information, and then maybe we can gear it a little bit more to certain architectural projects that maybe touches upon that problem.*

GEORGE L. LEGENDRE

If you go beyond the issues of formal making, i.e. making and representing pasta, what interests me is the problem of formal classification, and following, the unexpected revival of the illustration-based 'architectural treatise'. Let me explain: books such as Farshid Moussavi's *The Function of Ornament* and the *Function of Style* are, in my opinion at least, neo-treatises, in that they synthesize

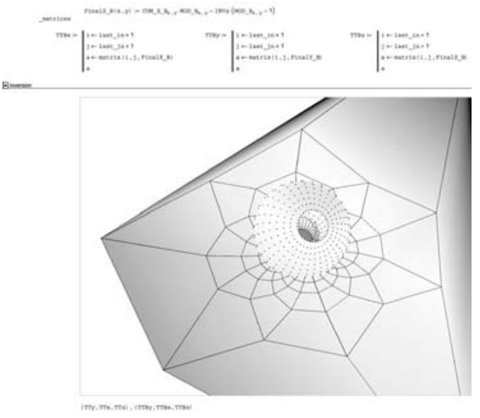


fig 1

architecture by normalizing building types across periods and construction modes by exclusively graphic means.

03 *Would you consider a revival of the notion of typology within these new publications? I find this question important in the light of your work. Both in your lectures and publications, you often juxtapose the form and its mathematical equation as if the form could not exist without its non-representational expression.*

GEORGE L. LEGENDRE

Yes, indeed. Looking back at my first book, *IJP The Book of Surfaces*, the image and the symbol are equally important to me, because they are complementary, and more specifically, because they are alternate facets of the same thing. As such, the code and the surface, or the formula and the form, are inseparable. Regarding the notion of typology, our understanding of it today is different than it was 30 years ago, because it does not impact the development of the project per se. My latest book *Pasta by Design* represents in that sense my own typological treatise. Yet, by dealing with food, instead of architecture (unlike Farshid Moussavi's *The Function of Form*), *Pasta by Design* operates within a given formalism that protects itself from any unwanted material and historical implications.

04 *You often refer to the fact that data matters. How would you qualify its relative value? Or, in other words, how do you make a decision on the formal result? What is the relationship between infinitesimal calculation relative to topology and the absolute value of a type? It seems that they are opposed to each other. In a type, for instance, you can classify certain categories built by conventions. Infinitesimal calculation is exactly the opposite: There is never a sense of predetermination and reference.*

GEORGE L. LEGENDRE

Data matters. Data here is understood as an abstract blueprint that I sometimes refer to as a machine language, or the low level of a computing machine. It is the idea that design syntax, or any kind of structured design thinking, is based on its own premises and produces a consistent set of working parameters, that do not necessarily match the experience or the world at large. This is what I call "imaginary variables"©. In IJP's work, for instance, the syntax, the computing aspect, and the mathematical formulation – all service the imaginary part of architectural design. Data is part of the imaginary variables and, therefore, it matters because architectural design requires equal emphasis on the intractable aspects of the imaginary, on the one hand, and the empirical knowledge, or "real variables"©, on the other (real and imaginary variables are clearly synthesized in our knowledge of, for instance, the skyscraper type). There is, ultimately, a convergence between these two modes. Hence data matters. If not, you would work with real variables, which is not possible. As such, I explore the nature of imaginary variables (which

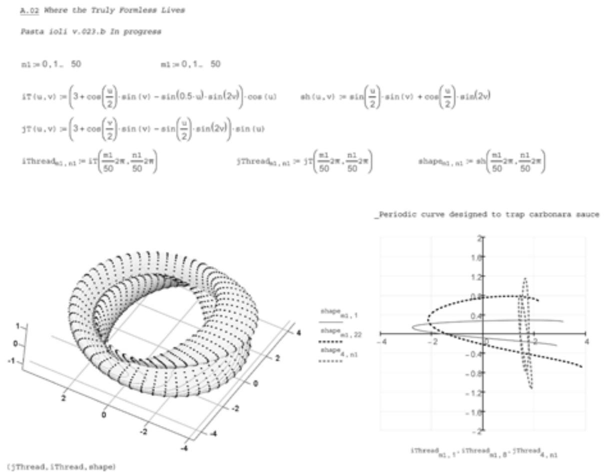


fig 2

means, in practice, exploring the dedicated knowledge of periodic equations, the value of discontinuity, and the difficulty of defining orthogonal functions when working within the paradigm of continuity.

05 *If I understand correctly, on the one hand, you have the real variable, that contains the empirical information, and on the other hand, an information that is foremost sensitive. So, in the context of a mathematical platform, how do you produce the form? Is the form extracted from a sensible idea, or are mathematics used as an ultimate, interpretative process?*

GEORGE L. LEGENDRE

Our practice concerns the new nature of typologies, which is not based on precedent: The new types are neither figurative, nor conspicuous. They are invisible, and irreducible to a set of variations or permutations. There are no permutations here, and nothing to look at. One can neither divide the form into pieces, nor describe the form as being made of top, bottom, and middle, for instance. What you can do is rationalize it by reflecting upon internal relationships. As I stated in my first book, rather than reducing the design process to fragments and analyzing them individually, I explore concurrent relationships expressed within the narrow premises of periodic analytic geometry – which is the engine of our typological investigations. This means that we have a lot more equations than we can use, because the process is not in any way optimized. We produce a lot, simply through (futile) attempts to test consistent instrumental assumptions. Therefore, we produce hundreds of ‘types’ we develop and ultimately return to, when starting a project. Designing in this manner is a very straightforward process. For instance, our proposal for the MOCAPE Shenzhen museum combines a series of clear spans with the density one would expect of a busy plan, which includes properly sized galleries as well as administrative offices. In this particular case, we effectively looked into the study of the so-called Implicit Field©, a mathematical process whereby continuous functions are aggregated on top of each other, until the discontinuities between them become, in and of themselves, operative.

06 *And that is what you qualify as the layering of information, according to which, instead of putting parts together, you actually calculate different types that merge with each other, producing something that is not possible to pre-calculate.*

GEORGE L. LEGENDRE

Exactly. There are no parts, because you operate within the premise of continuity. I am a devotee of the post-1995 paradigm of “parametric variation,” which means effectively continuous deformations, continuous instances of the same sort of process.

07 *How do you understand the differences between surface-based parametric models and current, parametric models that are indifferent to formal attributes? What are you describing concerning how continuity relates to the language of the surface? How would you define the difference between surface variations that were explored since the 1990s, to those of today, where parametric logic took over different organizational levels? How do you understand the difference between*

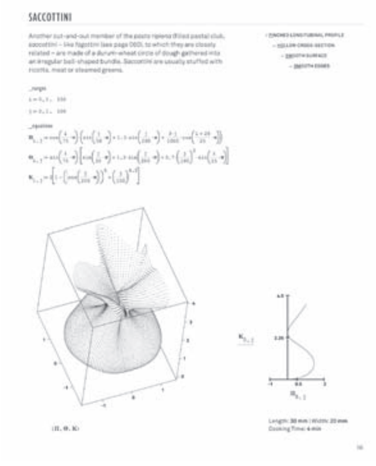

SACCOTTINI

fig 3

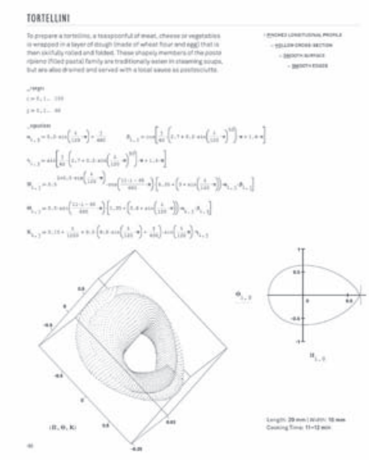

TORTELLINI

fig 4

working with parametric surfaces and working with parametric spatial relationships using elements?

GEORGE L. LEGENDRE

I am always working with surfaces. I do not worry about the term "parametric," which is, in a way, so fraught. We have attended conferences where we spend the whole time arguing over what "parametric" means. My understanding is essential and simple, because I draw it from mathematics. From my point of view, 'parametricism' is the study of the relation to variation. It is a kind of paradigm of the multi-varied. This is the reason, for instance, a graph is not parametric in any conceivable sense, nor is a topographical landscape understood in a geographical sense (in this last case there can be no undercut or holes unless you violate an essential mathematical premise). The parametric model of variation does not premiate any term in relation to the other. In this sense, I would not consider our project for PS1 as parametric per se, because it was not thought of in those terms.

08 *Regarding your competition entry for PS1, this project marks a shift in your production. Here, you embrace the idea of the architectural object as an icon. This is a very different approach than your earlier projects that called for a particular expertise. I am, therefore, wondering if you take into consideration the way the project is communicated to the viewer, to the user of those projects.*

GEORGE L. LEGENDRE

I absolutely agree with you. At first, we placed more of an emphasis on data and information, in the sense that we really tried to communicate the consistency of the process in the most academic way. For an architect there are two possible dialogues: The first occurs within our community of peers; the second is directed toward the world at large. In my early lectures, such as the one I delivered in September 2004 at Princeton, the discourse was almost entirely concerned with *IJP The Book of Surfaces* and the construction of my bridge in Singapore. I fancied that had discovered a nearly structuralist correlation between mathematical principles on the one hand, and physical construction on the other. This argument revealed the ubiquity of the underlying data model, theoretically and practically.

With our "Ghost House" project for PS1, there is indeed a shift. But this shift is not so much the red herring or the red banner, which I knew would annoy New York-based architects below the age of 25 (it did). The irony is that the mathematics of the ghost house are far more complex than the static analytic mathematics of the Henderson Waves bridge, for instance. The structural system of Ghost House is inherently unstable and calls for an empirical kind of material science of great complexity. I remain convinced this project is buildable; for all its mundane aspect, it was a seriously radical project in a material sense. The project worked against the grain of the chosen material, polypropylene rope, whose funicular nature did not lend itself to producing clean, straight lines.

09 *One of the questions that I always have with people that work with data is finding the relationship between how you work with certain pieces of information, and how that translates into form – if it is through a linear*

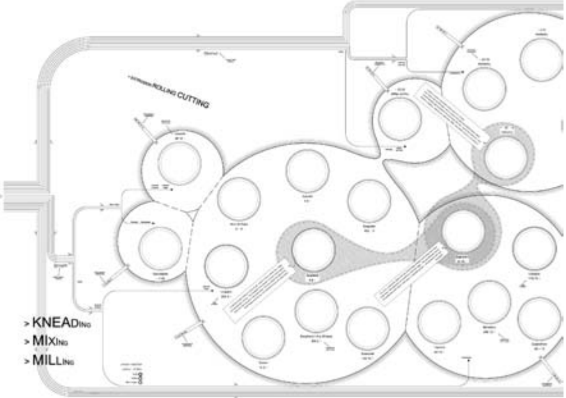


fig 5

process or not. If there is, as a result, an emerging iconic formal value, it means that there is not a linear translation between the information and form.

For instance, in the relationship between the logic of a set of data that you may be working with, which may have a specific value, and its translated formal result, they may share a relationship that may be resisting the logic of the material once it is actualized in material, thereby implying a nonlinear relationship between the instances and its actualization into physical form.

In this regard, I wonder: What is your position or critique of information mapping or data visualization, where the relationship between data and form is linear. It would seem that the designer is absent from the decisions taken, and that the formal result is unmotivated, as it constitutes a relational datascape without any qualitative intrinsic value. At the same time, there are people that manipulate the way these diagrams are formed, like politicians, for instance, who actually aim for a certain, specific drawing that they want to get, and they manipulate any information indexed in the graphics just to achieve it, in order to manipulate public opinion through the form of the graphics, and acknowledging the intrinsic power of formal relationships.

While architects feel they have to map data accurately, media is actually interested in how they can manipulate the form, indexed through data, to motivate a shift in the perception of a pattern they are tracking and indexing in the graphics. I think it is interesting, regarding the inversion of roles, that architects simply index data and data experts design the form of that data. Relative to what you are saying, in terms of the iconic form or the language that may emerge, there might not be a linear relationship between the underlying source code and the formal product, since once form is constituted, it actually acquires an independent visual appreciation, a formal logic that becomes independent from the set of parameters and information that constituted it....

GEORGE L. LEGENDRE

I agree with this approach. Today architects are so content-driven that their understanding of parametric modeling is often just a large-scale manipulation of data. Architects are as political as politicians, who only care about buttressing their own argument through some kind of evidence. Both strategies have something in common: an all-consuming obsession with data understood as content. Back in 2010, the theme of the ACADIA conference in New York gave me an amazing opportunity to revisit the questions of datascaping. I never expected the formalization of data to look like data itself – or even as a substitute for content. I remember sitting in student reviews, and looking at extruded grids that amalgamated the usefulness of rationalizing abstract data with pointless extrusions of 3D surfaces into some sort of architectural landscape. There was a moment when the data model turned into landscape; the representation of the artifact turned into the artifact itself, which was quite simplistic. A landscape of information does not have to be figurative. It is strictly concerned with a formal and syntactic problem, and as such, the political implications associated with content are secondary, in my view anyway.

10 *Would you not consider that the act of representing is inherently political? And, how do you position yourself in relation to your peers? You mentioned that you are a "post-1995": What happened in 1995?*

GEORGE L. LEGENDRE

Peter Eisenman and, to some extent, Greg Lynn, and (in Europe) MVRDV and UN Studio, brought the issue of data to a form paroxysm. For all these luminaries there was a general acceptance of the figurative role of data, which I find now very old-fashioned.

11 *You are interested in an underlying logic that has to do with relational qualities, which actually opposes the figurative value of form relative to the invention of categories, or the development of typologies. I think the sense that we share, your work, my work, and Aaron's work, is this understanding of form. That form is not something that produces a certain visual value. Rather, you are really interested in the underlying set of relationships at a structural level. That's what you say is the value of form at a constitutive level. The problem is what happens once those relationships acquire a certain autonomy relative to the set of problems that constituted those relationships. How do you define the structure of the formal attributes and the relationships that are established, and how do you understand the relative autonomy of form once it is constituted? How do you judge whether the form has an intrinsic value or not, and how do you test the result? Is there a specific moment where this shift occurs?*

GEORGE L. LEGENDRE

The convergence of real and imaginary variables corresponds to an ideal condition. What does that convergence mean in practice? In our work at IJP, the development of prototypes in parallel to publishing (such as our manual on skyscrapers) enables the association of the first with the second. In many ways, the real variables serve as parameters for imaginary equations. The real site sustains the imaginary one. I would like to add that a sort of ideal, syntactic regime is what we are interested in. We are not interested so much in form per se, but more in how form is actually generated and the functional legitimacy that the empirical evidence, the real variables, contribute to it. This is what I consider to be ideal.

12 *Do you, therefore, consider that eventually these two conditions of real and imaginary variables may share a moment of continuity?*

GEORGE L. LEGENDRE

By consistently studying both types of knowledge, I am not attempting to fuse them, but to assure their convergence, while preserving their distinct identities. This is the only way one may justify a schizophrenic process that considers both viewpoints simultaneously. In other words, if you look only at real variables, the result would be a good old functionalist approach. If, on the other hand, one approaches design solely as imaginary variables, the project would correspond to a pre-1995 model, in which the syntactic aspects would be disconnected from the bıg picture.

13 *One of IJP's major projects has been the building of a bridge in Singapore. This project is the product of transdisciplinary research between architects and engineers. How do you position the real and imaginary variables within such collaboration? How do you envision this dialogue between the architect and the engineer?*

GEORGE L. LEGENDRE

With regards to the nature of our collaboration with engineers AKT, we developed a lot of affinities, as they found themselves mainly in a position to post-rationalize the object we produced. At the time, in order to foster a transdisciplinary communication, our engineers employed architects (graduates from the Architectural Association), as a means to creating a synergy between architectural and engineering investigations. IJP not only produced three-dimensional models, but provided calculations, equations, and protocols AKT could incorporate into their own computational models. We provided them with parametric curves at a very early stage of the collaboration. As such, our equations contributed to their own practical research.

14 *So you gave them basically the basic set of relationship that you think were the essence of the project.*

GEORGE L. LEGENDRE

Indeed. AKT Director Paul Scott pointed out that the lateral stability of the proposed structure would eventually create torsion. We solved this issue by producing another curve based on three-dimensional parametric equations. The collaboration was therefore straightforward, and our communication based on an exchange of know-how.

15 *But, what was the relation of that new curve and its resulting pattern?*

GEORGE L. LEGENDRE

The new curve was already there.

16 *So, it was a matter of bringing it out?*

GEORGE L. LEGENDRE

It was a matter of solving one more equation for all of the values of one range and a fixed value of the other. In practice, I just asked AKT: Where should this new curve be located? This new curve constituted an extra solution of the initial equation. The main point was, therefore, to identify where this new curve should be located. We worked in this fashion, considering our mutual desire to combine our respective knowledge.

17 *So, you shared a form of partnership that happened at a different philosophical level, in a sense. You, in fact, bypassed the visual logic, because it was rooted in terms of a sort of meta-logic that goes beyond the appearance of things, rather than being anchored in relationships.*

GEORGE L. LEGENDRE

It was all about information. You can say that, in the most direct way, our engineers at AKT appreciated the fact that we shared information, as opposed to sharing the state of the project.

fig 1
Yeosu 2012 World Expo, mathematical study of inverse surface. The deployment of projective geometry provides a common spatial blueprint, uniting the two main features of the proposal – a spherical exhibitions volume, and a fanning surface dedicated to the exploration of marine life. © IJP

fig 2
Mathematical Study, Pasta ioli (2010–2012, in progress). © IJP

fig 3
Excerpt of Pasta By Design by George L. Legendre, London 2011. Pasta Sample.
© IJP with Thames & Hudson

fig 4
Excerpt of Pasta By Design by George L. Legendre, London 2011. Pasta Sample.
© IJP with Thames & Hudson

fig 5
Pasta table detail

EXIT

— DILLER SCOFIDIO + RENFRO
MARK HANSEN, LAURA KURGAN, AND BEN RUBIN

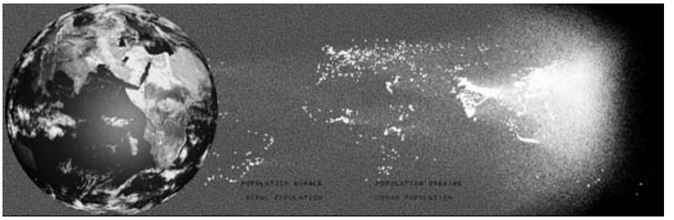
Exit

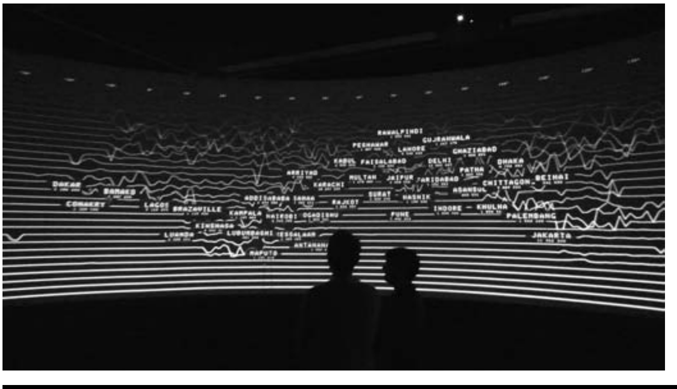
Global populations are unstable and on the move. Unprecedented numbers of migrants are leaving their home countries for economic, political, and environmental reasons. *Exit* was created to quantify and display this increasing global trend. *Exit* is an installation that was originally created by Diller Scofidio + Renfro, Mark Hansen, Laura Kurgan, and Ben Rubin, as part of the Cartier Foundation for Contemporary Art's *Terre Natale* (or *Native Land: Stop Eject*) exhibition. Originally shown in Paris in 2008, Exit has since been presented at the Kunsthal Charlottenborg in Copenhagen and the Alhondiga in Bilbao.

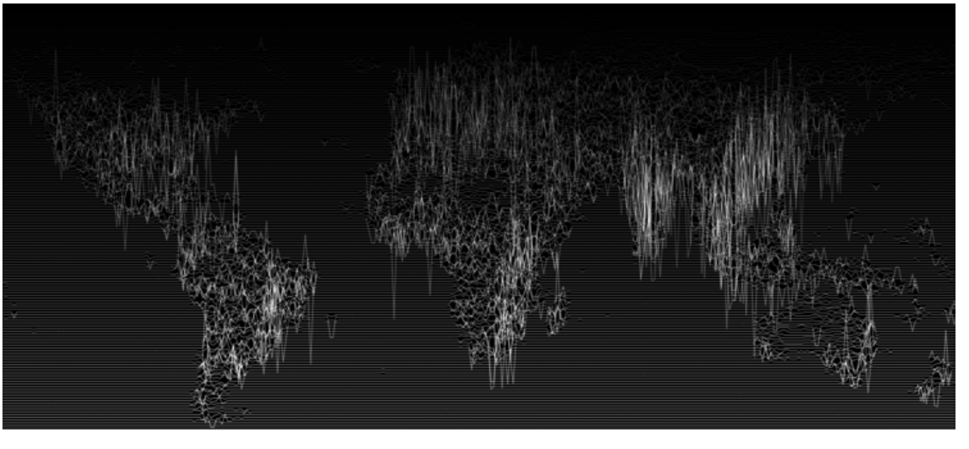
Exit: Part 1 offers an aesthetic re-framing of the media's coverage of global migrations. Forty-eight computers hang from the gallery ceiling store and display a living archive of news footage, photographs, and documentaries about global migration and its causes. *Exit: Part 2* immerses the viewer in a dynamic presentation of the data documenting contemporary human movement. The viewer enters a circular room and is surrounded by a panoramic video projection of a globe rolling around the room, "printing" maps as it spins.

Exit: Part 2

Statistics documenting population shifts are not always neutral, and the multiple efforts to collect them are decentralized and incomplete. *Exit: Part 2* re-purposes these statistics to build a dynamic visualization of global migration and its causes. Using the immersive environment of circular projection, a continually rotating globe leaves a transformed and renewed imprint on the wall, while depicting the mutations and inequalities induced by the unprecedented number of migrants in the world today. The resultant narrative and sound environment is entirely data-driven. The imprints, which are typically maps, are made from data collected from a variety of sources, then geo-coded and processed through a programming language for their visual translation. The presentation is divided into scenarios concerning population shifts, remittances, political refugees, natural disasters, and sea level rise.





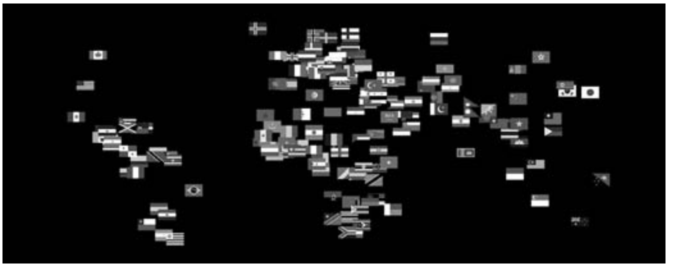


Population Shifts: Cities

This scenario displays two clear trends in urban population density. The first concerns the distribution of global population, which crossed a significant threshold in 2007: for the first time in history, 50 percent of global population lived in cities. The second concerns city growth. Statistics show that 48 of the world's fastest growing 50 cities will be located in the Global South (the developing world) in 2015. This data is displayed through a series of animations, all of which geo-reference population data to its location on the world map.

Data Sources:

Gridded Population of the World, version 3 (GPWv3)
Center for International Earth Science Information Network (CIESIN)
"The world's fastest growing cities and urban areas from 2006 to 2020"
City Mayors, Statistics



Remittances:
Sending Money Home

In 2007, 150 million migrants worldwide sent money home in the form of remittances. These transactions were typically in amounts of US$100, US$200, and US$300. This informal economic network plays a crucial role in the developing world. Remittances added up to 300 billion US dollars, which is twice the amount of global foreign aid. The first half of the scenario displays this data on a world map made from country flags geo-located over the country they signify. The second half depicts the amount of remittances sent as a global money sifter, which shows currency moving from the top 12 remitting countries into the top 60 receiving countries.

Data Sources:

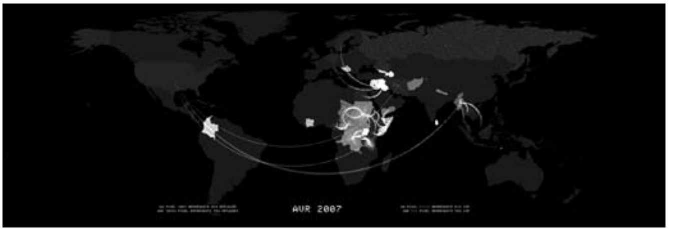
Global Migrant Origin Database (updated March 2007),
The Development Research Centre on Migration, Globalisation and Poverty (Migration DRC), University of Sussex
“Sending money home: Worldwide remittance flows to developing countries”
The International Fund for Agricultural Development (IFAD)
Data: courtesy Manuel Orozco
Statistical Annex from the 2007 Development Co-operation Report, Development Co-operation Directorate (DCD-DAC), Organisation for Economic Co-operation and Development (OECD)
World Economic and Financial Surveys,
World Economic Outlook Database (April 2008 Edition),
International Monetary Fund (IMF)
WEO Groups and Aggregates Information
World Economic and Financial Surveys
World Economic Outlook Database (April 2008 Edition)
International Monetary Fund (IMF)

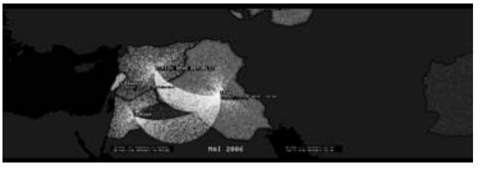
Political Refugees
And Forced Migrations

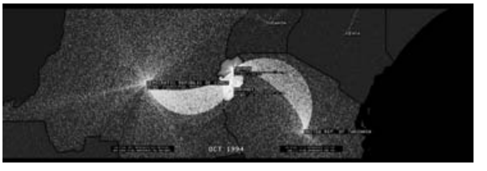
The journeys made by forced migrants, whether they are refugees, asylum-seekers, or internally displaced people, reveal the obstacles they meet along the way: refused asylum, turned back at the border, detained, or worse. Using data from the United Nations High Commissioner for Refugees, this scenario displays the global movement of refugees and internally displaced people in chronological order, starting with 1991 and ending in 2007.

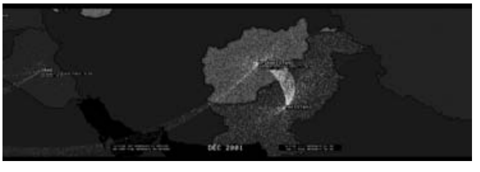
Data Sources:

United Nations High Commissioner for Refugees,
Online Statistical Population Database
(scraped September 25, 2008)







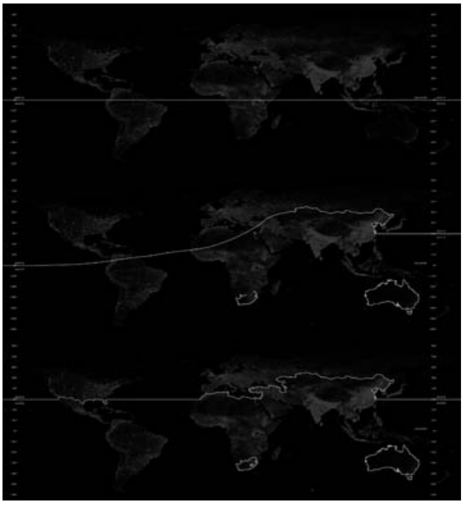


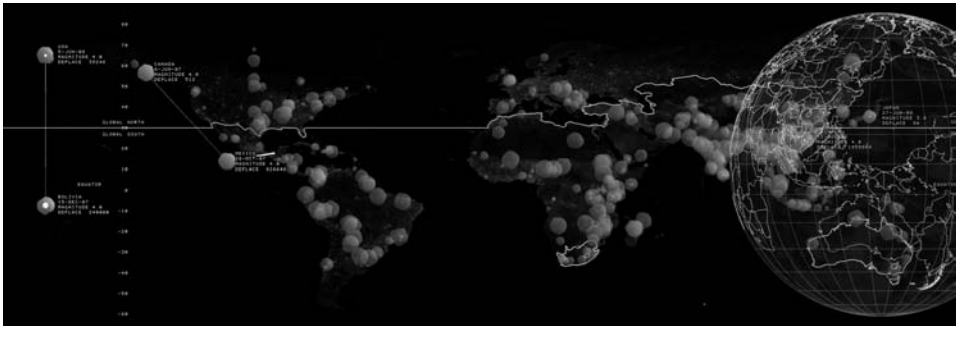
Natural Disasters

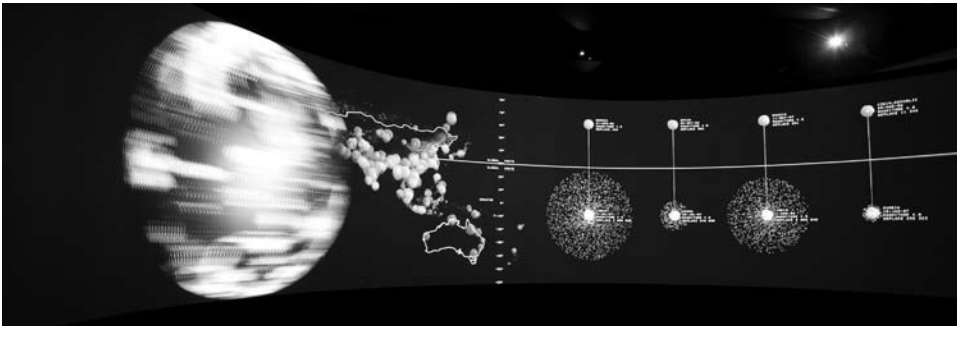
Natural disasters have been increasing steadily since 2000, tripling the number of people affected. Some cities and populations are more vulnerable than others. For example, there are far more people displaced by floods in the Global South than in the Global North. This scenario describes the location and number of people affected by storms, droughts, and earthquakes, and further compares the number of people displaced by floods in the Global North and the Global South (the developing world).

Data Sources:

EM-DAT, The Emergency Events Database,
WHO Collaborating Centre for Research on Epidemiology of Disasters (CRED)
Université Catholique de Louvain School of Public Health
Dartmouth Flood Observatory, Active Archive of Large Floods
Project of Risk Evaluation, Vulnerability, Information and Early Warning (PREVIEW)
Division of Early Warning and Assessment (DEWA)
Global Resource Information Database (GRID)

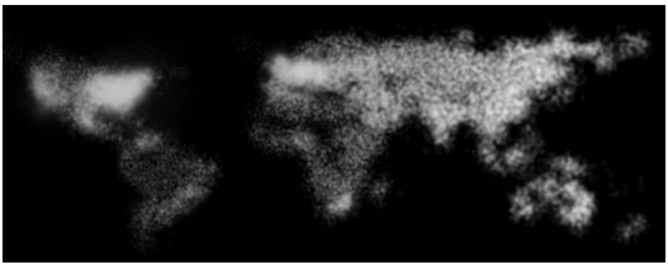


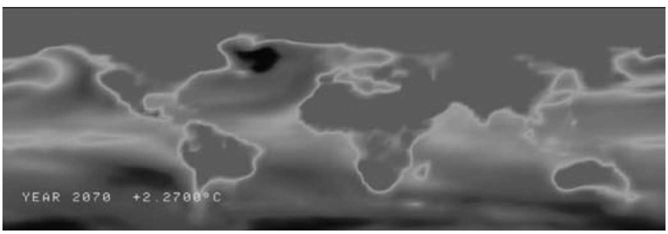


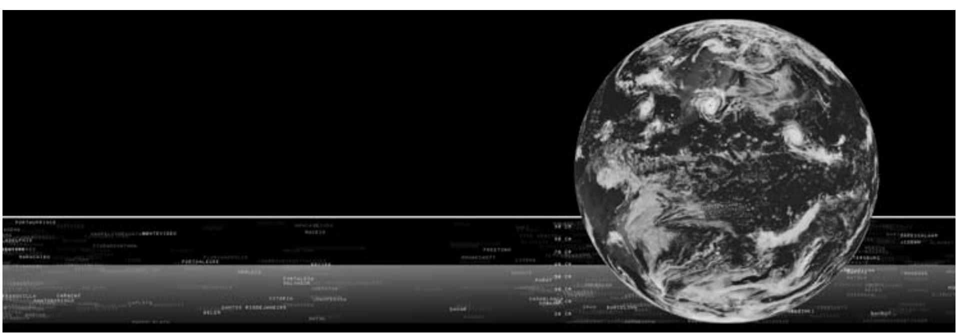


Rising Seas, Sinking Cities
By the year 2100, rising sea levels could submerge large parts of cities and, in some cases, entire towns. The inhabitants of many of these sinking cities will be the first victims of global warming, despite the fact that they are often the least responsible. This scenario tracks the sea level rise at affected cities with geo-referenced depictions of global carbon dioxide emissions.

Data Sources:
Model for the Assessment of Greenhouse-gas Induced Climate Change
A Regional Climate SCENario GENerator
CO2 emissions, Carbon Dioxide Information Analysis Center
Oak Ridge National Laboratory
Gregg Marland, Tom Boden, and Bob Andres
The Elevation Query Web Service
USGS Earth Resources Observation and Science (EROS)
U.S. Geological Survey (USGS)
Environment Working Papers No. 1: Ranking Port Cities With High Exposure and Vulnerability to Climate Extrems Exposure Estimates







Exit

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Laura Kurgan
Ben Rubin
2008

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Commissioned by
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Diagrams/Drawings/Renderings
Diller Scofidio + Renfro
Mark Hansen
Laura Kurgan
Ben Rubin

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Budget
Not disclosed

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UNWRAPPING RESPONSIVE INFORMATION

— MARK BURRY

How new to architecture is "responsive information," and in what ways might contemporary architecture respond to information that can be claimed as genuinely original? Taking a sideways glance at this question, I can begin to answer these questions by negotiating a central dilemma: The underlying tensions between pre- and post-digital design, that is, what can only happen in a post-digital design world that allegedly could not be undertaken prior.

In essence, one can understand why a dialectic framed around the perceived threat to architectural fundamentals has sprung up in post-digital times, as such grounding has, belatedly, in my view, been challenged to the core. Even for fundamentalists, it has become ever harder to maintain a practice based on time-honored traditional approaches to being a "professional." In an environment where seeking to conserve convictions for what were *sine qua non* canons, such conviction are now pitched against overwhelming evidence that not only are long-standing certainties less certain, they are also unlikely to ever return to being "just so." Architecture, which has been practiced as a guild with its concomitant traditions for many centuries bedding down and becoming comfortable with itself, now faces far less comfortable times.

A cursory examination of the principal mechanisms setting up the quantum shifts in post-digital architectural practice shows that some of the boasts of digital design revolutionaries can be reduced to being so obvious and self-evident, there might be, in fact, little room for any dialectic. The very newness of the digital domain may entice less critically aware individuals into thinking that surely there are few, if any, precedents that can be relevant for our time. On the one hand, architects still seek to offer the same services as they offered before computers came on the scene: laudable adjustments to the built environment and a positive influence on the development of towns and cities, the nature of which no other profession could claim to have been able to contribute: those features of cities that provide genuine *civitas*.[1] How relevant are the changes in the tools we use, when it is the resulting buildings and not the tools assisting their design and production that carry weight over the years? If an architectural work of note produced today using digital tools were no different than if it had been produced yesteryear without the use of the computer, the changes in production technology might not be so relevant for the building's critics, who might otherwise fear that something is being lost? This is a moot point and one I wish to develop in this short essay, as a means of connecting the past to the present.

1
I am referring to the shopping experience of Bologna's arcaded streets or the Milan *Galeria*, for instance in comparison to the contemporary shopping mall.

Where once we were restricted to drafting instruments such as the drawing board and the T-square, we now have quite startlingly different and radical means through which to explore, develop, and represent architectural ideas. But we have now been in a phoney war (a conflict founded on false premises) lasting almost two decades, as those we had perceived to be game-changers turned out to have been mere computer-drafting enthusiasts. Those who were uneasy about the more central positioning of the computer within the studio – as its usefulness began to become apparent, especially to commercial practices in the late 1980s – nevertheless consoled themselves for more than a decade by saying, "it's only a drafting tool," despite the efforts of Peter Eisenman, Greg Lynn, Frank Gehry, et al. to advance intellectual engagements with computers and esoteric software created for the animation industry, for instance, becoming unlikely new professional adjuncts. Now, we are in the thick of it: computers are being lifted from their drafting-assistance role to one with more design agency, and many are ill-prepared to absorb radical new departures such as building information modeling (BIM), precinct information modeling (PIM), and digital fabrication and are thus rather underprepared for the necessary professional practice transitions. One consequence of this has been two decades of denial despite the champions for radical change in practice, with the result that, globally, most of our schools have, at best, only skirted around the issues (and opportunities) of this change, while challengers to conventional architectural practice have assembled and successfully asserted rival approaches to the procurement of buildings: how many schools offer in-depth critical engagement with BIM, PIM, and digital fabrication, for example?

Coinciding with the years during which we were assimilating the computer into our offices, I had been lecturing on the posthumous efforts to continue the construction of Gaudí's *Sagrada Família Basilica*, a project with which I have been intimately involved since 1979. The interior of the project was finally completed and consecrated in late 2010, yet many are surprised by this fact, assuming the project to be one that could never be finished. During this time I have been describing and commenting on Gaudí's contribution to mathematics and design – intersecting second order (doubly ruled) surfaces through the combination of hand drawing simultaneously three separate geometrical projections the size of table cloths and scaled plaster modeling as the principal design media. These are both manually intensive methods and distinctly unorthodox to typical architectural design exploration at that time.

Despite commencing 3D digital modeling for this project in 1989, on the face of it a profoundly different design space, there was no equivalent shift in presentation technology with the Kodak Carousel slide projectors *de rigeur*. For many years I could only present photographic slides to reveal the "screen captures" from computer monitors depicting highly sophisticated digital models. It seemed odd to be making my points about being on the cusp of profound change, when the points being made were through the use of a technology little advanced from the Victorian lantern show. In 1992, I had confidently predicted that we would all be parametrically modeling within five years, yet, it was only in the late 1990s that computer images could be projected.[2] This was a period of unsynchronized shifts between representation and presentation technology. My focus initially was to explain that the revolution within Gaudí's thinking during his last 12 years was to ensure that others could accomplish what he would not be able to do himself. This focus evolved from explaining that this was not necessarily an anachronism as Gaudí's vision of future design and construction for the *Sagrada Família Basilica* converged with similar breaks with tradition initiated by Gehry Partners, among others, in the 1990s and still being tested more than 80 years since Gaudí died. This oscillation between old and new seems to be a characteristic of what remains as a long transition period moving from traditional to digital design approaches.

As the pace of the construction significantly increased (thanks largely to the emerging digital assistance), the fact that the computer was being used in a design capacity and the construction itself being a cutting-edge enterprise, along with the complexity of the project being without compare – especially given the millions of people visiting the building every year as the work took place around them, has meant the movement of my own message to match these changes. Quite often I dwell upon the fact that the main design software we are using for the more challenging parts of the project is sourced from the aeronautical engineering sector. Although it is not the same software we started with some 23 years ago, we are unable to use architectural software in any meaningful way for this project even today.

2
see Burry, M.C., **Gaudí:** The Making of the Sagrada Família, *Architects' Journal*, London UK, April 1992 and Burry, M.C., Building Techniques, *Architects' Journal*, London UK, April 1992.

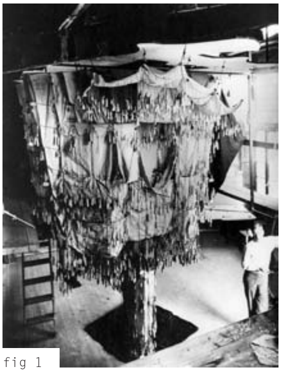


fig 1

A feature that has been consistent for most of my lectures on Gaudí's extraordinarily advanced conceptualization of architecture has been showing a few images of the *Colònia Güell Chapel* (1898–1914), probably Gaudí's most original building. But, like many of his projects, this work is unfinished. For this project he had been experimenting at a highly detailed level, prototyping many of the ideas that he later used during the final quarter of his 43-year engagement with the *Sagrada Família Basilica* (until his death in 1926 at the age of 74.)

The funicular (hanging) model that Gaudí spent a decade developing is well known: He assumed that a building modeled upside down would mirror the forces of compression as lines of tension through the suspended model. For this work, he had made a dynamic load calculation model, which can be considered as an architectural system of responsive information. Specifically, the model could reassign mass by adding pinnacles, towers, and parapets, or calculate the effects of subtracting material by making and moving windows. This model was the ultimate analogue calculator, as it could register the effects of any change almost immediately. In comparison, even today's most sophisticated computers would take significantly longer to calculate the sorts of adjustments essential to Gaudí's approach to design.

This model was only a part of the extraordinary innovation coming from this project. Consider the following:

We do not know if Gaudí had completed any special study of the acoustics of this church, but he was well aware that its structure, full of columns, pierced arches, broken volumes, and comers, was an effective way to avoid resonance. Furthermore, the hyperbolic paraboloid vaults disperse sound instead of concentrating it.

We also believe, on the base of our own experience, that such an internal structure avoids, to a great extent, the echoing that could be produced in the absence of extensive enough absorbent surfaces.[3]

The introduction of second-order (ruled-surface) geometry to the project, a constructional innovation in itself, was clearly intended by Gaudí to have a positive effect on reverberation times. This commentary comes from Puig i Boada who, as a young architect, attended many of Gaudí's impromptu architecture lectures in the final years of Gaudí's life, and who went on to direct the *Sagrada Família Basilica* project himself toward the end of his long and distinguished career. Puig i Boada also completed the first definitive account of the *Colònia Güell Chapel* shortly before he died. His work is a useful resource. In reading it, the framework for the dialectic I started this essay with, i.e. – the tensions emerging from the divide between digital and analogue design, can be reappraised. The *Colònia Güell Chapel* demonstrates, more than any other Gaudí building, that the ideas and inventions of architecture-in-formation with which the avant-garde flirts in these, probably initial, days of computing, can be referenced all the way back to an era without a sense of the digital epoch on the horizon.

In the same book, Puig i Boada also makes the following observation (captured from an exchange with Gaudí):

The first geometry was that of the Egyptian pyramids; its contribution is the right-angled triangle of measurements 3-4-5 which made verticals over the plain of the Nile. It is abstract since it produces only a line. It is a slave to the number 3-4-5. Pythagoras is the second milestone, in which, given the line a-b, there are not only two legs, but all that are in accordance with the (Pythagorean) law, since all real numbers can be considered as legs and have as their geometric locus the circle. It is synthetic; it is of geometry. Newton was the third landmark with his binomial which gives us not only the circle (an ellipse) but also the hyperbola and the parabola: it is analytic and abstract. The fourth milestone is the study of these curves (probably by Monge) not as conic sections but rather as warped surfaces. This process has progressed plastically even more due to the necessity of applying this knowledge to the Sagrada Família Church[4]

fig 1
Gaudí's 1:10 inverted (hanging) model for the Colònia Güell Chapel in Santa Coloma de Cervelló (1898-1906)

Credits: © photographs of the Expiatory Temple of the Sagrada Família: Expiatory Temple of the Sagrada Família Board of Works.

3
Puig i Boada, I., L'Església de la Colònia Güell, Editorial Lumen, Barcelona, 1976 Page LXXVII

4
Puig i Boada, I., op. cit., page XC, drawing from "Conversaciones . . . ", no. 122, El Propagador de la Devoción a San José, (Barcelona), 1917.

Of course, this project is not the equivalent of today's quest for buildings capable of responding dynamically to information. But, as Gaudí's level of thoughtful invention and creative application of geometry demonstrated so long ago, I believe we need to be careful about what, exactly, we can claim today to be original and "digitally driven."

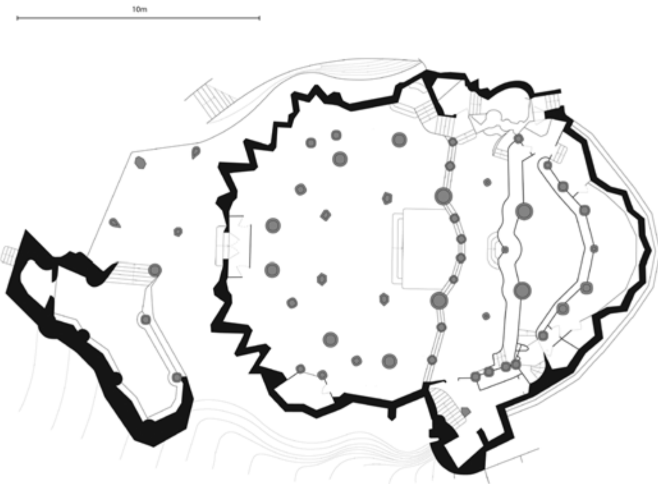


fig 2

fig 3

fig 2
Plan of the crypt. The altar is placed in the center of the building with the choir behind and the sacristy and other offices to the rear. [Credits: Original measured drawings of the Colònia Güell prepared by Lluis Bonet Garí redrawn and reinterpreted by Michael Wilson]

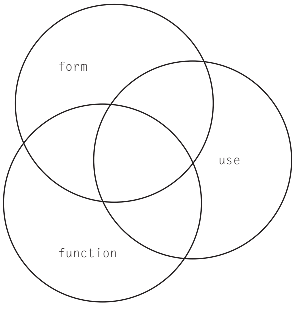
fig 3
Reflected ceiling plan showing the many structural ribs. Only traditional Catalan vaulting was used for the ceiling's structural elements. [Credits: Original measured drawings of the Colònia Güell prepared by Lluis Bonet Garí redrawn and reinterpreted by Michael Wilson]

BEYOND BIM: REPRESENTING FORM, FUNCTION, AND USE

— YEHUDA E. KALAY

Current architectural modeling tools, including popular Building Information Modeling (BIM) systems, represent a major step beyond previous CAD tools. Still, these systems continue to represent only the physical and material attributes of buildings. Buildings, unlike other consumer products, cannot be understood independently of their intended use and of their intended users. It matters, for example, whether a room is used as an office, as a classroom, a place of worship, or as a patient's room in a hospital. Such information is not represented by current building models, and must be inferred from the label or context. Likewise, information concerning the people who will use the building matters: it is not the same 'product' when the building is used by children or the elderly, or by North or Native Americans. In other words, a building cannot be understood without knowing *how* and *by whom* it will be used.

fig 1
Form-Function-Use triad.



Information concerning function and use is unique to the built environment. Although ergonomics are an important design consideration for the makers of automobiles, cell-phones, and airplanes, the same, exact products are used by people worldwide, regardless of cultural, social, or site-specific information. This is not so with buildings: a dwelling that might perfectly fit downtown New York City may be totally "out of place" if transplanted to Korea, or even to Europe, where customs and habits are vastly different.

The responsibility for making buildings fit the needs of their intended users rests with the designer. Yet, current CAD tools provide no help whatsoever for evaluating such suitability. Furthermore, current building modeling tools do not include enough data to run supplementary evaluation programs, as they do for energy, lighting, and structural analysis.

Rather, a more comprehensive building representation is needed – one that includes form, function, and use(r) information (fig 1). Such representation will allow designers and other stakeholders to evaluate their product as it will actually be used, which helps them eliminate performance errors, and thereby improve the lives of the building's intended inhabitants.

Form concerns questions of size, shape, and relative position of objects, as well as their properties (material, color, weight, etc.). It describes the physical characteristics of a building and its parts, and answers such questions as "What does it look like?" and "What is it made of?" Form, of course, plays an important role in architectural design, and BIM has done a good job representing it.

Function is a set of conceptual attributes that add meaning (semantics) to the object's form characteristics. It answers such questions as "What does it mean?" and "What do we do with it?" Function is independent of form: different forms can have the same function. Conversely, the same form can serve different functions. Function is a socio-cultural attribute: objects acquire meaning in reference to other objects. The reference is established by the observer.[1] The *referential* nature of meaning permits different observers to associate the same object with different referents, while the *inferential* nature of meaning allows them to interpret the reference differently. Moreover, the observer may associate the same object with different referents under different circumstances, thereby interpreting its meaning differently at different times.

Current modeling systems like BIM do not explicitly represent *function*. They rely on the assumption that the professionals who use the model will interpret the meaning of the represented objects in a similar way, as they have shared cultural, educational, and experiential backgrounds – a risky assumption that is not itself communicated.

Use is a property that adds time-based, socio-cultural information to the represented objects. It answers such questions as "Who uses it?" and "How is it used?" Use is both a quality of an object, or an environment, and of the individual or group of people who activate it: It is a quality that depends on the object itself, but can only be expressed by the person who uses it. The notion of use has been central to twentieth-century philosophy, as demonstrated most aptly by Martin Heidegger's two most basic neologisms, present-at-hand and ready-to-hand.[2,3]

Unlike forms, CAD systems completely ignore the notion of use. Elevators, for example, are represented statically, by use of a symbol or a geometric model that is stationary. Its capacity to move people up and down tall buildings – a function not only of its size, but also of its speed and schedule of operation – must be gleaned from external documents, which may or may not be available to all the designers involved with the project. Instead, a *Form-Function-Use* model provides a more capable building representation, one that can simultaneously support design collaboration among various professionals, and also support the simulation of buildings "in use," rather than only their static, built shell.

Progressively more sophisticated means to connect the professionals collaborating on building design have been developed over the years, starting with IGES in the 1970s, through PDES and STEP in the 1980s and 1990s, to the current IFC standard. While these so-called "interoperability" measures succeeded in allowing data to be transferred from one model to another, they failed to bridge the knowledge gap between the collaborating professionals: architects, structural engineers, electrical engineers, mechanical engineers, quantity surveyors, lawyers, accountants, clients, and more. Each of them has been educated to represent the same product – the building – in different ways, while relying upon different knowledge to interpret and analyze it. Absent a common, comprehensive core of building information, these differences often lead to misunderstandings, errors, and eventually, cost and schedule overruns.

The first objective of the model being advocated here is to add more meaning (semantics) to the core model, thereby allowing for more consistent interpretation by the various stakeholders, and reducing the chances for errors due to misinterpretations.

1
Morris R. Cohen (1944). *A Preface to Logic*. Henry Holt & Co., New York, pp. 47.

2
Martin Heidegger (trans. 1962). *Being and Time*. John MacQuarrie and Edward Robinson, trans. New York: Harper & Row.

3
Hubert Dreyfus (1995). *Being-in-the-World*. Cambridge MA: MIT Press, p. 162.

The second objective is to support building analyses and evaluations through applications that are not currently possible, or require significant enhancements to the models. Simulating the interaction between the building and its intended users is one such application. Currently, most human-building visualizations are animated by the designers themselves, who choreograph the "action" as they envision it. The eventual users of the building may well act very differently, for a variety of reasons – as can be revealed by the post-occupancy evaluations (POE) describing how the building really works (fig 2).

The main challenge facing the development of a *Form-Function-Use* model is the representation of these three information types. However, the combination of *form*, *function*, and *use* is neither additive, nor is there a specific, best construct to accommodate all three data types – as painfully demonstrated by the brute force approach used by some artificial intelligence (AI) researchers in attempting to make "intelligent" objects.

A distributed approach, based on a network of intelligent objects, may be more suitable: "intelligence," or the data that is used to represent function and use, can be disaggregated and located within different types of constructs, while linked to each other in a kind of a "social" network. For example, rather than making the "door" object exclusively responsible for "knowing" all there is to know about doors (such as form, function, as well as the various conditions for its use), this information can be disaggregated and distributed: the door object would only have basic knowledge about its form and its function. However, this information would be augmented by the knowledge residing within objects that represent the users, who "know" how to reach and open a door, even knowing when to knock before attempting to open the door. This last piece of knowledge can be derived by the user object from both the social and behavioral attributes associated with a room protected by the door. In turn, the room, which is itself an object, can have knowledge about the activity that goes on inside it, and whether the particular user at the door is allowed to join it (fig 3).[4,5]

The model advocated here will include such functional information at all levels of the building (doors, walls, furnishings, rooms, etc.), as well as account for the cultural and social models of the intended uses. The design, development, and implementation of such a model will consist of developing a coherent and consistent strategy to distribute knowledge in a building model that can support the combined *form*, *function,* and *use* objectives, without having the model sink under the weight of its own data. Only then will it be a complete model of the building, one that is able to help designers evaluate its function before it is built and inhabited (figs 4, 5).

4
Jaewook Lee (2006). *Designing Intelligent Virtual Environments with a Multi-Agent System*. PhD dissertation, UC Berkeley.

5
Yehuda E. Kalay and Yungil Lee (2009). *Auto-Animated Humanforms for Simulation, Evaluation, and Population of Virtual Environments*. Report to the Korean Culture & Content Agency (in Korean).

fig 2

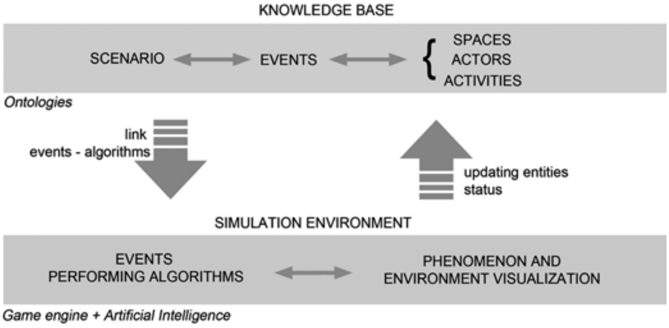


fig 3

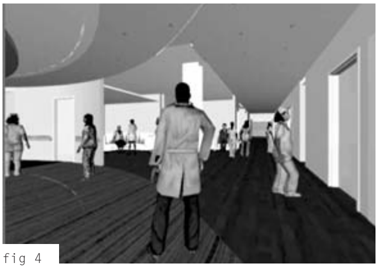


fig 4

fig 5

fig 2
The Form-Function-Use model as it has been applied to simulating the operations of a hospital, where the users (doctors, nurses, patients, visitors, etc.) and the functions (activities) are relatively well-known. They were grouped into entities called "Events." A sequence of Events makes a "scenario." (Graphic credit: Davide Simeone.)

fig 3
The knowledge associated with Event entities is represented and stored in an ontological knowledge base. It is communicated to a simulation engine, which has the necessary constructs to animate the users (actors) as they perform their respective functions within the given spaces. The simulation, in turn, communicates back the updated status of each entity to the knowledge base, where decisions about subsequent actions can be made. (Graphic credit: Davide Simeone.)

figs 4-5
The simulation engine allows us to visualize the cycle in a more understandable manner, in the form of simulated actors going about their business within the specified spaces (in our case - the hospital). The appearance of this simulation is similar to an animation, except that the actions are controlled by the knowledge base and its associated AI engine, rather than being choreographed by the designer. (Graphic credit: Seungwan Hong.)

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Years:
2010 - current

BLACK BOXES: GLIMPSES AT AN AUTOPOIETIC ARCHITECTURE

— OMAR KHAN

British visionary architect Cedric Price theorized about an *anticipatory* architecture that was open to change based on the evolving needs of its inhabitants. He argued this through the concept of *planned obsolescence*, where a user's changing tastes, needs, uses, and demands could alter the architecture – including its very existence.[1] Price's humanist impulse was often obscured by the technophilia of his architecture. His use of cybernetic, robotic, and experimental engineering systems has been criticized as mechanisms of control rather than the instruments for individual liberation that he sought. Regardless, his work presents a series of visionary proposals that demonstrate ways in which architecture and planning could become vehicles for a progressive public to construct and demolish utopias best able to serve their needs.

Like his critics, I also believe Price's optimism for his high-tech architecture should be met with some skepticism. But, unlike them, I see too much humanism in it. His architecture assumes that if people are provided the means to design their own environments they will do the right thing. However, in our contemporary society where corporations are people too and populist sentiments are regularly manipulated to suppress dissent, Price's anticipatory architecture is too easily compromised. In the name of the public good, the crowd's wisdom can be used to dismiss social and technological experimentation as elitist, excessive and expensive. Left to the conscientiousness of the people, what resistance can an architecture of planned obsolescence provide against such popular calls for problem solving?

Perhaps some new direction can be found in Price's embrace of cybernetics. Where his critics see too much technological control, I don't think his systems go far enough. He too easily gives up the power of architecture to resist quixotic change in favor of a populist stance to serve people. Instead, we should seek greater autonomy for architecture through technological systems so that they can engage more productively and surprisingly in the built environment. Such autonomy may be found in cybernetic's post-humanism through which we can develop new agency for architecture.

1 Cedric Price, "Life Conditioning," *Architectural Design* (October 1966).

fig 1
Design Innovation Garage, Buffalo, NY: A design innovation center modeled on open source concepts, uses multiple communications options between black boxes including secure information networks, projections, visual reflections, opacities and transparencies, occupant conversations, overhearing and glancing.

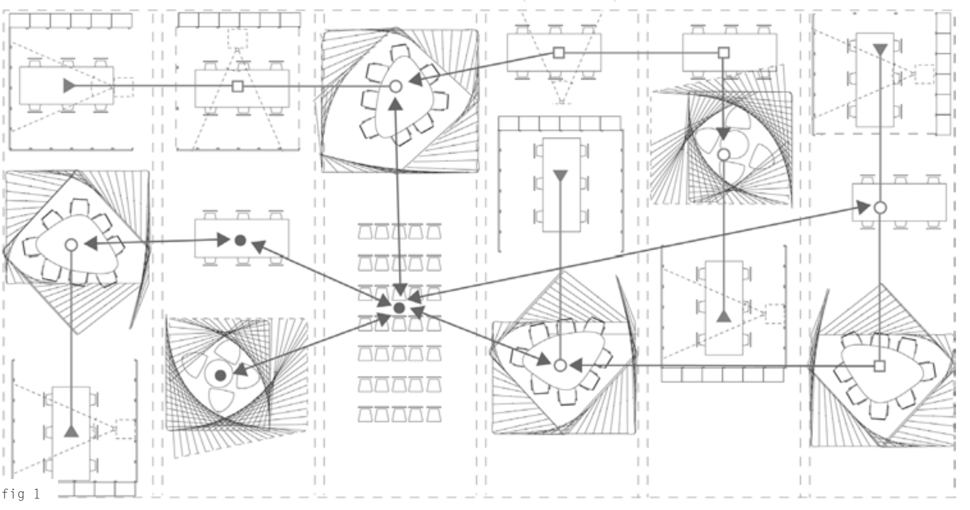


fig 1

Cybernetics and, by extension, systems theory are useful because their epistemologies are not grounded in the dichotomy of human and non-human. They provide a more accurate way to describe the complex interconnected relationships that exist between humans, animals, vegetation and technologies. For architecture to participate in this network, it must perform as an autopoietic system. Maturana and Varela's concept of autopoiesis,[2] presents a model of a self-generating system that is organizationally closed yet structurally open to its environment. Such an open/closed interactive system provides a radical description of living things that according to Maturana and Varela can be extended to physical systems. One can conceptualize it as a black box, whose internal organization is and will remain invisible to us. Yet even as it maintains this autonomy, we can come to understand it through our interactions. If these are situational they will be unique and varied; what cybernetician Heinz von Foerster calls non-trivial.

Price recognized that "architecture is too slow in its realization to be a 'problem solver'."[3] It is unfortunate that research on smart, sensing, and actuating technologies in architecture is perpetuating programs for optimizing human services. A more radical program would look to use these technologies to increase architecture's interactive capacities – sensitizing it to a greater variety of environmental stimulation, expanding its communicative capacities, evolving its material mutability, and making it an autopoietic system. Such architecture would be more capable of engaging the network of political, social, ecological, and technological systems that define our built environment. The problems it would address we can only imagine.

2
Humberto R. Maturana and Francisco J. Varela, Autopoiesis and Cognition: The Realization of the Living. Boston: Riedel, 1980.

3
Cedric Price, *Re: CP*, ed. Hans Ulrich Obrist (Basel : Birkhäuser, 2003), 136.

fig 2
Water Harvesting Housing Prototype: a study of packing algorithms for water harvesting housing that uses environmental performance criteria to create exterior microclimates for interior/exterior inhabitation. Each house functions as a homeostatic black box communicating with its neighbors.

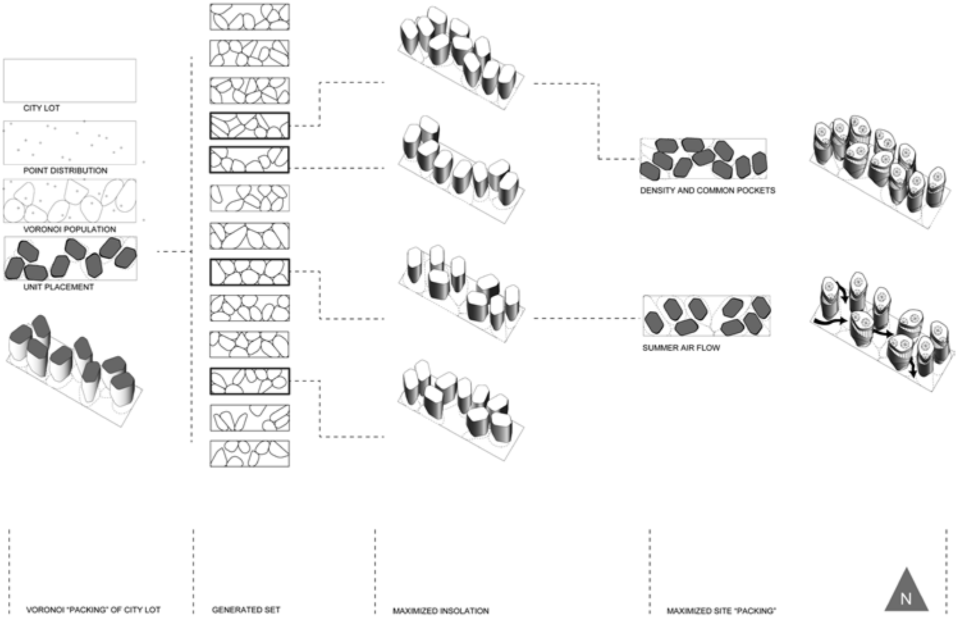


fig 2

fig 3
Water Harvesting Housing Prototype: a comparison of water usage to population density that can be achieved through the housing prototype. More significantly it provides a means to develop alternative types of urban movement in the city grid.

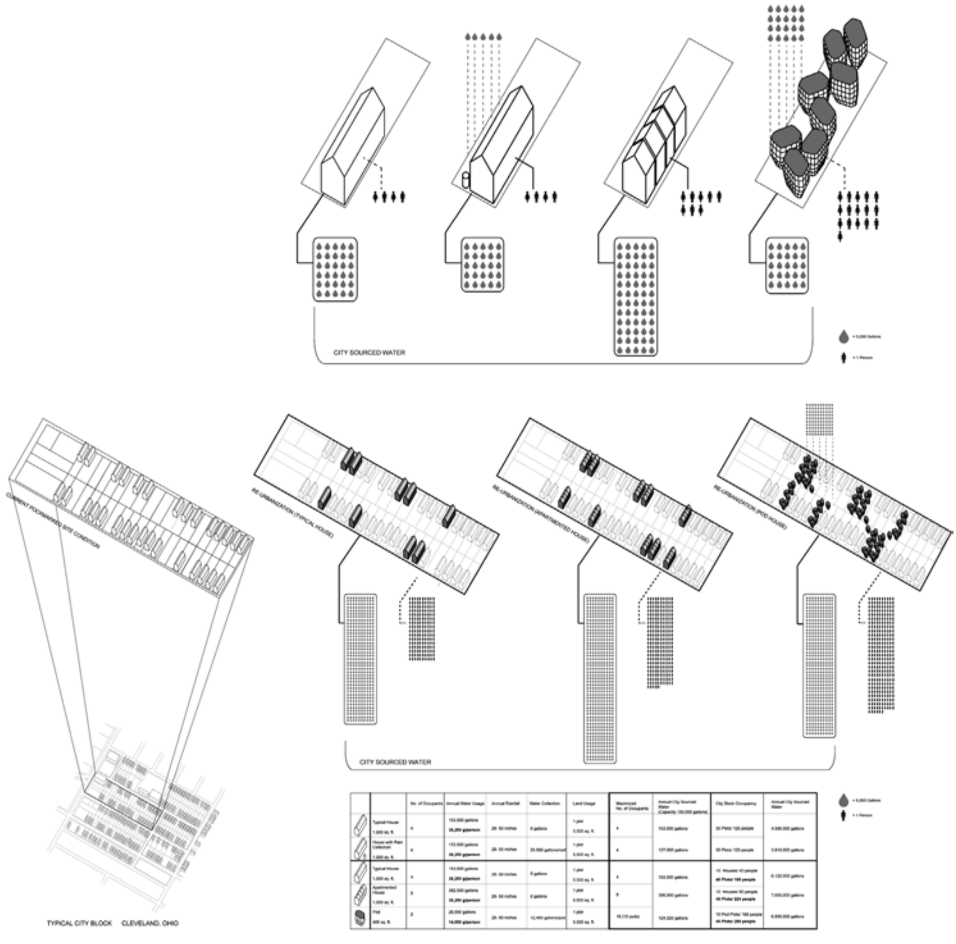


fig 3

THINKING THINGS, SENSING CITIES

— **JASON KELLY JOHNSON / FUTURE CITIES LAB**

When the basic building blocks of our cities begin to individually sense and respond to the world around them, how can we organize these elements into cooperative networks or ecologies that exhibit intelligence at a larger scale? When a building is constantly evolving based on feedback from its users, its environment, or the internet, what are the implications, potentials, or risks for architecture? When a city truly becomes "*cognizant*" and is interwoven with artificial intelligence, how can architecture become an active participant? Perhaps most importantly, what are the social, cultural, political, or ecological implications of these new soft, wild, and responsive cities?

Our research has led us to develop a hypothesis about cities that tends to have more in common with biology and cybernetics, rather than with anything resembling the traditional top-down hierarchy of urban planning. The contemporary examples that we find most fascinating, such as the Rocinha favela or the Occupy encampments, do not generally follow master plans or ancient foundations. Instead, they seem to be guided by many of the fundamental evolutionary principles found in migratory animals, insects, viruses, nomadic tribes, digital social networks, robotic ecologies, and more. These organizations are often swarm-like, borderless, wirelessly interwoven, ephemeral, intelligent, and responsive. Their collective organization is never designed from the top down. These new formations (and their citizens, technologies, information networks and physical infrastructures) emerge, prosper, and evolve by continuously mutating, breeding, incubating, cloning, fusing, and hybridizing. These virus-like changes occur at a fibrous, cellular, or "unit by unit" level and follow simple rules, feedback mechanisms, and long-term processes akin to natural selection. These processes tend to generate increasingly diverse and viral formations with profound ecological, political, and social dimensions. There is no sentient superstructure; rather, the sensing city will emerge informally in patterns that are at once elegant, grotesque, and confounding.

As recent events in Tunisia and Egypt have revealed, our urban entanglements are highly volatile and globally intermeshed in both physical and virtual dimensions. Social networking services such as Twitter are increasingly playing a critical role in informing how, when, and where citizens assemble, socialize, and protest. We explored these ideas in a recent installation project entitled "Datagrove" in downtown San Jose, California. This project aggregates local, trending Twitter feeds from Silicon Valley, and then whispers these feeds back through speakers and LCDs displays, which were woven into the Datagrove. It functions as a social media "whispering wall" that harnesses data normally nested and hidden in smart phones, in order to amplify this discourse in the public realm. The grove thrives on information from its urban environment. It renders invisible data and atmospheric phenomena into variable intensities of light and sound. It provides shelter and a place of calm in which one can contemplate data streams from sources near and far. As one drifts deeper, the grove gradually reveals flowing patterns in cadence, with data transmissions both random and meaningful.

Datagrove forecasts a world in which networked information is interwoven into the basic elements of the city: its bricks, mortar, building technologies, and appliances. Its architectural manifestations will exhibit increasingly life-like characteristics. It is an emerging city that will demand a critical shift in how architecture is currently conceived, how it is constructed, and how citizens engage and participate in its evolution.

fig 1

fig 1
Photograph of the final Datagrove installation in the courtyard of the California Theater in San Jose, California. Photo Credit: Future Cities Lab

fig 2
Detail view of one of the Datagrove media pods. In addition to an LCD display read out of the trending twitter feed, the pods also contained speakers that whispered computer generated words to visitors. Photo Credit: Peter Prado

fig 3
Photograph of the final Datagrove installation in the courtyard of the California Theater in San Jose, California. Photo Credit: Future Cities Lab

fig 2

fig 3

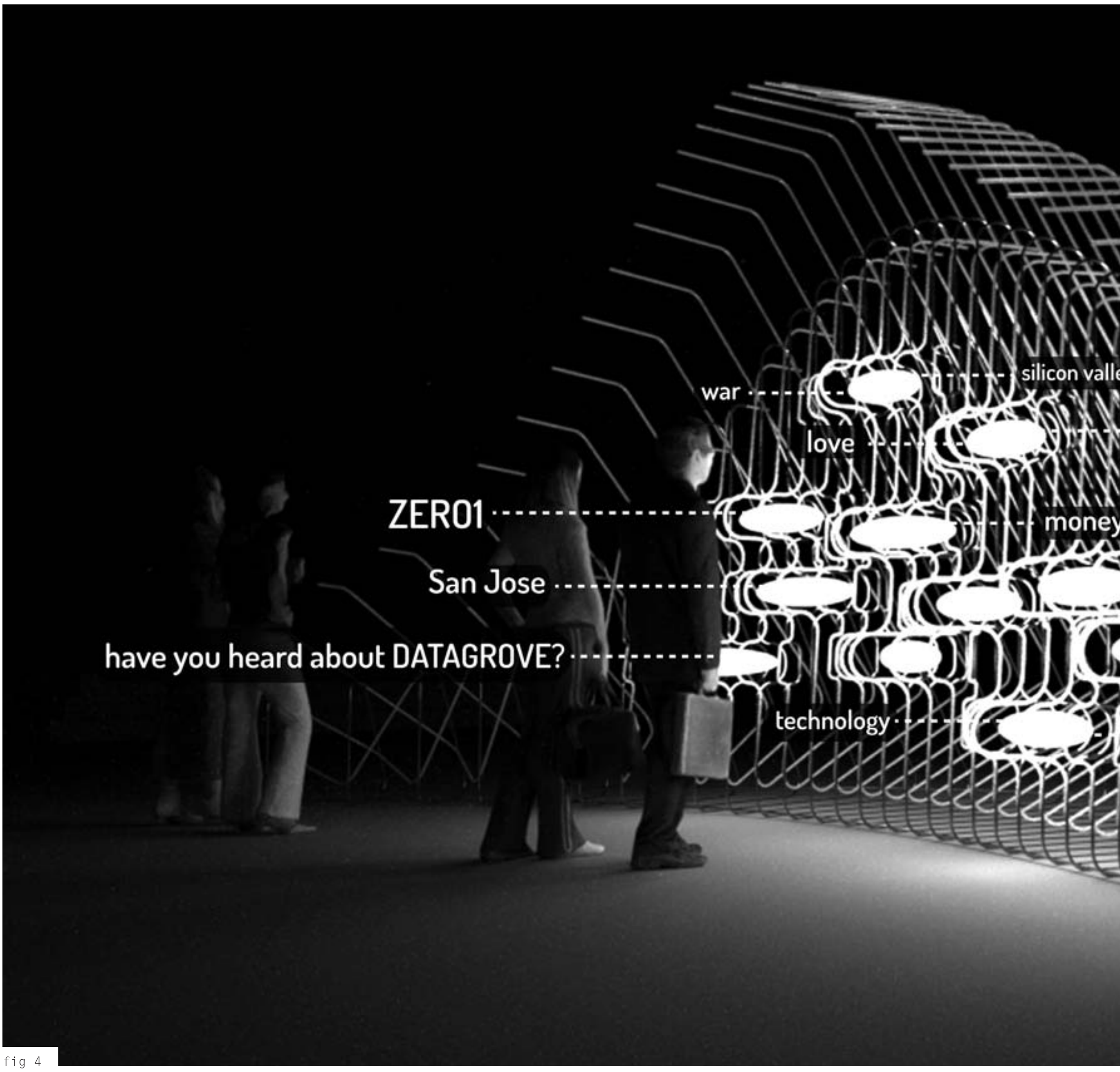
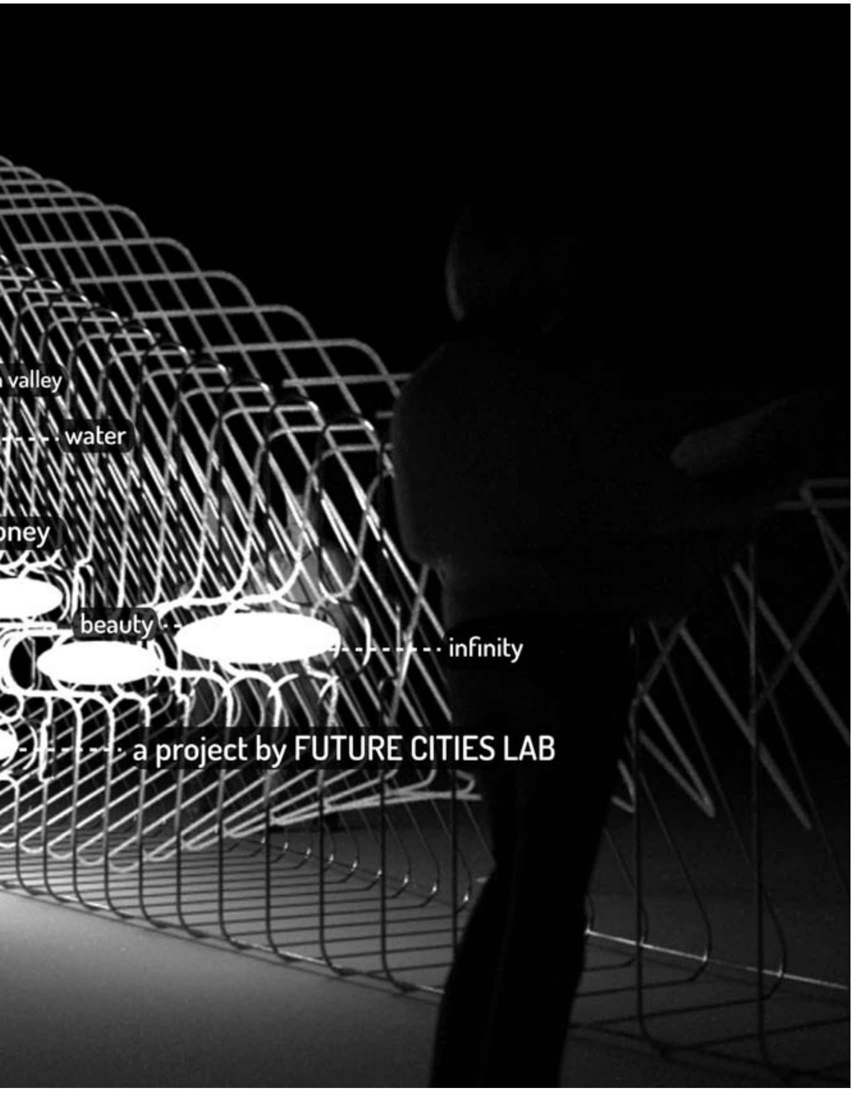

war
love
ZERO1
San Jose
have you heard about DATAGROVE?
technology

fig 4

fig 4
Perspective diagram of the Datagrove illustrating the variety of Twitter to text to speech responses that might be possible on any given day.



Datagrove Credits

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San Jose, California

Year
2012

$TR€$$€D €URO

— ALEJANDRO ZAERA-POLO AND MAIDER LLAGUNO MUNITXA

Our proposed installation aims to explore the effects of contemporary financial space and to make them available to the audience through their physical embodiment. The processes of globalization that have been intensifying over the last four decades have given rise to a novel space very different from the classical, capitalist space, which is based on a regime of simple accumulation. Our piece aims to capture the qualities of this new space and the way it connects local and global orders, forming an intensive and complex space.

We have used the euro as a paradigmatic case of globalization at play: The euro system integrated a number of local economies under a single financial order. The euro is itself an example of the convergence between global and local orders; it displays a trans-national head and a national tail. However, the adjacencies of these two spatial orders can no longer be as linear as the two sides of a coin. For our work, we have used economic data and a mass spring particle system, a physics-based simulation engine to produce a far more complex system of adjacencies, which we believe to be more representative of contemporary financial orders.

Early optimism for the euro has slowly given way to a less-optimistic view following what is presumed to be the long-term impact of the Greek bailout and other eurozone states like Portugal, Spain, Italy, and Belgium. After reaching as high as $1.4440 on the dollar, the euro retraced its gains to sit 0.20% lower at 1.4396. This followed the roller coaster ride of the last months, when sentiment towards the euro was driven by dramatic developments at the eurozone summit.

The events taking place in the last months have brought into question whether what was presumed to be a stabilizing and equalizing economic strategy for the eurozone countries has evolved in the exact opposite direction. Although many assumed that having a common currency would balance and homogenize the differences that were present in pre-euro Europe, we can now argue that, quite on the contrary, applying a common currency on an uneven landscape has enhanced the economic and political differences amongst the eurozone states – and produced an increasingly warped sense of spatiality. The purpose of this piece is to explore the phenomenology associated with this space.

Economists warn that the prospect of prolonged economic malaise in Europe's most debt-laden countries could undercut the continent's economy as a whole and linger for years, even if European officials managed to solve Greece's immediate funding crisis. Many are even questioning the survival of the euro itself.

Instead of physically representing the euro as a currency symbolizing stability and prosperity, our proposal tries to grasp its unstable nature by highlighting a particularly relevant moment in its history.

Our design monumentalizes a specific phase in the life span of the *stressed euro* by creating a *data fossil*.

fig 1

fig 2

fig 3

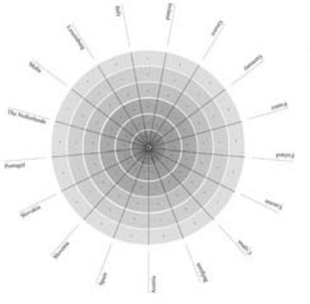


fig 4

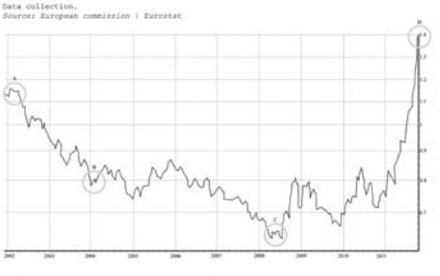


fig 5

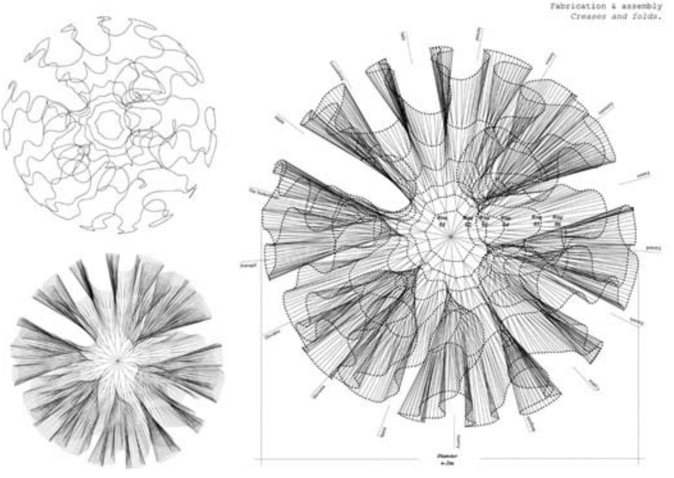


fig 6

fig 1

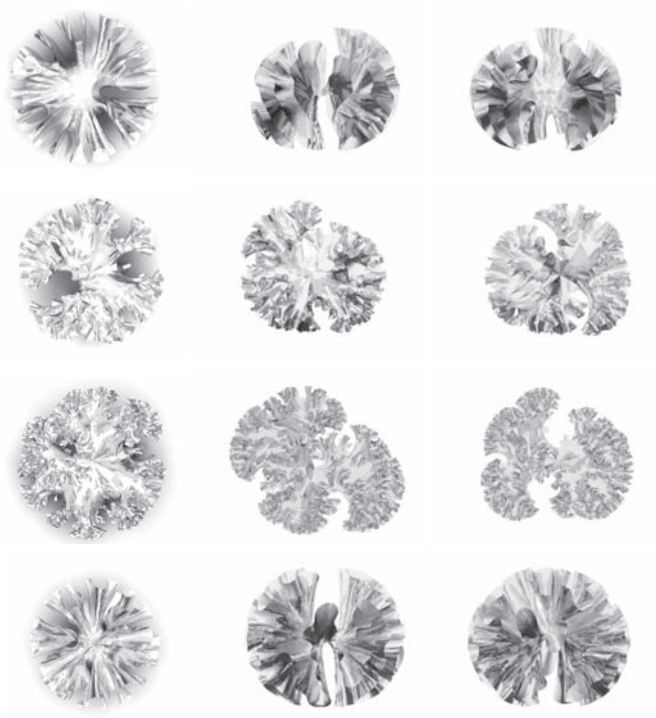
The Austrian Corona, the Belgian Franc, the Cypriot Pound, the Estonian Kroon, the Finish Markka, the French Franc, the German Mark, the Greek Drachma, the Irish Sterling Pound, the Italian Lire, the Luxembourgish Franc, the Maltese Pound, the Dutch Guilder, the Portuguish Centavos, the Slovakish Koruna, the Slovenian Tolar, the Spanish Peseta.... ceased to exist in January 2002. The eurozone was rendered with the same euro currency.

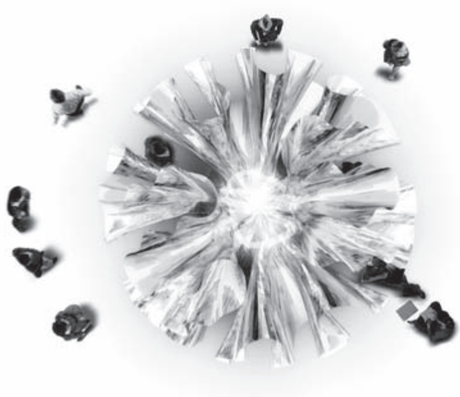
The euro (sign: €; code: EUR) is formed by 17 of the 27 member states of the European Union. It is also the currency used by the Institutions of the European Union. The eurozone consists of Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain. The currency is also used in a further five European countries (Montenegro, Andorra, Monaco, San Marino and Vatican City) and the disputed territory of Kosovo. It is consequently used daily by some 332 million Europeans. It is the second largest reserve currency as well as the second most traded currency in the world after the US dollar. As of July 2011, with nearly €890 billion in circulation, the euro has the highest combined value of banknotes and coins in circulation in the world, having surpassed the US dollar. Based on International Monetary Fund estimates of 2008 GDP and purchasing power parity among the various currencies, the eurozone is the second largest economy in the world.

fig 2

The name euro was officially adopted on 16 December 1995. However it was introduced to world financial markets as an accounting currency on 1 January 1999, replacing the former European Currency Unit (ECU) at a ratio of 1:1 and euro coins and banknotes entered circulation on 1 January 2002. Since late 2009 the euro has been immersed in the European sovereign debt crisis, which has led to the unstable economic and political situation that we are living today.

In order to find a graphic language to display the differences between the countries that comprise the €urozone, the proposal starts by creating an all/euro/nation representative coin. This coin will be divided in 17 regions as per the nations that comprise it. In each of the 17 pieces, data belonging to specific national economic indexes will be displayed by distorting the coin in the Z axes, so that each piece will display a particular economic topography of the region. The last step will be that of mediating





between the data of the different indexes (GDP Per Capita, Growth Rate, Unemployment Rates, Foreign Trade, Inflation Rate and Risk Premium.) and the 18 nations.

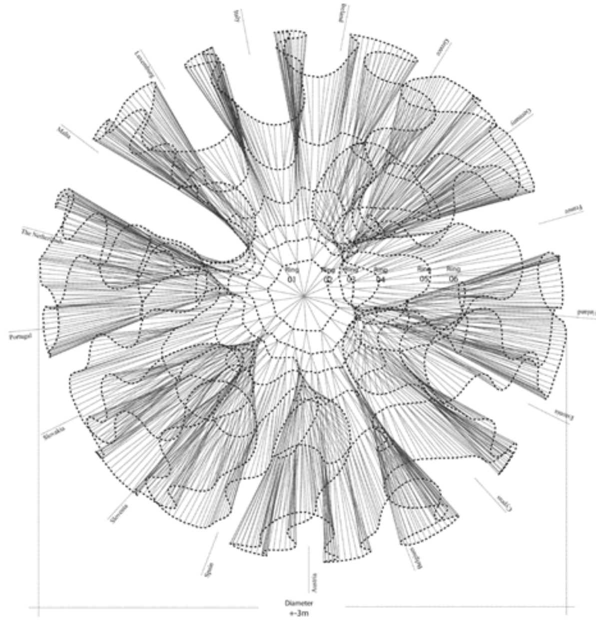
fig 3 (previous page)
1 Austria national euro.
2 Belgium national euro.
3 Cyprus national euro.
4 Estonia national euro.
5 Finland national euro.
6 France national euro.
7 Germany national euro.
8 Greece national euro.
9 Ireland national euro.
10 Italy national euro.
11 Luxembourg national euro.
12 Malta national euro.
13 The Netherlands national euro.
14 Portugal national euro.
15 Slovakia national euro.
16 Slovenia national euro.
17 Spain national euro.
18 nation mix | Hybrid euro

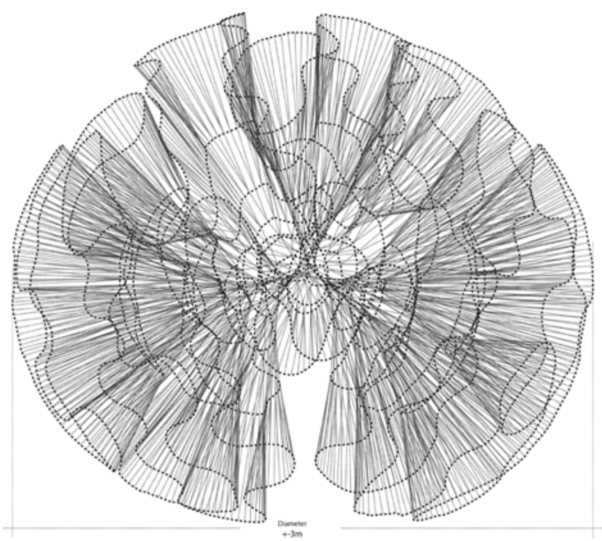
fig 4 (previous page)
Data translation diagram | 18 nations + 6 economy index rates.
These indexes will be ordered as follows:
Ring A | Index 01: GDP Per Capita ; Ring B | Index 02: Growth Rate; Ring C | Index 03: Unemployment Rates; Ring D | Index 03: Foreign Trade; Ring E | Index 04: CPI Inflation Rate; Ring 06: Risk Premium.

Euro zone activity data 'translator'
Each sector of the 'mixed euro', will be loaded with data that relates with the economical index values of the different nations. These indexes will be situated radially in the coin in order to graph a comparable diagram of the 17 nations that comprise the eurozone.

The data will be collected from online services such as European commission, eurostat. This source allows us to gather nation and month/year based data to feed each index section of every nation in the coin portion. Amongst all the national indexes collected, a mode will be drawn as the balance line from which each difference will be graphed as diversions in -Z and +Z. So that a positive balance of a particular national index will be tracked as a +Z value in relation to the mode obtained from all the nations. As a result the "coin" will present a corrugated profile with ups and downs from the mode > Z=0 level.

At the same time as the different indexes do inevitably affect each other, the Z values that have been fed will be mediated by applying physical forces to them. These forces will simulate the relationships that happen between different indexes and nations. As a result the geometry will be a data fossil that will draw a physical balance





state of a given moment in the history of the euro.

The translation protocol presented in this document allows for data for different moments to be displayed. For this purpose we have selected the most relevant years or “moments” of the euro and gather the pertinent data in order to feed the graph with it. The beginning of the euro in January 2002, the 2004 peak, the beginning of the financial crisis in 2008 and today at the end of 2011... However any date could be selected to develop the data fossil.

fig 5 (previous page)
The following graph shows the major peaks (both max and min) of the life of the euro. Amongst these, we have selected four moments as marked in the diagram.

A. January 2002 is the moment of the creation of the euro, still under the inertia of the previous financial system of national currencies.

B. Beginning of 2004, when the EU enlarged to include ten new countries, eight developing former-communist countries (including three which were part of the Soviet Union itself) along with Malta and the divided island of Cyprus.

C. In 2008, the EU’s eurozone entered its first recession, sparking a debate about possible economic collapse. It agreed to set up a bail-out mechanism and study proposals for more fiscal integration. Greece (as well as the UK, Portugal, Spain, Italy, and Ireland) has high amounts of debt.

D. In May 2010, the German parliament agreed to loan 22.4 billion euros to Greece over three years, with the stipulation that Greece follow strict austerity measures, against Greek public opinion. In October 2011, eurozone leaders meeting in Brussels agreed on a package of measures designed to prevent the collapse of member economies due to their spiraling debt. This included a proposal to write off 50 percent of Greek debt owed to private creditors, increasing the EFSF to about €1 trillion and requiring European banks to achieve 9 percent capitalisation. As of November 2011, the same Eurozone leaders that extended the package to save the Eurozone have extended an ultimatum toward Greece. Both Sarkozy of France and Merkel of Germany have made it public that both of their governments have reached the end of their patience with the beleaguered Greek economy.

fig 6
Diagrams and Images Stressed Euro: Creases and Folds

<u>FRAC centre pavilion.</u>
London, 7th of November 2011

Alejandro Zaera-Polo &
Maider Llaguno Munitxa

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FUTURE GESTURES

— MICHAEL WEN-SEN SU

With respect to any speculations upon the future or emergent trajectories of an "architecture of information," it is now possible to project the formulation of an "architecture of information" distinguished by its nonlinear, even chaotic, capacity to generate as yet unknowable variations of the usual architectural tropes of providing shelter (function), context (program), and presence (form) simply because we have been here before, during the period when architecture was once simultaneously enamored with all the technological achievements associated with the "moon-shot," yet humbled by the seemingly intractable problems of population growth and environmental emergency. At the time, the figure most prominently associated with projecting the future course of architecture was John McHale, whose landmark 1969 book *The Future of the Future* attempted to chart a course for the future of architecture. To better understand this singular work, and thereby connect with the long and varied history of an "architecture of information," it is necessary to revisit the years before McHale found himself in the position to rethink architecture.

By the end of 1954, the role of organizer for the Independent Group proved too demanding for Reyner Banham. The baton passed from Banham to both Lawrence Alloway and John McHale. Significantly, the latter's first recommendation in this official capacity was to invite a British expert on cybernetics, E. W. Meyer, to address the group. Although Meyer's talk was promisingly titled "Probability and Information Theory and Their Application to the Visual Arts,"[1] McHale found cause for concern:

… we found the expert to do it. Then we listened to him and realized, of course, what he was saying wouldn't make any sense whatsoever to the Group.

As a result, McHale

… decided in some way to debrief him, listen to him on it, write down the ideas and try to make a set of diagrams to translate the ideas…. We had a standard Shannon diagram, then we had an example of coding, all laid out, we had a statistical probability…. I think there were five sets of diagrams.[2]

In contrast to, say, Paolozzi's plethora of the now-mythologized Bunk! series of images at the Independent Group's first meeting in April 1952, Meyer's address would evidently have proven similarly intractable on account of its dearth, rather than abundance, of visual materials. Still, McHale's apprehension was surprising. After all, the Independent Group

1 This talk was presented as the third lecture of what has since become known as the "second session" of the Independent Group on 8 March 1955.

2 McHale's dialog for the 1979 film *Fathers of Pop* as quoted in Anne Massey, *The Independent Group: modernism and mass culture in Britain, 1945–59* (Manchester and New York, 1995). 91.

had asserted its very "independence" from the ICA by its ready embrace of science, technology, and industrialization. In fact, the group had previously convened for lectures on such esoteric topics as the engineering of De Havilland helicopter designs, the biology of "The Creative Activities of the Human Brain," and the philosophy of Logical Positivism, while its members vigorously debated the implications of works like D'Arcy Thompson's *Growth and Form*, A. C. Korzybski's *Science and Sanity*, and certainly, Norbert Wiener's *The Human Use of Human Beings*. Arguably, it would have been difficult to assemble a more receptive audience than the IG. Instead, McHale's anxiety regarding the reception to Meyer's talk bespoke the widening gap between his own interests and those of fellow members. This variance first became apparent at the ICA's October 1954 show entitled *Collages and Objects*.

Curated by Alloway, but designed by McHale, *Collages and Objects* exhibited both McHale's recently completed *Transistor* series of collages and his barcode-like collage books. In both cases, McHale addressed the issue of representational abstraction in terms of the emergent science and technology of control and communications systems. Given neither to the "pop" literalness, nor the critical juxtapositions, of better known works such as fellow exhibitors Paolozzi's "I was a rich man's plaything" and Nigel Henderson's "Screen," or more generally, prominent IG member Richard Hamilton's later work famously titled "Just what is it that makes today's homes so different, so appealing?," McHale's collages sought instead to further disperse the intrinsic incoherence of mass media by their abstraction from image or sound into pure information.

Similarly, his impetus to "debrief," "write down," and then "translate" Meyer's lecture into schematic diagrams intimated more than mere exegetic expediency. Instead, the likes of Shannon-, coding-, and probability-diagrams were conceived to illustrate the processes by which "information" – in its most abstract sense – traveled from transmitter to receiver. Thus, whereas Meyer had expressed diffidence regarding the "induction to the visual arts" of the "transmitter-medium-receiver complex" on account of its "hyper-spherical dimensionality,"[3] McHale chose to depict not the highly suggestive higher-order geometries of antenna radiation-dispersal patterns, but the comparatively intuitive linearity of the flow and regulation of information. Considered jointly, McHale's recommendation of Meyer and his participation in the latter's presentation marked a sharp departure away from the IG's interest in accounting for – and incorporating – the artistic ramifications of manifestly anti-Aristotelian, non-Platonic, mass-produced and mass-consumed media, e.g. – Alison and Peter Smithson's disclosure that "today we collect ads" and Alloway's simultaneous appeal to "Ad/Ad" as the inverse of *Dada*, and towards the *non*-artistic pursuit of ephemeral information. Effectively, where fellow members of the IG extended the foundation of art to mass culture, McHale's emphasis on information bespoke the further, more-radical expansion from mass culture to society.[4] Perhaps not surprisingly, this divergence eventually directed McHale into the path of famed prognosticator R. Buckminster Fuller and, thence, far into the future.

Evidently McHale rejected Sigfried Giedion's insistence upon distinguishing between constituent and transitory facts. That is, whereas the latter conceived of human progress as the persistence of fundamental constants beneath the masking tides of merely transient phenomena, the former considered change to be – by the very definition of "progress" – its sole qualifier. Instead of precipitating ideals, solutions, objects, or "truths," therefore, his distillation of Gropius' legacy yielded only methods and approaches, or more generally, process. For McHale, moreover, technology explicitly disinherited materials from their professed "natures." Thus, their "truths" derived not from their products, but from their production. Or, as he had asserted as early as the May 1954 *Artist versus Machine* exhibition (in which he participated independently of the *IG*),

3
A record of the IG's "second session" included this note – most likely made by McHale – on Meyer's lecture: "The statistical model devised by Shannon and others to explain the particular case of the transmission of information in an electrical communication network has proved eminently successful, but its induction to the visual arts would appear difficult because of the hyper-spherical dimensionality of the transmitter-medium-receiver complex (speaker's abstract)." See Massey, *The Independent Group: modernism and mass culture in Britain, 1945-59*. 143.

4
As Anne Massey and Penny Sparke noted, the IG attempted to blur the distinction between "high" and "low" art not by spanning the juncture between them, but by re-contextualizing both in the expanded terms of culture. See Anne Massey and Penny Sparke, "The Myth of the Independent Group," *Block* 10 (1985).

Industrial practice provides; mass-produced materials; standardized components. These suggest "concrete" usage in their own terms of surface, structural performance, technique of assembly.

In fact, the specifics of their manufacturing contributed to a larger, accumulated body of knowledge. Seen this way, the future course of *sustainable* – or, for McHale, even just *supportable* – architecture was clearly not chartable by either the revelation of materials or the erection of objects. Rather, its sole, temporal marker was insubstantial, but comprehensive, information. Indeed, McHale suggested as much when he advocated architecture's development of a common, self-consistent vocabulary and, accordingly, its assumption of the role of "a kind of information centre." Appropriately enough, just five months after publishing his article, he left for America to study for one year at Yale University as "special fellow" under Josef Albers.[5]

While Albers' reputation had been founded upon his tenure at the Bauhaus, McHale's rejection of its legacy instead rendered him more receptive to the ideas of Albers' close friend: R. Buckminster Fuller, the veritable pioneer – and pariah – who had distinguished himself some twenty years earlier by asserting the architectural significance of, among other unconventionalities, the purely schematic information center he called "Conning Tower," but most recently had been awarded the 1954 Milan Triennale's *Gran Premio* for his Geodesic domes.[6] In fact, McHale had already written Fuller on his own initiative upon assuming the responsibilities of organizing the IG sessions at the end of 1954. Although his letter merely inquired into Fuller's possible influence by the Bauhaus, the latter responded with a resounding negative in the form of a tremendously long letter which was subsequently published in the July, 1961 *Architectural Design*. Despite its uncertain impact upon McHale's "Bauhaus" article, Fuller's letter clearly left an indelible mark upon the young artist and writer. Indeed, in spite of McHale's return to England with the now-legendary collection of American magazines,[7] and even irrespective of either his continued affiliation with the *IG* or his further experiments with collage, he aligned himself ever more with Fuller. As Sibyl Moholy-Nagy later pronounced, his agenda would actually become indistinguishable from that of his "master."

Shortly after producing this warm defense of Fuller, McHale submitted an article to the student journal *Ark* exploring the intersection between "Technology and the Home."[8] Additionally to crediting Alison and Peter Smithson's recent "House of the Future" with extrapolating household technology some 25 years into the future,[9] this essay also reviewed Fuller's many contributions to the "penetration" of instruments and appliances into the home, e.g. – the central mast of the Dymaxion House, the Dymaxion Bathroom Unit, and the Autonomous Living Package.[10] However, McHale's characterization of the former differed markedly from that of the latter. In particular, while he considered the "House of the Future" to be a revelatory reflection of "strictly speculative production geared to market research," he maintained the validity and, hence, necessity of Fuller's 'far out' designing against future needs and emerging patterns, reasoned from a stubbornly individual brief with no concessions to popular taste and styling."[11] Apparently, despite his previous repudiation of Giedion's claims for permanence and, more pointedly, irrespective of his own interests in the impermanence of mass media, he now sanctioned Fuller's foundational *in*-variability. As shall be seen in the following section, this divarication actually followed from his struggle to simultaneously account for the influences of both Fuller and the Independent Group.

For McHale, Fuller was a veritable prophet whose ideas and accomplishments seemed to fulfill to preternatural order his own four-point program for architecture. However, rather than immediately espousing Fuller's concepts, methods, and agenda, he resisted the association for a

5
In light of McHale's "Gropius and the Bauhaus," his previous involvement with the IG, and his subsequent activities on behalf of Fuller's industrialized housing, it is difficult to sustain this description of his trip to Yale: "Ironically, a fellowship to study with Josef Albers at Yale in 1955 confirmed McHale's interest in popular culture rather than his intended areas of study, color theory and the use of industrial materials." From Jacquelynn Baas' description of McHale in Robbins, *The Independent Group: postwar Britain and the aesthetics of plenty*. 87-88.

6
Josef Albers was invited to the faculty of Black Mountain College in North Carolina after the closure of the Bauhaus in 1933. In 1948, he personally invited Buckminster Fuller to teach at BMC. It was there that Fuller constructed the first versions of his Geodesic domes. By the end of 1949, Albers had taken up the position of Chairman of the Department of Art at Yale University. However, both he and his wife remained close friends with Fuller. While details are lacking, McHale apparently met Fuller in person during his time at Yale. (He also met Marcel Duchamp on this trip.)

7
Of course, it was McHale's trunk full of glossy American magazines, which had provided inspiration for noted works like Richard Hamilton's famous collage "Just what is it that makes today's homes so different, so appealing?" for the landmark *This is Tomorrow* exhibition at the Whitechapel Art Gallery in August 1956.

8
John McHale, "Technology and the Home," *Ark* 19 (March, 1957).

9
Alison and Peter Smithson's "House of the Future" was conceived for the 1956 "*Daily Mail* Ideal Homes Exhibition."

10
Appropriately, McHale also noted the possibility of designating the "Planning/Communication Centre" of the "Motorama Kitchen of Tomorrow" as a "conning unit."

11
McHale, "Technology and the Home," 25.

brief period. Indeed, he conceded to the formative role of the *IG* by pursuing a parallel, if seemingly divergent, discourse. After all, it was during his tenure as organizer of the *IG*'s "second session" that the group famously conducted a "random, introspective survey of American advertisements with reference to the interplay of technology and social symbolism." Accordingly, he continued to explore the artistic, cultural, and sociological ramifications of ever more pervasive and, hence, effective modes of mass communication as it was modified – and fortified – daily by science, technology, and industry, e.g. – glossy and colorful journals, advertisements, fashion, television, radio, and film. When he finally yielded to the influences of Fuller, he did so with a distinctly *IG*-inflected variation all his own.

With respect to McHale's interests, influences, and pursuits, two parallel, if disparate, threads are apparent. On the one hand, his initial indictment of (heroic) architecture's persistent rhetoric towards stability, permanence, and object rendered him particularly amenable to Fuller's *anti*-rhetoric towards variability, progress, and objectivity. In fact, the latter's "Universal Architecture" even professed to derive its impetus from a union of art, science, and industry. On the other, his *IG*-propelled dedication to the preeminent medium of the modern era – that is, mass media – motivated him to, firstly, speculate upon its nature and behavior (e.g. – the *Transistor* collages); secondly, extend his investigation to its actual materiality (e.g. – the treasures from America); and lastly, explore its ultimate implications for transgressing not only the specific disjunction between fine and popular art, but also that between human (or alien!) and machine. Although never explicitly expressed, two of McHale's later essays effectively posited the inevitable intersection of these divergent threads at their common goals: *the convergence of immaterial information with material body*. Indeed, where Fuller considered architecture to be an "anticipatory," but externalized, mode of instrumentation which apportioned infinite means of collecting, manipulating, sorting, and disseminating information, McHale instead anticipated the necessity of countering the inevitable informational overload by absorbing, or internalizing, the mechanical into the biological. As such, if the former connoted a transformation of shelter into prosthetic, the latter evoked the further, final evolution into implant. Seen this way, McHale's suggestion to Fuller regarding representations of the energy-patterns of particular belief systems apparently constituted an extension of Fuller's earlier work on tracing the novel "stress-flow energy balance" for the structure of his Geodesic domes. Specifically, whereas Fuller's application of vectors, phases, and "module frequency" had enabled him to discover the critical "zigzag component" along which otherwise invisible, unpredictable forces traveled in his Geodesic structure, McHale essentially proposed to employ the same – but with a view toward the disclosure of some fundamental constancy underlying the propagation of religions. Rather than concerning himself with their manifestations, or merely the "introspective surface comparison of end products and artifacts," therefore, he considered their decomposition to data and, further, the depiction of this information in legible form to be the more revelatory approach. In fact, this derivation was later rendered explicit when McHale contributed a special article to the December 1964 *AD* on Fuller's Geodesic visualizing instrument called the *Geoscope*. Or, as he described it better, "The Minni-Earth." More particularly, the *Geoscope* enabled the visualization of events which spanned time and space intervals either too large or too small for human perception. As such, it "would powerfully locate man in his universe and its electronic display facilities would enable him to see and comprehend patterns far beyond his normal … range…."[12] For McHale, then, the "concept of history" was "energized" not by tangible forces or substances, but by intangible information.

On this very account, it then became possible for him to realize a future prospect. That is, the perception of patterns, relationships, logic, or even intrinsic chaos all intimated, firstly, the commonality of the human condition; secondly, the means by which both societal accord and individual discord were established; and lastly, the eventual predictability, or simply legibility, of the human subject and object. Thus, while the *IG* struggled to keep apace with the complex "end products and artifacts" of, now, modern life, and McHale himself anticipated the profundity of reducing these manifestations to their constituent signals, data, and processes and, further, their reconstitution in graphical or numerical forms – even as he perceived the requisite augmentation of human sensibilities with prosthetics and implants, the juxtaposition of subject and object as connoted by, for instance, the gesturing human body bespoke precisely the compatibility of these divergent methodologies and, hence, not just the previously described *convergence of immaterial information with material body*, but also the apprehension of its progress. Further, like the depiction of inherently inimitable gestures, the resultant view was necessarily manifold rather than singular. As such, this future prospect was projective and descriptive, but decidedly not prescriptive. More importantly, it was fully commensurable with McHale's previous efforts to peer into the future. He even pursued them to their logical conclusion: the compilation of information.

Subsequently, McHale dispensed with his artistic pursuits in order to dedicate himself to, on the one hand, the continuing promotion of Fuller, and on the other, the study of the future of humankind. For the former, he appealed to the still-sympathetic Theo Crosby to publish both Fuller's "Universal requirements check list" in 1960 and a special feature on his works in 1961,[13] and later, to the

ever-receptive Monica Pidgeon to invoke Fuller as exemplar – and prophet – of the future for the memorable "2000+" dedicated issue of 1967. Not surprisingly, he was also commissioned to write only the second of Fuller's biographies as part of publisher George Braziller's Master of the World's Architecture series. For the latter, he began to work with Fuller on a number of projects to, firstly, promote the transformation of architectural education to (actually, really) reflect the changed priorities of the modern era; secondly, institute a worldwide conglomeration of information centers after the fashion of Fuller's 1932 "Conning Tower" proposal in order to collect, organize, and distribute information; and lastly, extract the requisite patterns, trends, and vectors to produce viable and, therefore, applicable future prospects. Following Fuller, McHale designated this ambitious undertaking as "Total Design." To realize this ambition, they established an international "world retooling design" program with the title World Design Science Decade and the targeted interval of 1965–1975. McHale even assumed the responsibilities of its Executive Director, and contributed variously to its six publications.[14] Later, he followed Fuller to the Southern Illinois University, Carbondale in 1962 in order to pursue a doctoral degree in sociology and a specialization in "future studies." After completing his dissertation on "The future in social thought (with reference to the social theories of Saint Simon, Comte, Mead and Parsons)" in 1968, he worked exclusively on establishing his own future prospect.[15] Indeed, more than even his celebrated collages and sculptures, his accomplishments would, from then on, be defined by his "future gestures."
For the 1977 book *The Futures Directory*, Director of the "Center for Integrative Studies in the School of Advanced Technology" at SUNY Binghamton John McHale and Senior Research Associate Magda Cordell McHale prepared a directory of organizations and individuals nominally dedicated to "future studies." Interestingly, its appendix included an "Organizations-Methods Index" which listed the possible means by which future prospects were realized. These categories were:

BRAINSTORMING
CONTEXTUAL MAPPING
DELPHI TECHNIQUES
EXTRAPOLATION TECHNIQUES
HISTORICAL ANALOGY
NETWORK ANALYSIS
PROBABILISTIC FORECASTING
SCENARIO BUILDING
STATISTICAL MODELS.
CAUSAL MODELING
CROSS IMPACT ANALYSIS
EXPERT PANELS
GAMING
INDIVIDUAL EXPERT FORECASTING
OPERATIONAL MODELS
RELEVANCE TREES
SIMULATION

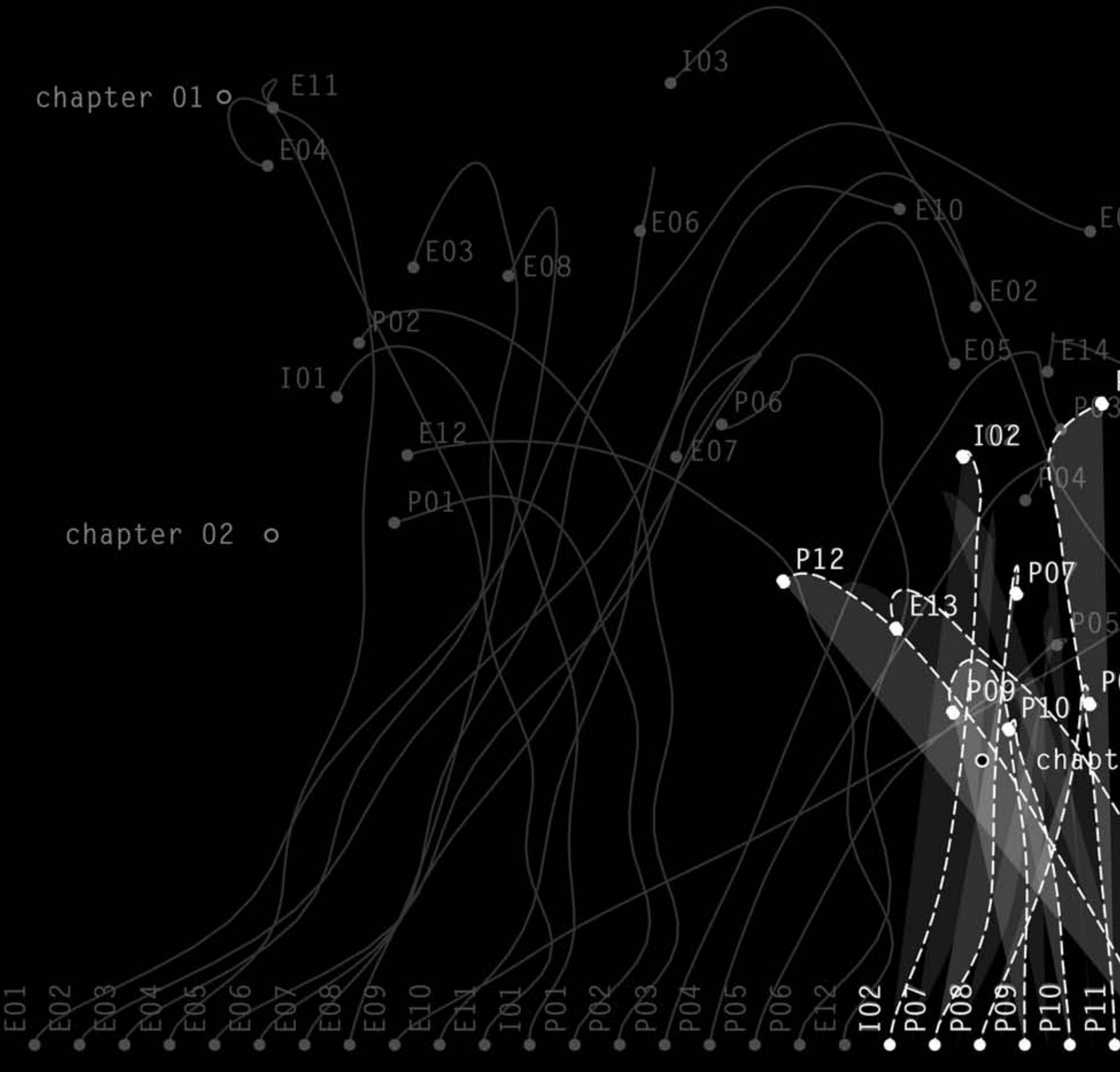
If, previously, McHale had sought to delineate the possible *convergence of immaterial information with material body*, the further augmentation of both prosthetics and implants with the above techniques evidently constituted the sum of his own gestures and, therefore, comprised a veritable "future gesture" spanning the personas of artist, writer, designer, architect, and finally, prognosticator. Or, as we can read it better in today's era of pervasive computation, big data, and the convergence of software and hardware, McHale had actually, presciently, proposed the figure of a "futurist" to formulate an "architecture of information."

12
John McHale, "The Geoscope," *Architectural Design* 34 (December, 1964). Quotation from the document he produced with Fuller for the World Design Science Decade. Fuller and McHale, "Document 1: Inventory of World Resources, Human Trends and Needs," 64-66.

13
John McHale, "Richard Buckminster Fuller," *Architectural Design* 31 (July, 1961). This issue also reprinted Fuller's long-winded response to McHale inquiry of 1955 regarding the possible influence of the Bauhaus.

14
Altogether, six volumes of associated documentation were prepared. These mainly contained strategies, charts, and reprints of Fuller's articles. See the bibliography for their respective titles.

15
John McHale, "The future in social thought (with reference to the social theories of Saint Simon, Comte, Mead and Parsons)" (Southern Illinois University, 1968).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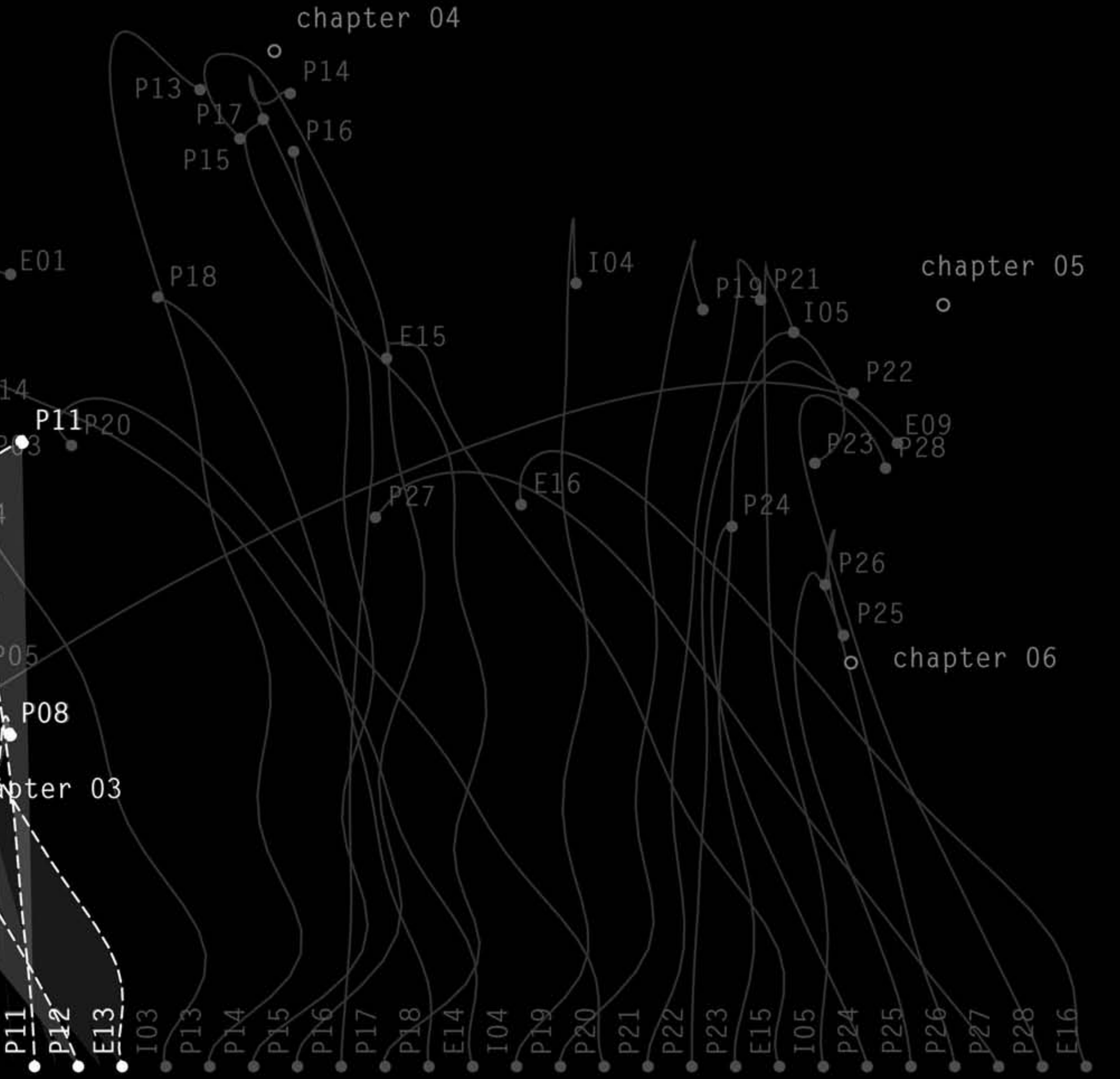

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INTERVIEW: ALESSANDRA PONTE

— WITH PABLO LORENZO-EIROA AND AARON SPRECHER

01 *An important aspect in your research concerns the way our western society perceives its natural environment and our increasing reliance on information technologies to domesticate the territory. What are the particularities of our perception of the environment today?*

ALESSANDRA PONTE

It would be more precise to say that lately the focus of my researches has shifted from the study of landscape formations to the analysis of the constitution of the notion(s) of the environment. I progressively abandoned the concept of landscape because no matter how you characterize it – natural or artificial, wild or civilized, rural or urban, vernacular or cultural, interior or exterior, landscape remains a historically overburdened concept that ties the relationships with our surroundings to a painterly western tradition. The connotations imprinted by this heavy heritage are traceable even in the more articulate attempts to revise and update the idea of (land)scape, as in datascape, or ethnoscape, mediascape, technoscape, financescape and ideoscape (and here I refer of course to the neologisms coined by social-cultural anthropologist Arjun Appadurai). Landscape evokes a two-dimensional image, a privileged point of view, a distance between the observer and the observed. These associations exponentially frustrated my efforts to read a host of phenomena that characterized the twentieth (and twenty-first) century attempts to define, construct, and represent the interactions between life and its surrounding. The problems related to the perception ("natural" or "mediated") of our surroundings ("natural" or "artificial") are just a fraction of a much bigger questioning about life and its milieu. I have on purpose employed three different words – environment, surroundings, and milieu – that together with ambiance and atmosphere are currently accepted as synonymous, to indicate an apparently self-evident notion belonging to common parlance. No one seems to need an explanation when the "problem" of the environment is raised, for example, or even when artists and designers talk in a rather specialized way about responsive environments. In fact, my problem, our problem, is to investigate what environment means, and how it relates to life itself. We need to understand the multiple significations of the concept and its history, because surroundings, environment, milieu, ambiance and atmosphere, far from being synonymous, signify dissimilar conceptions and refer to unlike historical constructs. I am certainly not the first to point this out. A recent attempt is Peter Sloterdijk's trilogy on spheres, where the German philosopher flamboyantly proclaims that the twentieth century discovered the environment. Sloterdijk proposes precisely a history, from remote antiquity to today, of the idea of environment in all its declinations: from atmosphere to milieu, from ambiance to *Umwelt* (a term that Sloterdijk borrows from Estonian biologist Jakob von Uexküll). However, already in 1952, the influential French philosopher of science Georges Canguilhem, in a pioneering essay that retraced the history of the concept of milieu, had observed that the notion was becoming a universal and required way of capturing both the experience and the existence of living beings and that it was possible to recognize the idea of milieu (or environment) as a category of contemporary thought. Another critical study is of course Leo Spitzer's "Milieu and Ambiance: An Essay on Historical Semantics" of 1942. Spitzer's vastly evocative survey proposes an archeology of the layered universe of meanings in which the concepts of milieu and ambiance are historically immersed. I mention these three canonical examples because they exemplify divergent approaches that underline the complexity and relevance of the topic.

02 *Similarly, you often refer to the way humans re-appropriate nature by technological means. How do you envision such a model and the way nature is increasingly "informed," or in other words, intensified with information assets that act in the deepest structure of nature (e.g. genetically modified nature as a direct product of technology)?*

ALESSANDRA PONTE

This question is answered by what I just said about the problem of truly understanding what we mean (and meant) by environment. I may add that it seems sort of self-evident that today human and non-human life inhabit designed environments, and that life itself is constantly redesigned and manipulated by information technologies. I can expand, borrowing from Bruno Latour's expanded notion of design. Latour, who is himself borrowing from Sloterdijk, asserts that today "*Dasein* is design." Reformulating and updating the Heideggerian notion of *Dasein*, Latour (and Sloterdijk), invite designers to think about a space age version of "being thrown into the world," where things, humans and non-humans survive on life support system. Today the problem is to decide if artificial atmospheres are well designed, and how architects, landscape architects, planners and engineers, should design and redesign membranes, and move from envelope to envelope, and from fold to fold. Designed environments, spheres, folds, membranes and envelopes demand a new understanding and representation of space.

03 *You refer to Gilles Deleuze and Felix Guattari's principle of nomadic "deterritorialization" and Marshall McLuhan's media theory in regards to the necessity to reconsider our cartographic projection of the world. What would be the qualities of such cartography in regards to our informed reality? Would you consider our increasing ability to record, integrate, and treat information as a function of this new cartography?*

ALESSANDRA PONTE

Marshall McLuhan's media theories were tied to an interesting investigation (and reformulation) of the notions of space and environment. Crucial in comprehending McLuhan are, for instance, his ideas of hidden or invisible environments and the complementary concept of counter environment. Briefly, for McLuhan environments created by media are inherently indiscernible because they perform as envelopes that entrap their inhabitants inside delusional worldviews. Extraneous, contradictory elements, "probes" or "percepts" in McLuhan's vocabulary, create counter environments that abruptly alert the dwellers of the invisible environment to its misleading, and limited perceptual field. Even more significant is McLuhan's concept of "acoustic" or "auditory" space, elaborated together with his collaborators in Toronto, including anthropologist and media expert Edmund Carpenter. According to McLuhan, acoustic space – as opposed to the visual space of literate and industrial societies – characterizes both preliterate cultures and the electronic age (i.e. information age), and is best described in Carpenter's analyses of Inuits' spatial perception as a space of flux, without a favored focus, and as a sphere without fixed boundaries, indifferent to background. Carpenter and McLuhan's ideas had a fascinating influence on Deleuze and Guattari's definitions of smooth and striated space and of nomadic deterritorialization. In fact, Deleuze and Guattari, in *A Thousand Plateaus*, which may be described as an effort to develop a novel cartography (it begins with the exhortation "Make a map, not a tracing"), devote a long section of the chapter "Of the Refrain" to the analysis of the intersection between territory and milieu. Inspired by Uexküll's definition of *Umwelt,* they write: "The territory is the product of a territorialization of milieus and rhythms [...] It is built from aspects or portions of milieus. It itself has an exterior milieu, an interior milieu, an intermediary milieu, and an annexed milieu. It has the interior zone of residence or shelter, the exterior zone of its domain, more or less retractable limits or membranes, intermediary or even neutralized zones, and energy reserves or annexes. [...] There is a territory precisely when milieu components cease to be directional, become dimensional instead, when they cease to be functional to become expressive." It is an extraordinary passage, deserving meticulous scrutiny. Here, however, it helps me to clarify how and why my researches on the notion(s) of environment are strictly connected to the investigation I am conducting on processes of territorialization and deterritorialization, and on the territory and its representation. It also explains why I left behind landscape as a method of figuration to concentrate on new forms of mapping.

04 *Another aspect of your research concerns the politics of territorial settlements and geographies. How have technological advancements contributed to shaping these politics? In particular, what role would you confer to today's communication devices, social and participatory networks in redefining the notion of territory?*

ALESSANDRA PONTE

It is clear that the shifting nature of the geopolitical events marking the last decade of the twentieth century and the beginning of the twenty-first have triggered the eruption of a debate around the notions of territory and/or territoriality. The discussion implicates the analysis of processes of territorialization and deterritorialization, and demands additional investigations about the concepts of border and frontier. Moreover, given the most straightforward and generally accepted definition of territory as "bounded space," the constitution of the notion of space itself is under scrutiny together with questions relating to sovereignty and power. A rediscovering of the work of Michel Foucault, elicited in part by the publication and translation of his lessons at the Collège de France, and prompted by Deleuze's reading or, more recently, Giorgio Agamben's interpretations of the Foucauldian theses on knowledge, power, and bio-politics, has supplied theoretical tools to approach and unravel the logic of emerging regimes of spatial politics.

Concomitantly, during the last couple of decades, cartography, a primary tool of territorial representation and governance, has been radically altered by the acceleration of the development of communication technologies that now operate with novel forms of data gathering and calculation, new platforms and interface systems with mashup capabilities, and with constantly multiplying mobile devices for accessing and producing geographic information. One salient character of these new applications and technologies is the almost virtual suppression of the materiality of the cartographic representation. Information are gathered and presented through screens and displays, while paper seems to subsist only as occasional support. The near disappearance of material representations of geographical data with their stable, time-freezing, figuration of the world appears to have boosted the already present concern with the tracing a more flickering, fluctuating, mobile, and event related reality. Not so coincidentally, the opening of these new realms of cartographic possibilities has contributed (among other things) to current arguments about globalization processes that, having declared the demise of the territory, bypass territorial investigations and representations, to focus on networks analysis and mapping. The interaction with geographical information through screens and displays has also prompted a return to a presumably "original" *navigational* use and interpretation of maps as opposed to the erroneous and misleading *mimetic* understanding of the cartographic effort. This is the proposition advanced recently by Bruno Latour (together with a group of scholars) in the context of an investigation about the relationships between maps, territory and risks, that lead the researchers to pose the following queries: "Is a map [...]

not a representation of the world but an inscription that does (or sometimes does not) work in the world? Do maps and mapping precede the territory they 'represent', or can they be understood as producing it?" These interrogations are inscribed by Latour and his team against the background of conceptual uncertainty concerning the meaning and role of cartographic practices that has characterized the studies in the field during the last decades.

In parallel to the upheavals taking place during the last couple of decades in the geo-sciences and cartography, the design disciplines (architecture, landscape architecture, urban design and planning) together with a number of artistic practices, have exhibited a growing fascination with theories informing geography, while exponentially borrowing and taking control of mapping tools. The geographic and mapping fever of the last decades, more than signaling, as it has been suggested, a "geographic turn," or even a "geological turn" in architecture, may be the symptom of a profound anxiety about the loss of control over space and its production, an indicator of deep angst about the waning agency of architects, urban designers, planners and landscape architects. The search for a merging or hybridisation of the disciplines, the attempts to integrate in the design practice environmental and social sciences together with engineering, and the loudly vocalized ambitions of architects and landscape architects reclaiming the right to design infrastructure at a territorial scale, raise at least two orders of problems. The first entails the obvious need to address the ongoing process of redefinition of the interrelated notions of environment, space, territory, border, and network, a process in which a few architectural theorists are already engaged. The second demands the equally urgent investigation of the frontiers and agency of each design discipline. Questions may be formulated as follow: Is there a territory of architecture (or landscape architecture, or urban design)? And if so what are its borders? Are the disciplines undergoing a process of deterritorialization? Is it advisable to suppress the frontiers between art, architecture, landscape architecture, urban design, engineering, physical, environmental and social sciences? Is it plausible to think that all these sciences and disciplines are engaged in design practices, and that this is the bond that ties them together? If such is the case, how this coming together of the arts and the sciences under the banner of design would differ, for example, from the 1960s repeatedly frustrated efforts to build a discipline of "environmental design"? A question which, of course, confirms the urgency and necessity of the task I described at the beginning, i.e. the understanding of how the twentieth and twenty-first centuries have defined the relation between life and its milieu.

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ELECTROACTIVE DYNAMIC DISPLAY SYSTEMS (EDDS)

— ANNA DYSON / BESS KRIETEMEYER, PETER STARK / CASE RPI

As computation has permeated all aspects of architectural practice, the inevitably rampant technophoria has occasionally been tempered by lament for a perceived loss of connection to material behavior within the design process. Yet, even as the rote building information modeling programs increasingly embed formulaic, material-based feedback, we maintain that the initial sub-genre of virtual form-making, which largely presaged material considerations, had ironically provided an important imaginative precursor for the incipient *info*-material revolution, in which, as designers of material, we are the inevitable protagonists.

Central to this debate is the question of what, exactly, will characterize the relationship between information flows and materials within emerging models? That is, will we continue to design according to the known properties of materials, or can we designate properties according to our designs? A fundamental shift may be underway, but the question of scale remains: is it inevitable that we retain predominantly top-down[1] material manipulation procedures, or will a combinatorial approach that involves self-assembled processes at bulk scale finally become viable? Regardless of what will happen at the macroscale, it seems certain that even current Stone-to-Steel Age bulk materials will be surfaced with matter whose mechanical, electrical, and optical behaviors will bear little resemblance to the materials we have known, thus far, in our daily environments. Crucially, emerging material opportunities constitute a radical departure, as we become capable of designing quantum effects at the nanoscale to attain unprecedented control over surface phenomena, which could interact and adapt to energy and information flows in a completely different manner than those of material behaviors at the micro and macro scales.

The images on these pages emerge from analysis of system prototypes that are firmly rooted in the (*pre-nano*) twin material protagonists of the last century: polymers and microelectronics, together with multiple fusions of these two materials into electropolymeric films and electroactive "micro-muscles." The micro-pixelated films are layered into the interior surfaces of glazing units as a kind of "programmable frit" for glazed building envelopes that strive for the adaptable and responsive characteristics, which had been missing from modern fixations, thereby seeking a malleability that has yet to figure prominently within architectural constructs. Experimentation with these display materials afforded us the opportunity to observe and record bioresponsive feedback loops, in which the material responds to multiple environmental and/or aesthetic inputs from both ambient conditions and design preferences. Critically, it allowed for the development of an "information framework": a series of programmable code that provided us the opportunity to both create switchable dynamic patterns within the glazed envelopes and receive real-time interpretations of the multiple energetic and informational performance effects of the various formal choices.

1 Here, the term 'top down' refers broadly to our current paradigm of manipulating material by forming it, as opposed to 'bottom up' processes that 'grow' or selectively add atoms to create structures,as per organic or life processes, through "self-assembly," in which independent entities coordinate to realize larger structures or shapes.

As a result of this experimentation, whereby the algorithms basically mimicked the behaviors, which the multifunctional material was capable of producing, we were induced to push for far greater adaptability by considering the manipulation of quantum effects at the nanoscale, such that we could develop a material behavior that responsively switches its properties, e.g. – transparent to opaque, absorbing to insulating, blue to red, etc. As such, our most recent prototypes depart, fundamentally, from the "fixed" material paradigm in a critical way – in a way that is emblematic of the radically new material opportunities that we, as a society, are grasping for the first time. Critically, these opportunities are rooted in a fusion of solid state and life processes, rather than the operative manipulations inherent to the top-down material processes of the past. We would argue that electropolymeric films, although adaptive and "multifunctional" are still diagrammatically similar to and, in fact, directly descended from, the top-down, *throughput* material economy[2] that we have been effectuating since the bronze age: namely, we heat or burn something in order to form, cut, or shape a material, thereby imbuing that material with various properties, or most recently, multiple "functions." Yet, we are still designing with the known properties of materials, from the micro to the macro scale, even if the structures of micrometric dimensions are fabricated to embed electromechanical information and/or the "intelligence" within them.In contrast, even though we obviously still seek to mimic, at the nano-scale, the top-down forming processes so deeply ingrained within our history, we are now fundamentally within the emerging age of molecularly engineered materials that can assemble themselves chemically through molecular recognition, which constitutes such a radical and fundamental departure from how we have ever manipulated material in the past, that the repercussions are still entirely open to speculation. The possibility that such bottom-up approaches should theoretically be much cheaper, be able to avoid the high heat fluxes associated with carbon-intensive processes, and be capable of producing devices in parallel in mass quantities, has thus far been an unbreached barrier. However, the potential departure from throughput processes has unprecedented capacity for profound social and environmental implications. The emerging informatics of material science is fundamentally altering our potential relationship to certain materials within the design process: from specifying materials and engineering around their known capabilities, to specifying desired material behavior and designing the material(s) accordingly.

fig 1
Mediated Bioresponsive Building Envelopes. In contrast to existing dynamic glazing technologies, emerging display technologies have the potential to actively reconfigure their basic patterns to respond to fluctuating environmental flows while simultaneously adjusting to variable aesthetic preferences. This research is prototyping Electroactive Dynamic Display Systems (EDDS) with thin film electroactive materials to enable instantaneously switchable patterns to be embedded within the surfaces of insulated glazing units (IGUs).

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2
Throughput Material Economy is described variously in Environmental Economics and Life-Cycle Analysis as the linear "extractive" material processes that, historically, have characterized almost all urban economies up to recent times, whereby materials are extracted, treated, manipulated, installed, and eventually discarded.

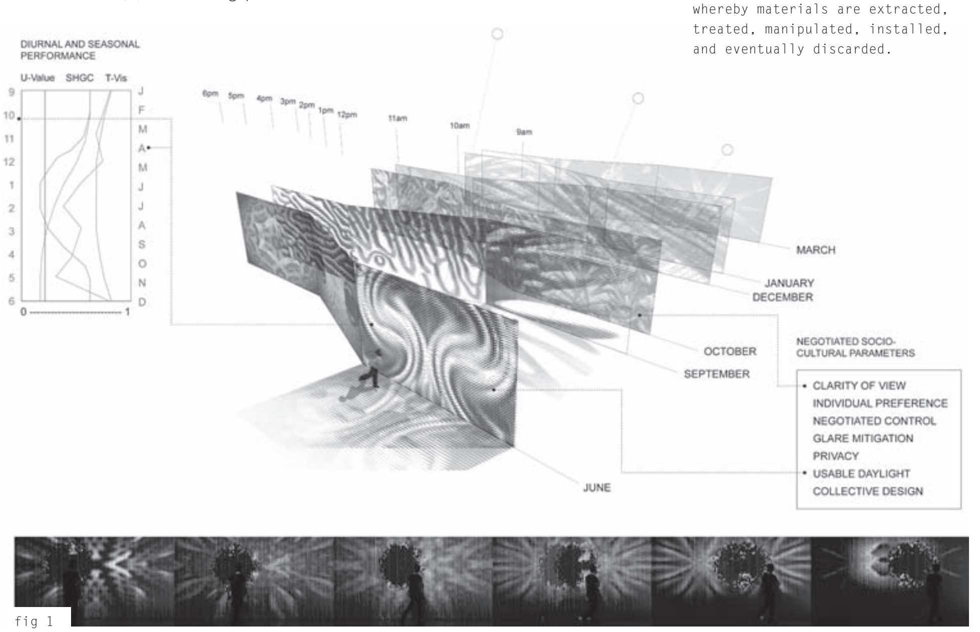
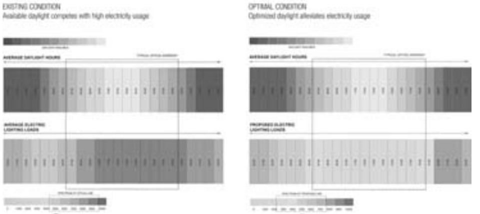


fig 1



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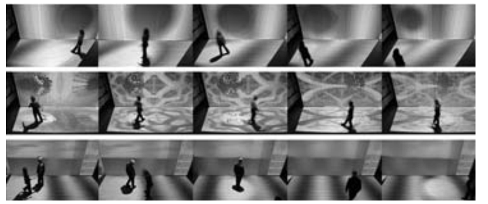

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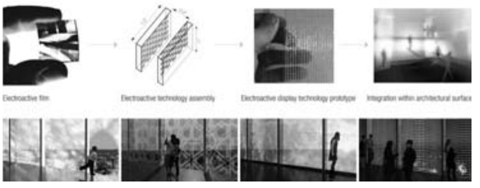

fig 4

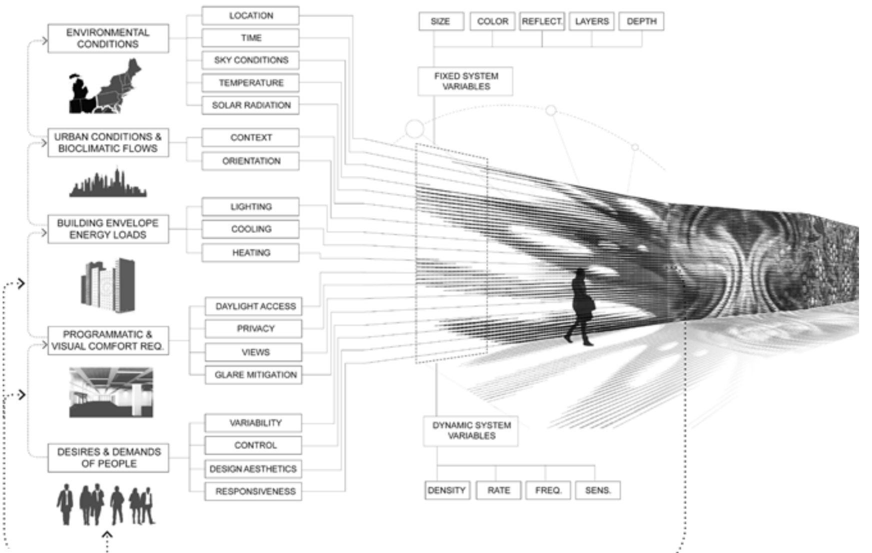

fig 5

fig 2
Missed Opportunities between Available Daylight and Programmatic Requirements. A key example of the tension between environmental and aesthetic desires in the design of building envelopes: admitting quality daylight and access to exterior views while controlling glare and solar heat gain through glazed surfaces. Currently, existing technologies mitigate heat gain and glare disturbance at the expense of views and useful daylight, leading to maximum artificial lighting usage in commercial buildings during peak solar hours.

fig 3
Emergent Biomorphism in Response to Environmental Fluctuations and Individual Preferences. The simultaneous mediation of bioclimatic and social information flows creates a flexible and adaptive boundary condition. In responding to bioclimatic flows, the EDDS can be programmed to dynamically adjust its local pattern densities according to shifting solar geometries and temperature fluctuations for increased whole-building energy efficiency, synergistically interacting with aesthetic and communication preferences with real-time feedback on the various impacts of choices being made.

fig 4
Electroactive Dynamic Display System (EDDS). Recent breakthroughs in the field of information display technology have provided opportunities to transfer emerging materials to glazing systems that can offer increased variability, solar modulation, and user control over visual effects. The emerging informatics of *new* multifunctional material science will fundamentally alter our relationship to materials within future design processes. Instead of specifying materials and engineering performance around their known capabilities, we will specify desired material *behaviors* and design the material(s) accordingly.

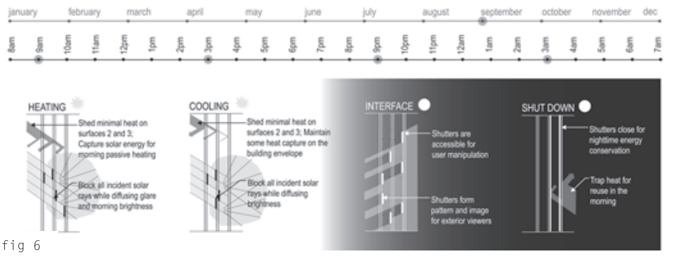

fig 6

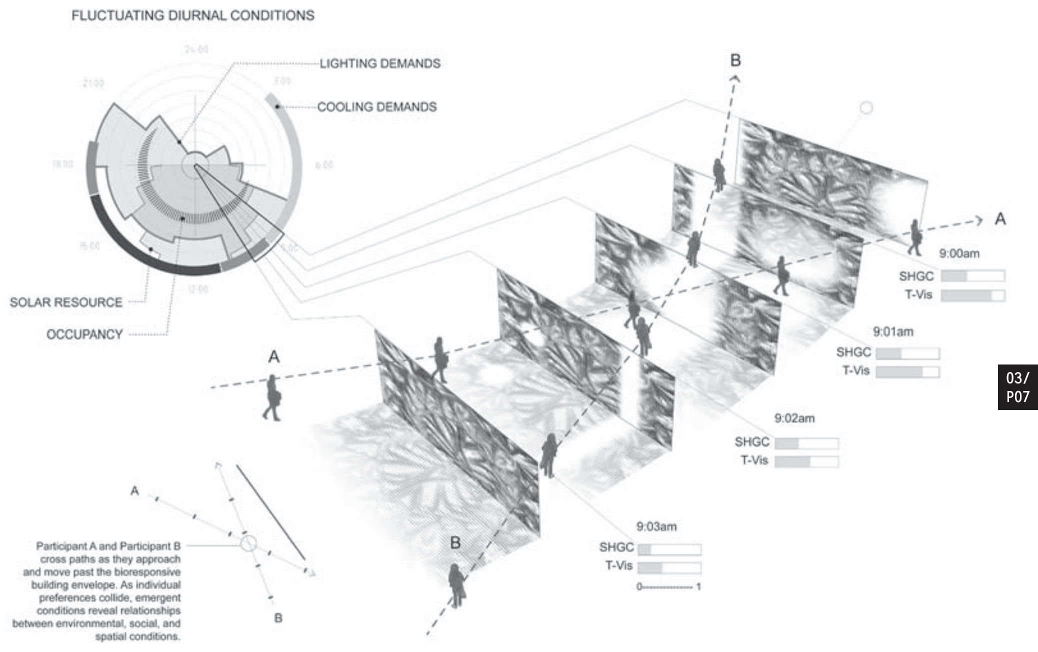

fig 7

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fig 5
Multi-Scalar Dynamic Design Framework. In exploring methods to incorporate bioclimatic and biological inputs in the design and testing of highly responsive, adaptable, and information-rich patterning technologies such as the EDDS, addressing environmental modulation, building demands, design intentions, and the diverse preferences of building inhabitants within an integrated and *simultaneous* framework is essential. The mediated bioresponsive building envelope framework embodies multi-scalar environmental, programmatic, and social parameters into the design feedback loop for real-time understanding of the implications of pattern decisions.

fig 6
Twenty-Four Hour Bioresponsiveness. Examples of trade-off decision-making for the design of pixel placement for a day in September, New York City. When electroactive 'shutters' are applied as multiple layers onto at least two surfaces of an IGU, selective geometric and spectral solar tracking throughout the day (and year) is possible. This layered and staggered pixelization effectively creates a selective two-axis solar tracking system that is programmed to intercept all incident solar rays, thereby blocking heat gain and glare while permitting views and diffuse daylight. Furthermore, this technical approach enables the progammability of various patterns for information display or to adjust degrees of privacy.

fig 7.
Negotiating Environmental and Socio-Cultural Information Flows. Example of a switchable building envelope condition that negotiates the personal preferences of two occupants while simultaneously adjusting to fluctuating environmental flows. When environmentally responsive patterns were combined with multiple user interactions in full-scale experiments,[3] an unexpected biomorphism emerged, unveiling interdependent aesthetic, material and temporal relationships that shaped the system's performance and architectural expression.

3 A fully interactive and immersive environment for designing and testing bioresponsive material behaviors was installed at Rensselaer's Experimental Media and Performing Arts Center (EMPAC) for the 2012 International *SmartGeometry* workshop and conference.

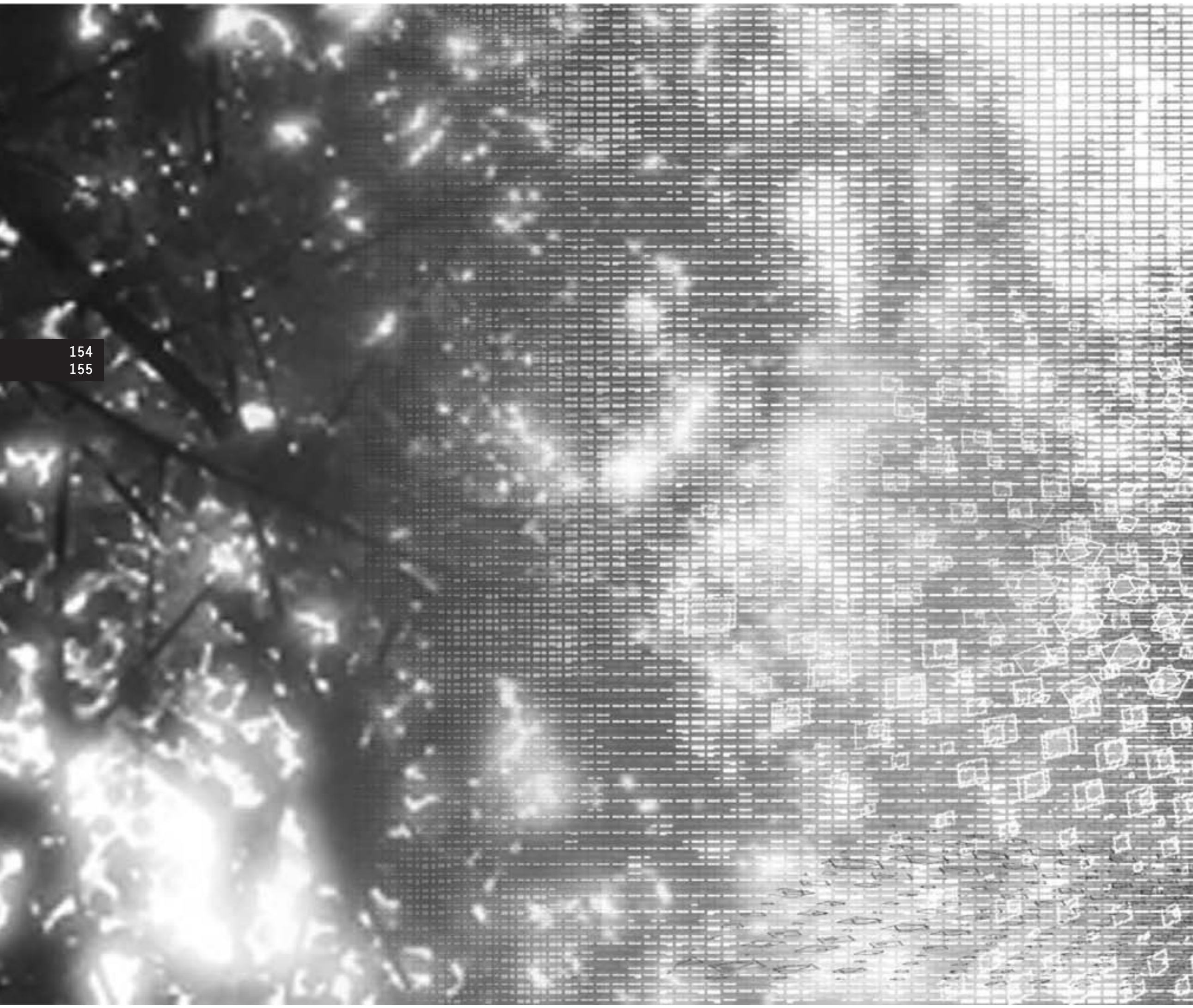
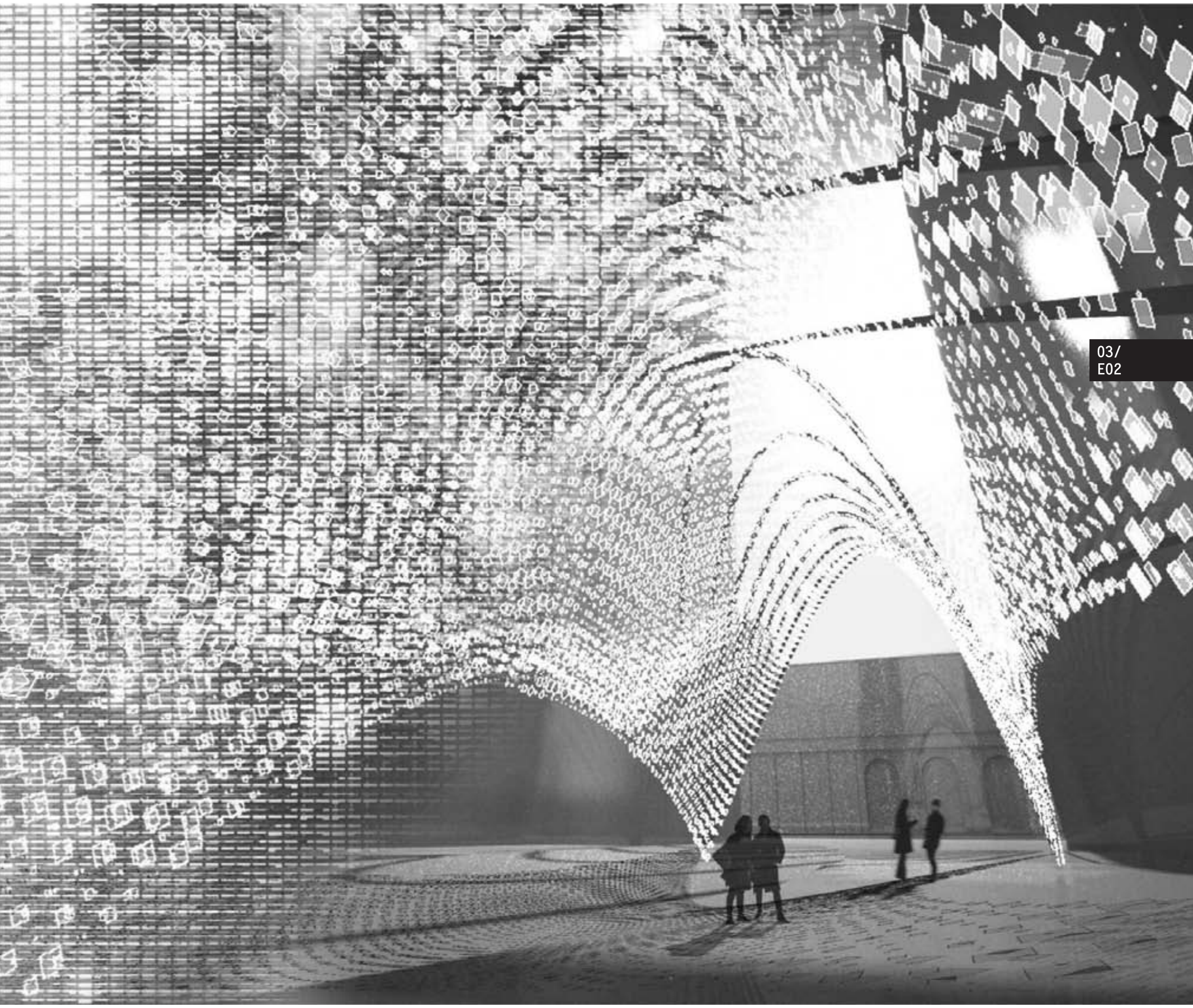


fig 8

fig 8
Proposal for a New York City Public Covered Plaza, Skidmore, Owings and Merrill LLP (SOM) and the Center for Architecture Science and Ecology (CASE). A proposal for a public plaza attempted to reveal the fluctuating programmatic activities informing the patterning and movement of the electroactive shutters for dynamically filtering sunlight, shedding unwanted solar heat gain, and expressing information in a way which is open to the public and variably programmed by multiple public and/or private entities.



<u>Electroactive Dynamic Display Systems (EDDS)</u>

Architects
Bess Krietemeyer
Anna Dyson, Center for Architecture
Science and Ecology (CASE)

Collaborating Architect
Nicholas Holt
Skidmore, Owings and Merrill (SOM)

Physicist
Peter Stark, Center for Architecture, Science and Ecology (CASE)

Mechanical Engineer
Nikhil Koraktar, Rensselaer Polytechnic Institute (RPI)

Electrical Engineer
James Lu, Rensselaer Polytechnic Institute (RPI)

Building Controls Engineer
Sandipan Mishra, Rensselaer Polytechnic Institute (RPI)

Material Scientist
Robert Hull, Rensselaer Polytechnic Institute (RPI)

Computer Programming
Sam Seifert, Rensselaer Polytechnic Institute (RPI)

GRADATING SPACES: PLOT, CONTOUR VS. *SFUMATO*, DIMMING IN ARCHITECTURE

— PHILIPPE RAHM

We begin with questions prompted by the interesting parallels between architecture's formal demarcation of space relative to the environment and distinguishing the figure and ground in paintings. How does one lose the figure of a substance? Or, how does one delineate the boundaries of a space from its site? The history of art provides some interesting answers to this question, depending on: time period, recording/representational techniques, and scientific knowledge.

On the one hand, there is the age-old strategy of clearly separating form and context with the path or contour of a line. This strategy began with art itself, and can be seen in both Egyptian frescoes and Byzantine icons. It can also be found in nineteenth-century academic paintings, like the use of black lines on the pants of Edouard Manet's fifer, and even in the clear lines of the stripe of the twentieth century. Here, the contour line of the figure can: define an interior of an exterior, separate a foreground from its background, and differentiate a figure from its context.

On the other hand, there are the strategies of dissolving the boundary between a subject and its context, or between two adjacent figures. This strategy interests us more, as it derives from the technique known as *Sfumato*. *Sfumato* was invented by Leonardo da Vinci, and can be best described as drawing "without lines or contours, like smoke." Da Vinci achieved *Sfumato*, an effect of ethereal, undefined, and gradient transition between a figure and its background, by overlaying dozens of very thin layers of glaze, each containing very little pigment, at thickness of 1 to 2 μm. This gave a sense of depth to the otherwise solid colors of paint, and allowed da Vinci to avoid drawing contours. The technique later acquired scientific explication with the invention of photography.

At the end of the nineteenth century, the noted Austrian photographer Heinrich Kühn famously characterized photographs as a medium consisting of the continuum between black and white, and photography as work with gradations of brightness, rather than with contours. According to Kühn, this allowed photography the ability to render even the most delicate play of light, as it could subtly express the seamless succession of gradations caused or carried by lighting effects. He went on to establish a palette of gradations while working on his "Studies on the gradations," which described the "fine gradations" allowing the photographic medium to create an image only by changes in light tones. For Kühn, then, the photograph did not represent the outline of a figure against a background. Rather, the figure was represented only with changes in light intensity, from lighter to darker, thereby distinguishing objects and backgrounds by their ability to absorb or to reflect, more or less light. Kühn's photographic techniques were later adopted by the Impressionists, and then even more radically by the neo-impressionists and pointillists. These artists abandoned paint lines and contours in favor of a paint-by-point color, which was distributed not according to the subject being depicted, but on variations in both the tone and intensity of colors and light. This practice anticipated Frederic Crockett Billingsley's invention of the pixel for digital imaging in 1965.

Having made this connection between *sfumato* and the pixel, we can dispense with the strategy of merely following the trace and contour of an object. After all, with our knowledge of the physical world and our understanding of the constant communication between all things, we can dispense with the notion of boundaries between objects. Specifically, we suggest that the traditional way of tracing the contours of space with walls and floors to clearly separate two spaces, one inside and one outside, can be displaced in favor of a mode of composition in which spaces are created by both the gradation of light, following Kühn, and gradations of heat, vapor, noise, or air pollution. Architecture belonging to this paradigm shift would be composed through gradations of both climatic intensities and densities of chemical and physical components. To demonstrate this shift, we describe two recent projects, which were designed using this mode of architectural composition.

Gradating Atmospheres, Taichung Gateway Park

The structuring principle of this park is based on the climatic variations within specific areas of the park: those that are warmer, more humid, and more polluted, and the subsequent augmentation of these areas to create cooler, less humid, and less polluted areas. Beginning with the existing conditions, we defined three climate maps of the park responding to: (1) the cold wind coming from the north, (2) the humid wind coming from the sea, and (3) the polluted air coming from the roads. Each map corresponded to a particular atmospheric parameter – heat, humidity, and pollution, and was produced with climatic devices to modulate the intensity of their respective atmospheric parameters. These three maps intersect and overlap randomly, creating a diversity of microclimates and experiences.

To generate these weather maps, we invented an exhaustive catalog of climatic devices. Each device modulated climatic conditions by reducing excess heat, humidity, and pollution. These devices, which we call “weather instruments,” are similar to plants and trees, in that they have specific properties for reducing pollution and absorbing sunlight. They consist of water jets, misters, fountains, and other technologies of dehumidifying the air – and sometimes warding off mosquitos with ultrasound. Depending on the density and the number of devices, any particular climate could be superimposed, separated, regrouped, made more dense, and then expanded, in order to generate a variety of atmospheres with different properties, which users can then freely select and use.

The devices include contemporary extensions of traditional, urban furniture, such as benches and fountains, and small buildings such as kiosks, factories, or the follies that are commonly found in parks. Each of these devices reduces excess, uncomfortable climate by generating more comfortable climates, even if with just one atmospheric parameter. If, say, we wanted to create a dryer area by lowering the moisture content to 70 percent, we can just install more dehumidifiers. Thus, the distribution of programs, including public buildings, recreational areas, paths, and playgrounds, will be able to naturally, *actually* follow new climate zones.

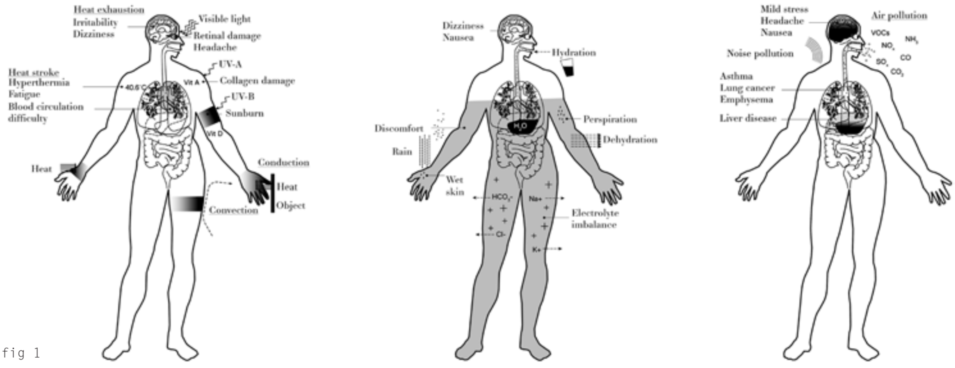

Heat exhaustion
Irritability
Dizziness
Visible light
Retinal damage
Headache
UV-A
Collagen damage
Heat stroke
Hyperthermia
Fatigue
Blood circulation difficulty
40.6°C
Vit A
UV-B
Sunburn
Vit D
Heat
Conduction
Heat
Object
Convection
Dizziness
Nausea
Hydration
Discomfort
Rain
Perspiration
Dehydration
Wet skin
Electrolyte imbalance
Mild stress
Headache
Nausea
Air pollution
VOCs
CO
Noise pollution
Asthma
Lung cancer
Emphysema
Liver disease

fig 1

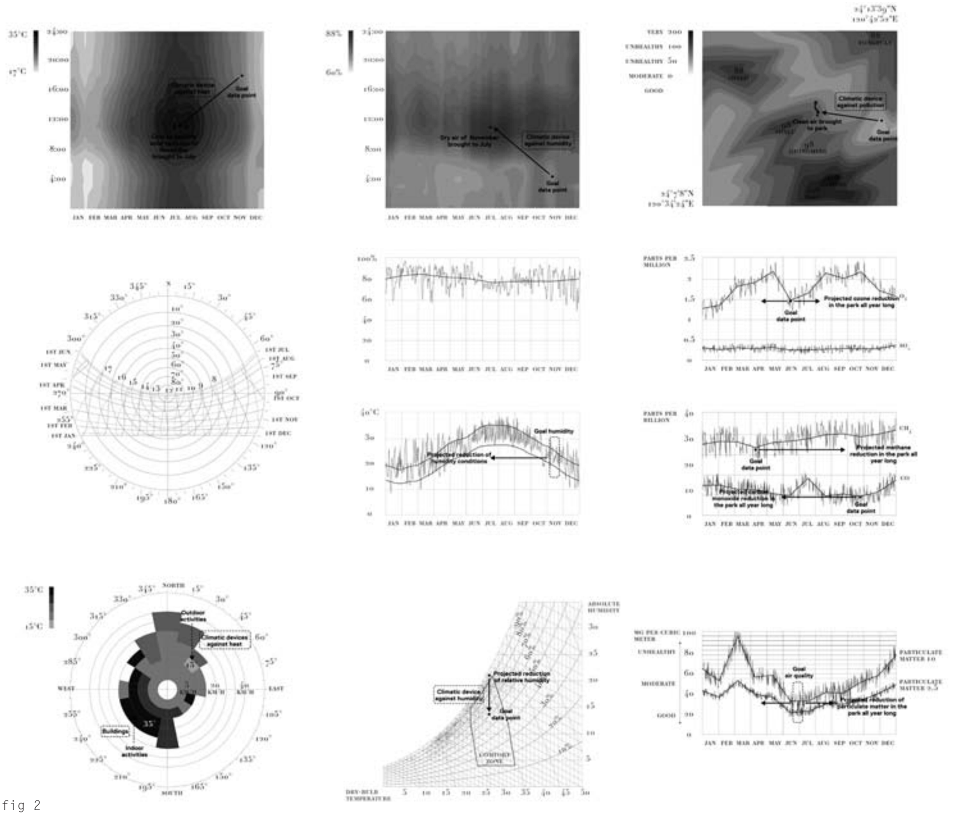
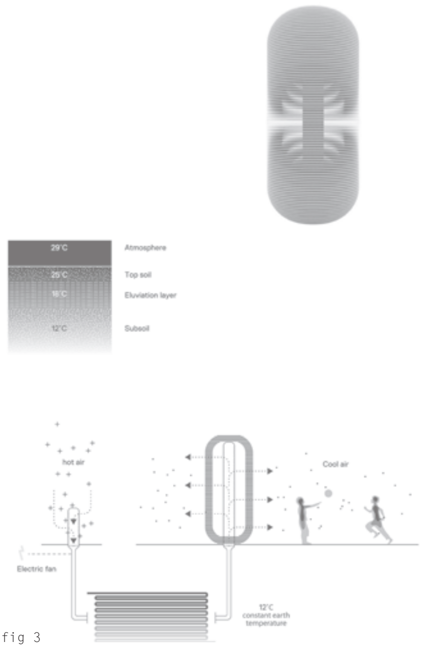

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Goal data point
Climatic device against humidity
Climatic device against pollution
Projected reduction of humidity conditions
Goal humidity
Projected ozone reduction in the park all year long
Projected methane reduction in the park all year long
NORTH
SOUTH
WEST
EAST
Outdoor activities
Climatic devices against heat
Buildings
Indoor activities
Projected reduction of relative humidity
Climatic device against humidity
COMFORT ZONE
DRY-BULB TEMPERATURE
ABSOLUTE HUMIDITY
Goal air quality
UNHEALTHY
MODERATE
GOOD
PARTICULATE MATTER 10
PARTICULATE MATTER 2.5

fig 2



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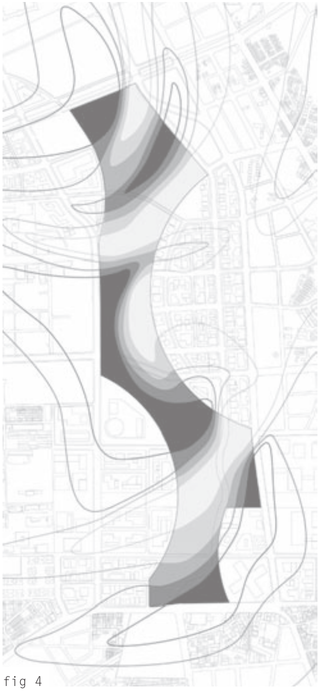

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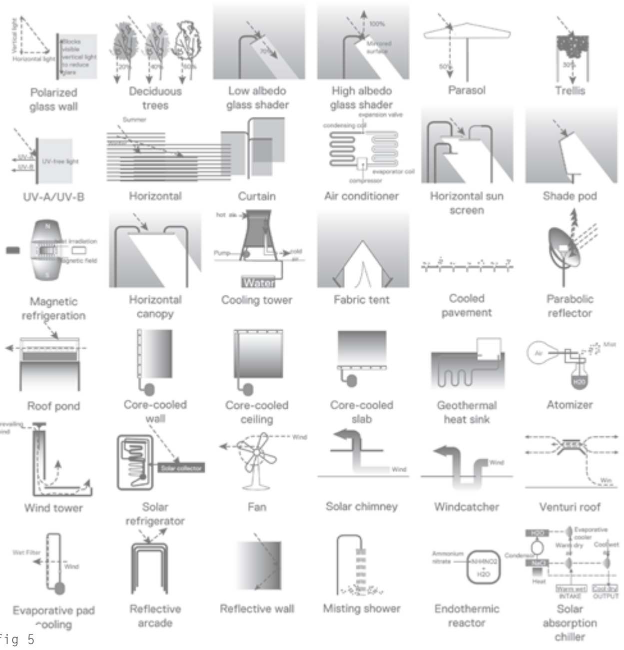

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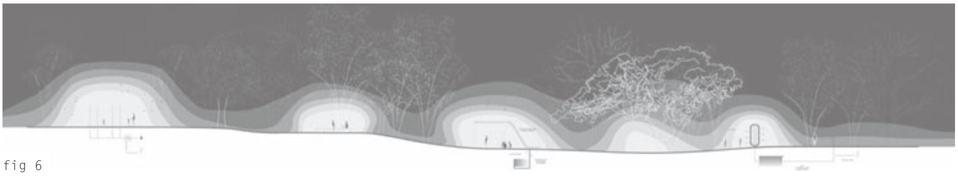

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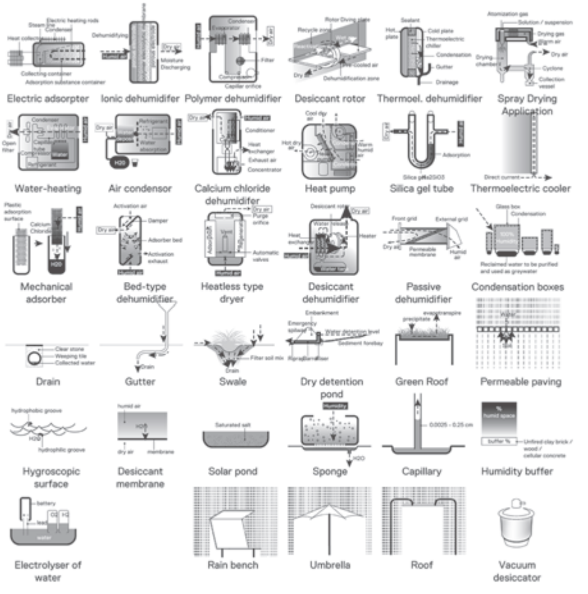

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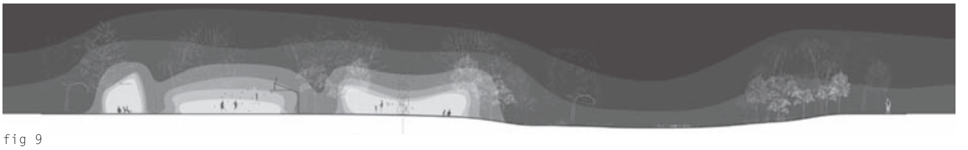

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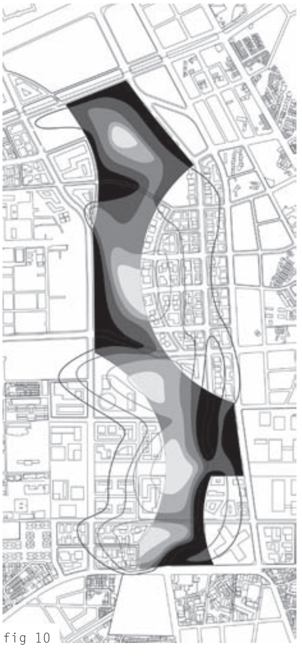

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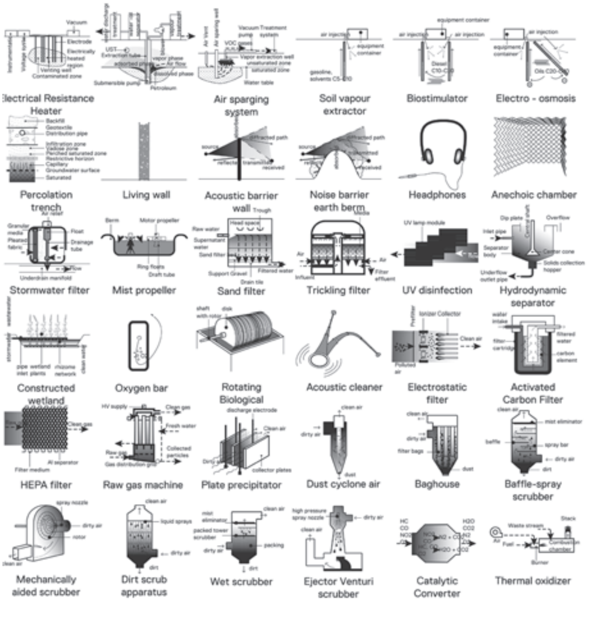

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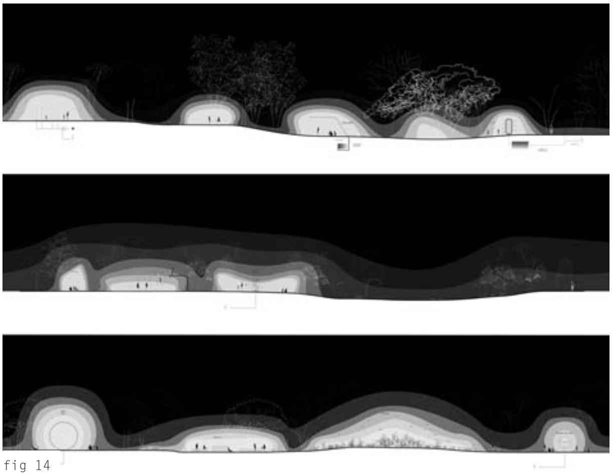

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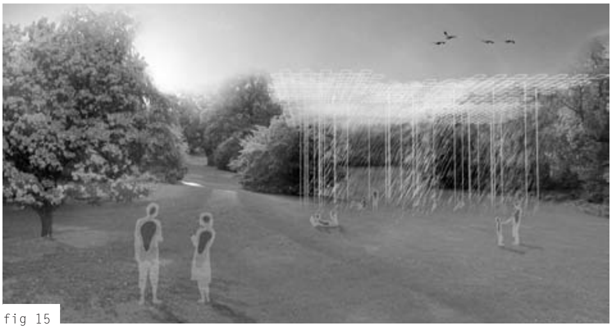

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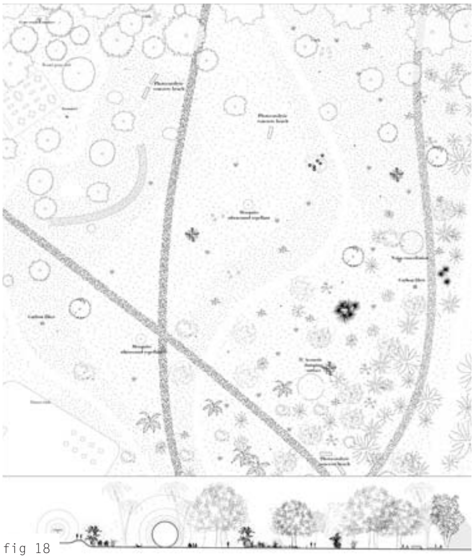

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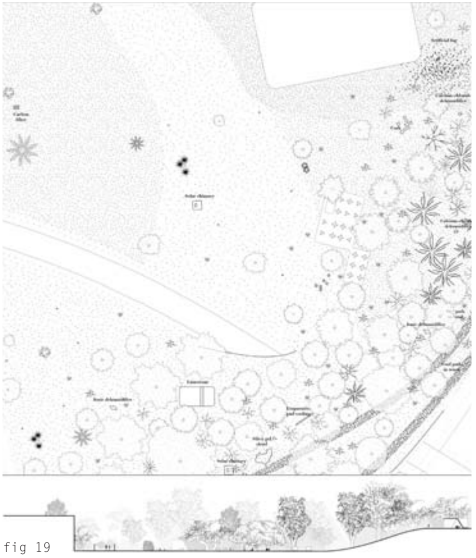

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fig 20


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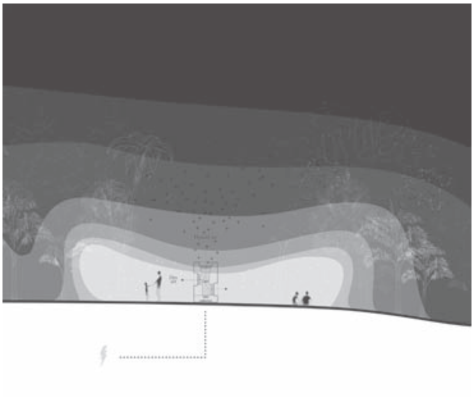


figs 1-26
Taichung Gateway Park, Taiwan

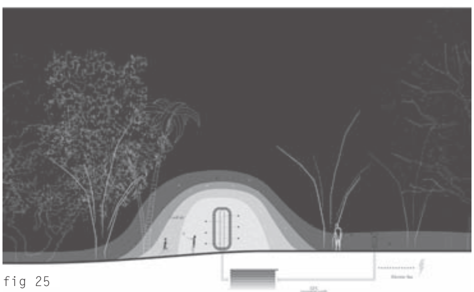


fig 25

fig 26

Gradating atmospheres
Taichung Gateway Park

Architects
Philippe Rahm Architects

Landscapers
Mosbach Ricky Liu, & Associates

Customer
Taichung City Government

Site area Taichung Gateway
Total floor area: 70 hectares

Design phase
January 2012-December 2012

Construction phase
January 2013-July 2015

VACUUM WALL

— LYDIA KALLIPOLITI AND ALEXANDROS TSAMIS

Vacuum Wall is a proposition for a cleaning device embedded in the structure of exterior envelope components. The scope of this study is to reevaluate the function of large exterior surfaces in polluted cities and augment their environmental performance by collecting dust. Floating dust particles are collected on the wall, thereby purifying the air. The surface, then, by polluting itself, attains a positive, productive role for the global atmosphere.

The mechanism for collecting dust from the air is activated by electricity, which, similarly to the role that a magnet plays in the collection of iron fillings, channels or vacuums floating dust particles onto the felt surface. Felt, a non-woven fabric formed by bonded irregular masses of animal waste, is a quasi-manufactured material. It can be manufactured, but, by incorporating more particles, it can also occur incidentally in time. In this case, felt attracts floating, airy dust particles and integrates them into its body. Though this is a significantly time-consuming process, it can be artificially accelerated by electricity, which plays the role of the catalyst in a catalytic, chemical reaction. The electricity to power this process comes from the surface. If subjected to even small amounts of stress, piezoelectric materials integrated in the exterior wall structure will generate electricity. Air currents in tall buildings can actually provide sufficient stress for this to occur.

Vacuum Wall primarily consists of two translucent façade layers which enclose a folded surface of felt. The felt layer can unfold, through designed apertures of the facade, in both directions. A special mechanism of pneumatic bubbles is embedded in the felt in order to regulate this unfolding. Piezoelectric materials configured in cable form are attached to the exterior layer of the envelope, generating the necessary electricity. When triggered, the felt vacuums the dust and converges into a thicker, denser material. Over time, the material changes drastically, which has an impact on the building façade. Eventually, the felt layer can be removed and used as the moisture barricade in the construction of building foundations.

Vacuum Wall purifies the polluted air of your city. Retrofitted to the exterior envelope of buildings, it functions as a cleansing device that attracts floating dust particles, incorporates them into its body, and then outputs reusable felt. By substituting your traditional curtain wall with a performative system that purifies the atmosphere, you, too, can make a difference in our global cause to reduce air pollution.

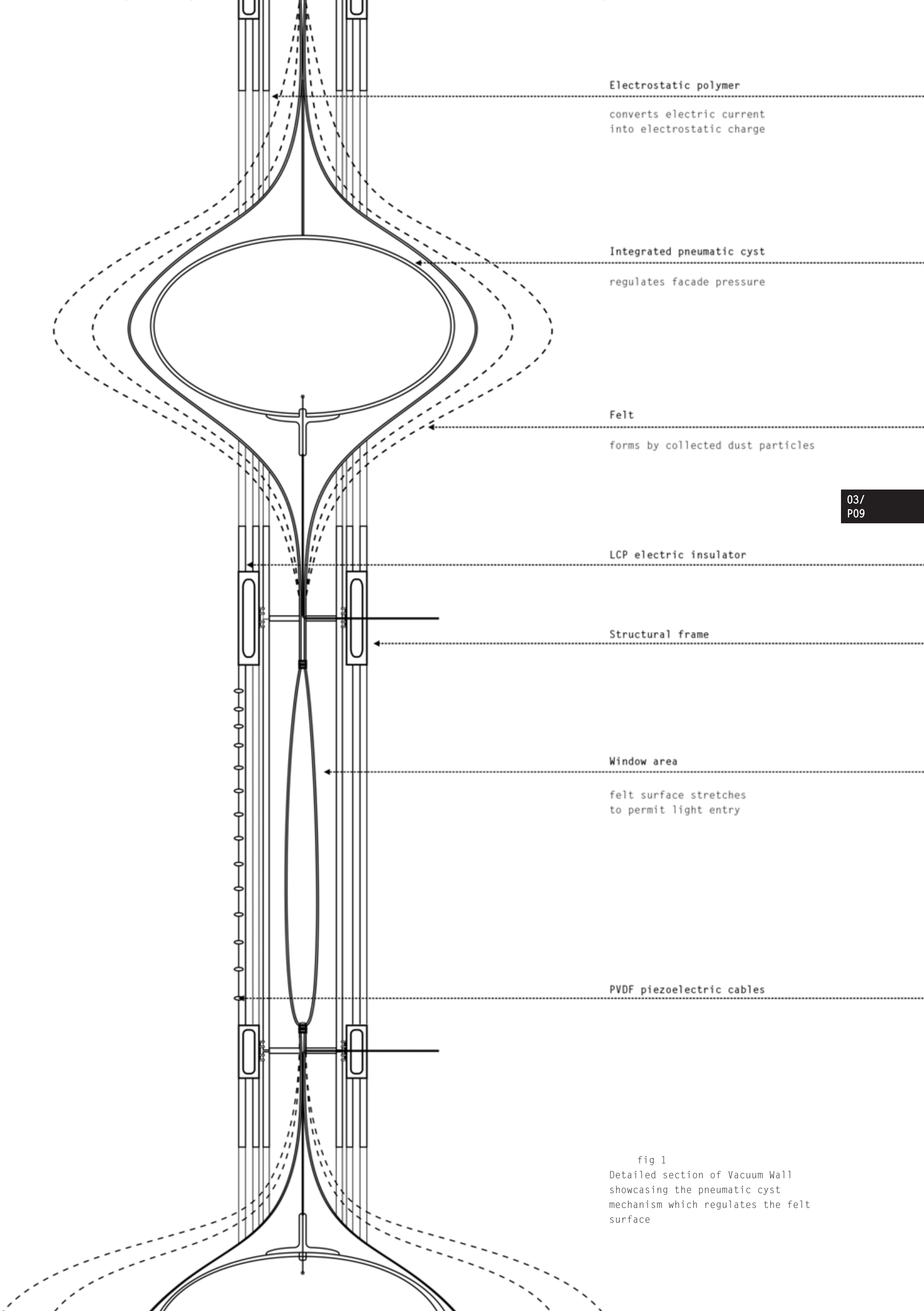
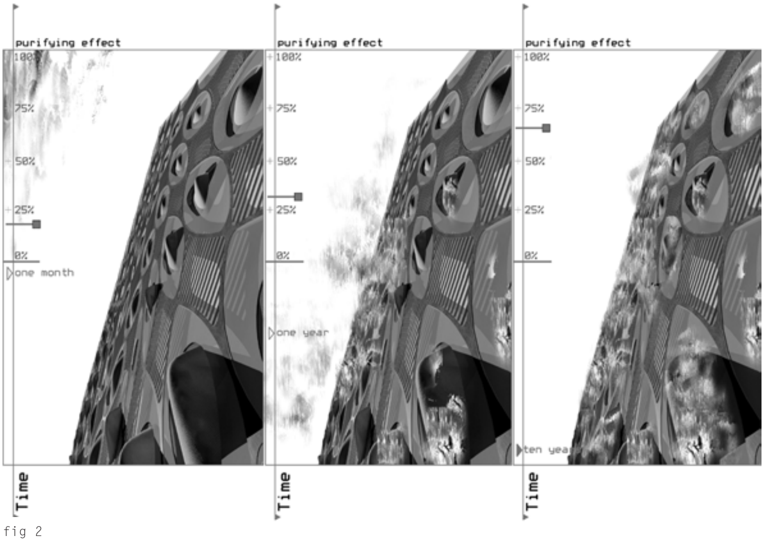


fig 1
Detailed section of Vacuum Wall showcasing the pneumatic cyst mechanism which regulates the felt surface



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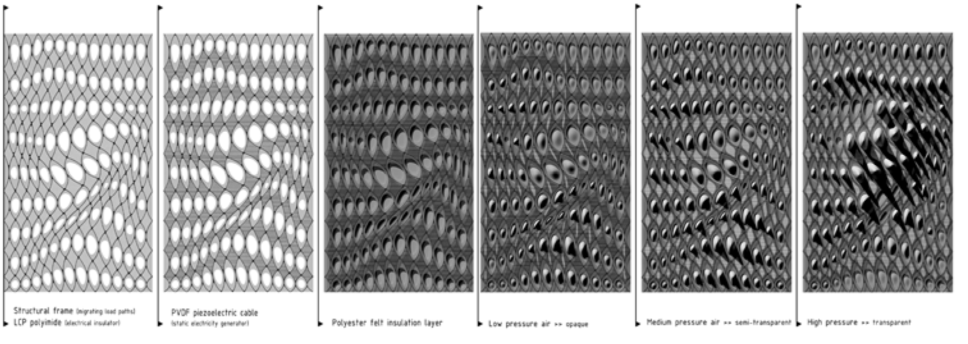

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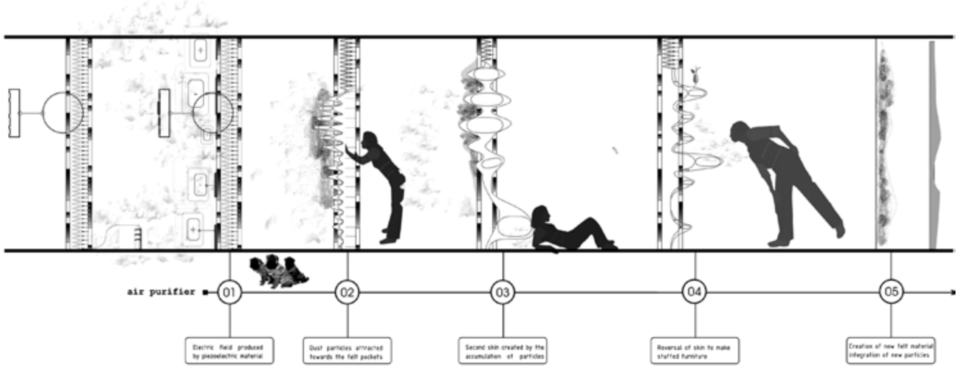


fig 4

fig 2
Vacuum Wall perspective timeline, indicating the accumulation of particulate polluted matter from the atmosphere over time.

fig 3
Series of material layers that compose the Vacuum Wall prototype.

fig 4
Vacuum Wall sectional timeline scenario.

fig 5
Vacuum Wall exploded axonometric.

fig 6
Vacuum Wall elevation sketch.

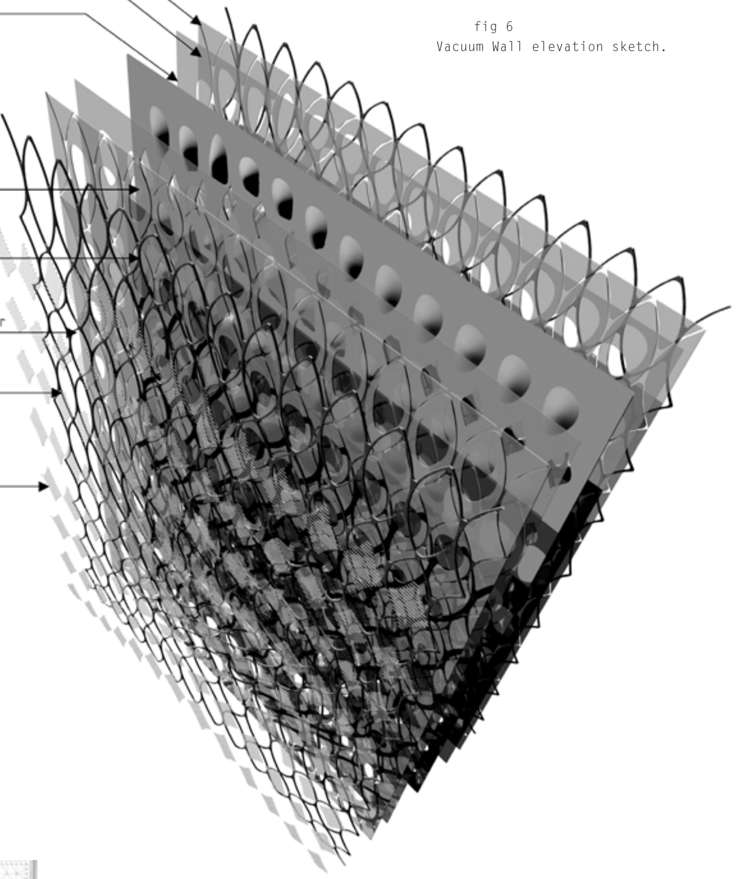


fig 5

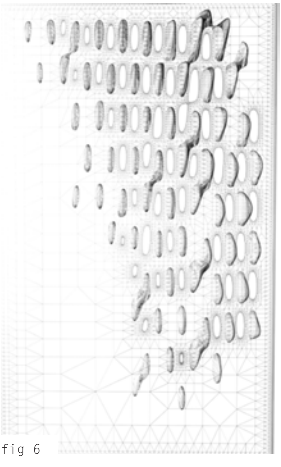


fig 6

Vacuum Wall
2005

Architects
Lydia Kallipoliti & Alexandros Tsamis

Location
Cambridge, MA

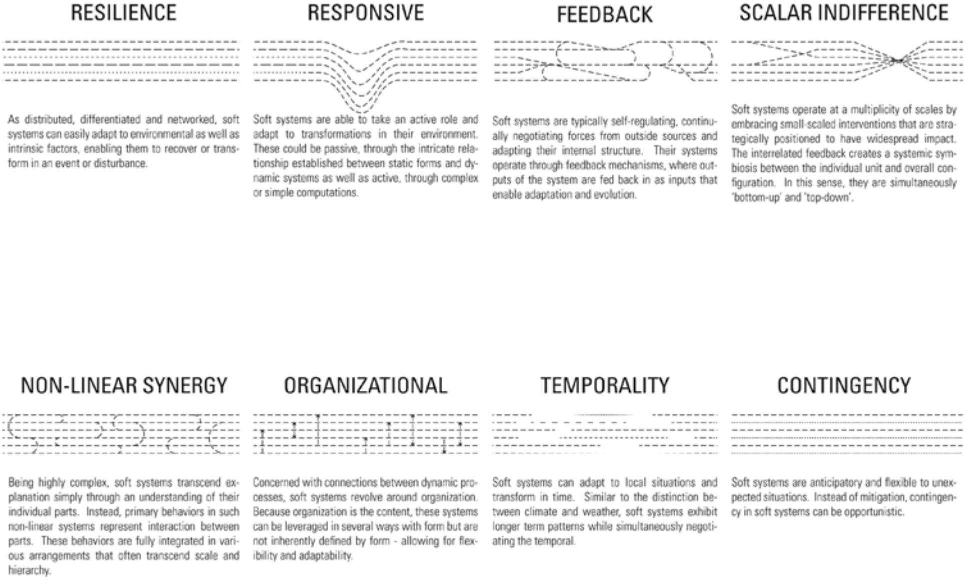
Type
Research Design Project in Building Technology

SOFT INFRASTRUCTURAL SYSTEMS AS A TEMPLATE FOR ARCTIC URBANISM

— NEERAJ BHATIA / INFRANET LAB

Creating a network of hard infrastructure in the Canadian north has been a difficult endeavor due to its extreme climatic conditions, immense scale, and remoteness. Presently, the north is scattered with a fragmented system of infrastructures and settlements that have taken their cues from those in the "south" – hard, permanent, and independent systems that are difficult to upgrade or alter. However, the characteristics of ecosystems — as non-linear, self-organizing, and complex feedback systems capable of juggling various forms of hierarchies and scales – provides a more sensitive template to respond to the variegated systems, climate, and cultures of the Canadian Arctic. We could describe these characteristics as "soft" in terms of their adaptability, responsiveness, immateriality, and ability to impact a territory much greater than their scale. (fig 1)

fig 1
Characteristics of soft systems
Liquid Commons.



Liquid Commons

A recent report by The Royal Commission on Aboriginal Peoples has suggested that the original goal of the Canadian government's set of formal educational strategies, as implemented in the Arctic in the 1950s, was to assimilate Inuit populations.[1] While it is difficult to determine exactly how far the ramifications of such an assimilation strategy might have spread, there are several statistics that reveal a general pattern. Recent studies have found that more than half of Nunavut's working-age population and 80 percent of the youth (ages 16–25) struggle with literacy.[2] More specifically, some 88 percent of the Inuit scored below level 3,[3] which is considered the minimum level necessary to meet today's societal challenges.[4] The premier of Nunavut, Aariak, has suggested that the lack of education is at the root of the poor housing conditions, high suicide rates, domestic violence, poverty, and lack of job skills in the Inuit communities.[5]

One of the largest challenges to providing education in the Arctic is the geographic dispersal of many small settlements over a large landscape. *Liquid Commons* addresses this issue by providing a malleable network of knowledge to bridge these scattered populations. The proposed "Hudson-Ungava" Library consists of a series of "knowledge boats" that travel between Northern Quebec and Nunavut, thereby connecting the harbors of Cape Dorset, Kimmirut, Ivujivik, Salluit, Kangiqsujuaq, Quaqtaq, Kangirsuk, Aupaluk, Tasiujaq, Kuujjuaq, and Kangiqsualujjuaq during the summer months. (fig 2) Currently, the area and number of books in a library is dictated by Capital Planning guidelines, which is based on population. By having mobile libraries, smaller settlements in close proximity to each other can consolidate their respective collections. In these settlements alone, a total core population of 7,500 is formed, which now enables other educational spaces, such as internet cafes, community rooms, and areas to exhibit traditional culture through practice and art. Thus, "knowledge boats" allow for both the dissemination and creation of knowledge, which feeds back into the networked settlements. Various boat hierarchies tied to differential schedules allows for a dynamic system that is easily adaptable and conducive to expansion or contraction (figs 3-4). During the fall, before the Hudson Straight and Ungava Bay freeze, the boats travel to a series of flexible nodes, which are positioned at the junction of several winter snowmobile trails. The ensuing winter freeze anchors the boats at these nodes to create a central hub, which allows communities to interact, as well as harkens back to the traditional, nomadic winter lifestyle. Further, these boats are positioned to "bridge" the fissure created by ice-breaker routes, allowing communities to be connected via snowmobiles. (fig 5) In the summer, this nodal meeting-point serves as both a habitat for native birds and a harvester of tidal energy. (fig 6) By utilizing water as a distributor and energy harvester during the summer, and by acting as a shared connective platform in the winter, *Liquid Commons* becomes a soft unifying network and node. (fig 7)

Soft Environments

The Canadian Arctic is defined by its extremes – from very long to very short days, and from severe freezing to rapid thaw cycles. Architecture and infrastructure operating in such a context are typically designed for the most extreme of these annual conditions, with built forms that are often permanent, static, and imbued with high capital costs. Soft systems, on the other hand, typically leverage an existing condition to find opportunities of engaging in malleable relationships. The complex feedback loops in such systems, and the ability to dynamically update the system as events unfold, allow for a designed openness. Ultimately, the project of soft systems allows the designer to consider the complex networks in which their interventions exist, and to position architecture and infrastructure within these networks in ways that allow them to create systemic symbiosis, nested hierarchies, and feedback loops.

1 "Backgrounder on Inuit and Education." *For Discussion at Life Long Learning Sectoral Meetings, November 13 and 14 in Winnipeg and November 18 and 19 in Ottawa* (October 2004), Inuit Tapiriit Kanatami, accessed 24 March 2010, http://www.aboriginalroundtable.ca/sect/lrng/bckpr/ITK_BgPaper_LLL1_2_e.pdf

2 "Literacy in Nunavut," Nunavut Literacy Council, accessed 24 March 2010, http://www.nunavutliteracy.ca/ "International Adult Literacy and Kills Survey (IALSS)," Stats Canada (2005), accessed March 24, 2010, http://www.statcan.gc.ca/daily-quotidien/051109/dq051109a-eng.htm; "Learning a Living: First Results of the Adult Literacy and Life Skills Survey," Organization for Economic Cooperation and Development (2005), accessed 8 September 2012, http://www.oecd.org/education/educationeconomyandsociety/34867438.pdf

3 According to levels set by The Organisation for Economic Co-operation and Development (OECD) based on Canadian Language Benchmarks Literacy Placement Tool and Assessment surveys.

4 "Literacy in Nunavut," Nunavut Literacy Council, accessed 24 March 2010, http://www.nunavutliteracy.ca/ For comparison, in the rest of Canada, only 40 percent of the population scored so low.

5 "Nunavut Premier Says focus should be on Education." Weber, Bob. *The Toronto Star*, (2009), accessed 24 March 2010, http://www.thestar.com/news/%20anada/article/611147

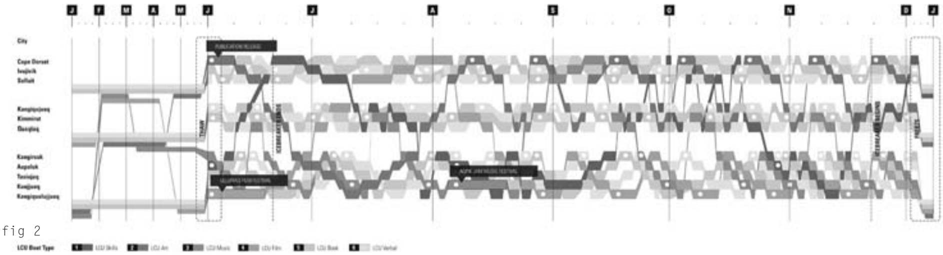


fig 2

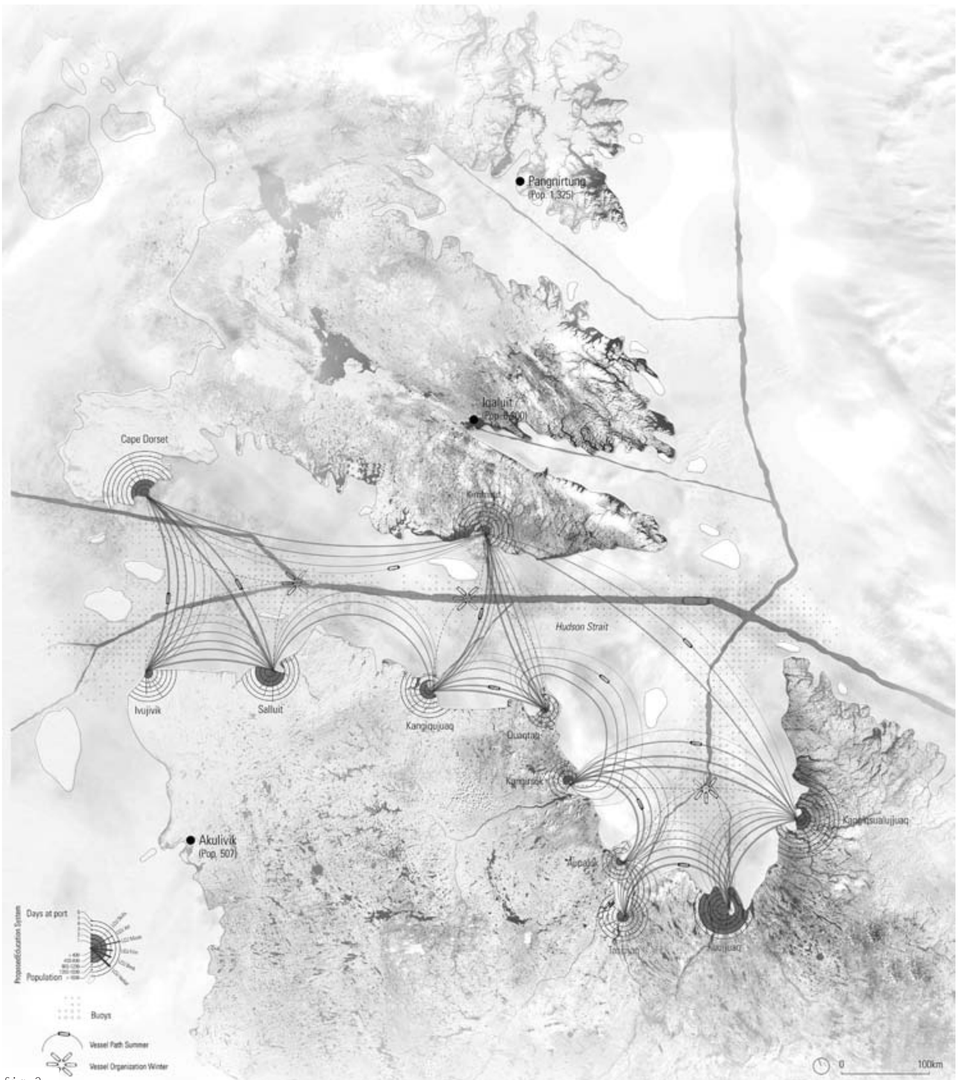


fig 3

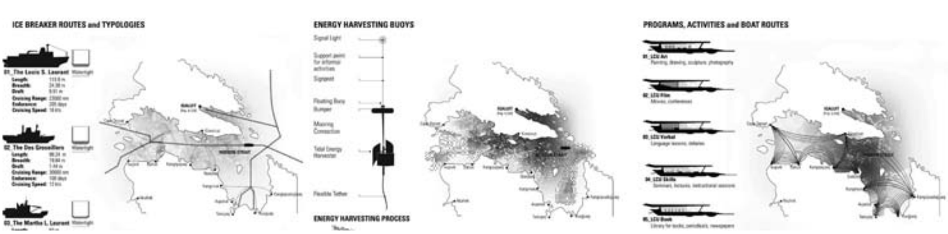


fig 4

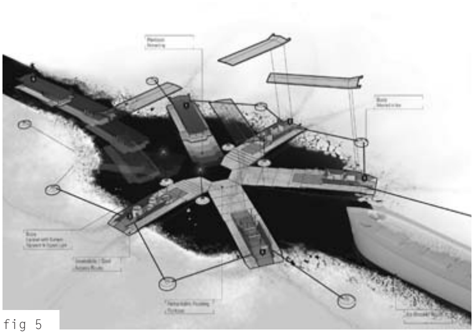


fig 5

fig 6

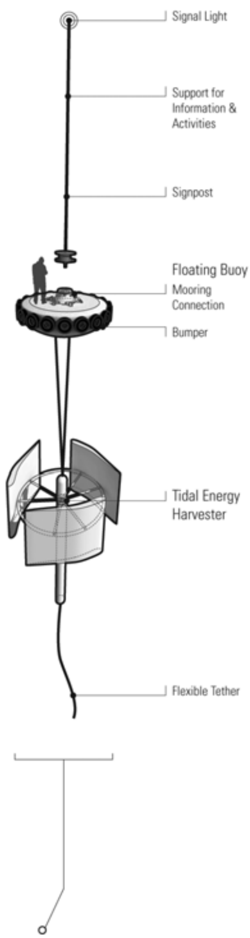


fig 7

fig 2
Liquid Routes: Map showing the network of boats travelling between settlements.

fig 3
Soft Programming: Schedule of educational infrastructural network over one year, accounting for freeze/ thaw dates and festivals/ cultural events.

fig 4
Mobile components and their relationship to the larger liquid network.

fig 5
Axonometric of Scheme in “frozen state” showing flexible mooring, retractable floating pontoons and bridge configuration creating a crossroads.

fig 6
Soft Mooring: A grid of floating buoys is flexibly tethered to the seabed. Equipped with tidal generators, these buoys also act as ice mooring locations for the nodal arrangement of boats.

fig 7
Grouping of boats in the Liquid Commons produces a new flexible crossroads where a public sphere emerges between the boats and between the settlements.

<u>Liquid Commons (InfraNet Lab)</u>

InfraNet Lab Directors
Neeraj Bhatia
Maya Przybylski
Lola Sheppard
Mason White

Project Research and Design Team
Fionn Byrne
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BRANCHING MORPHOGENESIS

— JENNY E. SABIN / LABSTUDIO

LabStudio, co-founded by Jenny E. Sabin and Peter Lloyd Jones in 2006 at the University of Pennsylvania, is a hybrid research and design network with active members now based at Cornell University, the University of Pennsylvania, and Stanford University. Within LabStudio and the extended projects of its members, architects, mathematicians, materials scientists, and cell biologists are actively collaborating to develop, analyze, and abstract dynamic systems through the generation and design of new tools. These new approaches for modeling complexity and visualizing large datasets are subsequently applied to both architectural and scientific research. The real and virtual world that LabStudio occupies has offered radical new insights into generative and ecological design within architecture, and it is providing new ways of seeing and measuring how dynamic living systems are formed and how they operate during development. Overall, the members of LabStudio seek to produce new modes of thinking, working, and creating in both design and the sciences by modeling dynamic, multi-dimensional systems with experiments in biology, applied mathematics, fabrication, and material construction. The sophisticated biological models being studied at LabStudio, particularly those aimed at understanding self-organization and the emergence of complex, non-linear global systems from simple local rules of engagement, have led to the discovery of new forms and novel structural organizations for architectural design. Our collaborative work operates with a multi-year and multi-phase research plan. Project work is typically divided into three phases: (1) Producing catalogs of visualization and simulation tools, which are then used to discover new behaviors in geometry and matter, (2) exploring the material and ecological potentials of these tools by producing experimental structures and material systems, and (3) generating scientifically-based, design-oriented applications in contemporary architectural practice for adaptive building skins. For example, the project entitled "Branching Morphogenesis," which was originally exhibited at the SIGGRAPH Design and Computation Galleries (Los Angeles), and then at Ars Electronica (Linz, Austria), investigates the part-to-whole relationships revealed during the generation of the branched structures produced by lung cells as they form blood vessels. The study and quantification of this network allows for greater understanding of how variable components might give rise to structured networks in both biology and architecture.

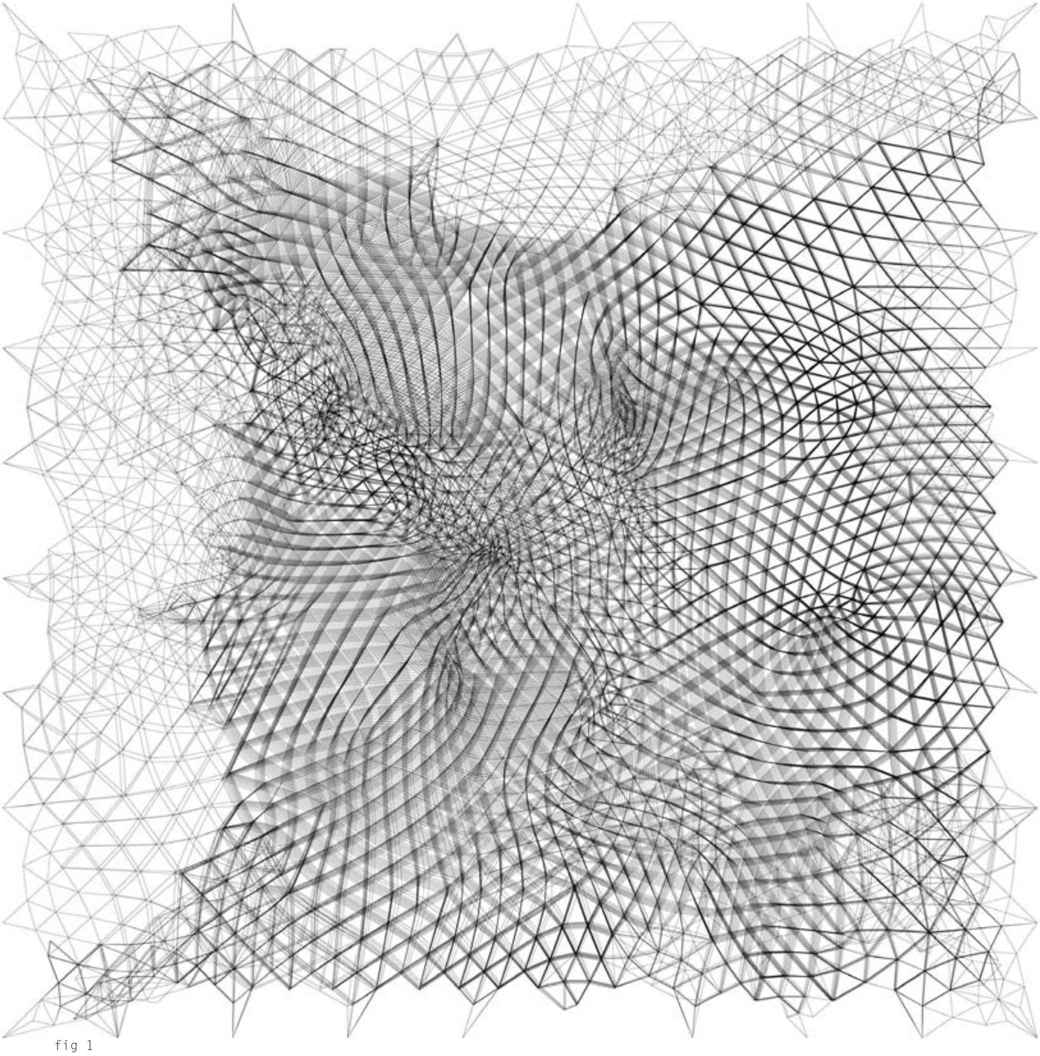


fig 1

Branching Morphogenesis explores fundamental processes in living systems and their potential application in architecture. (fig 1) This installation aims to reveal, through abstraction, the unseen beauty and dynamic relationships existing between endothelial cells and their surrounding, extracellular microenvironment. The project investigates the part-to-whole relationships revealed during the generation of the branched structures, formed in real time, by interacting lung-endothelial cells placed inside a 3D matrix environment. Movies of networking endothelial cells cultured on a 3D matrix were analyzed to generate computational tools able to simulate this process. The installation materializes five particular slices in time that captured the force network being exerted by interacting vascular cells upon their matrix environment. The time lapses are manifested as five vertical, interconnected layers made from over 75,000 cable zip ties. Gallery visitors are invited to walk around and in-between the layers, and thereby immerse themselves within the organic and newly created "Datascape," which fuses dynamic cellular change with both the human body and human occupation – all through the constraints of a ready-made.

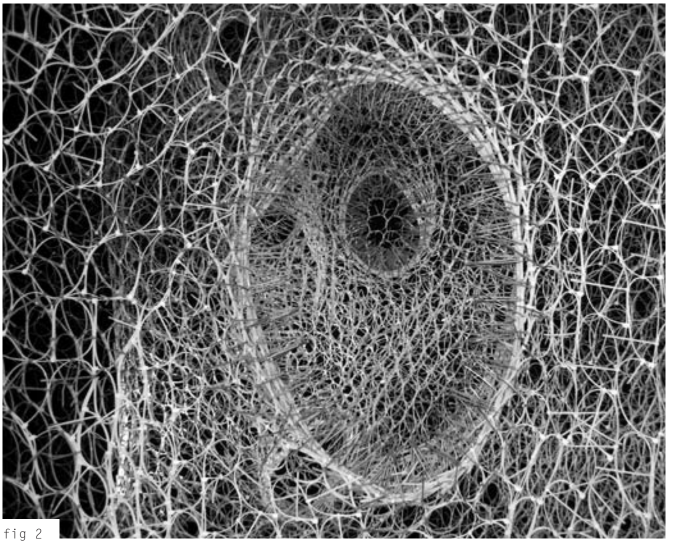


fig 2

fig 2
This installation materializes five slices in time that capture the force network exerted by interacting vascular cells upon their surrounding matrix scaffold. Time is manifested as five vertical, interconnected layers made from over 75,000 cable zip ties. This image won 1st Place for the AAAS/NSF International Visualization Challenge and was featured on the 19-2-2010 cover of *Science*.

fig 3

fig 3
Gallery visitors are invited to walk around and in-between the layers of Branching Morphogenesis, and immerse themselves within an organic and newly created "Datascape." Dynamic cellular change is fused with the body and human occupation, all through the constraints of a ready-made.

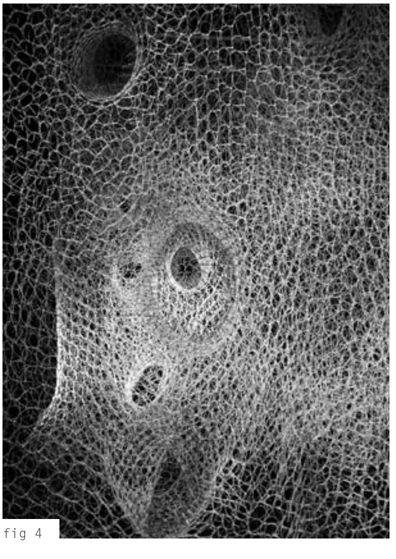


fig 4

figs 4-7
Branching Morphogenesis, LabStudio, 2008; Jenny E. Sabin, Andrew Lucia, Peter Lloyd Jones; originally on view at the Design and Computation Gallery, SIGGRAPH 2008 and subsequently at Ars Electronica, Linz, Austria, 2009-2010.

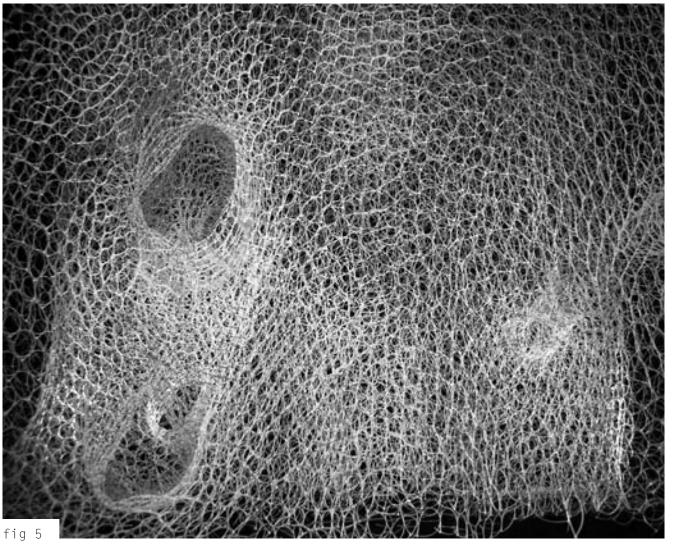


fig 5

fig 6

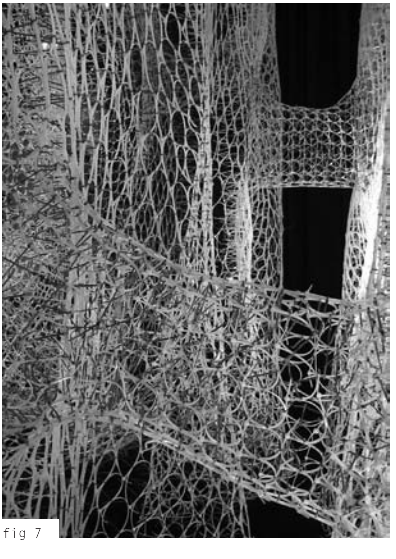


fig 7

Branching Morphogenesis

Architects
LabStudio 2008

Jenny E. Sabin
Andrew Lucia
Peter Lloyd Jones

Originally on view at the Design and Computation Gallery, SIGGRAPH 2008, Los Angeles; and subsequently at Ars Electronica, Linz, Austria, 2009-2010.

POSTURE : AN EXPERIMENT IN MULTIFOLD REALITY

— LUC COURCHESNE / SAT

We have to agree, again, with psychologist William James (1842–1910) that there is only one, experience-based, reality. To Myrion Kruger's Artificial Reality (1983), Jaron Lanier's Virtual Reality (1989), Thomas Caudell's Augmented Reality (1990), Steve Man's Diminished Reality (2010), Paul Milgram and Fumio Kishino's Mixed Reality (1994) and probably more, it is reasonable to oppose a unified reality model made of folds, after Deleuze (1988) who finds his inspiration in Leibniz to describe reality as an indivisible body, flexible, elastic and folded.[1] In this new unified model, folds are positions (or postures) one can adopt in more or less continuous or disrupted spaces between the physical and the virtual. From within, the cycles of retroaction between the imagined and the experienced are shortened, and the boundaries between opposites are blurred (fig 1).

Multifold reality is a result of combined biological and technical evolution. If the virtual fold origins in the human brain with consciousness, its artifacts (visions, concepts, ideas…) have increasingly escaped into the physical fold and been objectified, typically as a window onto their virtual origin. These have gained reality with increased accuracy in the art of representation and, more so, with the invention of classical perspective roughly five centuries ago. Dynamic perspective and movement in the last 100 years have exposed the reality of the virtual and brought it closer, just beyond the frame. The expansion of the frame through modern multiplication of screens and mapping now affords a view from within; after immersion, interaction definitely gets us involved. Finally, connectivity with other participants (telepresence) and the physical space (data visualization) make us stay.

These technological advances are both a result and the cause of an increased consciousness of our own existence and of the complex systems of relationships we are engaged in. In the new experience of being, the human brain is simply a busy hub for the complex processes in Nature (fig. 2).

The current technologies formalizing the concepts of framed virtualization (media screens) and virtual immersion (fully immersive displays) are forcing a re-examination of the forms associated with the physical fold of the reality model. To the concept of framed virtualization – when a window on the virtual (visions, ideas, concepts…) is opened in physical immersion – we now have to oppose the concept of framed physicalization – when a window on the physical (data visualization) is opened in virtual immersion. These formal transformations between the physical and the virtual are far from linear and their rapid cycles continue to expand the concept of Nature to include virtuality with physicality, and to blur the distinctions between its constitutive elements including humans which have now come to accept to be in, or better, to be it.

1
Gilles Deleuze, *Le Pli: Liebniz et le Baroque*. Paris: Les editions de Minuit (1988). Pp 192.

Leibniz, *Pacidius Philalethi* (C, p. 614-615)) "La division du contenu ne doit pas être considérée comme du sable en grains, mais comme celle d'une feuille de papier ou d'une tunique en plis, de telle façon qu'il puisse y avoir une infinité de plis, les uns plus petits que les autres, sans que le corps se dissolve jamais en points ou minima."

Posture: New Terrains of Apparition

The *Posture Platform* is an example of multifold reality systems and apparatuses. (fig 3) Its networked immersive bases,[2] interactive gears, and inhabitable worlds offer an experience in immersive telepresence.[3] Participants share a virtual environment, observe, explore, transform the space, and engage in real time with other distant participants. Ideally, the *Posture Worlds* are self-evolving, malleable and sensitive to use and occupation. They can be modeled after, or inspired by existing physical places, or they can be imagined and constructed in real time by participants. They should be permeable to information from the physical, as well as able to impact on it. These worlds, combining the virtual and the physical, are naturally sensitive to occupation and use, able to keep traces, and to self-deteriorate.

The Posture Platform becomes a genuine multifold reality apparatus when real-time data opens windows onto the physical. It thus also qualifies as a framed physicalization device and complements the framed virtualization that we have been accustomed to with the proliferation of screens in the physical space. The technologies to virtualize the physical and physicalize the virtual are giving force and substance to the idea of a multifold reality.(fig 4)

Such conceptual and technological developments may contribute in the reduction of humanity's footprint on the physical by rooting essential expansion projects in the virtual. By repositioning architectural practice beyond the frontiers of materiality, in a world constructed in information, rooted in the virtual with connections to the physical, we open a vast project that promises to keep us busy for centuries to come.

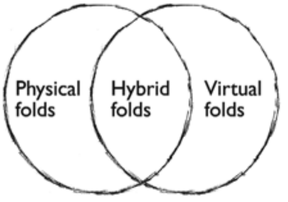


fig 1

fig 1
Multifold Reality Model

fig 2
Forms of multifold reality

fig 2

2
Courchesne, L. (2000) *Panoscope 360 in Emerging Technology/Sketches and Applications*, Siggraph '00, 2000, 4 pages.

3
Courchesne, L. (2006). *Where Are You: An Immersive Experience For The Panoscope*. ACM Multimedia Conference, University of California, Santa Barbara.

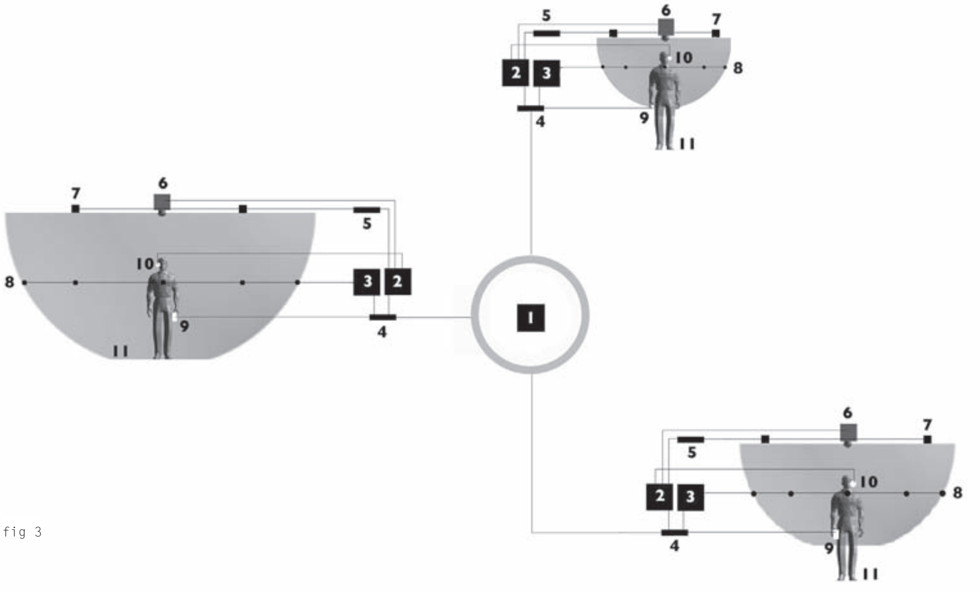


fig 3

fig 4

Posture Platform

1 Posture Net (SPIN Server)
2 Posture Base (SPIN Client)
3 Posture Teleporter
4 Wi-Fi router
5 Audio amplifier/mixer
6 Projector
7 Speakers
8 Camera array
9 Posture Pad/iPhone
10 Headset with microphone
11 Posture Base (Panoscope 360°)

fig 5

fig 3
Courchesne's Panoscope 360°

fig 4, 5, 6
Courchesne's Panoscope 360° (Photo Credit: Joey Kennedy)

fig 6

Panoscope 360°

Overall concept, design, prototyping, fabrication
Luc Courchesne

Additional design
Sébastien Bire
Sébastien Dallaire

Optical System
D'nardo Colucci
(Elumens, Elumenati)
Simon Doucet
(Immervision)

The work was presented in the following venues:
Wired's NextFest, Chicago, USA (June 2005)
06 en scène, Nice, France (April 2006)
ACM Multimédia, Santa Barbara, USA (October 2006)
PFOAC, Montreal, Canada (January 2007)
SAT, Montréal, Canada (October 2007)
NAMOC, Beijing, China (June 2008)
EspooCine, Espoo, Finland (September 2009)
Code Live, Vancouver (February 2010)
Wood Street Galleries, Pittsburgh, USA (July-September, 2010)
Mediation Biennale, Poznan, Poland (September-November 2010)

The Panoscope 360° has been under development since 1998. The first working prototype was introduced at Siggraph in New Orleans in July 2000 (see picture).

The first prototype of the second generation was introduced in Ogaki City (Japan) in September 2001. The first prototype of the current version was first demonstrated at the SAT in November 2004 and premiered at Wired's NextFest in Chicago in June 2005.

No matter how profound the changes wrought on architecture by the electric lamp … the fact that such changes were not visible on the exterior of the building denied [it] a place in the history of architecture.

Reyner Banham, *The Architecture of the Well-tempered Environment*

To predict the future of a curve is to carry out a certain operation on its past.

Norbert Weiner, *Cybernetics: Or Control and Communication in the Animal and the Machine*

AN*OTHER* ARCHITECTURE: THE RESPONSIVE ENVIRONMENT

— CHRIS PERRY

Introduction

Architecture's engagement with temporality has a long history stretching back to the turn of the twentieth century, when the technological advances of the Industrial Revolution merged with a cultural mindset of progress and futurism. Running parallel to these developments was an even larger shift within the sciences, from a Newtonian physics of certainty to one of contingency and indeterminism.[1] As a result, architecture was re-imagined not only in terms of its formal and aesthetic appearance, but, more profoundly, in terms of its relationship to time.

Whereas the architecture of the First Machine Age, including the speculative work of Antonio Sant'Elia, borrowed from the dynamism of large-scale machines and factories,[2] the post-war architects of the Second Machine Age, including Cedric Price and Archigram, drew inspiration from a miniaturized, machine environment populated with electronics, communication technology, and audio/visual media.[3] Much more recently, beginning in the early 1990s, a Third Machine Age emerged through the advent of computing, the Internet, interaction and sensory technology, and robotics. As a result, much of the design work from that decade, including those of the experimental practice Diller + Scofidio, drew inspiration from the computerized world of software, information and multi-media technology, and robotics.[4]

While the architectures of each of these three machine ages, stretched out over the course of a century, are markedly different from one another in terms of their aesthetic and instrumental qualities, they shared an interest in temporality, thus demonstrating an ongoing, cross-generational desire within architecture to incorporate time into a traditionally static discipline. Perhaps even more so than previous generations, contemporary architects are faced with the challenge of engaging a society characterized by ever-increasing speed, making the implications for the discipline of architecture that much more complex and illusive.

Thus, in thinking about contemporary architecture, it is useful to reflect on the past, in part because one inevitably discovers that, while the work of the present may seem novel in many respects, it is inextricably linked to the issues, challenges, debates, and ambitions of previous generations. It is in this sense that the quotation at the beginning of this essay, Norbert Weiner's framing of the future within the context of the past, provides a useful lens through which to evaluate our contemporary moment.

1
Norbert Weiner, *The Human Use of Human Beings: Cybernetics and Society*, (Da Capo Press, 1954), 8.

2
For a discussion of Antonio Sant'Elia's work in the context of scientific, technological, and cultural advancements at the turn of the twentieth century, see Sanford Kwinter "La Citta Nuova: Modernity and Continuity," in *Zone 1 / 2*, Jonathan Crary, Michel Feher, Hal Foster, Sanford Kwinter, eds. (Urzone, 1986).

3
For a detailed discussion of post-war architecture as it relates to the technological and cultural trends and innovations of the 1950s and 1960s, see Nigel Whitely, "Science for Kicks," in Reyner Banham: Historian of the Immediate Future (MIT Press, 2002) 140-185.

4
For a detailed discussion of Diller + Scofidio's work in relation to the technologies of the Information Age, see Anthony Vidler, "Robots in the House: Surveillance and the Domestic Landscape," in *Daidalos*, 73, 1999. 78-85.

Temporalism in the First Machine Age

In the preface to his highly influential book, *The Human Use of Human Beings: Cybernetics and Society*, first published in 1950, Norbert Weiner traces the dramatic transition at the beginning of the twentieth century from a Newtonian physics of certainty and determinism, in which "everything happened precisely according to law," to a new understanding of the universe, in which the world is characterized by contingency and "incomplete determinism."[5] It is this dramatic shift within the discipline of physics that Weiner credits as the beginning of the new science of cybernetics.[6] It is this same shift, in conjunction with the new technologies of the First Machine Age, that had such a consequential impact on the discipline of architecture.

As Sanford Kwinter argues in his article "La Citta Nuova: Modernity and Continuity," the Italian Futurists were among the first to translate the implications of this shift into the creative fields of art and architecture.[7] Futurist theory, he argues, was a direct parallel to Einstein's physics of space-time, in that it "gave rise to a fundamental new entity – the event – as well as the new geometry through which it could be expressed."[8] In this way, Antonio Sant'Elia's La Citta Nuova proposal of 1914 represents not only a break with the historical architectural styles of the nineteenth century, but, more importantly, provides a new "morphological language" representative of the twentieth century.[9] For Kwinter, Sant'Elia's architectural forms are not mere objects of novelty. Rather, they suggest "a new orientation toward a phenomenal field of events and interactions," whereby the modern metropolis and its variegated urban forces, channeled through vast networks of mechanical and infrastructural systems, actively shape architectural form.[10] Kwinter even ventures to compare Sant'Elia's buildings to a "servomechanism" – like massive urban machines, these buildings absorb, process, and distribute a vast assortment of temporal urban and industrial flows.[11] In this way, Sant'Elia's architecture is continuous with the city fabric, woven into its various conduits and circuitries of mechanical and human circulation, thereby blurring conventional demarcations between building and city, object and field, and further demonstrating that La Citta Nuova represents a new orientation in the discipline of architecture, one that is characterized by a "spatial continuum."[12]

Temporalism in the Second Machine Age

Although this interpretation compellingly links large-scale transformations in society to new directions in architecture, it must be recognized that, while the urban and industrial flows pulsing through Sant'Elia's vast urban machines are dynamic, the architecture itself remains fixed. This distinction is important as it raises a difficult question for architecture – one that challenges its disciplinary limits.

In his article "Futurism and Modern Architecture," published in 1957, Reyner Banham implicitly raises this question of disciplinary limits by quoting Felippo Marinetti, author of the Foundation Manifesto of Futurism, who had declared in 1914 that "the fundamental characteristics of Futurist architecture will be expendability and transience," and that the houses of the future "will last less time than we do" with "every generation" being required to build "its own city." While Marinetti seemed to be calling for an architecture of transience and impermanence, Sant'Elia's grand industrial architecture remained both static and monumental in form. It is this inconsistency that Banham seems intent on exposing:

If Sant'Elia disapproved of this last [section of Marinetti's manifesto], which is only an extension of his anathema on durable materials, then he is thereby diminished as an architectural pioneer, lacking the courage to pursue his own ideas to their revolutionary conclusions, and it is Marinetti, not Sant'Elia, [who]…should have [been] praised for anticipating the scrapping-and-replacing theories of the 'twenties.[13]

5 Norbert Weiner, *The Human Use of Human Beings: Cybernetics and Society*, (Da Capo Press, 1954), 8.

6 Ibid., 12.

7 Ibid., 95.

8 Ibid.

9 Ibid., 98.

10 Ibid., 104

11 Ibid., 101

12 Ibid., 111

13 Reyner Banham, "Futurism and Modern Architecture," *Journal of the Royal Institute of British Architects* 64, no. 4 (February 1957), 131.

Indeed, if the radical scientific and technological transformations taking place at the turn of the twentieth century indicated a new age characterized by transience, it could be argued that the real challenge for architecture was the invention of temporal buildings driven by the kinetic properties of machine technology.

Banham, along with other influential post-war architects and thinkers during the Second Machine Age of the 1950s and 1960s, engaged this challenge, believing that their endeavors were an attempt to manifest Marinetti's unfulfilled dream of a transient architecture for the twentieth century.[14] Beginning in the 1960s and culminating in 1969 with the publication of his provocative book *The Architecture of the Well-tempered Environment*, which was an homage to Johann Sebastian Bach's *Well-tempered Clavier* – and with it, a reconceptualization of architecture as environmental instrument – Banham began work on the theory and development of an "other" architecture, or what he referred to as "Une Architecture Autre," conceived generally as an architecture of "environmental performance and effects rather than architectural form."[15] This conception of architecture, and especially Banham's use of the term "environment" in place of "building," was a direct challenge to the discipline's design conventions and carefully protected orthodoxy, or what he referred to as "the lore of the profession."[16] Providing a clear definition for this "other" architecture in his article "Stocktaking" of 1960, Banham stated that "architecture, as a service to human societies, can only be defined as the provision of fit environments for human activities."[17] In this article, as well as his "A Home is Not a House" essay of 1965, Banham argued that, while the profession has traditionally relied upon "the cave or primitive hut" as its disciplinary point of origin, to the extent that, like a cave, a building typically provides protection from the natural environment through the provision of a physical, static, enclosure, architecture might be better served to consider the "camp-fire" as an "other" model of enclosure – one that is more responsive to its users' changing needs and desires. According to Banham, unlike a cave, "the space around a camp-fire has many unique qualities ... above all, its freedom and variability."[18] This pursuit of "freedom and variability" ultimately led Banham beyond the limits of static form, and toward what can be thought of as the "responsive" environment.[19]

One example of a responsive environment is Cedric Price's Fun Palace proposal of 1961. Working with numerous collaborators, including the cybernetician Gordon Pask, Price conceived the Fun Palace as an architecture of dynamic feedback between the building and its users.[20] Combining both static and dynamic building elements, such as a large-scale gantry crane, flexible roof system, and adjustable floor plates and wall partitions, the architecture itself actively engages and responds to changing programmatic conditions over time:

The whole complex, in both the activity it enables and the resultant structure it provides, is in effect a short-term toy to enable people, for once, to use a building with the same degree of meaningful personal immediacy that they are forced normally to reserve for a limited range of traditional pleasures.[21]

Thus, one sees in the Fun Palace a truly temporal architecture; never assuming a stable form or configuration, the building drifts in a perpetual state of flux.[22] Although never realized, the Fun Palace greatly influenced a new generation of architects in the late 1960s and early 1970s, among them the experimental group Archigram, whose Instant City project of 1969 adopted many of Price's ideas and ambitions for creating a reflexive and adaptive architecture at the scale of the city.[23]

Temporalism in the Third Machine Age

Norbert Weiner anticipated the profound technological shift that occurred in the second half of the twentieth century by describing the future of

14
Nigel Whitely, "Science for Kicks," in *Reyner Banham: Historian of the Immediate Future* (MIT Press, 2002), 180.

15
Nigel Whitely, "The Expanded Field," in *Reyner Banham: Historian of the Immediate Future* (MIT Press, 2002), 208. For a discussion of Banham's concept of Une Architecture Autre, see Reyner Banham, "The New Brutalism," in *A Critic Writes: Essays by Reyner Banham* (University of California, 1996). Essay originally published in *The Architectural Review* 118 (December 1955): 354-361

16
Reyner Banham, "Stocktaking," *Architectural Review* 127, no. 756 (February 1960), 96

17
Ibid., 93.

18
Reyner Banham, "A Home is Not a House," *Architectural Design* (January 1969), 58.

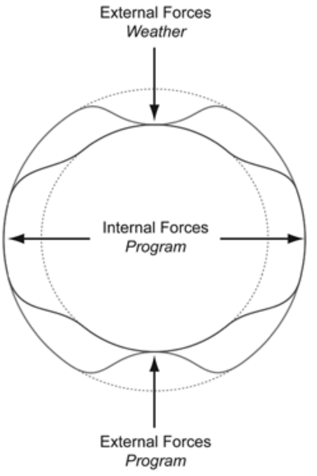
19
Nigel Whitely, "The Expanded Field," in *Reyner Banham: Historian of the Immediate Future* (MIT Press, 2002), 212.

20
For a discussion of Cedric Price's collaboration with Gordon Pask, see Mary Louise Lobsinger, "Cybernetic Theory and the Architecture of Performance: Cedric Price's Fun Palace," *Anxious Modernisms: Experimentation in Postwar Architectural Culture*, ed., Sarah Williams Goldhagen and Rejean Legault (CCA / MIT Press, 2000).

21
Cedric Price, "Fun Palace" (1965), reprinted in *Cedric Price: Works II* (Architectural Association, 1984), 56. (Exhibition catalog)

22
Mark Wigley, "The Architectural Brain," in *Network Practices: New Strategies in Architecture and Design* (Princeton Architectural Press, 2007), 32.

23
Nigel Whitely, "The Expanded Field," in *Reyner Banham: Historian of the Immediate Future* (MIT Press, 2002), 221.



The Responsive Environment

human experience in the Third Machine Age as one defined by the temporality and contingency of information networks.[24] As prophesied by Weiner, this Third Machine Age of Information – with its technological milieu of man–machine interfaces and communication networks, poses a dizzying cocktail of opportunities and challenges for contemporary architecture, as a new generation of designers struggle to harness the temporal forces of the twenty-first century. While computing technology has been addressed extensively within the discipline of architecture since the early 1990s, the predominant focus has been on using modeling and animation software as a generative design tool for formal innovation, thereby limiting the architecture itself to a static representation of dynamic forces.

What has been less pervasive in the last two decades, although it is perhaps more apparent in recent years, is an exploration of how, by shifting the discipline toward an exploration of dynamic conditions and effects, computing technology might introduce qualities of temporality into the architecture itself. This would suggest incorporating computing technologies directly into buildings as a means of expanding their capacity to adjust and respond to changing programmatic and environmental forces over time, which is a reconceptualization of architecture very much in keeping with the efforts and ambitions of Banham and Price.

One example of keeping with this historical lineage of temporal architecture is Diller + Scofidio's Blur Building pavilion at the 2002 Swiss Expo. Working in collaboration with EAR Studio and MIT's Media Lab, both specialists in interaction design and computing technology, the Blur Building combines a wide variety of information and environmental technologies, including meteorological systems, misting infrastructure, and a wearable computing/sensing apparatus, or what the firm refers to as a "braincoat." The effect, of course, is a literal, as well as figurative, "blurring" of the definition of "building" in any conventional sense. In

24
Norbert Weiner, *The Human Use of Human Beings: Cybernetics and Society*, (Da Capo Press, 1954), 8.

fact, one could argue that this project embodies Banham's very definition of an "other" architecture of environmental performance and effects:

The artificial cloud is made of filtered lake water shot as fine mist through an array of 12,500 fog nozzles. The dynamic form is regulated by a smart weather system that responds to shifting humidity, wind direction, and speed... Unlike entering a building, the experience of entering this mass-less and elastic medium in which time is suspended and orientation is lost is like an immersion in ether.[25]

Thus, despite being much softer in its visual, spatial, and material qualities and effects – largely by incorporating climate and information technologies in place of heavy gantry cranes and shifting floor plates like Price's Fun Palace, the Blur building can well be compared to the Fun Palace as they are remarkably similar in their general ambition toward designing responsive environments. To this extent, the Blur Building, while novel in many respects and certainly of its time, might also be viewed as part of a historical lineage within the discipline, one that can be identified with the desire to discover and promote "other" forms of temporal architecture.

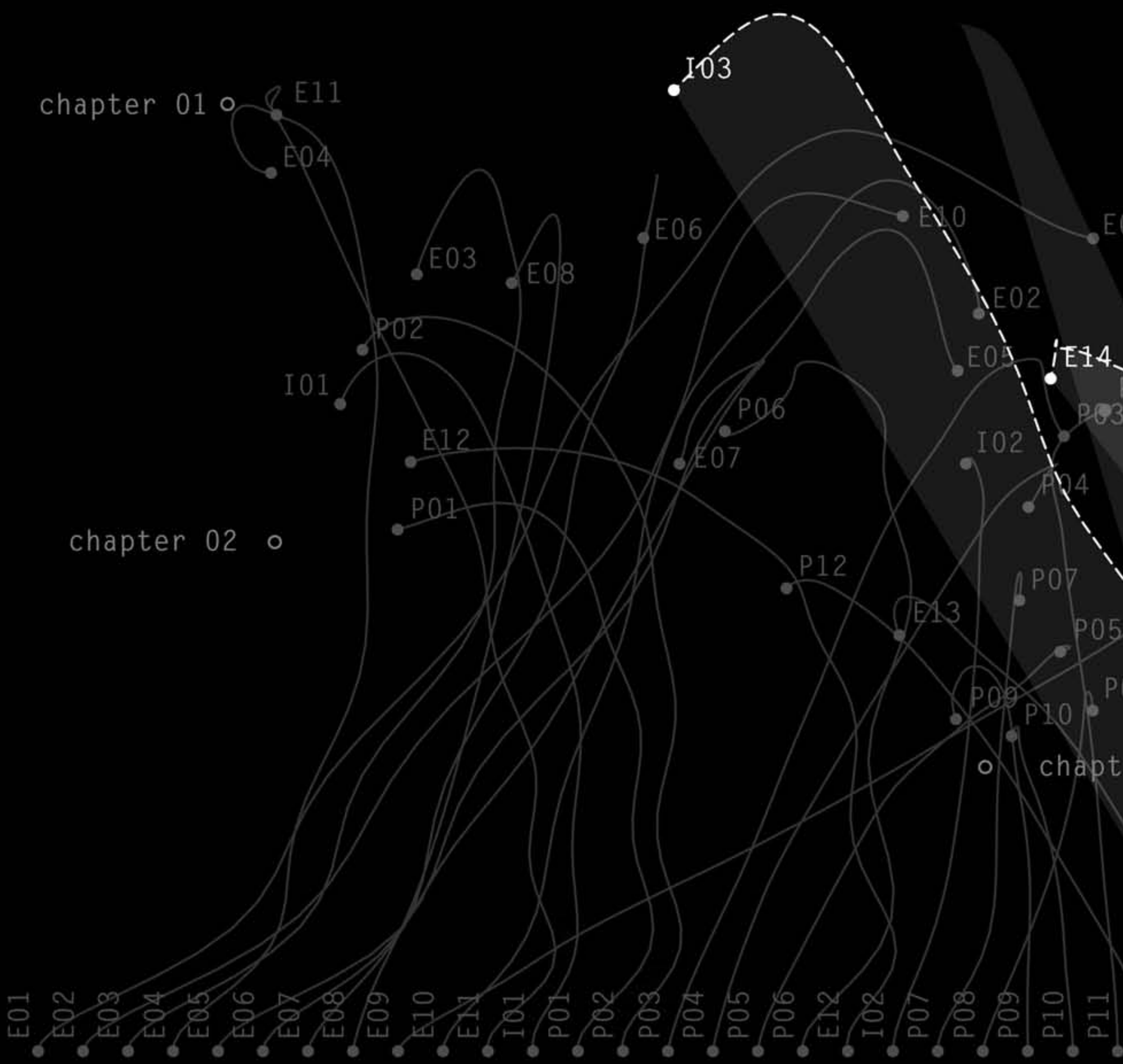
Other examples include Philip Beesley's evocative and dynamic interactive installations since the mid-1990s, as well as the work of servo, whose decade-long experiment starting in 1999 produced a prolific body of full-scale responsive environments, each of which incorporated numerous computing, lighting, sound, and interaction technologies. Also, since the mid-2000s, the practices of Howeler+Yoon and Future Cities Lab have been investigating the application of robotic technologies in architecture, producing full-scale installations and environments that serve as working prototypes for the study of responsive skins and dynamic structures. In the last few years, an increasing number of designers have engaged in this kind of work, contributing to what might be viewed at this point as a new generation of temporal architecture for the Third Machine Age. This includes the practices of IK Studio, Khoury Levit Fong, François Roche, Weathers, The Living, Philippe Rahm – and the architecture/landscape firm pneumastudio, which expands the scope of temporal architecture to include ecological and environmental systems.

Conclusion

As mentioned at the outset, when considering the work of these and other contemporary practices, especially as it concerns their perceived desire to produce a temporal architecture for the twenty-first century, it is useful to reflect on the past, and with it, the efforts and ambitions of previous generations. Returning again to Norbert Weiner's assessment of the future in relation to the past, one sees that the work of architects like Cedric Price and Diller + Scofidio, while separated by time and circumstance, nonetheless form a recursive historical loop of desire to "expand" the discipline, and thereby allow for "other" forms of architecture to emerge.[26] It is precisely this historical lineage that makes the responsive architecture of today interesting, namely the degree to which it participates, wittingly or unwittingly, in a century-long ambition to engage temporality through the development of an "other" architecture: the responsive environment.

25 Diller Scofidio, "Blur: Swiss EXPO 2002 Diller + Scofidio, Ear Studio, MIT Media Lab," in *Assemblage*, No. 41 (April, 2000)

26 Nigel Whitely uses the phrase "the expanded field" in reference to Reyner Banham and post-war design culture, while crediting Rosalind Krauss with coining the phrase, as it relates to her influential article of 1979 "Sculpture in the Expanded Field." Nigel Whitely, "The Expanded Field: Fit Environments for Human Activities," in *Reyner Banham: Historian of the Immediate Future* (MIT Press, 2002), p.189



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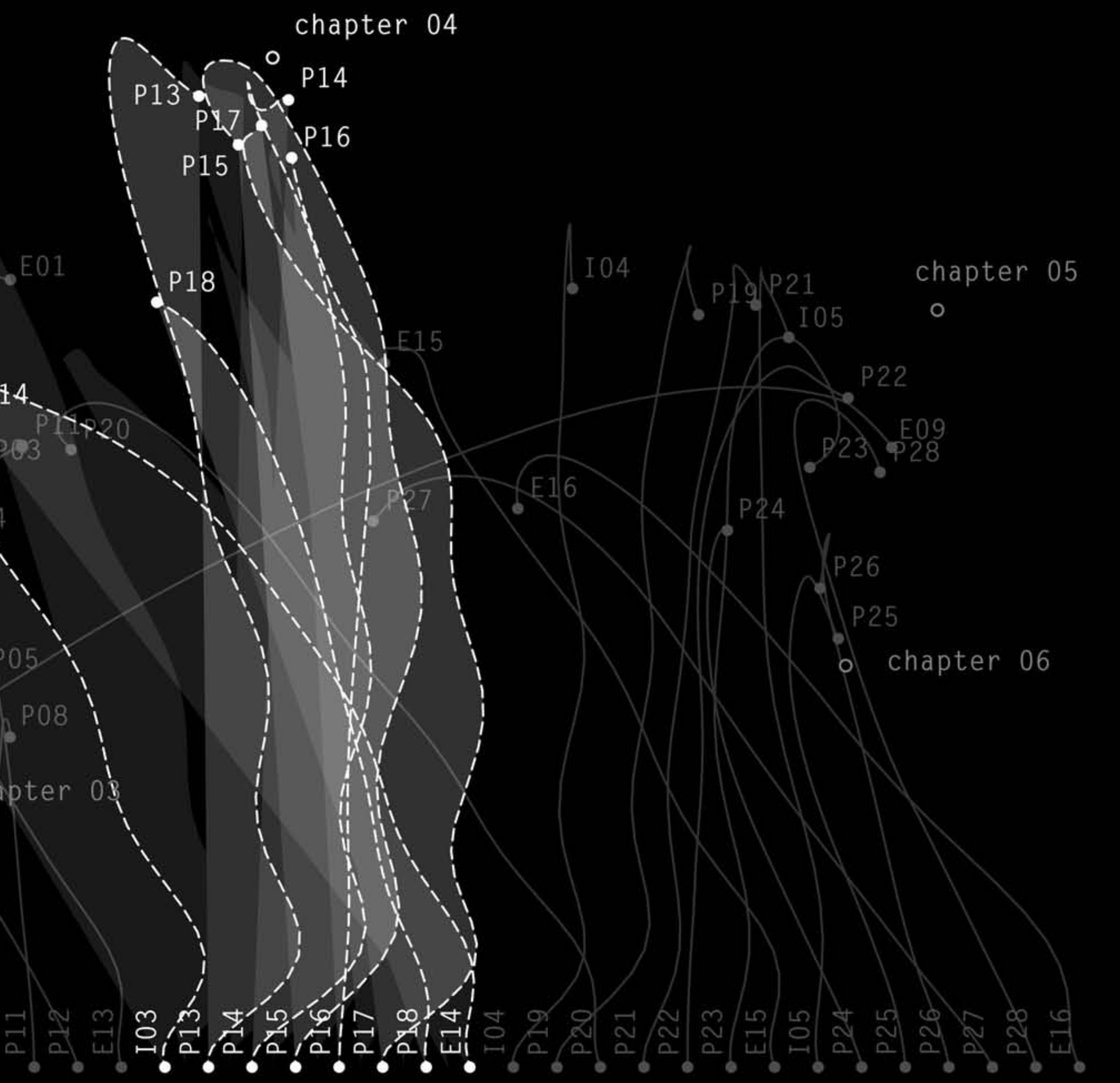
04

EVOLUTIONARY INFORMATION



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INTERVIEW: KARL CHU

— WITH PABLO LORENZO-EIROA AND AARON SPRECHER

01 *Can you define, according to your work, what is architecture in the age of information technologies?*

KARL CHU

There are a number of ways of approaching the question: What is architecture in the age of information technologies? Before answering the question, allow me, first of all, to contextualize the so-called information age in relation to the preceding paradigms – namely, the mechanical and the industrial paradigms, and see how they differ in terms of their manifestation and impact on architecture. In architecture, the default orientation is, of course, the material and energetic conceptions, which align almost exclusively with the art of making buildings. Incidentally, this is also the definition of architecture offered by *Webster's Collegiate Dictionary*. Material and energetic systems are intrinsic properties of the physical universe and, therefore, they play significant roles in any definition of architecture. The legacy of the mechanical paradigm is still alive and well, and is expressed most succinctly in the early part of the twentieth century by Le Corbusier, through his notion that a house is a "machine for living." In the late modern period, we still find buildings designed to resemble machines. The Pompidou Center in Paris is a classic example of an iconic building derived from the functional logic of the machine.

On the energetics side, we are now in the early phase of moving toward a critical threshold, insofar as sustainability of the planet is concerned. The field of architecture has become acutely aware of the distribution of energy within building systems, but it has taken on a disproportionate sense of urgency that, if left unchecked, will eclipse other issues of equal importance in the larger scheme of things. Unfortunately, the politics of sustainability in a capitalist society is rather complex in that the motivation of the market economy, which is directed toward the accrual of surplus value in the form of profit, is at odds with the imperatives that drive the movement toward sustainability. Nonetheless, architecture is constrained and reduced to a one-dimensional criteria, instead of incorporating energetics in ways that would induce creative, novel, unconventional deployments of energetics, and the paradoxical and surreal manifestations of the metaphysics of matter, energy, and information, which together constitute the three parameters of the physical universe.

The confluence of matter and energy has brought to the foreground a metaphysics of action functioning in conjunctive synthesis within the continuum of existence. Specifically, the following is a list of attributes and performances that are brought to bear by the morphodynamics of matter and energy, coalescing and distributing across the plane of material energetics:

01 The immanence of the world is defined solely in terms of physical attributes and properties that take on virtual propensities.
02 The localization of being and time by means of physical action and communication is restricted to the immediacy of act and performance.
03 At once a mediation and a full body contact with the substance of flows, the distribution of material energetics is part and parcel of the larger distribution of the self-organizing matrix of desire, a collective investment of

fig 1

the libidinal flow of flows that get interrupted within the durational experience of the socius (a Deleuzean term for the societal body), which is distributive across time and space.

04 At the level of a monadic subject, it engenders conditions of possibility for a phenomenology of embodiment; it is an organic unicity of thought and action in the here and now such that....

05 It triggers the sensation of pure immanence emanating from the material affects surrounding a subject.

06 The course of intensive thought and action together engender a virtual topology of being and existence over time. It is an incarnation of phase space topology from local points of situated-ness. This virtual topology is crisscrossed by lines of flight such that it forms a plane of consistency giving performance to a phenomenology of the continuum. It is an induction of full body sensation and experience embedded and implicated within the web of flows.

07 Last but not least, it is a metaphysics of the immanence of the One-All, a virtual totality where the world is thought of as a manifold, and the concept of existence is delimited by the anonymity of material substances. It is a metaphysics of material energetics that virtualizes the world into a continuum and by giving shape and form to dispersive movements of monadic beings in time.

Given the performative nature of material energetics, what, then, are we to make of architecture in the age of information technologies? Having outlined a quasi-Deleuzean set of material imperatives, let it suffice to say that information systems – understood in the widest sense of the term – augment and radicalize the performative dimension of matter by expanding the horizon of immanence into one that is infinite and without bounds. In speaking about information that extends to the infinite, it would be necessary to point out two different ways of conceiving information: the qualitative and the quantitative. Qualitative information predominantly comes from a transcendental materialism that emits material affects into the space of reception, where a monadic subject perceives global affects pertaining to wholes. Quality, in this case, is irreducible to the discrete logic of being; it cannot be readily couched in terms of differences between parts or part to whole relation.

Quantitative information is discrete. An information-theoretic conception of the world is predicated on a discrete logic of existence. It belongs to anontology of the multiplicity of the infinite that is antithetical to the One-All, or totality. Correspondingly, it ushers in the non-locality and entanglement of monadic entities that are separated across vast regions of space, time, and distances. Monadic entities percolate out of nowhere and for no reason, and they do not necessarily behave in accordance with the material logic of flows due to random surges in the percolation of monads. In general, the interaction between discrete entities is a form of computation that is akin to the discrete logic of cellular automaton. The modern theory of computation is built upon the interaction between binary numbers or integers, and an universal Turing machine is an exemplification of the discretization of cellular units to compute in conjunction with the logic of recursion. As such, it is inherently

fig 2

capable of self-replication, mutation, and synthesis of form. Like all biological systems, it operates both at the level of phylogeny and ontogeny; at every level of the complex development and formation of the self-organization of a complex ensemble, it is the difference in the information content of an entity that differentiates it from another entity. In other words, it is the difference that makes a difference. Such a discrete logic of the world is predicated upon an ontology of multiplicity with built-in contradictions that are indicative of incommensurable differences among monadic entities. As a result, only an ontology of multiplicity can incorporate within itself an inconsistent multiplicity, which is the true multiplicity that stems from the omnipotence of chaos, but which is another term that stands in for the absolute. An ontology of multiplicity, therefore, is an absolute ontology of being and nothingness founded upon the Void. The Absolute is the inverse name of the void. In such an absolute ontology of being and existence, there is no metacode that would encapsulate the One-All for the reason that the existence of such a metacode would be the condensation of multiplicity into a totality that annuls the logic of an inconsistent multiplicity.

The omnipotence of chaos is not something to be associated with a theological conception of either the diabolical or the chaotic. There are two ways of conceiving the omnipotence of chaos: by random percolation, or the insertion of the chaotic through a performance of contingency that is freed from the Kantian transcendental imperatives of the subject, and by a decompression of the infinitesimal condensation of the infinite, which is akin to the inception of the Big Bang, and into finitude. For Quentin Meillassoux, it is the necessity of contingency that is paramount in the behavior of a world that is fundamentally devoid of the principle of sufficient reason, while for Alain Badiou, it is the contingency of necessity that is pertinent to a world that is not totally devoid of reason and consciousness. The position I espouse, with regard to necessity and contingency in relation to a new form of architecture in the age of information systems, is the dialectics of the necessity of contingency and the contingency of necessity. The foundation of this dialectics is Meillassoux's notion of the omnipotence of chaos. Just as there are infinite orders of infinity in the transfinite mathematics of set theory, there are infinite orders of the omnipotence of chaos – a metaphysics of randomness exemplified by Gregory Chaitin's Omega number, which is a halting probability that, taken to its extreme logic of hyperchaos, veers into transcendence by conjoining itself with the absolute. The absolute, in this regard, is a non-theological conception that cannot be aligned with the transcendent God of religion. It is, essentially, an absolute ontology of multiplicity.

Where is all this leading to, concerning architecture? As an ontology of multiplicity, this points to a metaphysics of modality, or of possible worlds. From this, we can establish a general proposition that is broad and open enough to be sufficiently adequate to describe architecture as the construction of possible worlds, and the non-computable excess of the Real as a form of hyper chaos that resists encapsulation and embodiment. As can be inferred

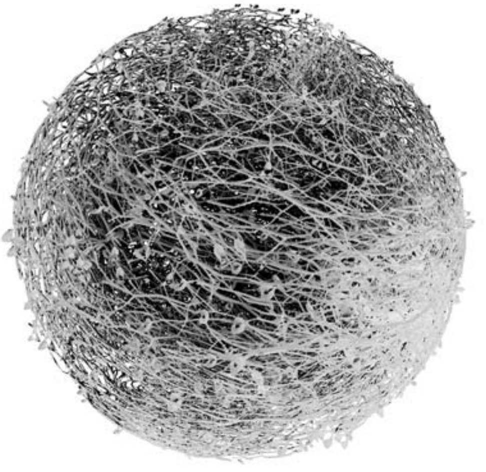


fig 3

from the above statements, I am more of a philosophical architect, who is doing philosophy by architectural means – which is not to say that I privilege philosophy over architecture. On the contrary, architecture should not submit its modus operandi to the authority of philosophy – the two have points of contact that are inseparable. Just as Plato defines a philosopher as a lover of wisdom, architecture is a discipline predicated upon the construction of the best of possible worlds – notwithstanding Voltaire's satirical adumbration on the naïve metaphysics of Leibniz – in light of the wisdom one has accrued over time. In other words, there is implicit philosophical content pertaining to architecture.

In light of modal space, it is insufficient to speak about architecture as the construction of possible worlds without defining what a world is. What, then, is a world? The simplicity of the question belies the complex nature of the problem it solicits. In brief, a world is an incompletable totality – the word is an oxymoron, insofar as the concept of a world presumes the presence of limits enclosing a world. Even in cases where the limits are indiscernible, the notion of a world still takes hold, insofar as there is the presence of multiplicity, which is a loosely defined, amorphous entity that condenses within itself features that differentiate its specific mode of existence from others.

Nonetheless, there are simple worlds that are amenable to more or less finite descriptions, and there are complex worlds that escape description by exhaustion. Every world is a multiplicity that exists at various scalar and specification regimes of organization. Correspondingly, a description of a world can be given either exogenously or endogenously – from within or from without. If it is from within, the limits of the world are in excess of the perceivable limits of its boundary condition by a human subject. The subject is implicated in the world-ing of the world, such that every description that he or she comes up with concerning a world is incomplete. The subject is then implicated and involved in the processual evolution of the world. Consequently, the subject suffers from the paradox of self-reference, e.g. – a barber, who is himself a man, only shaves all the men who do not shave themselves. The question is then, does he shave himself? The subject who attempts to describe a world from within the world suffers from the fact that his own description is not included in a description of the world, rather than because he has knowledge of all possible descriptions concerning a world. There is a real-world correlate to this conundrum – scenario planning, which operates under the pretense of mapping the set of possible states of affairs pertaining to a given situation, and which belies the fact that the set of narrative descriptions are nothing more than indications of how hidden parameters play into how a system unfolds into a set of possibilities. In addition, Gödel's famous theory of Incompleteness and Undecidability suggests that no sufficiently complex system can lay claim to completeness, since there are statements that can be made within the system that are true for no reason, and whose existence cannot be derived from the axioms of the system. Given these conceptual problems, a world, by definition, is an oxymoron that can only be experienced from within as the phenomenology of reception, which is experienced by a subject.

figs 1-3
Seedo_Evos are generated by the Lindenmayer system based on a set of axiomatic codes, which function as the genetic seed.

MEMORIAL TO THE MURDERED JEWS OF EUROPE

— EISENMAN ARCHITECTS

This project manifests the inherent instability of what seems to be a system, here a rational grid, and its potential for dissolution in time. It suggests that when a supposedly rational and ordered system grows too large and out of proportion to its intended purpose, it loses touch with human reason. Then, it begins to reveal the innate disturbances and potential for chaos in all systems of apparent order.

The design begins from a rigid-grid structure composed of 2,711 concrete pillars, or stelae, each 95 centimeters wide, 2.375 meters long, and with heights varying from zero to 4 meters. The pillars are spaced 95 centimeters apart to allow only individual passage through the grid. Each plane is determined by the intersections of the voids of the pillar grid and the gridlines of the larger context of Berlin. As a result, a slippage in the grid structure occurs, causing indeterminate spaces to develop. These spaces condense, narrow, and deepen to provide a multilayered experience from any point.

Remaining intact, however, is the idea that the pillars extend between two undulating grids. The way these two systems interact describes a zone of instability between them. These instabilities, or irregularities, are superimposed on both the topography of the site and the top of the field-plane of the concrete pillars. A perceptual and conceptual divergence between the topography of the ground and the top plane of the stelae is thereby created. This divergence denotes a difference in time. The monument's registration of this difference makes for a place of loss and contemplation – both constituent elements of memory.

In this monument, there is no goal, no end, no working-one's-way in or out. The duration of an individual's experience inside the monument grants no further understanding, since understanding the Holocaust is impossible. The time of the monument, its duration from top surface to ground, is disjoined from the time of experience. In this context, there is no nostalgia, no memory of the past. Rather, there is only the living memory of the individual experience.

fig 1
Berlin model.

fig 2
Topography model.

fig 3
Looking southwest from the roof of the Hotel Adlon toward Potsdamer Platz.

fig 1

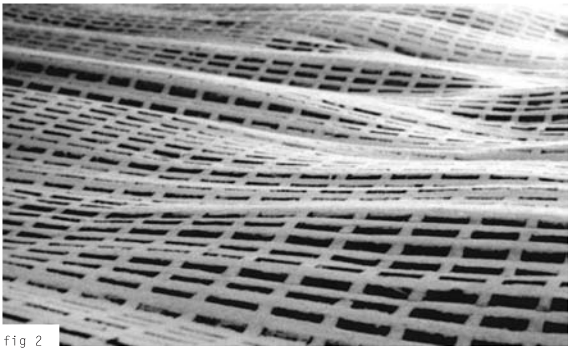
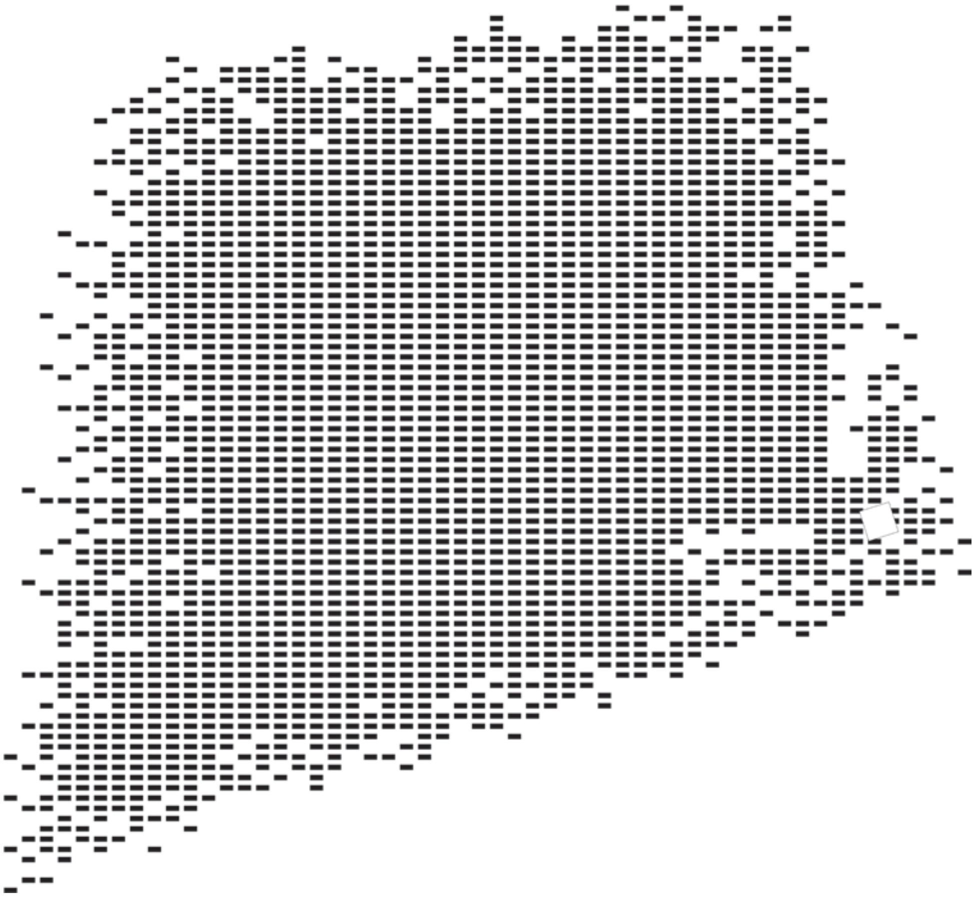


fig 2

fig 3



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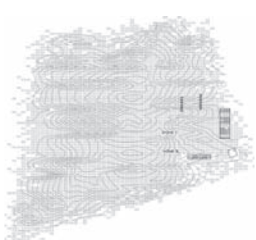

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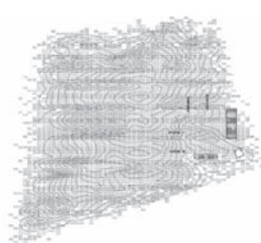

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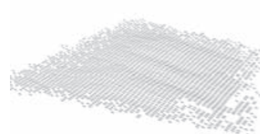
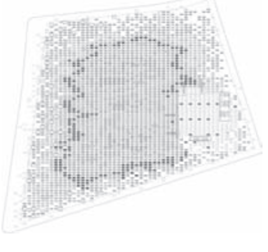


fig 7

fig 8



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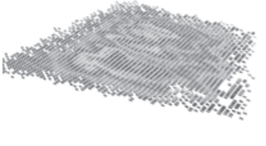

fig 10

fig 4
Site plan.

fig 5
Site topo.

fig 6
Site topo without context.

fig 7
BHM top.

fig 8
111 stele tilts no frame.

fig 9
03a-color-coded stelae plan.

fig 10
BHM.

fig 11

fig 12

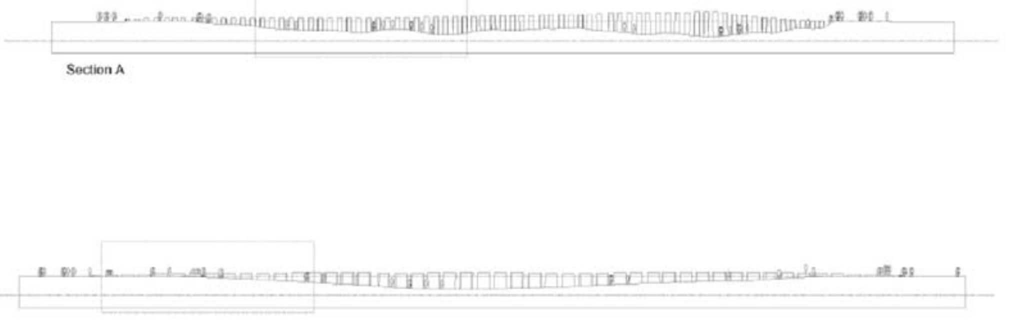

fig 13

fig 11
Visitors walking through the memorial.

fig 12
Stormy sky reflecting on wet surface of stelae

fig 13
Section with people

fig 14
View of interior.
Photo: Gunter Lepkowski

fig 14

Memorial to the Murdered Jews of Europe, Berlin, Germany 1998-2005

Client
Stiftung Denkmal Für Die Ermordeten Juden Europas

Chief Executive
Dr. Hans-Erhard Haverkampf
Dr. Günter Schlusche

Design Architect
Eisenman Architects

Design Principal
Peter Eisenman

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Wiebke Schneider
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Project Assistants
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Volker Bollig
Anja Brueggemann
Artur Carulla
Stefano Colombo
Nina Delius
Constantin Doehler
Hayley Eber
Alexa Eissfeldt
Karsten Fiebiger
Juliane Fisher
Christian Guttack
Bart Hollanders
Nadine Homann
Peter Hufer
Julia Hochgesand
Tilman Kriesel
Christian Lange
Jakob Ohm Laursen
Dirk Leblanc
Philipp Muessigmann
Claire Sà
Nicole Schindler
Stephanie Streich
Minako Tanaka
Wolf Von Trotha
Karen Weber

Construction Manager
Architekt Manfred Schasler
Manfred Schasler
Axel Heintz

Engineer
Happold Ingenierbuero Gmbh
Paul Rogers
Martin Strewinski
Ewan Mcleod
Steffen Philipp

Landscape
Olin Partnership
Laurie Olin
David Rubin

GEOMETRY VS. ARCHITECTURE

— PRESTON SCOTT COHEN

Today, it is possible for the architect to conceive of an unprecedentedly precise relationship between geometrical and architectural configurations, in which these configurations are mutually agitated and transformed. But, in the present moment, unlike earlier ones, this relationship remains a provisional hypothesis, in which the absolute foundations of geometry are not taken for granted.

Architecture cannot provide axiomatic foundations comparable to those of complex geometry. That is, seldom does architecture develop according to advanced forms of geometry. Yet, in a practical sense, architecture is permeated by geometry. After all, geometry is needed to give contours to enclosures of space. The geometric definition of shape is the basis of composition, which mobilizes all of the elements that define the ensemble of causes and elements in architecture. As the result of so many fallible judgments, composition – both vague and imprecise, more often than not draws on relatively rudimentary geometric forms.

Geometry is considered to be indispensable to architectural production, even if the relationship is not reciprocal, i.e. – geometry is not dependent upon architecture, and rarely advances as a result of architecture. From the architect's point of view, therefore, only by separating these two fields can their relation be clarified. Unification in practice and separation in theory allow the architect to ask: Why does architecture need geometry? What kind of geometry does architecture need? What does geometry do for architecture? What does architecture do for geometry?

To begin a new project involving the fertile agitation of forms in building design, with respect to geometry, it is useful to look at geometry from the time of the Renaissance. The development of seventeenth-century projective geometry can be traced, in part, to the Renaissance by recognizing that there were other dimensions in the understanding of geometry in the Renaissance, which were indicative of an alternative vision of the architecture/geometry interaction: the instrumental, technical advancements in representation and construction, such as perspective, orthogonal projection, axonometry, and stereotomy. This vision could not be realized in practical terms in the succeeding two centuries because projective geometry, in the seventeenth century, and descriptive geometry, at the end of the eighteenth century, were disembodied and disassociated from architecture. Renaissance architecture required axiality and grids to manifest hierarchical, centralized forms through perspectival convergence. Projective geometry, for the most part, advanced remote from both the space and discipline of architecture, and was generally only narrowly applicable to the problems of stereotomy.

Between the eras of the Baroque and the Enlightenment, we see two connected developments: the codification of these forms of geometric knowledge – the period that gave birth to the means of intersection between cylinders, cones, ellipsoids, and spheres – and the gradual disappearance of the reliance upon non-orthogonal forms as the commitment to programmatic standards. For architecture, the result of these developments was that basic shapes predominated, so that even in the nineteenth century, though complex geometric techniques were taught to architects, they were rarely used. Instead, it was only in the field of engineering that the techniques of intersection, as enabled by stereotomy and projective geometry, were used, e.g. – for the design of machines, ships, trains, etc. In the twentieth century, of course, these mechanical forms would be transferred back into architecture as iconography and analogy (as opposed to geometric technique), and thereafter mimicked as a new "machine aesthetic." Today, to be taught projective geometry by means of digital media is to learn the methodological foundations of the forms and ideas we inherited from Modern Architecture. The computer renders these foundations transparent in unprecedented ways.

In architecture, there have been other, nostalgic returns to geometry as an iconographic program. The fragmentary forms of Deconstructivism, set against normative elements like floors and structural elements, were thought by architects and theorists to be necessitated by either developing technologies or the fluidity and indeterminacy of modern life. Yet, they remain as arbitrary, vague, or imprecise as the compositional methods that lead to "normal" architecture. The claims that these developments are inevitable, necessary, or follow from the technologies advancing in our time are spurious. Indeed, I would argue, those who seek to guarantee the legitimacy of architecture through such claims are behaving as if they were metaphysicians. The assumption that the changing circumstances of contemporary life can be given a fixed shape is oxymoronic.

Would it not be more productive today to recognize the autonomy of geometry, and to understand the consequences of disrupting this autonomy according to circumstance and architectural conventions? For example, can the architect intervene in the world of inviolable geometric autonomy? Can the arbitrary (and conventional) lines and spatial divisions of practical Euclidean forms merge with the necessary lines and spatial indivisibility of non-orientable geometric figures and their linear intersections? By seeking similar degrees of surface curvature between independent geometric figures, i.e. – the primitives of cones, spheres, cylinders on the one hand, and non-orientable, self-intersecting rectangles and self-intersecting, one-sided surfaces such as helicoids and catenoids, on the other, near tangencies can be achieved, thereby invoking a possible, but ultimately unattainable, synthesis. This discord parallels the perennial disagreement between geometry and materiality. Only this time, what happens to the relationship between inside and outside? How do we contend with this problem programmatically? What are the thermal and material implications and consequences? Finally, do these conditions need to be shaped explicitly or inexplicitly, according to the geometric principles that beg these questions? For us, it is the promise of order and evidence of the struggle undertaken in order to reach it, that is of interest. Perhaps, then, there will be a new "near miss" between the disciplines, another iteration in the ongoing contest of architecture vs. geometry.

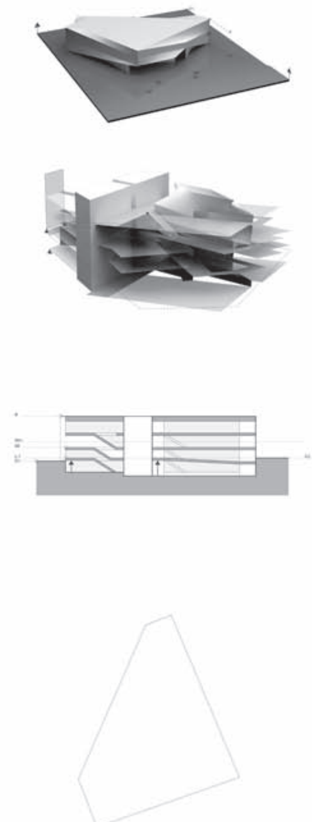


fig 1
Analysis Layout

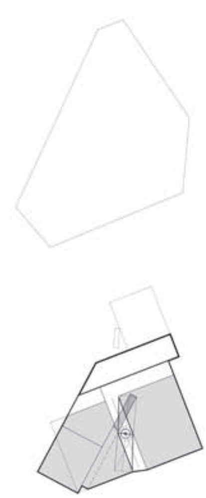


fig 1


fig 2


fig 3


fig 4


fig 7


fig 5


fig 6

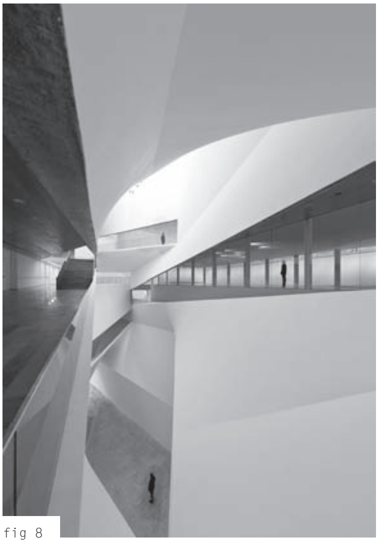


fig 8

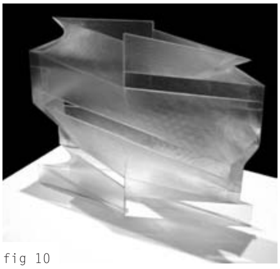


fig 10

fig 2
Plan level -4,
Courtesy Preston Scott Cohen, Inc.

fig 3
Plan level -3,
Courtesy Preston Scott Cohen, Inc.

fig 4
Plan level -2,
Courtesy Preston Scott Cohen, Inc.

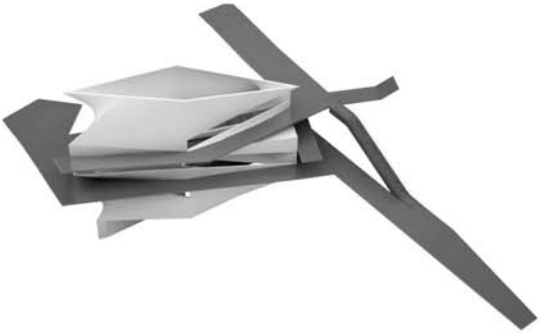
fig 5
Ground level plan, Courtesy
Preston Scott Cohen, Inc.

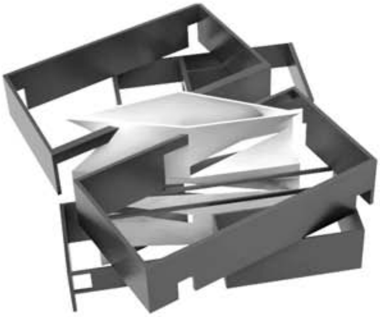
fig 6
Plan level 01/02, Courtesy Preston
Scott Cohen, Inc.

figs 7-8
Lightfall, Amit Geron, Courtesy
Tel Aviv Museum of Art

fig 9
Lightfall, circulation, galleries,
and envelope (top to bottom),
Courtesy Preston Scott Cohen, Inc.

fig 10
Physical lightfall model,
Courtesy Preston Scott Cohen, Inc.





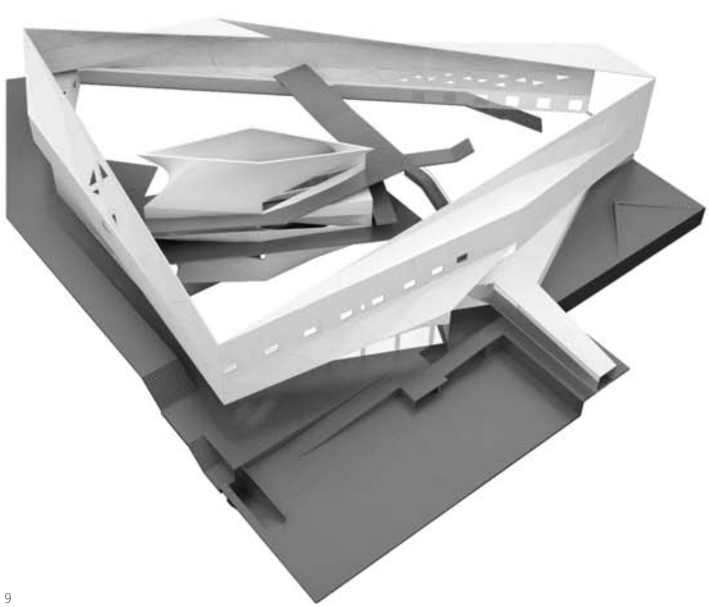


fig 9


HERTA & PAUL AMIR BUILDING
TEL AVIV MUSEUM OF ART
מוזיאון תל אביב לאמנות
הבניין ע"ש שמואל והרטה עמיר

Tel Aviv Museum of Art,
Amir Building 2003-2011

Project Location
Tel Aviv, Israel

Project Type
Art Museum

Project Schedule
2003, First Prize winner in the International competition with finalists Ada Karmi Melamede and Partners (Israel); Gigon and Guyer (Switzerland); SAANA Sajima (Japan)
2005-2007, Design Development and Construction Documents
2007-2011, Construction.

Total Project Budget
$50,000,000

Project Team

Principal Designer
Preston Scott Cohen

Project Architect
Amit Nemlich

Project Assistants
Tobias Nolte
Guy deMoor
Collin Gardner

Client
Motti Omer, Director and Chief Curator
Shuli Kislev, Deputy Director

CARTOPOLOGICAL SPACE: POST-STRUCTURALIST FORM IN FORMATION

— EIROA ARCHITECTS

Codes that cipher data and reference identity have reaffirmed the relevance of structures, forming a new structuralism. Informed systems define architecture through binary codes that structure form and relational linkages that structure space. Through the translation of information technologies, any extrinsic content is reduced into mathematical binary codes. Information systems structure and process information through interfaces as mediums of representation which regulate this flow. *Interfaces* are spaces of differentiation. Form, as an output of information, becomes independent from the set of variables that have indexed its constitution. Once form is generated, new conditions emerge that may induce relationships further than those which were originally predetermined. This dimension recognizes an affection inherent in form relative to space and inhabitation once it acquires an autonomy.

Panofsky's perspective as symbolic form has not been questioned relative to computer interfaces. Today it is critical to acknowledge the structuring of interfaces, the logic of the underlying binary codes that are motivated in the process of representation to transcend their implicit predetermination. Likewise, the superstructures that have dominated the discipline such as typologies, grids, and other underlying structures must be recognized and displaced, in order for the work not to be trapped by predetermination.

Leibniz's differential and infinitesimal calculus presented a critique to Cartesian predetermination. Post-structuralist concepts, such as mapping, suspend Cartesian reductive reasoning. Resisting cultural conventions such as typologies or homogenous grids, this critique opened the consideration of the indeterminacy of topographies avoiding predetermination. Such indetermination is entering computation through topology, swarm intelligence and non-linear computational systems. Since the second half of the last century, a new tectonic for architecture related to the reactionary criticism of the modernist universality, which demanded a reconsideration of the place and the territory. From this disciplinary expansion architecture incorporated the ground surface as part of its syntax and an important architectural canon emerged – the thickening of the ground surface as inhabitable space.[1] Continuing this expansion, the mathematical parameterization of the now canonical topological surface provoked a return to the architectural object, therefore informing the architectural envelope and inducing spatial warping. Part of this scenario left only two alternatives: the reconfiguration of neo-modernism ignoring the displacement of the discipline and post-structuralist blobs reacting to and then ignoring Cartesian structures. But this confrontation is also part of a false opposition, as these reactionary positions belong to the same logical system that acknowledge each other. Differential calculation which enabled the parameterization of curvature through computation, can be understood as an extension of Cartesian logic. Through relational software, the attention shifted from surfaces to parametric relationships. These new interfaces should address deeper structural levels of displacement, aiming to redefine the most stable level in parametric reference: Cartesian Space.

1 Kurt Forster's IXth Venice Biennale preliminary discussions quote. Forster, Eisenman, Davidson, Zuliani, Cainer, Lorenzo-Eiroa round table discussion.

Yet the autonomy of the surface promptly assumed the presence of a different type of space, a "topological" space based on bi-continuous deformation and non-linear spatial relationships. Dynamic computer representation has ignored the ground surface in architecture since XYZ became exchangeable with each other. The now autonomous topological surface promptly assumed a "topological" space-system, substituting and also ignoring Cartesian reference. Topology reacted by negating Cartesian order, substituting it but not displacing it. Topology acquires its full potential when it can be contrasted by exploring alternative spatial relationships and dimensions by displacing its three-dimensional frame reference. Topological space does not serve as a system of measurement and reference as non-Euclidean geometry is contained within a range (calculus), constructed, structured, regulated, parameterized, and measured against a Cartesian coordinate system. Topology deals with self intersecting form that cannot be projected into bi-dimensional planes, resisting representation, while topological surfaces can only be represented in a dynamic three-dimensional plot.

fig 1
Möbius surface, Klein surface and Boy surface conceptually parameterized against Cartesian coordinate space, identifying the topological displacement that each of these surfaces activate relative to each Cartesian coordinate space-plane.

The Möbius surface model displaced XY "ground plane," continuing the first post-structuralist process of reaction to Cartesian order engendered by grounded buildings. The Möbius surface acquired autonomy from the ground informing the architectural envelope. The self-intersecting Klein topological model is a combination of two Möbius models integrating XY to YZ adding independency from the ground and acquiring autonomy as an object informing another dimension. The Boy Surface model integrates three Klein topologies and six Möbius models into a continuous sequence, articulating the three coordinate planes XY-YZ-XZ self-intersecting each other, providing a continuity between the negative and positive sides of each referential plane and opening up a model that is meant to displace the Cartesian reference.

Spatial organization plays an essential role at a cognitive level, presenting limits to how architects and other disciplines measure and understand different space-time paradigms. There is an emerging necessity to work by layering information in a multi-dimensional space surpassing the constraints of three-coordinate space. Computation can activate an interesting future disciplinary scenario by resolving multi-dimensional and multi-scalar projection. This problem manifests the necessity of a transitional time between the shifting of these paradigms. This necessary process should re-qualify these categories, enabling a different architectural synthesis that may surpass the dialectical model between structuralism and post-structuralism. House II engages with this problematic, activating multiple typological and topological levels that parameterize and displace each other. House II presents the following manifesto:

Cartopological space becomes active as a critical suspension between dynamic Cartesian parametric space and topological displacement, attacking an ongoing historic metaphysical project in digital architecture.

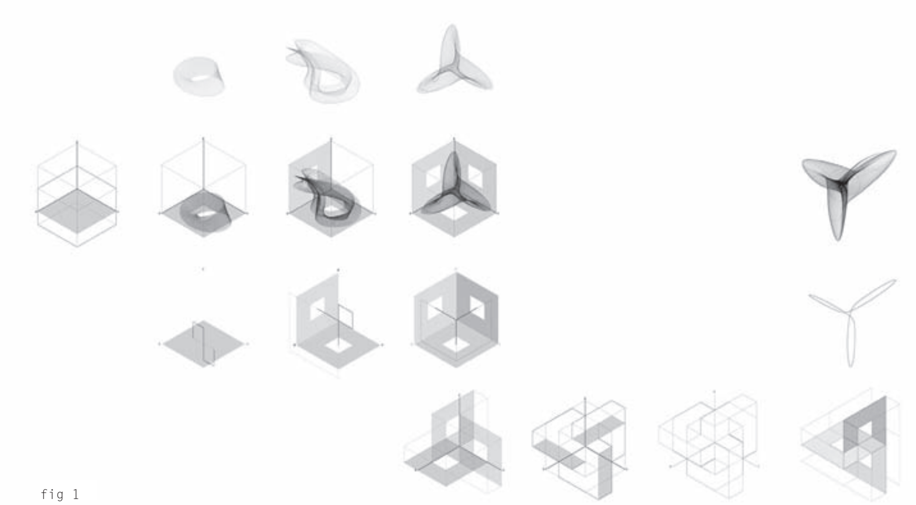
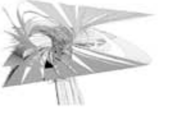


fig 1

fig 2
House II develops three topological displacements that affect the stability of each of its three referential Cartesian coordinate planes. These displacements layer information parametrically, combining different source codes through multiple interfaces. Relative displacements are targeted to activate emerging typological instances to overcome the original organizational structure. Beginning with three centralized nine square grid volumes, the center of one volume is displaced by becoming continuous with the corner of the other – a relationship repeated in the three axes. The relative relationship between the three axes is also displaced, activating multiple typologies within a unifying continuous topology. Therefore House II



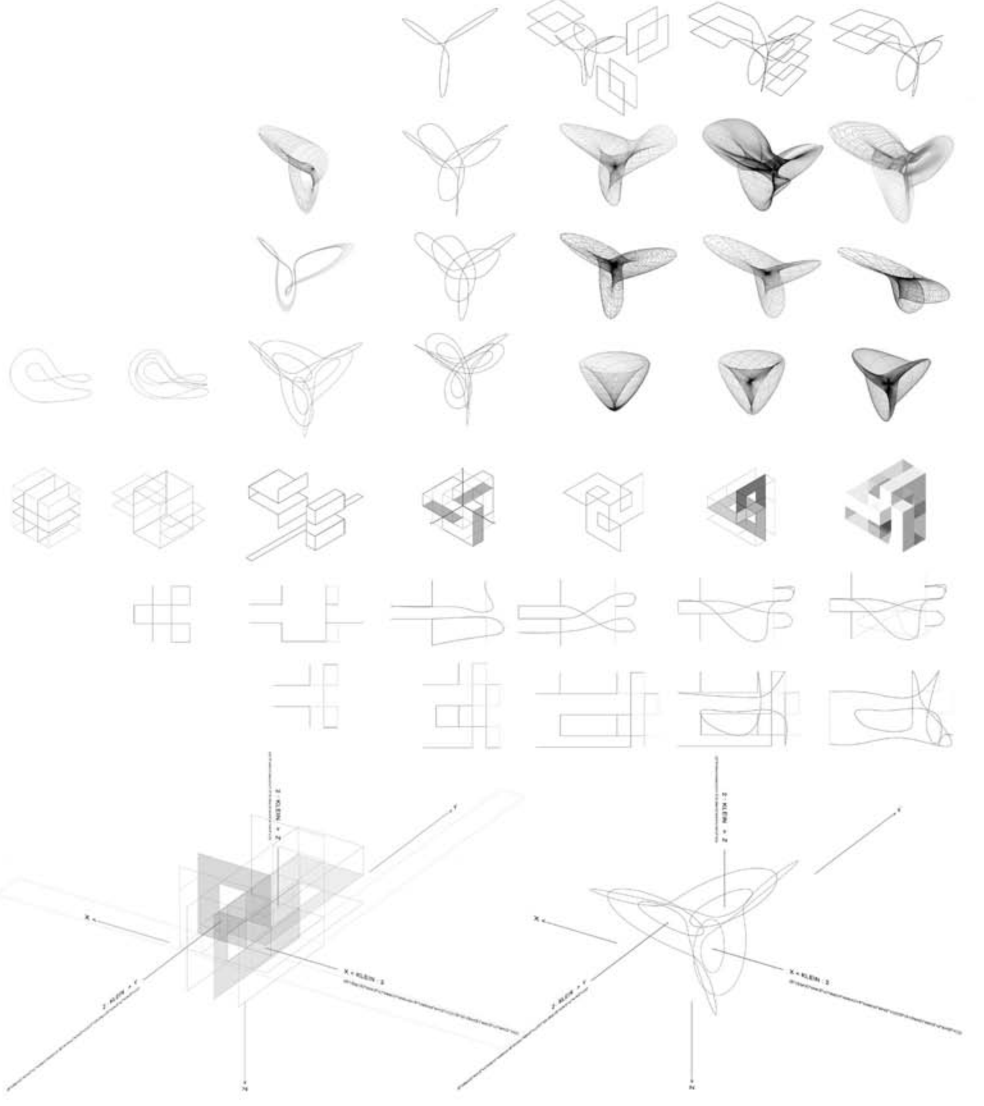
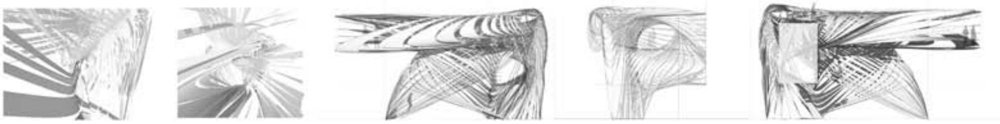
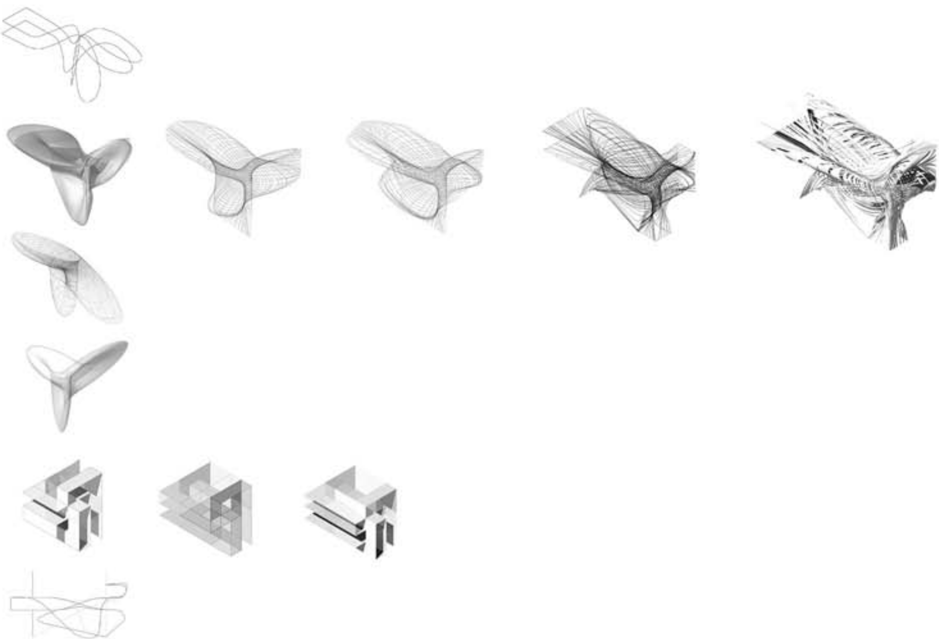
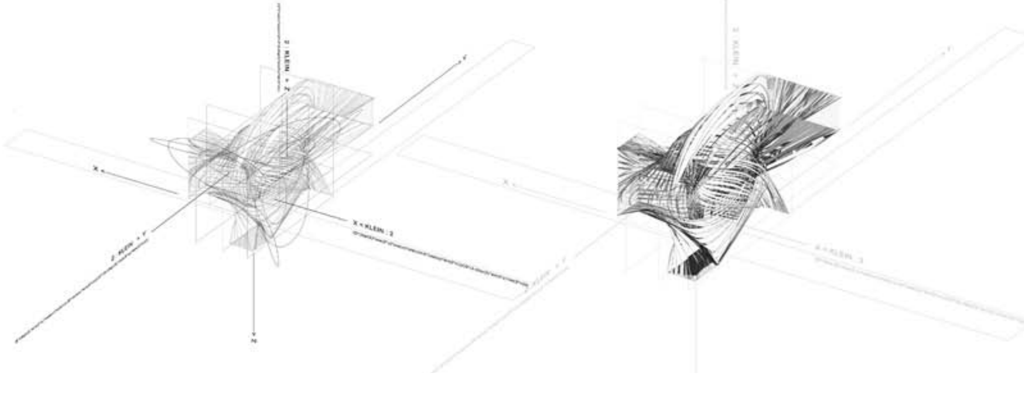


fig 2

resolves multiple typologies that are first activated and then critiqued through topological displacements. Synthetic complex continuities between centralized courtyards become internalized through the corners; exterior bridge-spaces become internalized; and finally a twofold L-shape space integrates a horizontal XY house, a vertical YZ house and vertical XY house in a continuous topology. All of these typologies are integrated into a continuous synthesis that displaces their initial set of categories. The displacement of center-corner and interior-exterior relationships through topology is also taken to another level, since the surfaces that actualize these continuities are also delayered. An internalized topo-logos activates a bodily affection by displacing the deterministic binary-based planar condition of the surface into a differentiated field of interstitial spatial delimitations. Architecture has been expanding toward the landscape. By infolding this process to displace the architectural container, House II develops an internalized topo-logos that reveal non-deterministic relationships displacing the original referential Cartesian container space through multiple operations.







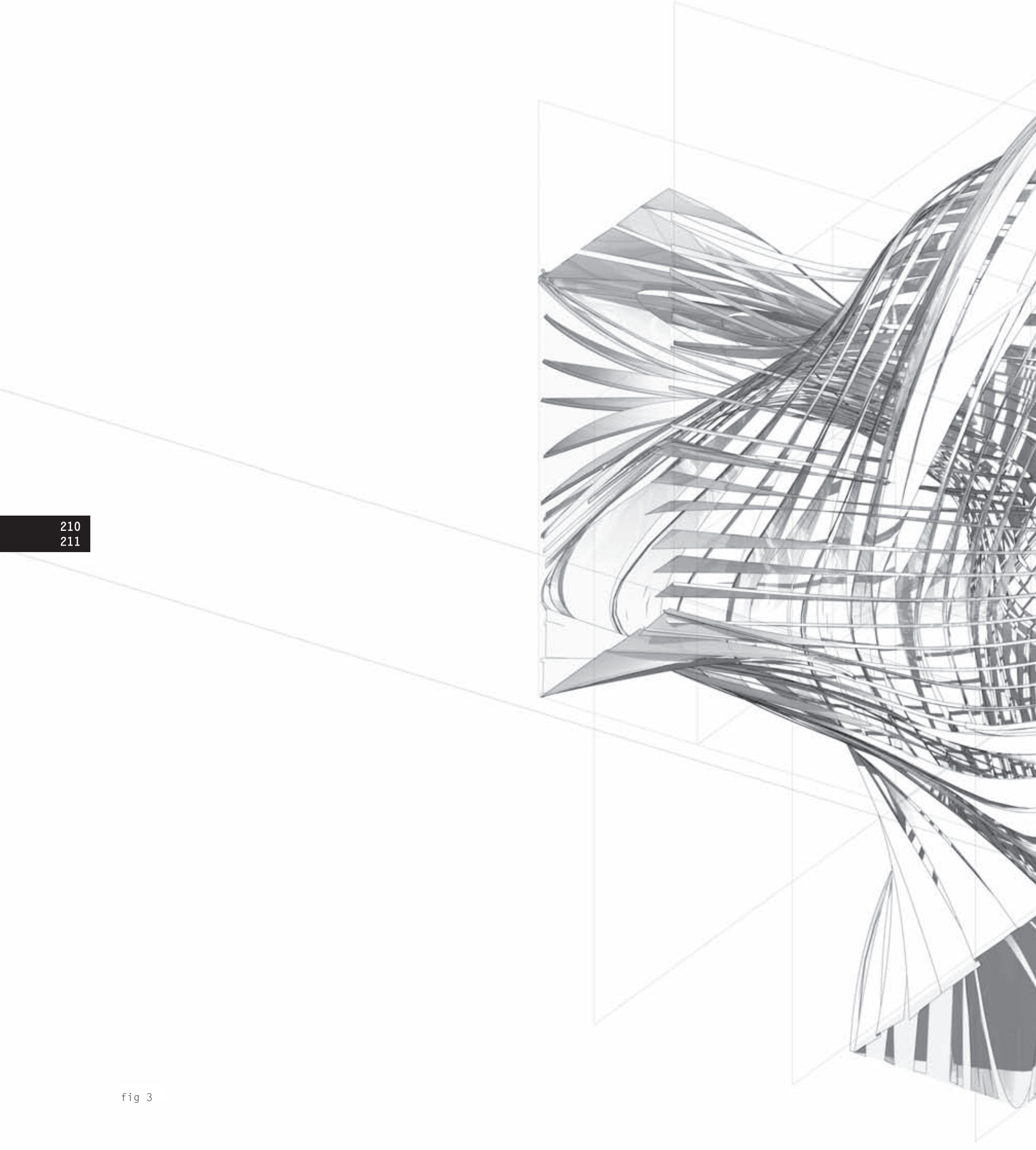
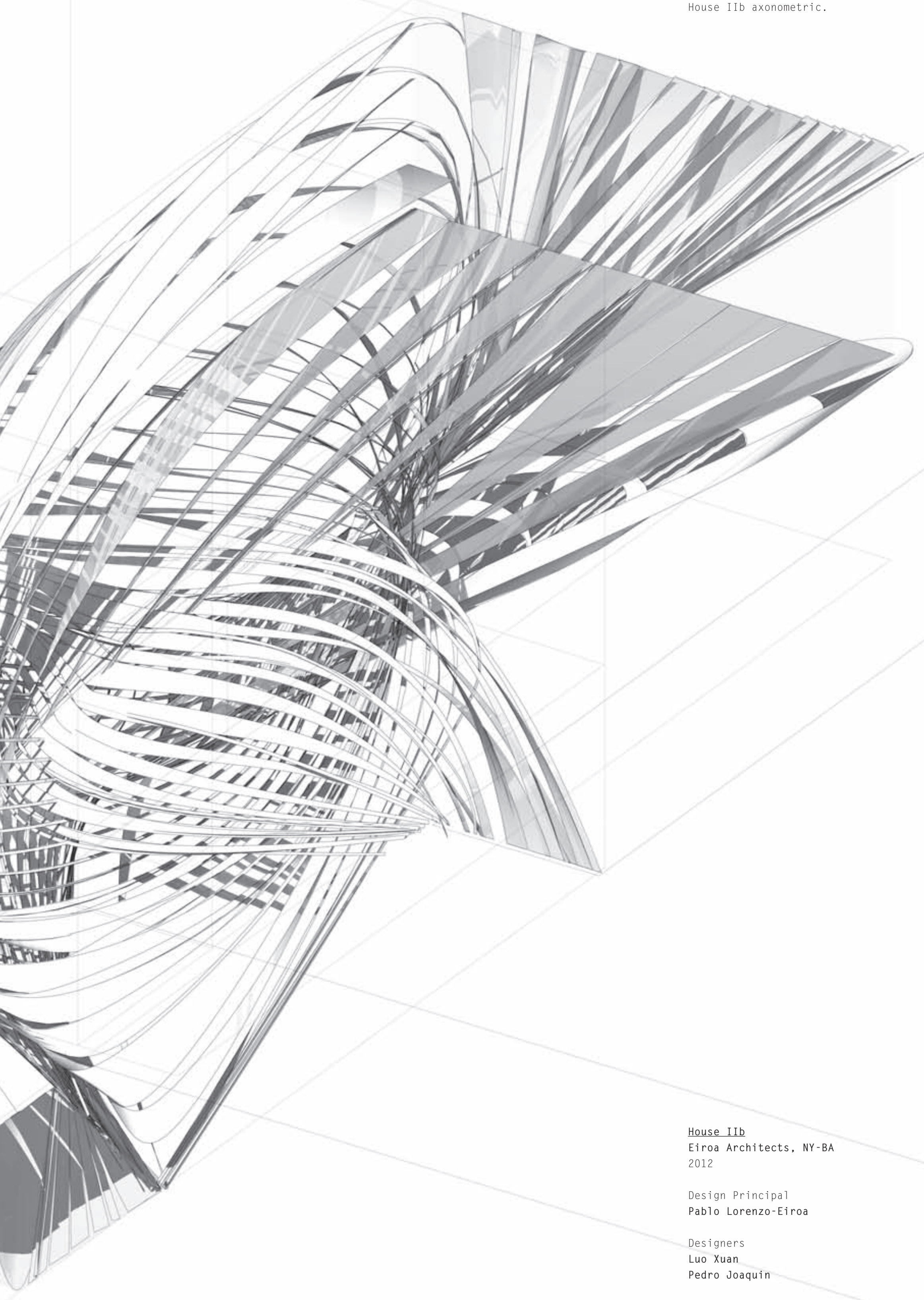


fig 3

fig 3
House IIb axonometric.



House IIb
Eiroa Architects, NY-BA
2012

Design Principal
Pablo Lorenzo-Eiroa

Designers
Luo Xuan
Pedro Joaquin

THE SIXTH ORDER

— MICHAEL HANSMEYER

Architecture stands at an inflection point. The confluence of advances in both computation and fabrication technologies offers architects the possibility of designing and constructing hitherto unimaginable forms.

With increases in processing power, the roughly triangulated geometries and simple blobs of the early 2000s, themselves as much a product of the possibilities, as well as the restrictions, of early software packages, have given way to the possibility of complex geometries at multiple scales and details approaching the threshold of human visibility. In parallel, advances in additive manufacturing technologies have put us at the verge of printing any form. Rather than just printing small architectural models, recent machines with a print volume of two cubic meters have made it possible to print full-scale architectural components. As a result, a form with a few million surfaces is as easy to print as a form with a few dozen.

For the first time, complexity is not an impediment to design and fabrication. Rather, it is an opportunity that is waiting to be explored. For years, it was information technology that constrained architects. Arguably, this relationship has reversed: it is now architects who are constraining the possibilities of information technology. This development raises the questions: How can we best explore the opportunities that information technology offers us? How can we understand the possibilities?

To truly exploit the possibilities, we can no longer draw by mouse in CAD programs. A single object with millions of unique facets would take years to draw. Neither can the new opportunities be fully exploited using parametric approaches, as these usually involve morphing existing geometries using control parameters, rather than creating geometries that are genuinely new. So far, the results have been largely predictable, and can oftentimes be reduced to the parametric operations that created them.

What is needed is a more abstract and open-ended method: a procedural approach. In procedural design, parameters do not control the geometry directly. Rather, they control the operations of a time-based, predefined process that is itself transforming or generating geometry. As such, an ideal process of exploring form would strike a balance between the expected and the unexpected, between control and relinquishment. It would be deterministic – so as not to rely on randomness, but it would not necessarily be predictable. Instead, it would have the power to surprise.

Once formulated, such an approach can be applied again and again. One no longer designs an object, but a process to generate objects. It is no longer necessary to successively refine a singular design, as one can work with many variants in parallel. These variants can be bred and cultivated into entire families of objects by combining and mutating their constituent process parameters.

This approach enables architecture to be embedded with an extraordinary degree of information. Structure and surface can exhibit hyper-resolution, with endless distinct formations at multiple scales. The processes can generate highly specific local conditions, while ensuring an overall coherency and continuity. As such, the resulting architecture will not lend itself to a visual reductionism. Rather, in the best-case scenario, the procedures will devise surprising topographies and typologies that go far beyond what one could have traditionally conceived.

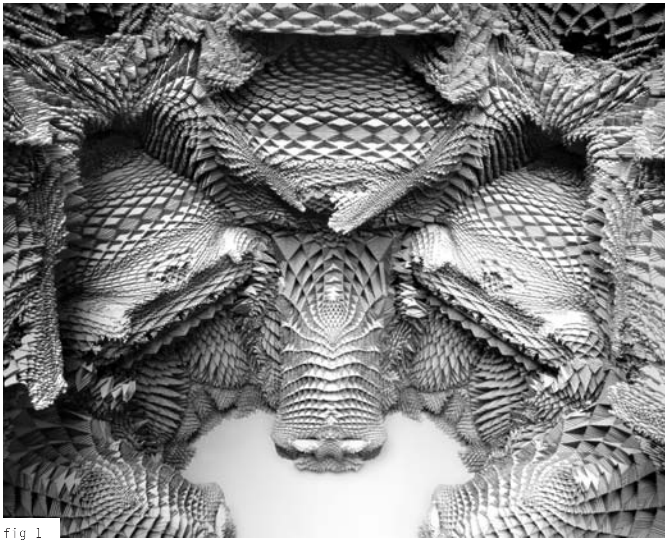


fig 1

fig 2

fig 1
Subdivided Column Studies
Credits: Michael Hansmeyer

fig 2
Subdivided Column
Prototype Negative
Credits: Michael Hansmeyer

The Sixth Order installation by Michael Hansmeyer opens at the Gwangju Design Biennale 2011. The installation engages the main theme of the Biennale "dogadobisando" (design is design is not design) by presenting not a designed object, but instead proposing the design of a process to generate objects.

The Sixth Order involves the development of a column order based on subdivision processes. It explores how a procedural approach to form can define and embellish this column order with an elaborate system of ornament. This approach inherently shifts the focus from a single object to a family of objects: endless permutations of a theme can be generated. For the Gwangju Biennale, a single process was used to generate four individual columns. The resulting columns have not a single surface or motif in common, yet due to their shared constituent process, they form a coherent group.

When entering the exhibition room, the viewer at first perceives sixteen columns. This effect, created by the use of two floor-to-ceiling mirrors on adjoining walls, is intentionally accentuated by the columns' design. Thus the columns are symmetrical along only a single axis, and they have a different appearance when seen from the front or the back. In effect, two column permutations are united in a single column – with eight virtual models forming the four physical objects.

While the procedural approach to design enables this multiplicity of output, it also expands the solution space on the level of the single object. It thus allows the creation of objects that are otherwise undrawable – and perhaps even unimaginable – in terms of their detail and complexity.

fig 3
Subdivided Column Prototype
Credits: Michael Hansmeyer


fig 3

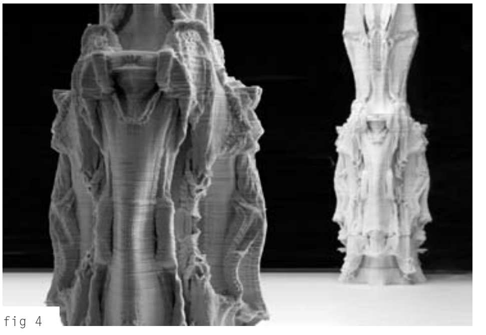


fig 4

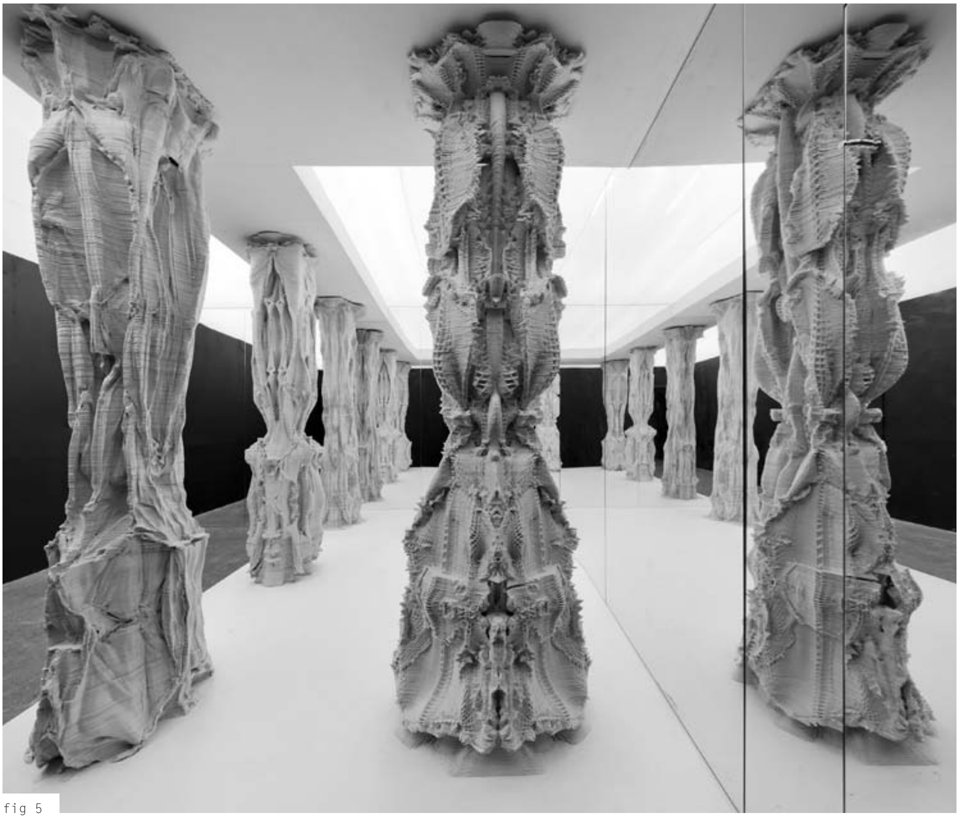


fig 5

figs 4–8
Sixth Order installation –
Gwangju Design Biennale 2011
Credits: Kyungsub Shin

fig 9
Horizontal X-ray of
subdivided column
Credits: Michael Hansmeyer

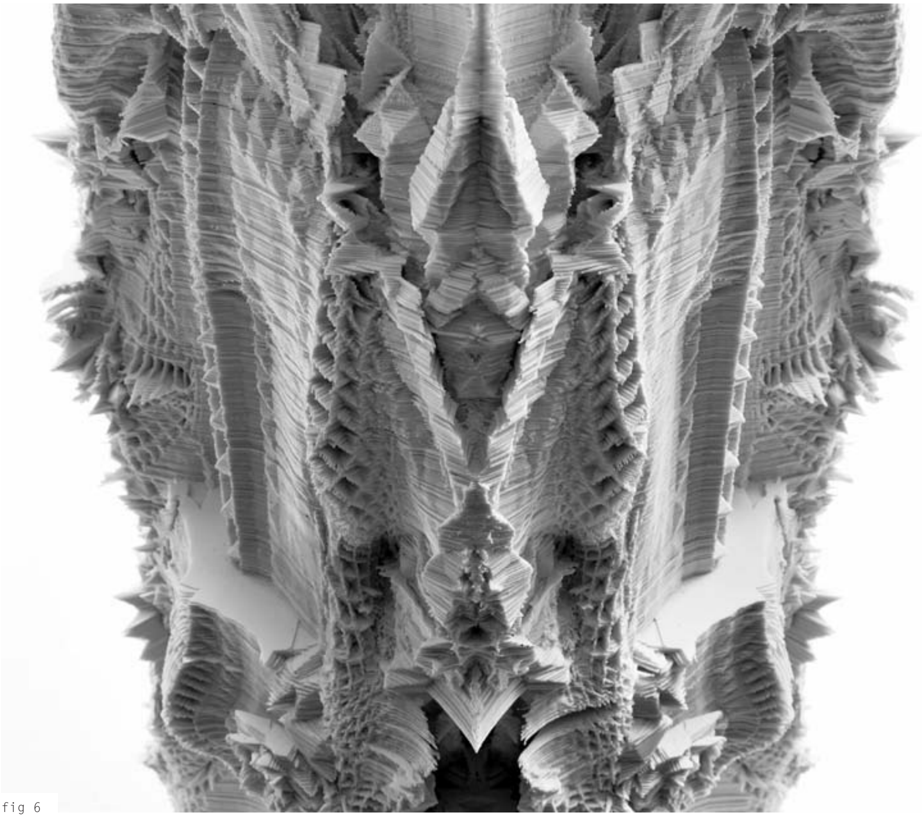


fig 6

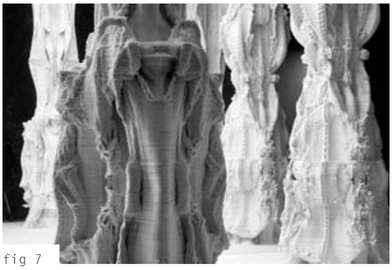


fig 7

fig 8

The Sixth Order
Michael Hansmeyer
Gwangju Design Biennale 2011,
Gwangju, South Korea
2 September–23 October 2011

Materials
ABS plastic in 1 mm sheets
(10,800 sheets total)
wood and iron core

Individual columns
40–70 cm diameter
270 cm height

Exhibition room
700 x 500 x 300 cm

Biennale Directors
Seung H-Sang
Ai Weiwei

Image credits
Kyungsub Shin

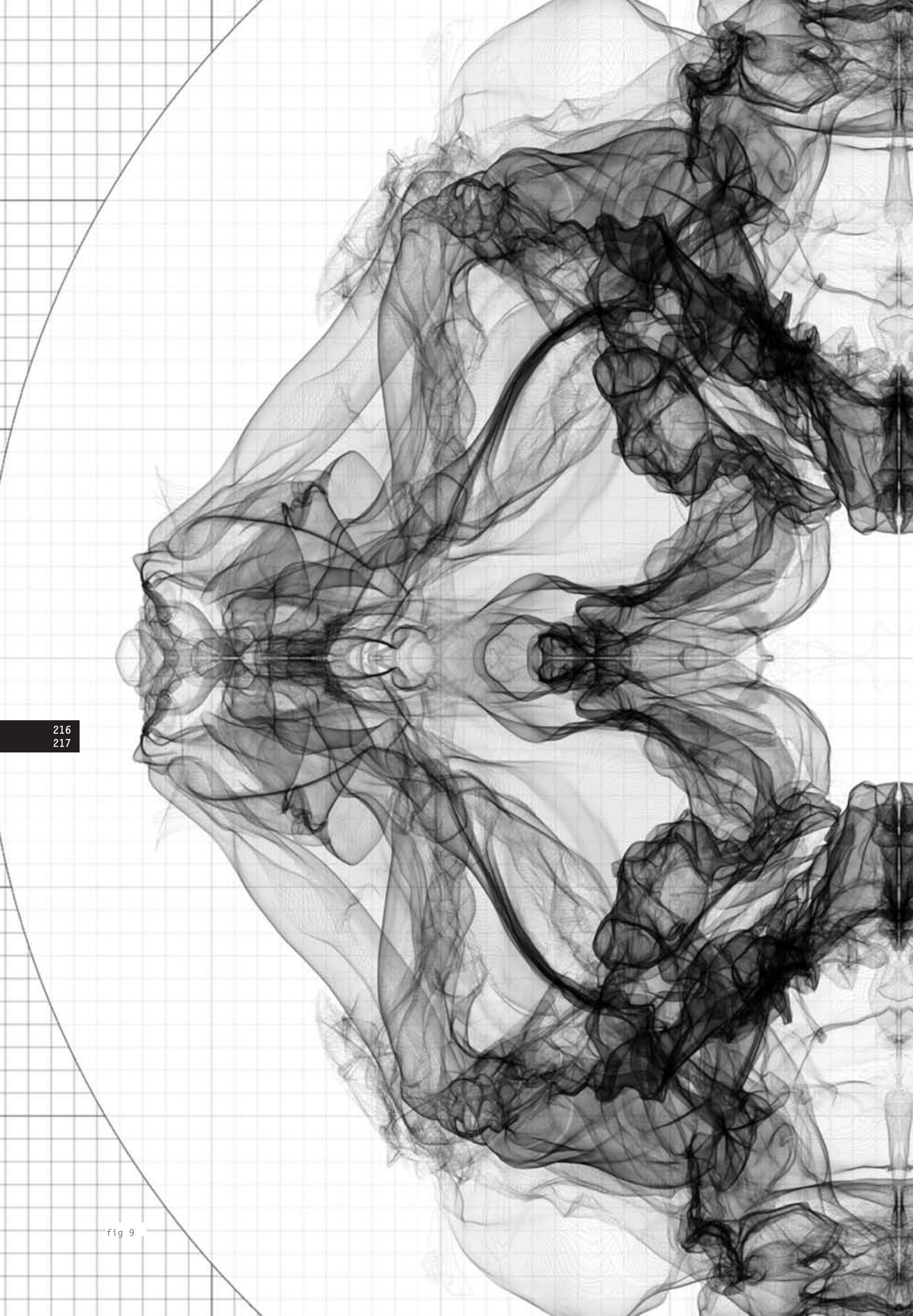
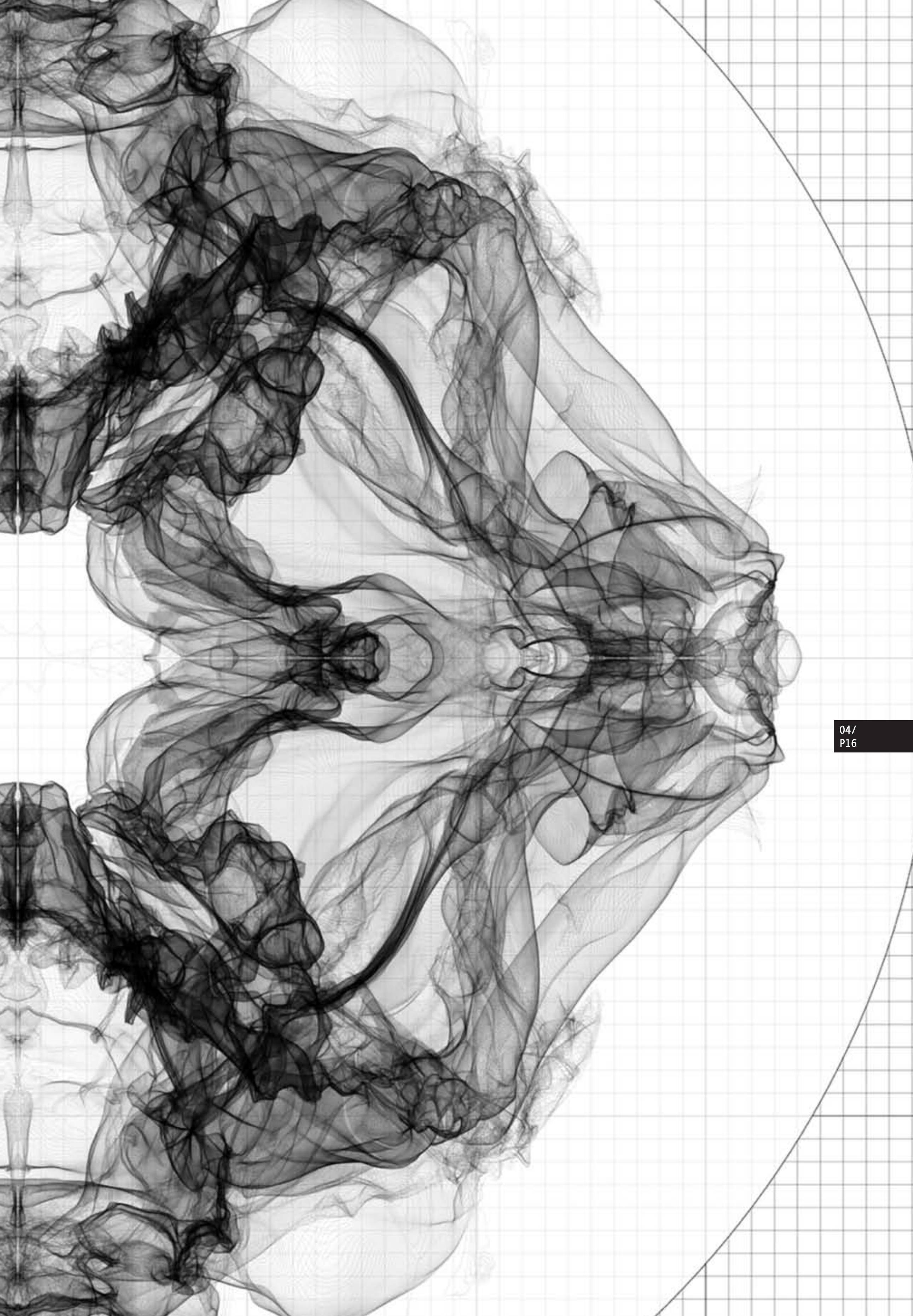


fig 9



INFORMED PERFORMANCE: FORM GENERATION ACCORDING TO POLYVALENT INFORMATION

— CHANDLER AHRENS / OPEN SOURCE ARCHITECTURE

The integration of computational technology into the design process promotes the integration of multiple streams of information into the generation of the architectural object. Beyond the utilization of technology to accelerate the previously established linear design process, computational tools promote the generation of data-compressed equations that filter, parse and combine multiple flows of information. The ability to handle massive amounts of information allows computational systems to create a network of relationships that push and pull on the formation of the architectural object. Within this methodology, design is redefined as it shifts forward in the process from designing the object to designing the relationships of information defined by desires and limitations. It is here that we see the generation of form as a dynamic performance negotiating multiple desires and limitations. This marks a significant shift in the design process from creating static spaces and material assemblies to generating dynamic relationships based on performance and interaction.[1]

Utilizing a computational platform to generate the form, multiple streams of information are integrated into a dynamic design process that develops a series of iterations to uncover a desirable balance between various and often conflicting criteria. The integration of desires and limitations for a project enables the generation of an informed form where the designer is able to negotiate a balance between multiple sets of information. Limitations and desires are enfolded into the design process allowing them to define the range of potentiality integral in generating the form. At an urban scale, this potentiality can be read as abstract boundaries such as Hugh Ferris' zoning envelope drawings or as a method to generate novel solutions such as the development of the Mansard Roof.[2] Limitations and desires are merged as parameters in a computational algorithm for the generation of the architectural object. (fig 1)

A dynamic computational algorithm that integrates multiple streams of desires and limitations was created for the project D-Velop. Located in Boulogne, just outside the periphery of Paris, D-Velop is a proposal for a multi-family residential project composed of two independent structures surrounding a courtyard. (fig 2) The data-compressed equation negotiates limitations such as the three-dimensional zoning envelope, floor area requirements, and economics with desires such as high climatic performance and spatial and atmospheric qualities including transparency and translucency to manipulate natural light and views (fig 3). Integrating formal limitations with spatial desires is indicative of the merging of the morphogenic and atmospheric projects.[3]

1
Michael Hensel, "Performance-oriented design from a material perspective: domains of agency and the spatial and material organization complex," *Performalism*, New York, Routledge, 2012, p 43.

2
The Mansard roof was developed as a way to add more usable floor area in the roof of a building above the zoning height restrictions that were measured to the cornice of the roof.

3
Aaron Sprecher describes the rise in prominence of both the atmospheric and morphological projects in recent years and the desire to fuse the architectural object to its environment, "Informationism: information as architectural performance," *Performalism*, New York, Routledge, 2012, p 27.

fig 1
The zoning envelope defines limitations of the form of the proposed building.

The development of the formal and spatial aspects of the project focuses on the generation of multiple iterations of the dual skin system, which is composed of a curtainwall and ETFE (ethylene tetrafluoroethylene) panels (figs 4, 6). As a means to evaluate the iterations developed through a dynamic algorithm, performance is utilized as a measuring device. Performative aspects of effect and affect such as engineering efficiency, material properties, energy consumption, visual effect, framing of views in and out, and the perception of the architectural object in the urban context are established as parameters within the computational algorithm that can be compared to the desires and limitations of the project. (figs 5, 7) The algorithm promotes the ability to adjust the parameters to find an optimal balance between the multiple streams of information for the project.

fig 1

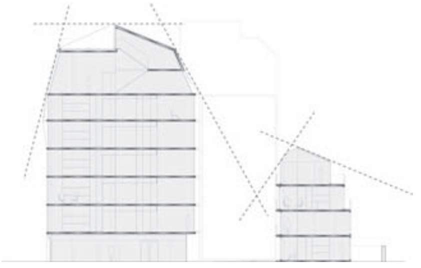


fig 2

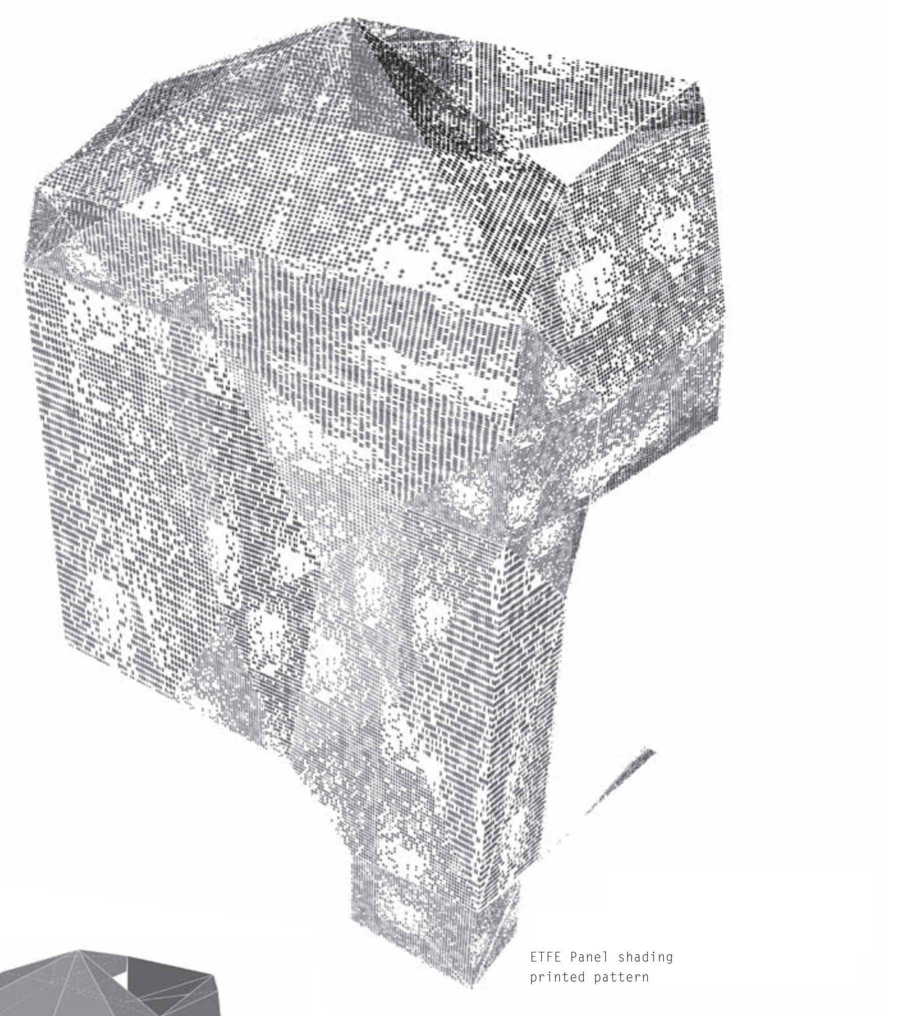
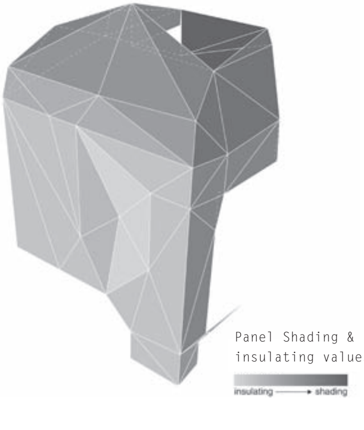


fig 4

ETFE Panel shading
printed pattern



Panel Shading &
insulating values

fig 2
Site section through large and small buildings.

fig 3
Individual systems that influence the form-finding algorithm.

fig 4
ETFE secondary skin systems components

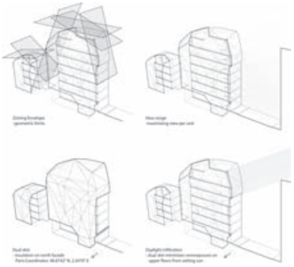
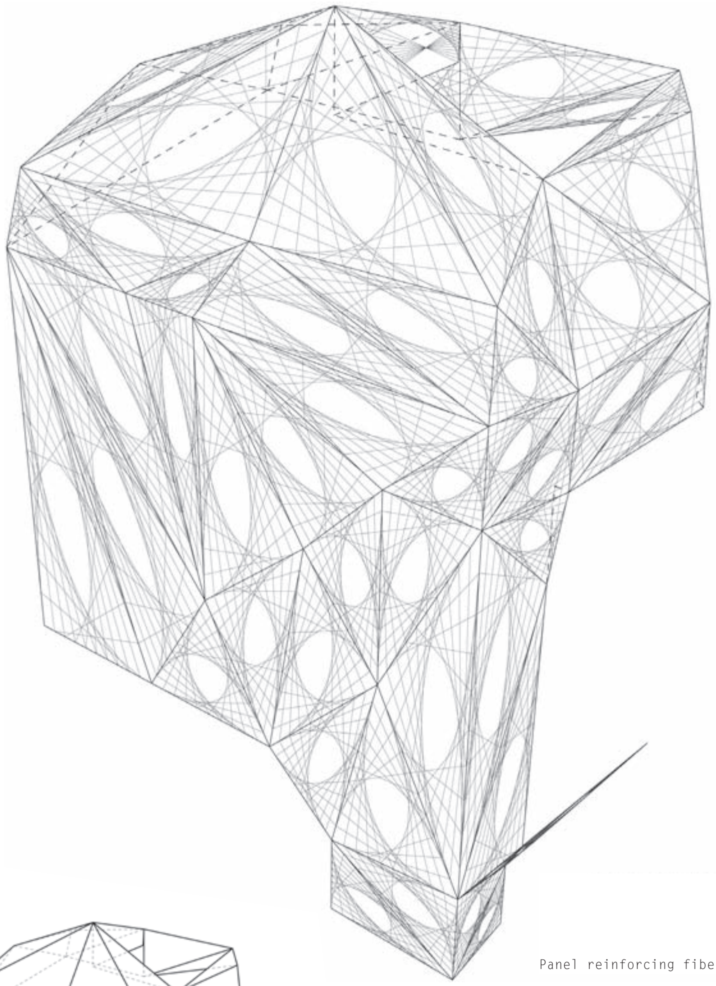
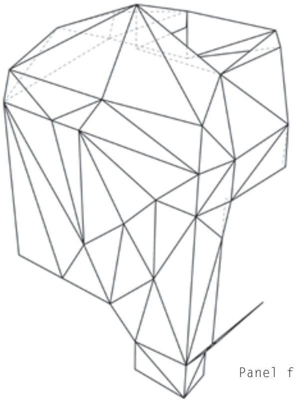


fig 3



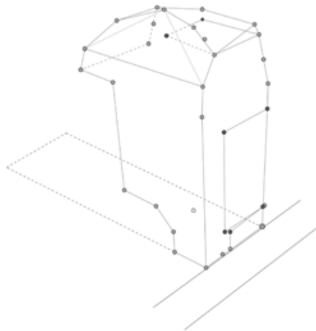
Panel reinforcing fibers



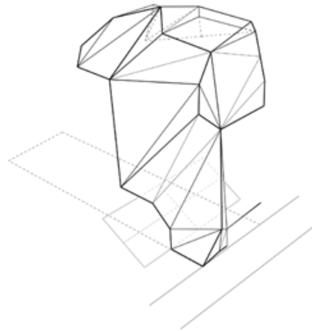
Panel frame structure

Point Cloud

blue > urban regulations
red > architectural requirements
Yellow > key virtual point

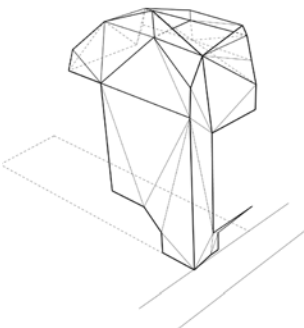


Point cloud with lines defining the shell



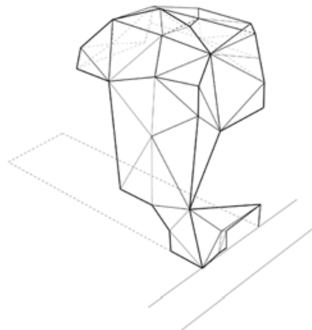
iteration 1: entire cloud calculated according to the guide plane.

settings:
noise: .002 guide plane<: 36 virtual points: no



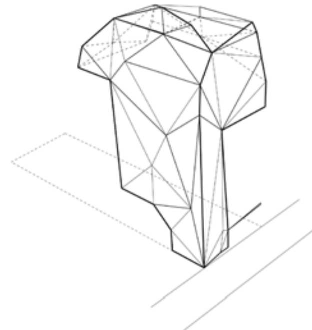
iteration 2: individual sides calculated separately.

settings:
front- noise: .002 guide plane<: 90 on y VP: no
side1- noise: .002 guide plane<: -85 on x VP: no
side2- noise: .002 guide plane<: 90 on x VP: no
back- noise: .002 guide plane<: none VP: no
top- noise: .002 guide plane<: 55 VP: no



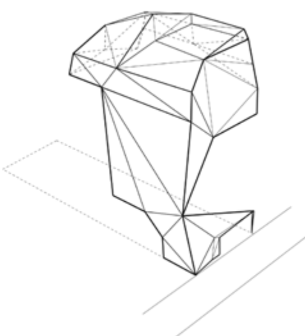
iteration 3: individual sides calculated separately. Virtual points used to subdivide the mesh.

settings:
front- noise: .002 guide plane<: 90 on y VP: 14
side1- noise: .002 guide plane<: -89 on x VP: 18
side2- noise: .002 guide plane<: 90 on x VP: no
back- noise: .002 guide plane<: none VP: 20
top- noise: .002 guide plane<: 55 VP: 17



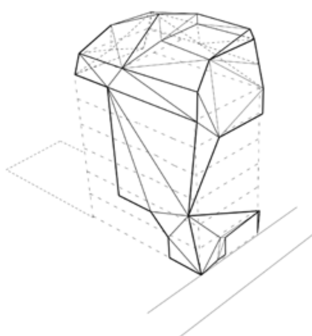
iteration 4: individual sides calculated separately.

settings:
front- noise: .002 guide plane<: 90 on y VP: 14
side1- noise: .002 guide plane<: -89 on x VP: 18
side2- noise: .002 guide plane<: 90 on x VP: no
back- noise: .002 guide plane<: none VP: 20
top- noise: .002 guide plane<: 55 VP: 17



iteration 5: individual sides calculated separately.

settings:
front- noise: .002 guide plane<: 90 on y VP: no
side1- noise: .002 guide plane<: -89 on x VP: no
side2- noise: .002 guide plane<: 90 on x VP: no
back- noise: .002 guide plane<: none VP: 20
top- noise: .002 guide plane<: 55 VP: no



iteration 5 with floor slab demarcation

fig 5

fig 5
The computed architectural object according to multiple parameters.

fig 6
Analysis of the iterated skin geometries.

fig 7
The form and skin system in the urban context.

fig 6

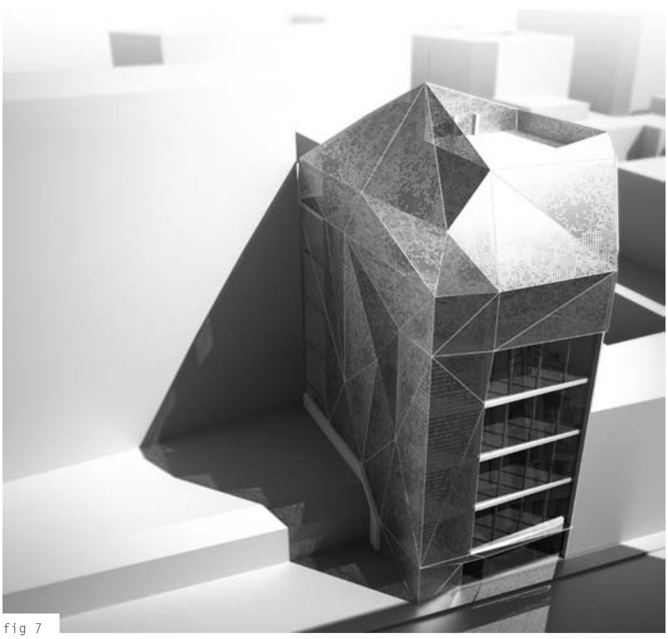


fig 7

D-velop, Paris

Design Team
Open Source Architecture
(Chandler Ahrens, Eran Neuman, and Aaron Sprecher)
www.o-s-a.com

and

R_are Architects, Paris

Client
Millenium Co.

Location
Boulogne-Billancourt, France

Size
15,000 sqf residential,
800 sqf retail

BAROQUE PARAMETERS

— ANDREW SAUNDERS

"Though few modern scholars make use of the fact, or even seem to realize it, Baroque architecture was, above all, mathematical."

George L. Hersey[1]

Scripting: the return of mathematical intuition

One of the most promising aspects of parametric design is that it promotes a distinct and disciplined bottom-up process of modeling geometry. A scripting-based approach to parametric modeling utilizes features of programming within a native modeling environment. Geometry can then be generated by flow control (skipping and repeating lines) and variable control (logical and mathematical operations - data storage).[2] The ability to model with mathematical operations allows unprecedented accessibility to the generative possibilities and comprehension of equation-based geometry.

Instrument for analysis

Recently, the opportunity arose to explore scripting as a tool for analyzing how geometry operates in Baroque architecture. Geometry and mathematics were integral to seventeenth-century science, philosophy, art, architecture, and religion. It is what links Baroque architects Francesco Borromini and Guarino Guarini to other great thinkers of the period including Descartes, Galileo, Kepler, Desargues, and Newton.[3] Plasticity and dynamism are explicit signatures of Baroque architecture. Less obvious are the disciplined, mathematical principles which generate these effects.

Trigonometry through the Arc and the Chord

Borromini is often portrayed with traditional drawing tools of the seventeenth century, the compass to draw an arc, and the ruler to draw a straight line or chord. In order to construct a square, seventeenth-century architects would, first, compose a governing circle, and then segment it with chords to constitute the four sides.[4] Geometry derived from this process is related by its association with a governing circle. As a result, triangle, circle or any equal-sided polygon can be understood as parametric variations of each other.

To script these relationships, trigonometric functions are used to plot geometry by polar coordinates.[5] Trigonometry originated from chords. Ptolemy's Table of Chords was the most famous trigonometric table. Calculations used to solve for these chord lengths are equivalent to the modern sine function.[6] Through the exploitation of these ingrained trigonometric parameters, Baroque architects produced astonishing effects, performance, and continuity.

1
George L. Hersey, *Architecture and Geometry in the Age of the Baroque*, University Of Chicago Press, (Chicago) p. 4.

2
David Rutten, *Rhinoscript101*, Robert McNeel & Associates, 2007, p.4.

3
John Beldon Scott, *Architecture for the Shroud: Relic and Ritual in Turin*, University Of Chicago Press (Chicago) 2003, p.157.

4
Antonino Saggio, (Re)searching and Redefining the Content and Methods of Construction Teaching in the New Digital Era, Eaae-Enhsa, Atene 2005 (isbn 2- 930301 25 2) pp. 13-34.

5
Jess Maertterer, *Script to Create Nested Regular Polygons*, Rhino 3DE Online Education, 2007

6
Morris Kline, *Mathematical Thought from Ancient to Modern Times* (New York, Oxford University Press, 1972), pp. 119-120.

In Sant' Ivo, Borromini capitalizes on verticality by parametrically transitioning from the most basic of polygons, at the base, two overlapping triangles to the infinite sided polygon, the circle. One can trace the movement downward, from the chastity of forms in the heavenly zone to the increasing complexity of the earthly zone.[7] This continuous morphology from crude to smooth initiates, in turn, a novel structural performance. Because it cannot be reduced to a static element, the cupola of Sant' Ivo avoids technical classification as a dome and stands as its own, unique structure.[8]

In the Santissima Sindone, Guarini uses a similar strategy to progress from a triangular base geometry, culminating in a kaleidoscope of hexagons. The staggering hexagons on the interior create an effect of perceptual psychology, fostering an illusion of extreme depth through telescoping vertical space.[9] The porosity of the nested geometry results in the relatively lightweight structural solution of an openwork dome, and allows for maximum light to penetrate into the chasm below. A parametric model reveals that Guarini integrates both structural performance and spatial effect through equation-based scalar and rotational operations.

Re-interpreting the Baroque

The analysis of Baroque geometry was the starting point of the 2007 Rensselaer Rome Architecture Program, under the premise of "Re-Interpreting the Baroque." The associated studio went on to problematize the original parametric principles of the seventeenth century using the contemporary design parameters of *performance* and *effect* for the design of a Counter-Reformation Art and Architecture Museum in the historic center of Rome.

fig 1
Diagram of sinusoidal geometry from trigonometric chord logic by Andrew Saunders

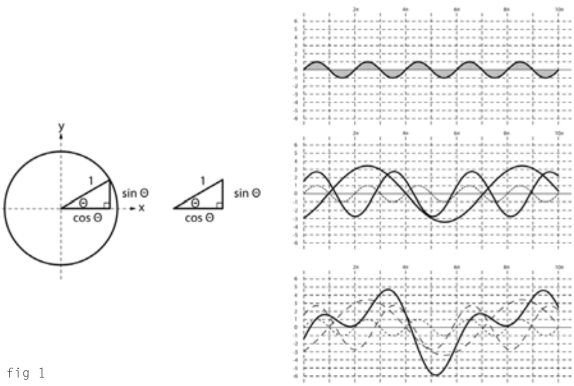


fig 1

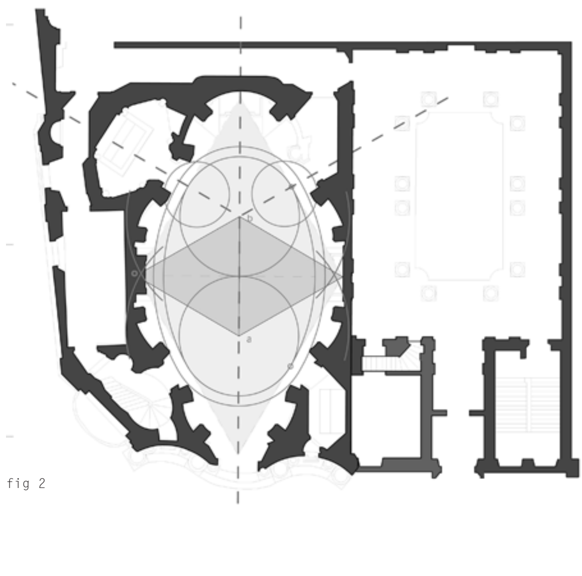


fig 2

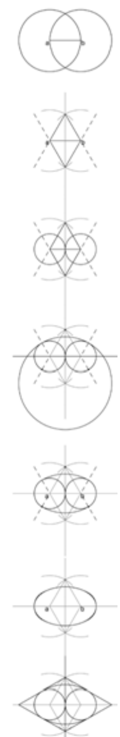


fig 3

7
Rudolf Wittkower, *Art and Architecture in Italy 1600 to 1750*, Penguin Books (Baltimore), 1958, p. 138

8
Federico Bellini, *Le cupole di Borromini. La "scientia" costruttiva in età barocca*, Documenti di Architettura (Milano) 2004, p.

9
H.A. Meek, *Guarino Guarini and His Architecture*, Yale University Press (New Haven), 1988, p. 75

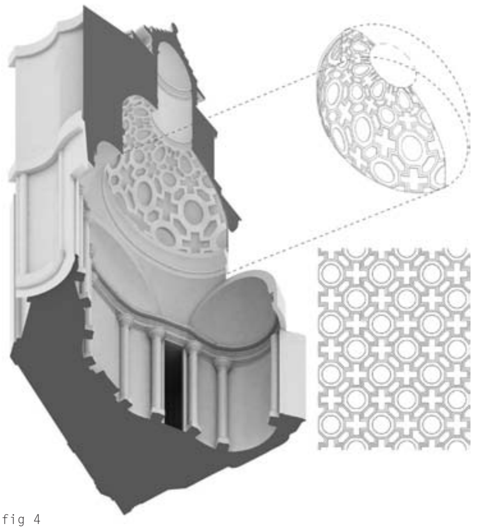


fig 4

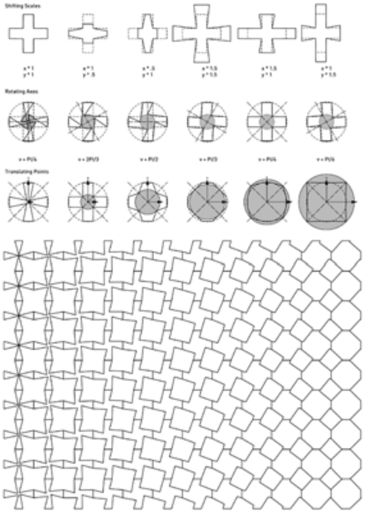


fig 5

fig 6

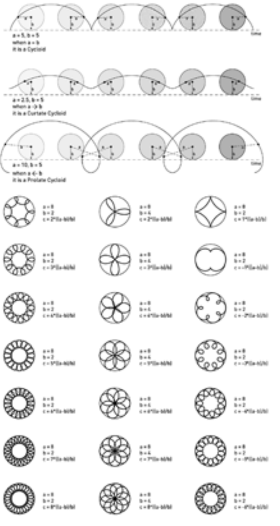


fig 7

figs 2-5
S. Carlo alle Quattro Fontane, Francesco Borromini 1634-1641
Professor Andrew Saunders, students Andrew Diehl & Erica Voss

figs 6-7
Sant Agnese In Agone, Girolamo Rainaldi, Carlo Rainaldi, Francesco Borromini 1652-1672
Professor Andrew Saunders, students Andy Zheng & Morgan Wahl

figs 8-9
Chapel of the Holy Shroud, Guarino Guarini, 1611-1694
Professor Andrew Saunders, student Brian Spangler

figs 10-11
S.S. Luca e Martina, Pietro da Cortona
Professor Andrew Saunders, students Andrew Chardain & Darcy Edmunds

figs 12-13
S. Ivo alla Sapienza, Francesco Borromini 1642-1660
Professor Andrew Saunders, students Dave Holbrook & Rachele Louis

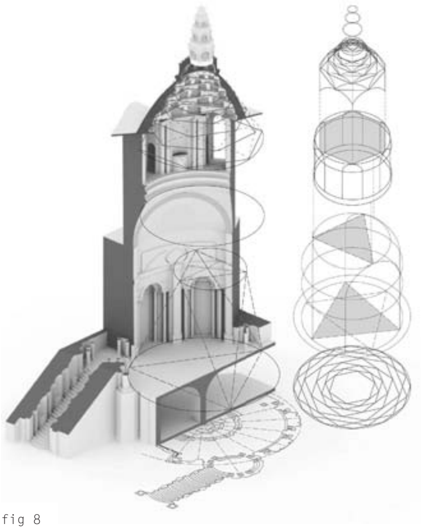


fig 8

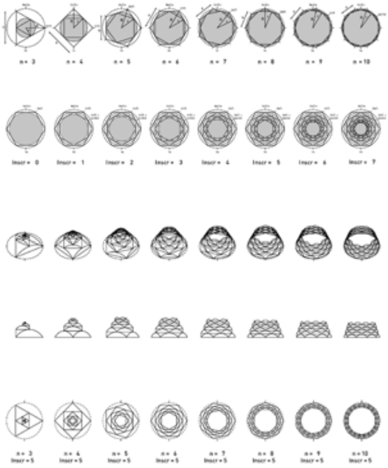


fig 9

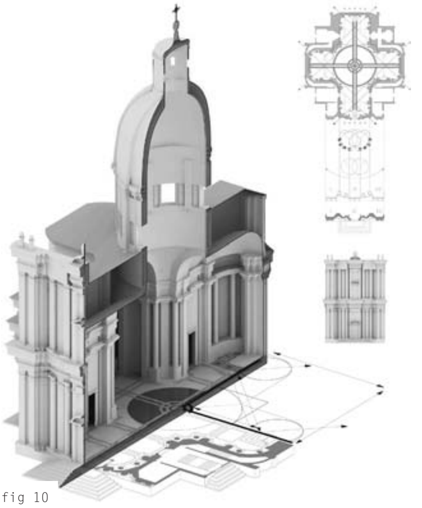


fig 10

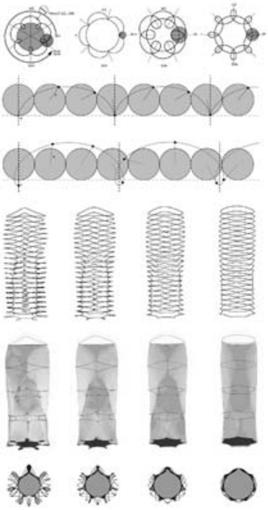


fig 11

Baroque Parameters Studio
Rensselaer Polytechnic Institute
Professor Andrew Saunders

Diagram of sinusoidal geometry from trigonometric chord logic by Andrew Saunders

S. Carlo alle Quattro Fontane, Francesco Borromini 1634-1641
Professor Andrew Saunders, students Andrew Diehl & Erica Voss

S. Ivo alla Sapienza, Francesco Borromini 1642-1660
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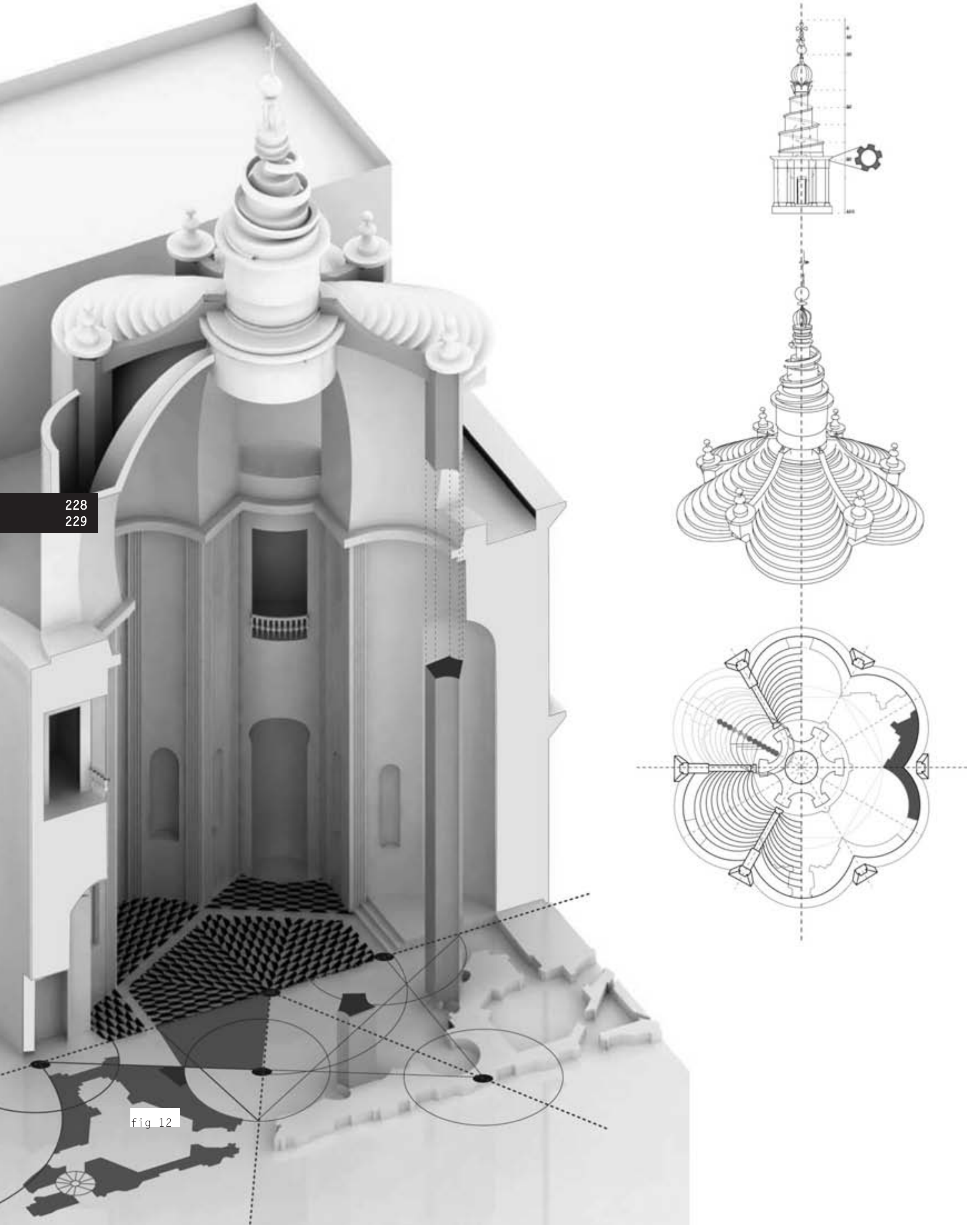

fig 12

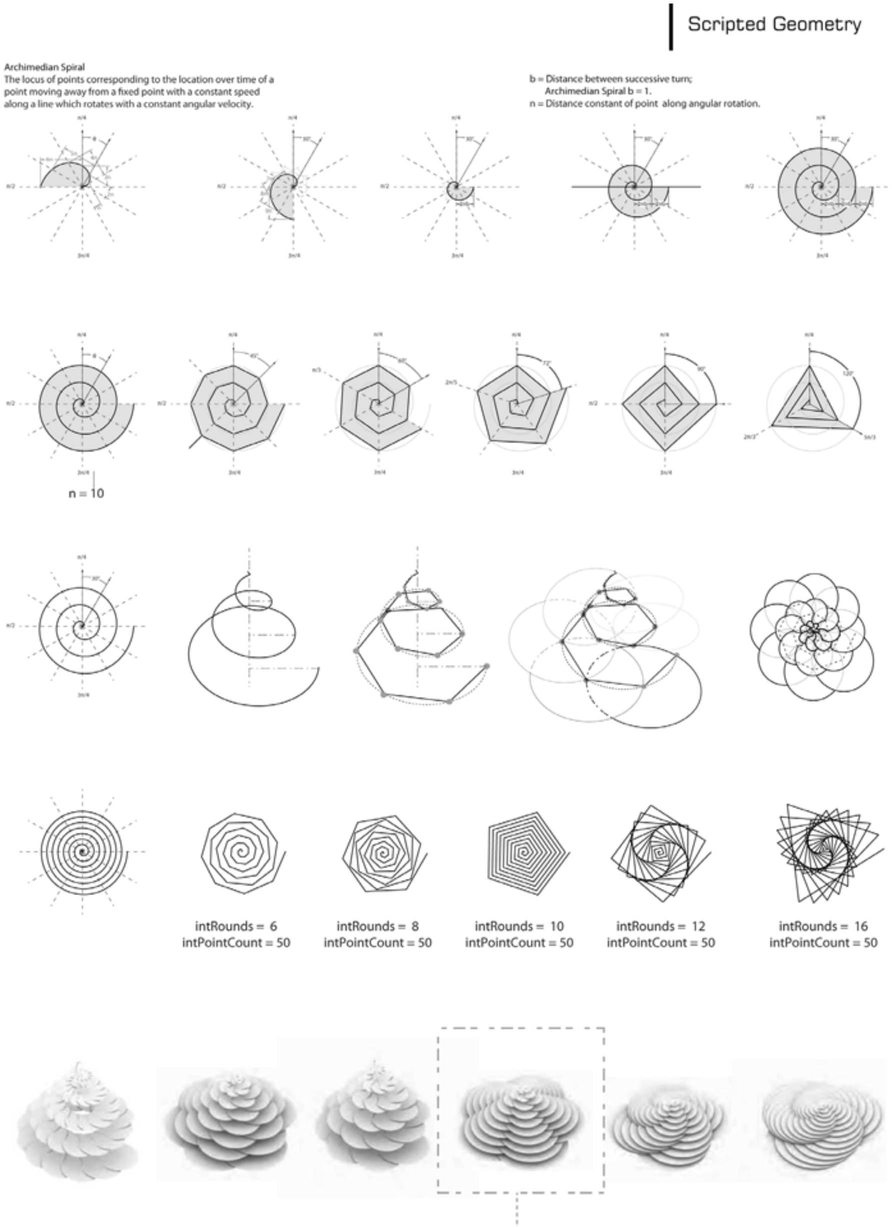
Scripted Geometry
Archimedian Spiral
The locus of points corresponding to the location over time of a point moving away from a fixed point with a constant speed along a line which rotates with a constant angular velocity.
b = Distance between successive turn;
Archimedian Spiral b = 1.
n = Distance constant of point along angular rotation.
n = 10
intRounds = 6
intPointCount = 50
intRounds = 8
intPointCount = 50
intRounds = 10
intPointCount = 50
intRounds = 12
intPointCount = 50
intRounds = 16
intPointCount = 50

fig 13

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COMPUTATION AGAINST DESIGN? TOWARD A NEW LOGICOCENTRISM IN ARCHITECTURE

— ALEXIS MEIER

After 25 years of "Chora L Works" standing between architecture and post-structuralist philosophy, we face a new technological era in which mathematical *logicocentrism* has replaced *logocentrism* as the reigning authority figure. Everywhere, biogenetic algorithms inseminate computing systems and codification transforms matter into a zoo-centric paradigm supposedly extending our potential for spatial experience through volumetric modulations. The purpose of this essay is to articulate the critical and theoretical aspects of this instrumentalization of technology within architectural processes. We will then examine technical and theoretical strategies that can help avoid the totalizing effect of computation's positivistic structure and thereby open up an un-programmable future far beyond "weaving" and calculated design.

There are at least two types of codification related to architecture. The first concerns the direct apprehension of a building's shape as a message: an architectural set of "signs" that must be a symbol or an image necessitating reading. The second, more-subtle type concerns computation and is related to the internal organization and generative structure of the architectural object.

What does this mean for computation? It means that if we reduce architectural conception to a programmed algorithm, we may risk, to some extent, reducing architectural expression to a new, conventional codification system, like a mathematical syntax. This may produce an architectural object defined by a formal or technical operation – for example, a direct consequence of a script protocol. Reducing architectural creation to such an operational technique – as geneticists do in their experiments – necessarily voids the possibility of metaphysical speculation within architectural processes, while also casting systems for architectural creation into a neo-positivistic structure. This structure only leaves open the possibility of operating through a formal (here, mathematical or scripted) reasoning. Such evolution could lead us to ask whether we face a shift from an old *logocentric* system to one that is *logicocentric*, where mathematics – or another information science language – dominates the syntax of architecture. The problem with this logicocentric domination is not that it positions architecture closer to science than to art. (After all, architecture can feed itself from everywhere.) Rather, it is that mathematics "believes" it may become architecture's new *reason*. For example, some may consider an architectural apparatus to be the solution to a mathematical problem, related to a "set theory." This has nothing to do with the problems of "being and living together" that architectural systems have to solve. Why is mathematics useless

fig 1
"I've heard about" / New-Territories-R&Sie(n) - Experience Urbaine d'auto-organisation (2005 / MAM), Self-Organization urban experiment (2005 / MAM).

fig 2
Alisa Andrasek / Jose Sanchez. Turing Pavilion, Biothing in collaboration with D-shape, 2010.

fig 1

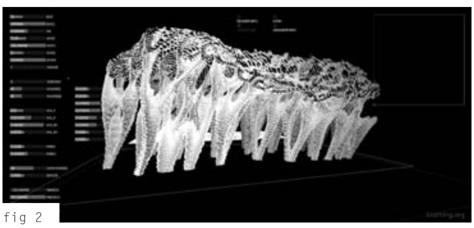

fig 2

here? It is useless because architectural perception has nothing to do with computer syntax. Instead, it concerns a cognitive and sensible system surpassing computational logic. It is true that computation has opened up research into important questions – for instance, the *performativity* of robotic fabrication, *mass customization*, and geometry. Nevertheless, architecture, if not exactly an art, is also not a science. It is unnecessary to read Heidegger's critique of technology to understand that once you reduce the design process to a technique of codification (a process Jean-François Lyotard identifies ironically as producing a "scripting surface"), you risk making the architectural designer into nothing more than a digital technician. Perhaps more importantly, because of codification's potential for reproducibility, you also open the door to the unchained globalization of architectural expression, which results in the alienation of social relations through mathematical logic, and gives rise to a super, code-driven "International Style" that replaces architectural autonomy with a kind of "regressive" materialism. As, for example, there can be questions about the multiplication of some "Bio-digital" aesthetic (figs 1-3).

Computation against design?

After this preliminary warning, a difficult question arises: how can we integrate powerful digital techniques like computation while resisting their syntactic limitations and potentially alienating effects?

The first answer is that we can program various "accidents" into the computation-scripting matrix, thus avoiding a pre-determined standard repetition of shapes. While this may indeed be possible, the question is perhaps not so much related to the "parametric" performance of the process, but rather to its relational properties. Consequently, another question appears: When does a scripting accident become architectural instead of only being related to formal design? That is, why would a scripting "accident" be more architectural than one engineered by a

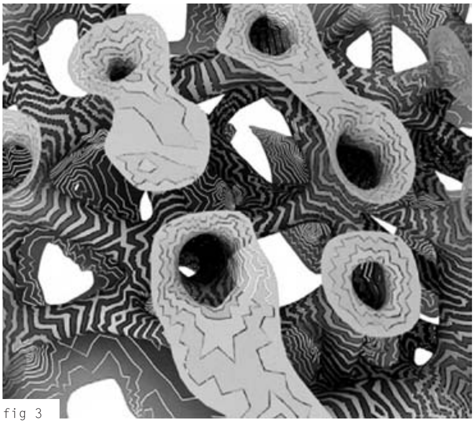

fig 3

fig 3
Marc Fornes. "Labrys Frisae", indoor pavilion, Art Basel Miami, 2011.

designer, a sculptor, or a cartoonist? What makes a simulated topological singularity, such as a fold, more relevant at the architectural scale than at the object scale? Along these lines, Peter Eisenman has declared (at Greg Lynn's Columbia University design studio a few years ago): "The studio project proposed a spatial theory that moves the virtual world closer to something that resembles a 'jungle'.... Finally, I realized that using the jungle as a spatial concept of reference for the virtual seemed a useful metaphor.... They did not attempt to define a virtual jungle; they never questioned the value of their concept, what might have created it, and how this new jungle might be organized."

In this view, the metaphor of accident, even correctly scripted, creates a kind of "digital jungle".[1] This is perhaps mathematically interesting, but also possibly architecturally useless: useless so long as the resulting morphological process has not proven (beyond its computational operating capacity) relevant for the resulting dynamic spatial relations. That is, the task of architectural design, even computational architectural design, is not only to improve matter through technical, structural, or practical operations, but also to perform critical-esthetic maneuvers, including the articulation of complex relational systems, and of new perceptive and affective mechanisms between subject/object and subject/subject, into space.

This leads to a clarification of the relationship that may exist between spatial perception and the environmental structure "under original relations," as Deleuze has pointed out. What kind of relationship, for example, can guarantee that once digital traces become material, the structural organization of matter produces a specific experiment in such a way that our condition in the environment would be re-actualized?

Computational architectural strategies should open up the possibility of creating new dynamic properties for the environment, not just new accidental shapes. Conversely, the danger of creating new shapes

1
Cf. Eisenman, P. (2003). A matrix in a jungle, in *The Charter for Zurich*, Basel: Birkhäuser, Ed. Furio Barzon et al., pp. 28-37.

without interrogating them architecturally is that of producing objects with the attitude of a designer or a sculptor: producing architectural space as crockery (the tea-pot), as household furnishing (chair, carpet, wallpaper), or as any design object lacking critical, political, and cultural relevance. It would mean that you could inseminate the computer, in a literal sense, with bio-genetic algorithms to create architectural entities the same way you would create life: the very positivistic mystification of world control.[2] However, such a bio-genetic paradigm cannot provide a radical interiority against all exteriority without also denying cultural singularities.

Thus, the problem of architectural conception cannot totally be resolved through code and calculation. Rather, the relation between visible and invisible, between shape and syntax, between what appears and what is appear-ing is, to some extent, "mutant". Its "perceptive structure" does not belong to a pre-established rationality like computational logic; it is an experiment of space that will open a new condition of the subject in its environment. Significantly, this experiment will not be based on any programmed logic.

The world is an incalculable invention; the structure of its shape cannot simply be restricted to the re-presentation of a mathematic rationality, as it once was when it was the subject of the "functional". To paraphrase Heidegger, the world must be part of a process that is born, and not the mere result of an operation – even when the operation is a biogenetic algorithm, a calculation "imitated" from life's paradigmatic complex system. Let us try, then, not to totally ge-stell architecture by any one technique, especially one as potentially powerful as computation. Instead, let us postpone integral simulation to the benefit of more "un-knowledge", i.e. – ethics. Because, in the end, algorithms can only come into being through our own *body filters*.

2 "This new speculative image of matter reveals things that go beyond established concepts of 'nature' via matter as information, active agency, as strange and unnatural." "Dustism, Creatures And Speculative Materialism In Architecture: An Interview With Alisa Andrasek/Biothing". Carla Leitão – *The Huffington Post* – April 25, 2012.

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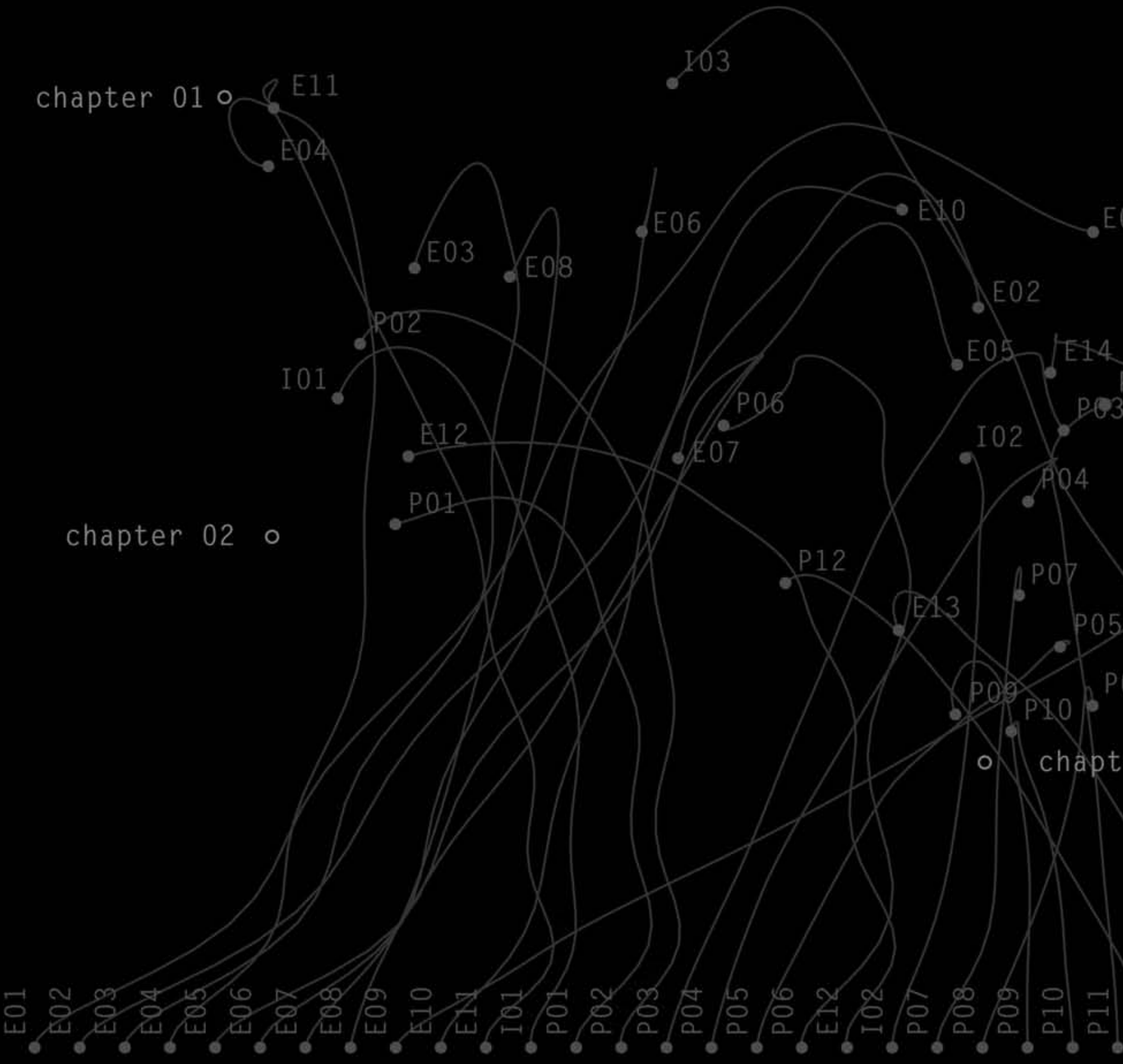
chapter 01
chapter 02
E11
E04
I03
E03
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E10
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E12
E07
P06
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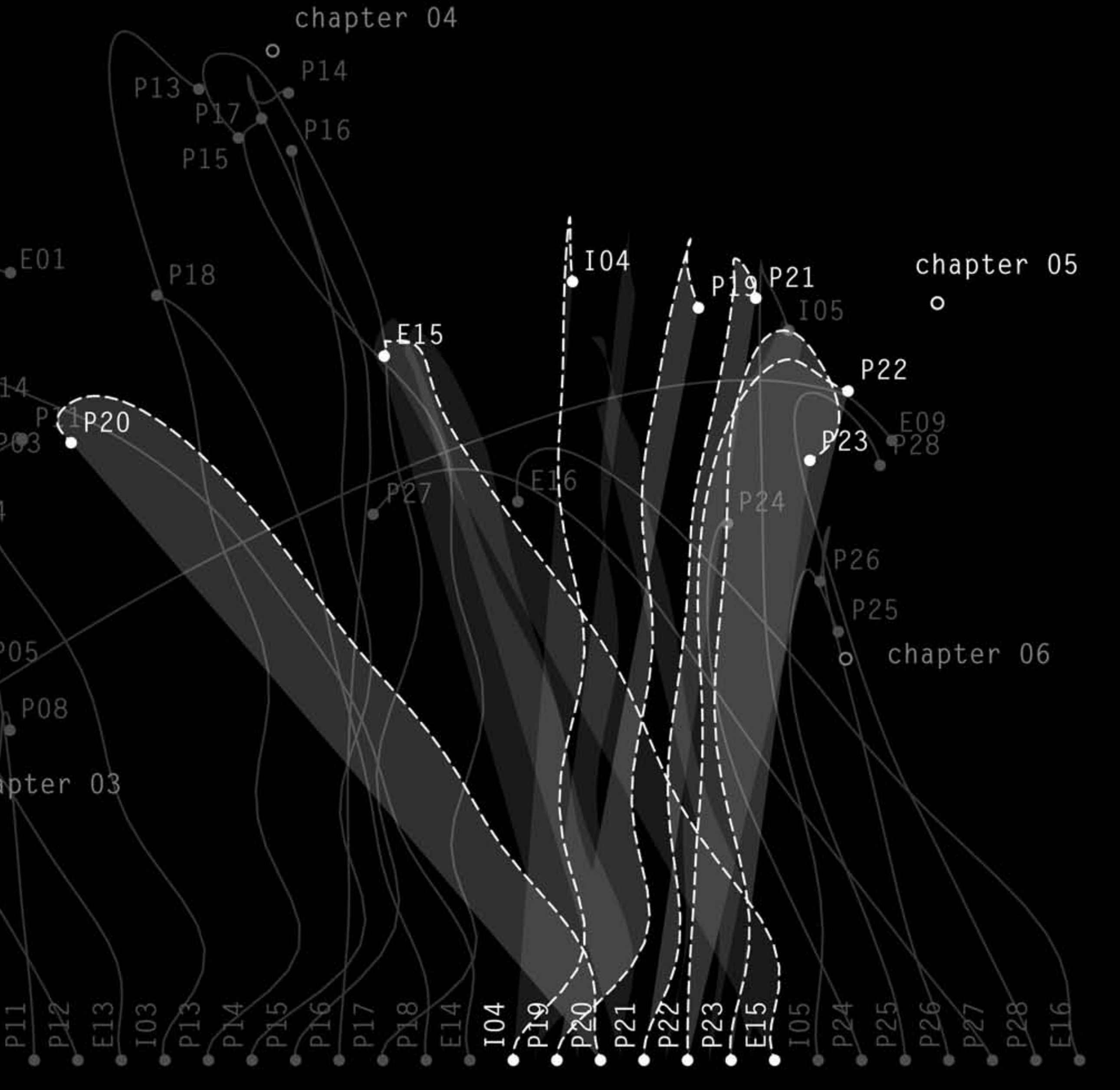
05

EXTENSIVE INFORMATION:

— MATERIAL INFORMATION



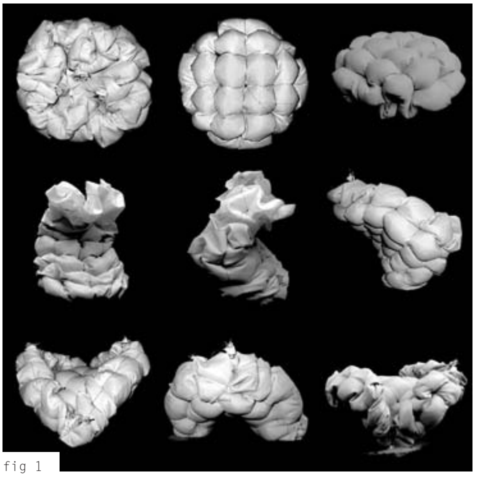


fig 1

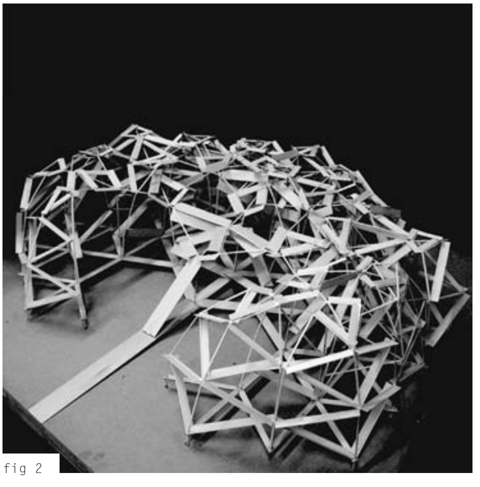


fig 2

fig 1
Ciro Najle, Material Discipline, Ottoist Diversions
Cornell University, spring 2005
Jason Lim, Wrinkle Field
Model: studies of structural behavior

fig 2
Ciro Najle, Material Discipline, Ottoist Diversions
Cornell University, spring 2005
Thomas Wong, Catenary Bifurcations
Sample: braced branching catenary

INTERVIEW: CIRO NAJLE

— WITH PABLO LORENZO-EIROA AND AARON SPRECHER

01 *Can you define* ***material discipline?***

CIRO NAJLE

Material Discipline is an agenda that develops forms of architectural intelligence via internal consistency, and breeds sense without the need of a transcendental apparatus laying behind and validating what we do. The research aims at overcoming the dependence of architecture on ideological systems of value and externalized parameters of legitimization, that tend to displace the hard nucleus of the discipline out of itself, making it falsely reliant on the logics of one or another of the domains it engages – these being social, political, economic, or ecological. The idea of a material discipline attempts to overcome these "displacements" without rejecting the multiple dimensions of our practice through a self-destructive idea of autonomy based on criticality. For this purpose, the research embraces the broader material processes with which our field is inherent committed, processes vitally ingrained in matter and often imperceptible, that are far slower or faster than the duration of our existence, and that make buildings profoundly "indifferent" and uncaring. In other words, the notion of material discipline reaches "in" the ubiquitous productivity of matter and regards it as if embedded of a mind, far more prolific than any form of human creativity or imagination operating "outside" the material. The challenge is how to perform this engagement without projecting prejudices in the process, yet without mystifying the process as an untouchable self-organizing system. Furthermore, it is about how to both empathetically and unemotionally expose architecture to the dynamics of the material systems that it ordinarily coordinates, to the behaviors and restrictions that constitute the inner conditions of architecture's organizational potential. Understanding architecture as a material discipline means developing procedures that concretely explore complexity and exploit the non-linearity of the material behaviors that have always pre-existed architecture, but have insistently remained obscured by the conventions of representation. Although consistent, these procedures remain irreducible to autonomous procedural formats, whose capability of emulating value only grants an illusory image of specificity. But, it is not either about plainly rejecting the strength of disciplinary autonomy through the blurring of its specificity and the neglect of its expertise, an attitude so frequent nowadays in the fascination for the trans-disciplinary, or in the celebration of the logics of globalized production – at least not without a medium through which these are mediated. Beyond the trap of falling in the opposition between these two positions, the challenge is how to launch models for engaging material systems, while breeding discipline in the process, with both asceticism and abundance – a rigorous form of hedonism.

02 *Your recent research to be published in the book* Material Discipline: The Engineering of Life in Material Systems *investigates the architecture of opportunistic deviations in the work of Frei Otto, Pier Luigi Nervi, Robert Le Ricolais, and Richard Bukmister Fuller.*

CIRO NAJLE

In general, interesting structures tend to express a creative relationship between

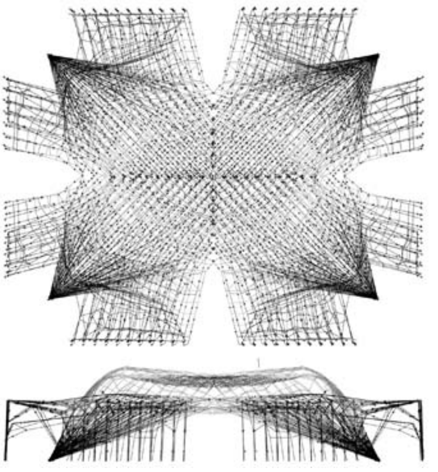


fig 3

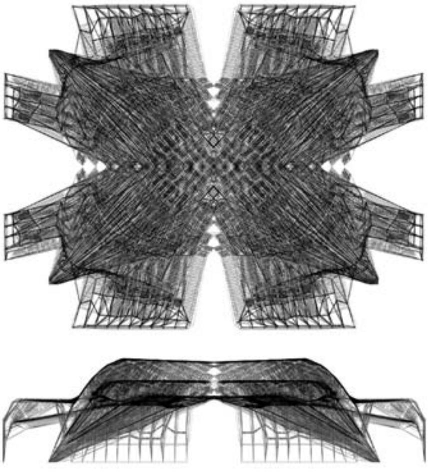


fig 4

the organization of forces and their materialization, aiming for an aesthetic based on certain economic efficiency. When activating deviations in the structures of these engineers in search for architecture opportunities, the relationship between structural organization and materialization also deviates, reprocessing relationships. Through their engineering principles, each of these authors understand forces and how they become active through different ideologies and, therefore, different architecture questions emerge in your research. It is interesting to recognize the different relationships between structural organization, forces, and matter that these structures propose. For instance, when this relationship is rather linear, or when a material is forced to work using a logic that goes against its common use, activating forces that emerge into alternative organizations.

03 *How do you understand the relationship between forces and matter relative to organization? Could you describe interesting moments in these relationships?*

CIRO NAJLE

Several engineering practices in the twentieth century, like Frei Otto, Pier Luigi Nervi, Robert Le Ricolais, Richard Buckminster Fuller, Felix Candela, or Eladio Dieste, have been understood as operating at the margins of the mainstream practices and theories of architecture. And yet, the poignancy of their results still persists, clearly demonstrating that their methods were far from just reducible to pure engineering logics. Evidently, they have offered attributes that much overwhelmed the premises of their own rationality. Not only precise, but also very fertile techniques of material organization have been developed, often configuring a supple medium of experimentation, disguised by methods of analysis and simulation of structural relationships. Not accidentally, these approaches to engineering were often supported by a network of associated architectural practices, and developed formally within architecture's academic environment. Clearly, these practices did not merely pursue technical solutions for structural problems determined by architectural desires, but rather the opposite: they constructed entirely new forms of doing architecture, growing "as if" out of technical constraints. Their framework was, therefore, not sustained on the basis of efficiency or optimization, even if that was in principle their claim. Far beyond this appearance, they constituted ways of thinking our practice as an open model: by setting a strictly defined scope of material problems and by developing techniques to unfold them, a precise set of procedures, jargons, and constraints was put on the table as a medium for the generation of new architectural types. The intelligence embedded in material behavior was thus used as a vehicle to produce new forms of architectural order and coherent structural systems. And although their results were usually idealized as universal models or standardized in practical conventions, such understanding of structural engineering constitutes today a traceable precedence to establish continuity between material and form, expanding the scope of our discipline beyond its dependence on discursive meaning. The relationship between the dynamic properties of matter and the rules of generative design processes that these

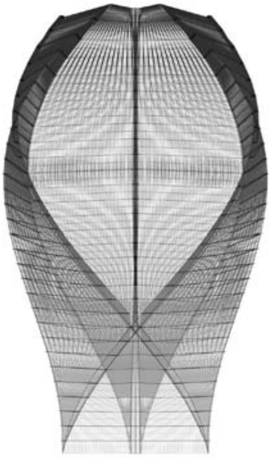


fig 5

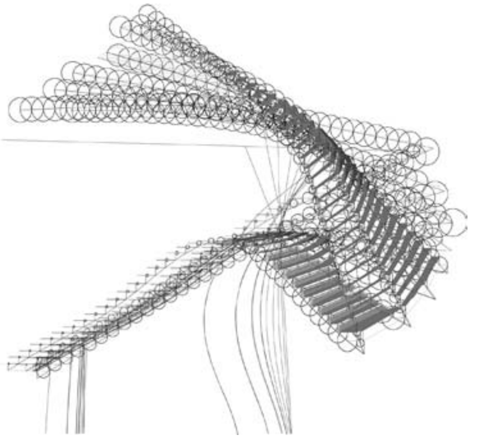


fig 6

practices disclosed help rethinking the consistency of architecture by swimming in the depths of its material immanence.

04 *You work with material logic to compute formal processes and parameterize information. What is your position relative to computation and the disembodiment that interfaces promote?*

CIRO NAJLE

The research we developed at Cornell University in the mid-2000s attempted, as a whole, to engage with these traditions. It followed the scope of investigation of four engineering practices (Otto, Nervi, Le Ricolais, and Fuller) that exceed both the encapsulation in the problem-solving ethics of traditional engineering and the representational idealism of the classical western architect. Yet, their methods were diverted from the idealization of geometry and form, and suspended their search of behavioral balance, obliteration of matter, absolute infinity, pure nothingness, expressive plasticity, or will of control. Investigations were based, firstly, on the appropriation of these models, and secondly, on their deviation by means of taking literally and exaggerating their premises. Rather than criticizing their work, the research learnt from its logics and used its techniques to engender difference, to the point of challenging back the same determinations that initially put them at work. Our interest was to make them "reverberate from within," in such a way that the basic positivistic premises still laying behind them could be turned upside down while preserved. We categorize this "cynical" framework under several "isms" (ottoism, nervism, ricolaism, fullerism), neither as the register of an ideological position nor as a sign of idealization, but as the register of a paradoxical process that, while starting with literal affiliation, continued with playfully making their rules divergent, and ended with the multiplication and evaluation of the architectural potential of their outcomes, consequently proposing an understanding of the cultural role of an "ism" as the possibility by which lineages of disciplinary development can self-transcend. In this context, material processes were parametrically described according to radical versions of the methods and techniques developed by these precedents, and from this they were simulated as consistent fields of interaction between internal determinations that self-differentiate via form. On the basis of these fields, new determinations could be then absorbed and integrated. Yet, the construction of these controlling mechanisms was not the aim of the research as such, but the means to assure consistency in a method of formal self-defiance and systemic open-endedness. Computation works here not as a means of technical control, but as a vehicle of architectural creativity by means of complexity. Therefore, disembodiment was not really an issue. Firstly, because those fields were constantly checked with their material sources, but more importantly, because what we were looking for was not about material precision, but about organizational novelty, ultimately an immaterial condition. Personally, I am not so concerned about the truthfulness and exactness of models as much as with the rigor of the construct in terms of its consistency to the organizations produced.

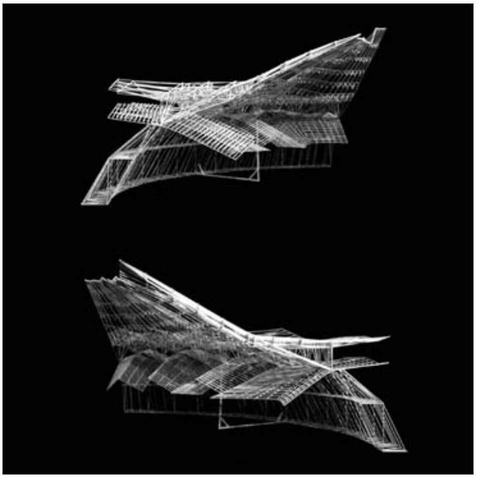


fig 7

05 *Formalist experimentation has been critiqued due to the progressive automatization in form-finding processes, sometimes fed by the immediacy of computing tools, which may even displace authorship to programmers. The use of complex geometry derived from mapping, pattern generation, or the processing of complex information within others, has reached an excess and a relative autonomy attempting to redefine architecture boundaries, but often running the risk of not engaging with architecture. Meanwhile, the recognition of certain architecture value in the research does not imply that the subsequent implementation of that research in the design process would maintain such architectural value, or moreover, activate any architecture performance in the final design.*
In your form-finding research process, you work with materials and organizational structures. How do you judge whether they have an architecture potential or not? In implementing your research in a particular project, how do you understand the layering of information relative to architecture autonomy? And in the final design, how do you judge the project relative to its architecture performance?

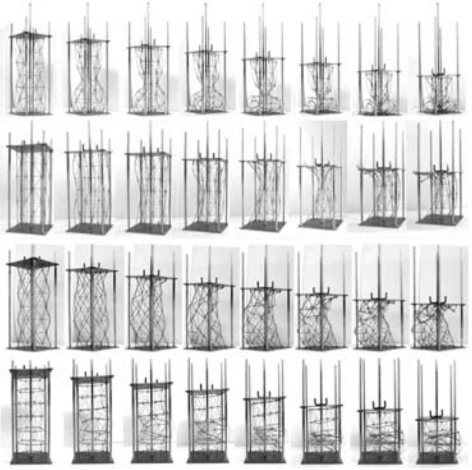
CIRO NAJLE

There are two issues at work here, which often appear mixed in contemporary architecture culture as the result of plain naïveté or, say, "good will." One is about the architectural relevance of the project, that is, its cultural significance; the other is about the practical relevance of the project, that is, its performative aptitude. While it is crucial to merge these two aspects in a complex intertwined set up, where matter integrates the multiple contingencies of knowledge, it is equally important to not idealize this realm as a self-evident "superior" domain. It must be acknowledged that, while we can do a lot by engaging matter as an intelligent medium, all we can think through it and say about it is limited by definition by the conventions of knowledge, and therefore only provisional. Particularly in academic contexts, one is obliged to unveil the inevitable differentiation, even the inherent friction, between the cultural and the technical registers of what we do, while attempting to construct an operative medium of continuity between them. So my answer would be two-fold: by means of historically grounded forms of intuition and by means of visibly reductive forms of evaluation. At the first level, I would argue for a loose, rigorously playful, "seriously irresponsible" relation to history. At the second, for a joyful, rather than a truthful, understanding of what evaluations mean in architecture, characterized by an incessant drive for the self-transformation of its products, its techniques, and its beliefs. It is an uneasy position, inevitably oscillating and political. One always wants to avoid declining both in the ideology of historical determination and in that of mere technological instrumentality.

06 *There is an unavoidable reduction in structuralist thinking that is necessary for the understanding of a consistent logic in organizations. Do you think there is a limit in the amount of information we can handle and manipulate in the computation of complex form and relationships?*

CIRO NAJLE

History finds its way through its own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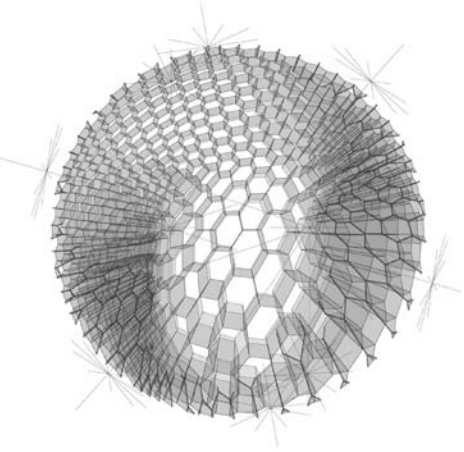


fig 9

thresholds, and personally I prefer to not pay so much, so much attention to that kind of problems, and rather to believe that the architectural work is not about understanding limits a priori, and self-punishing for ideologically failing to "inevitable conditions," but about teasing those limits from within and as far as possible. In any case, limiting the dynamics within which architectural organizations are engendered often proves to be more interesting than trying to be comprehensive about them. In this sense, the thinking of limits, no matter if it is about the choice of lines of investigation, the infinitude of information, or the possibility of completeness of a project, can be framed as a moral problem or as an artistic drive, and I lean toward the latter. In other words, I worry less about understanding and fully comprehending the multifarious aspects of matter than about creating new forms of organizational significance and new interest by means of them. Consistency is clearly a means, not an end, as in some coherent ideal essence, and therefore being reductive is not a dilemma, but a condition on which the work stands more or less courageously.

07 *Systems derive their conformation from both internal information and the response to external information. In reference to Henri Bergson's fluid form, how do you establish the relationship between time-based topological variations and/or typological change in the performance of a system?*

CIRO NAJLE

By means of what I call "protostructures," which unfolds out of the idea of the "pre-architectural," understood not as a precondition of architecture but as the ultimate architectural condition, resultant of the indexing and assemblage of relationships in a materially determined system, as it evolves. Understood as a protostructure, the project is constituted by the integration of a number of forces, reciprocal behaviors, and diverse motivations, assembled in a material dynamic. In them, material constraints operate as the ground on which legal restrictions, functional requirements, or technological traditions are incorporated and mediated, to, in turn, stiffen the armature of relations and increase the creativity of the organization. A protostructure breeds a consistent tectonic regulation and enriches it with protocols that enhance its responsiveness to external conditions. It is, by definition, an incomplete system, nonessential and adaptive, but consistent. It works like an index, which incorporates restrictions to localize itself. It is neither problematic, nor critical, like a representational project. It is neither generic, nor indifferent, to variation, like its modernistic predecessor, the prototype. It does not segregate problems or configure strategies, but integrates potentials and manages their fluctuation. Given its capacity to engender novelty from within, difference is not as a nuance, a weakness, or an accident, but the ultimate source of value. It becomes the condition of existence of generality, not merely its specification. And, in turn, generality is not idealized in a neutral organization, but is generated as an open potential, growing through the accumulation of contingency. Protostructures thus evolve as they incorporate difference and develop complexity. Their responsiveness to conditions, their internal differentiation,

fig 10

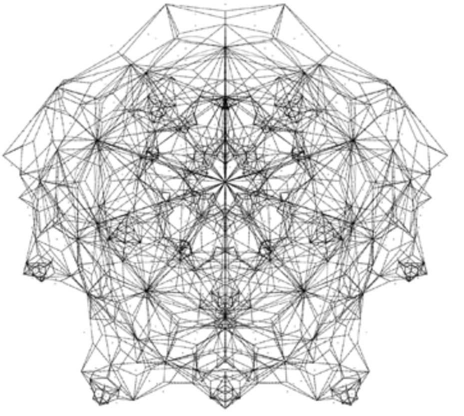


fig 11

and their propagation cannot but expand the potentials of a material medium into an increasingly robust organization, which can move across scales, domains, and times. Any site, no matter how restricted it may be, any exterior to the internal systematicity of a protostructure, is nothing but a manifold of systemic circumstances, a bundle of gradients within which a protostructure fluctuates, and for which it is a codifier, a marker, an indicator of adequacy, a register of potentials, and a device to steer order. The usual limits of the architectural project (unpredictability, change, anticipation, possibility, invisibility, creativity, novelty) here become embedded in a process of fluctuation within gradients. Architectural organizations of this kind are engendered not as objects, but as processes of production without a program, with an increasingly complex diagram. Technical regulations, conventions, and restrictions are adopted and absorbed, and kept open to adjustment. This is why a protostructure is radically different from the modern idea of a prototype. It is not purposeful but wise, not single-mindedly efficient, but rigorously multi-tasking. It does not impose itself, but interpose its medium. And it changes only in order to preserve itself. The question of determination is reconfigured, overcoming the assumption of materials as obstacles of form, understood as a mental projection, and incarnating instead the simplest device for breeding unpredictability and for engineering the intangible via the systematization of graceful models of systemic life.

08 *You developed experimental projects that use growth as part of their formal process. New definitions go all the way from permeable boundaries between elements, the behavior and properties of matter at different scales in nanomaterials, to biomaterials where their composition, growth and response to external stimuli can be programmed through genetic coding. How do you envision the future of a material discipline with an embodied knowledge that has been displacing previous notions of matter?*

CIRO NAJLE

The role of the architect increasingly appears as one of configuring material mediums capable to receive, hold, and move across determinations, understanding them as gradients of interaction within material compounds as they absorb demands, requirements, and limits. The work becomes similar to that of a computer programmer, but only similar, as it now develops models of interaction with feedbacks loops, only in view to rigorously lose control, rather than gaining it (or simultaneously as gaining it). The “operativity” of these material compounds does not attempt to impose a rationale, but to regulate fluctuations and interpose techniques in a multiplicitous rationale, building up a far broader effectiveness than that of an efficiently articulated general strategy, and opening up the possibility for true collective creation. This collective creation is, again, not a literal means of participation, but an “as if” condition, and the author only “assumes” that the design and construction of a project happens in time and with openness. As such, authorship requires a new standard, with a far higher and more ductile intelligence, not an ideological denial. Without falling in falsely new utopian challenges, these processes must be technically and rigorously mediated, as if with an abstract sieve that manages information, programs responses, generates organizations, evaluates performance, coordinates collaborations, establishes protocols of exchange, and builds languages of communication. But, this task still requires, perhaps more than ever, the irreplaceable presence of an author, now of one with a more advanced capability of creativity via management, and of detachment via embedment. At present, unfortunately, this capability still appears as a paradox, or as a contradiction of terms. This is, to my view, an important cultural challenge yet to come.

fig 3
Ciro Najle, Material Discipline, Nervian Iterations
Cornell University, fall 2005
Allison Dailey, Diaphanetics
Model, plan and section: proliferated ribs

fig 4
Ciro Najle, Material Discipline, Nervian Iterations
Cornell University, fall 2005
Allison Dailey, Diaphanetics
Model, plan and section: proliferated ribs

fig 5
Ciro Najle, Material Discipline, Nervian Iterations
Cornell University, fall 2005
Jennifer Chuong, Buckle Column
Model, elevation

fig 6
Ciro Najle, Material Discipline, Nervian Iterations
Cornell University, fall 2005
Nikole Bouchard, Failing Rib
Surface Piece section: deflecting slabs

fig 7
Ciro Najle, Material Discipline, Nervian Iterations
Cornell University, fall 2005
Patricia Brizzio, Sports of the Dome. Maquette: reinforced dome

fig 8
Ciro Najle, Material Discipline, Ricolaisiac Propagations
Cornell University, spring 2006
Sara Arfaian and Kelly Yarasavage, Automorphic Grace
Sample: grace modalities in automorphic tubes

fig 9
Ciro Najle, Material Discipline, Fulleristic Augmentations
Cornell University, fall 2006
Stephen Wong, Edenism
Prototype: hexagonal geodesic dome

fig 10
Ciro Najle, Material Discipline, Fulleristic Augmentations
Cornell University, fall 2006
Laura Coombs, Tensairgrity
Prototype: enriched transitional geodesic tensegrity

fig 11
Ciro Najle, Material Discipline, Fulleristic Augmentations
Cornell University, fall 2006
Patricia Brizzio, Startropic
Prototype: branching star tensegrity

THE MATERIAL, THE GEOMETRIC, AND THE STRUCTURAL

— NADER TEHRANI / OFFICE dA NADAAA

The experimentation of Office dA and NADAAA installations has been the medium in which we combined our research on materials, geometry, and structural speculations. These installations served as a proto-architectural device to bridge our interests between research and building, art and architecture, and theory and practice. While none of them engage the conventional array of architectural protocols that is required of conventional buildings, the saturated focus on certain areas of research has advanced areas of invention that are rarely achievable in everyday commissions.

In this equation, the three main protagonists of research interact with each other in potent ways. Materials are explored for their performance potentials, innate qualities, and latent uses. Prototypes are developed to explore half- and full-scale mock-ups, testing out qualities such as malleability, expansion–contraction, reaction to temperature, and other specific aspects of the molecular structure of materials. As each material is predisposed to unique forms of deformation, each offers different approaches and opportunities for assembly and figuration.

fig 1
Immaterial Ultramaterial Mockup.

Within the context of our work, much of the research is also focused on the development of construction units, both standard and non-standard types, with an eye toward how units may be aggregated to establish a meaningful rapport between part and whole. Some of these entail mass production; others mass customization. Dimensional limitations are conventionally the result of industry standards or manufacturable potentials; in turn, the means and methods of fabrication are impacted, offering ways of engaging the building industry on complementary and, sometimes, challenging ways, but always in a fashion that is deliberate and strategic. This bottom-up approach also envisions ways in which geometric extremities may be tested against material agencies.

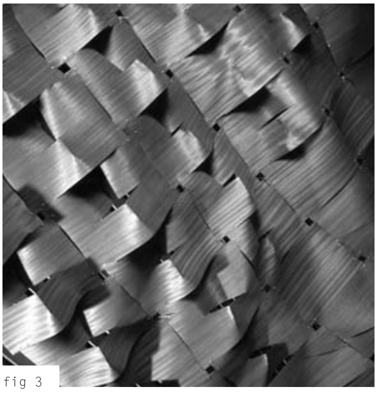
As a discipline all its own, geometry is engaged in both abstract and material ways: "abstract" in the way in which figures, forms, and shapes are brought to organic precision, and "material" in how the discrete geometry of construction units are adopted to discretize, tessellate, or aggregate toward a larger whole. While the former suggests a top-down ordering protocol, the latter involves bottom-up experimentation, forcing figurative and configurative approaches to reconcile with each other. Thus, by employing the elements of materials, construction blocks, sheets, and units as a medium of exploration, geometry is used not only to bring order to the assembly process, but also to radicalize the spatial, formal, and figural possibilities of construction.

Material and geometric experimentation invariably implicates the structural performance of the installations; in some instances, even testing them to failure. More importantly, the structural implications of these tests underline the centrality of engineering as an engine in our research process. At a time when economies require a value-engineering mentality, this becomes a critical way of working, because it ensures that the irreducible aspects of the design are never compromised. At the same time, it offers the possibility of spatial, material, and technological innovation, overlaying architectural criteria on the quantitative data of performance.

Of course, this approach invariably puts various theoretical narratives on a collision course with each other, as it pits form against performance, geometry against discretization, and the will-to-form against material predisposition. While never fulfilling the desire for absolute determinism, but always offering partial alibis as substance for justification, these processes require a non-linear approach to the design process. Our process, therefore, oscillates among representation, simulation, and actuality by overlaying various research protocols in relation to each other. Simultaneously, we adopt precise mechanisms of drawing to exact geometries, fabricate mock-ups to challenge the "representational" bias of drawing, and, in turn, overlay performance software to simulate structural performance – the sum total of which helps define a bias within each project as it takes on formal and material definition. The friction between these approaches is a central component of our process, and arguably a defining theoretical foundation of our understanding of tectonics.

In tandem with this, common techniques are tested against different material systems to tease out the particularities of each medium as the basis for innovation. For instance, while the "undulating" geometries for Casa La Roca, the Weston House, and the MoMA Fabrications all have one trope in common, the way it is played out in each project relative to masonry aggregation, copper corrugation, and steel-folding cannot be more different. Each project bears common operations that are at once abstract and serve as allusive figures engaging other cultural readings: as screen (Casa La Roca), as fabric (Weston House), or as stairs (MoMA), among other both functional and symbolic devices serving to broaden the architectural performance of each piece. As each project engages multiple contingencies, e.g. – of function, program, construction, materiality, structural, or semantics, among other categories, none takes on the mantle of a dominant narrative. Instead of the fallacy of integration, then, this approach acknowledges the artifice of integrity, while bringing the various competing narratives toward a difficult and complex synthesis.

fig 2



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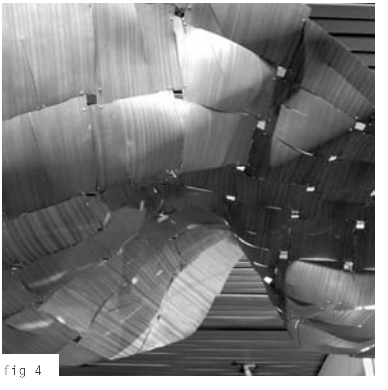


fig 4

fig 2
Immaterial Ultramaterial completed project.

figs 3-4
Immaterial Ultramaterial detail of completed project.

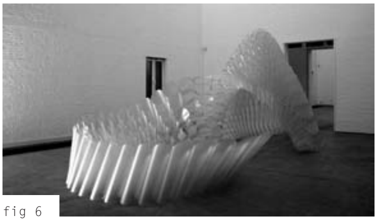
figs 5-8, 11-14
Voroduro completed project.

fig 9
Voroduro detail of completed project.

fig 10
Voromuro geometry study.

fig 15
Voromuro analytical study of coffer conditions.


fig 5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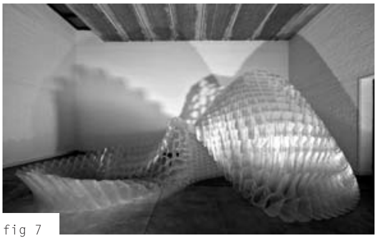
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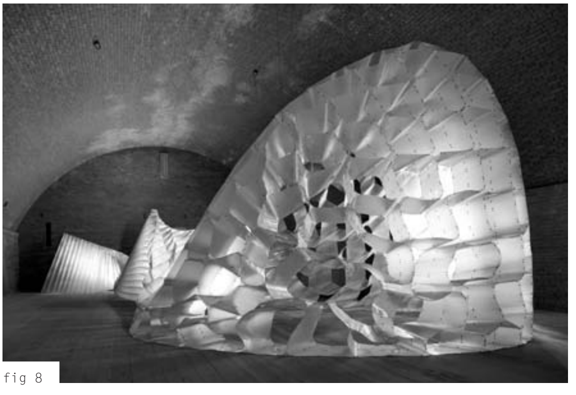
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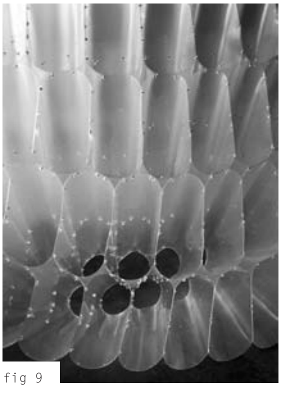
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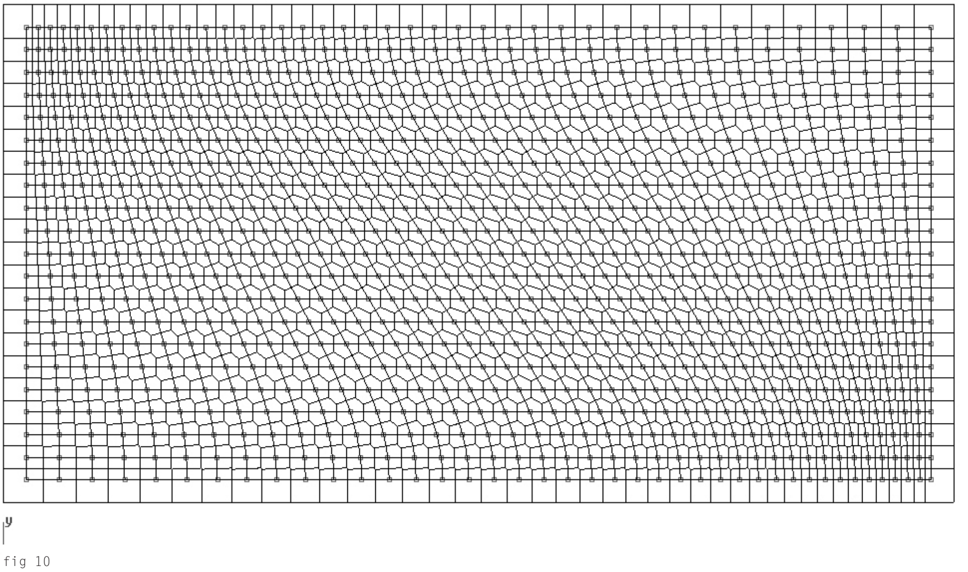


fig 10

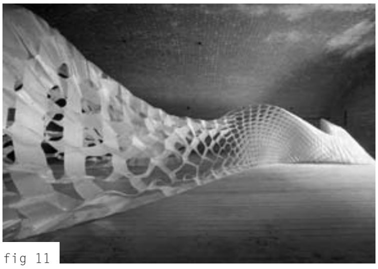


fig 11


fig 12


fig 13

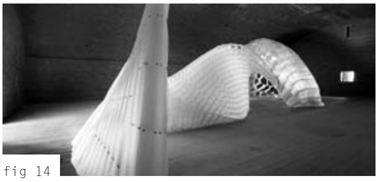


fig 14

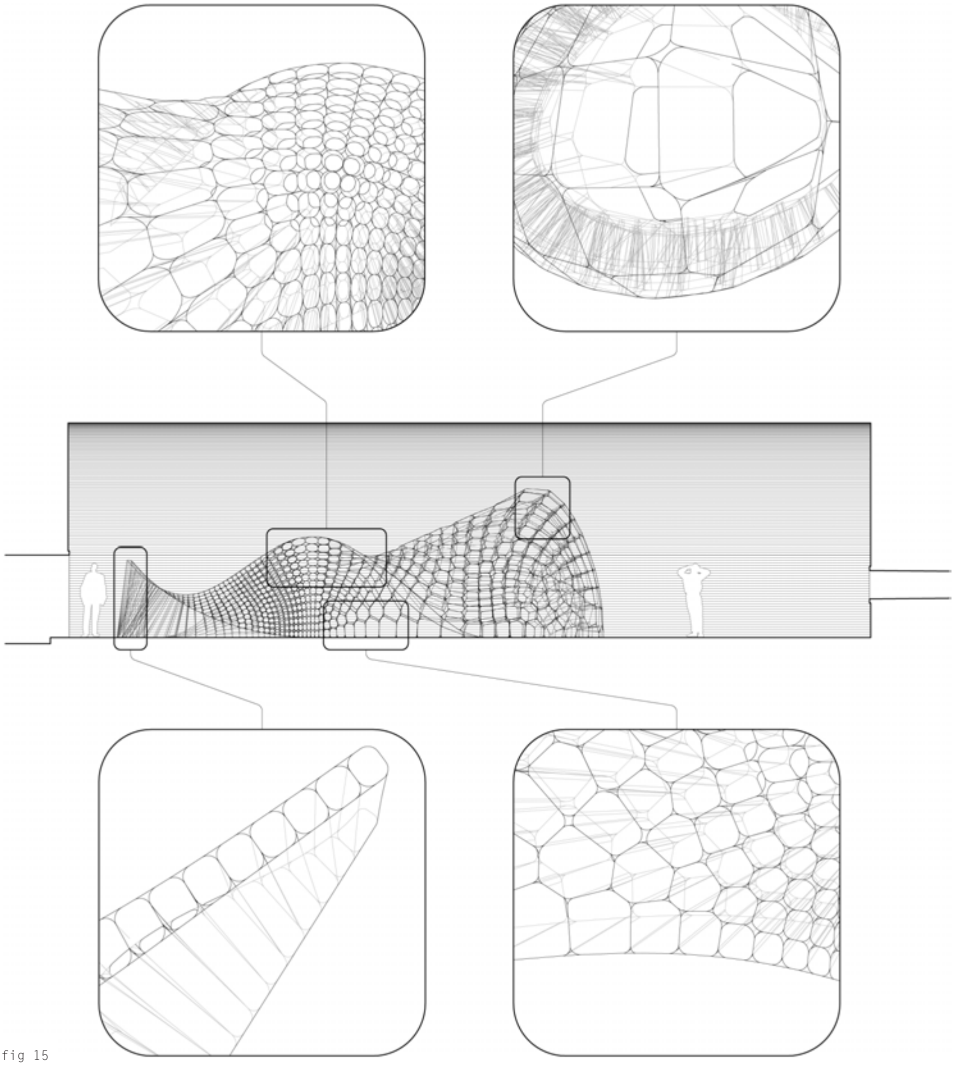


fig 15

fig 16
Ventulett 2006
Unit study from 2/4/8 strands.

fig 17
Ventulett 2006
Parametric unit studies.

fig 18
Ventulett 2006
Analytical construction types.

fig 19
Ventulett 2006
Analytical construction types.

fig 20
Ventulett 2006
Axonometric.

fig 16

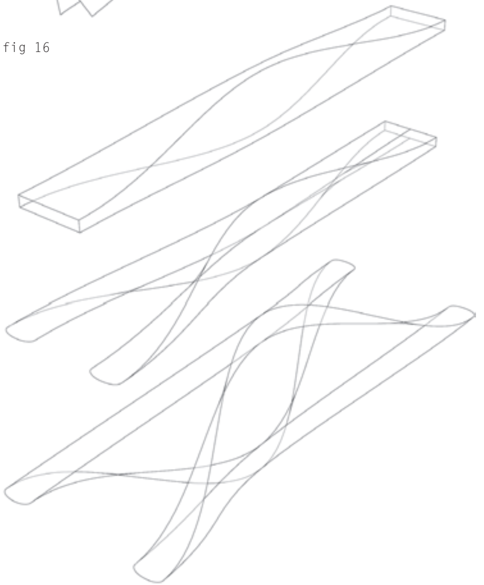
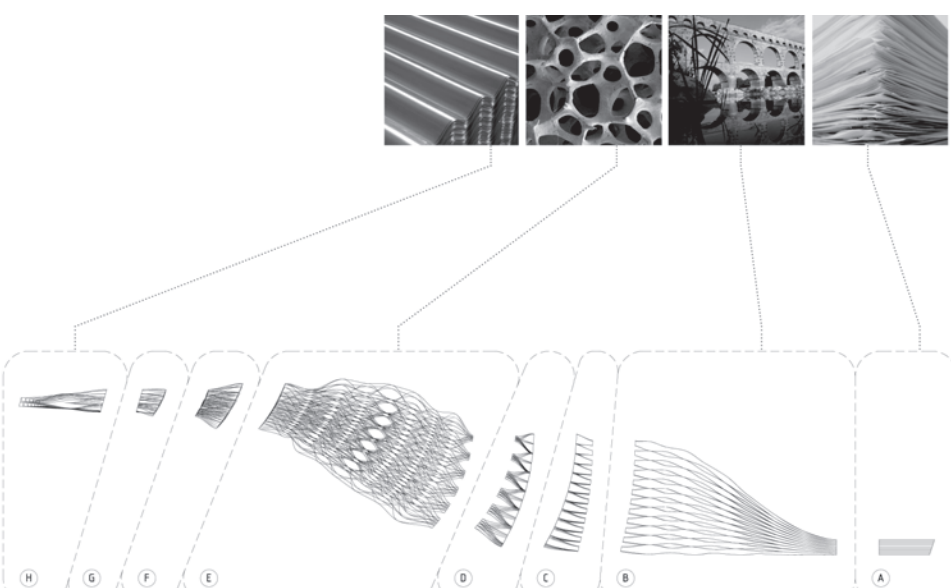


fig 17

fig 18



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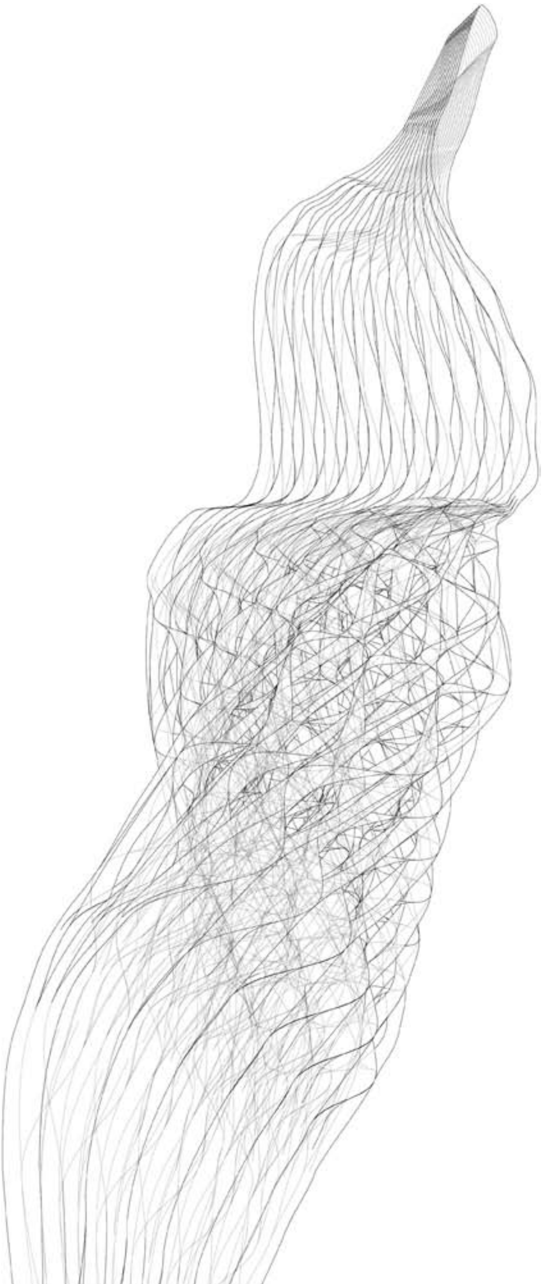

fig 20

figs 21, 22, 24, 25
Ventulett 2006
Completed project.

fig 23
Ventulett 2006
Detail of completed project.


fig 21


fig 22

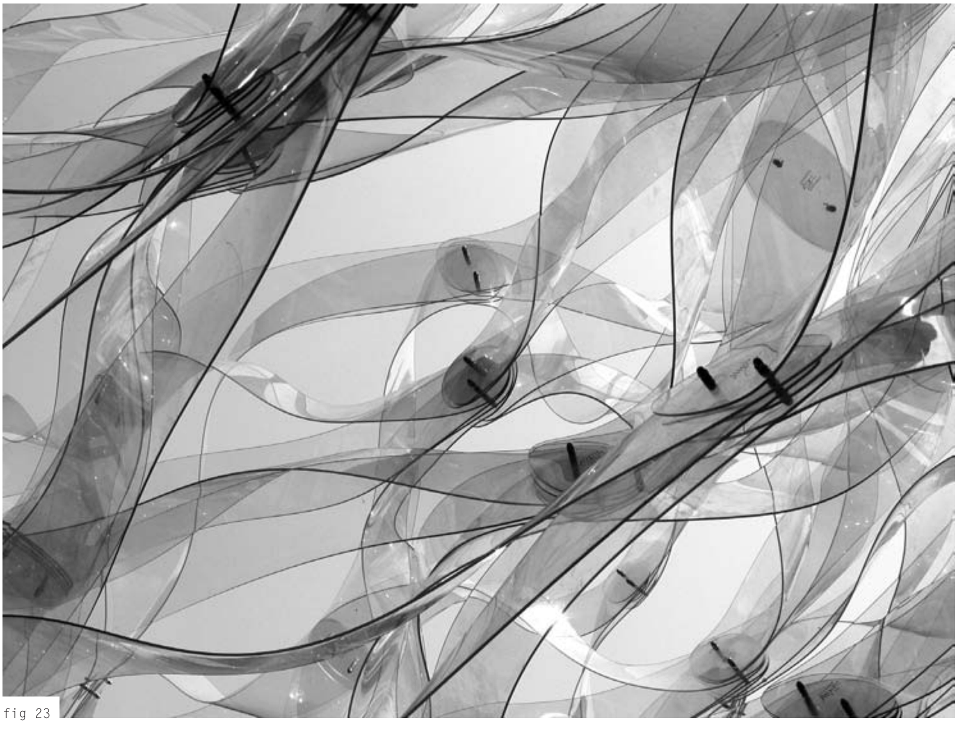
fig 23

01-04
Immaterial/Ultramaterial
Harvard Graduate School of Design, 2001

Project Advisor
Nader Tehrani, Assistant Professor

Project Collaborators
Kristen Giannattasio
Heather Walls

Installation Assistants
Hyuek Rhee
Mario D'Artista

fig 24

fig 25

Voroduo
Pekin Fine Arts, 2008

Design
Office dA

Principal in Charge
Nader Tehrani

Project Coordinator
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Georges Island, Boston, MA
2007

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Atlanta Georgia, 2005-2006

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IRREGULARITY AND RATIONALITY MEDIATED BY AGENTS: MODELING PROCESS OF PHARE TOWER

— SATORU SUGIHARA / ATLV, THOM MAYNE / MORPHOSIS

The pursuit of design with non-repetitive geometries and non-linear complexities in contemporary architecture pushes us to explore design tools and processes suitable for design. One such tool is the bottom-up process, which is popular in many fields of modern science, such as the study of complex systems and chaos theory. Whereas conventional design tools use a top-down process based on the application of macroscopic rules, the bottom-up process focuses on microscopic rules – and on the parts out of which the whole emerges after iterations of these microscopic rules are applied.

Modeling Structure as Agents

Unique in form, the Phare Tower's structure has irregular boundaries due to its site constraints. The challenge was to model a smooth diagrad structure under these conditions. To solve this issue, we took a bottom-up approach that used an agent algorithm. In the algorithm, each connection node of the diagrid is modeled as an agent with certain rules defining its behavior through simulated time. For example, one rule constrains a node to stay on an offset curve of the floor slab edge, while another allows a node to simulate Newtonian physical behavior responding to external forces. A diagrid link between two nodes is also modeled as an agent. The rule set even includes the simulation of tension between two nodes according to their distance. As a whole, the resulting agent system simulates a physical, tensile network overlaid on the tower form. However, the system also shows high flexibility in working with a non-standard form and irregular boundaries.

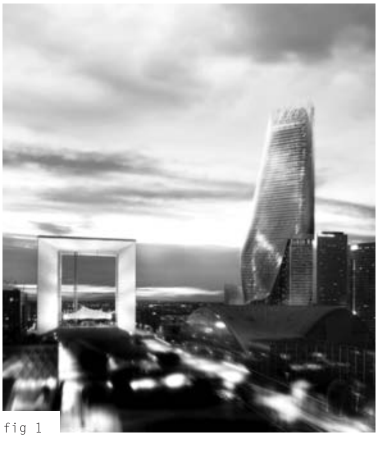

fig 1

Modeling Skin as Agents

The solar-shading skin panels of Phare Tower are also modeled as agents. Each panel is a diagonally installed rectangular panel constructed of woven metal mesh. One of the agent's rules is to seek the best orientation around the diagonal axis for solar-shading by calculating each panel's solar altitude and cast shadow area. Another rule defines the optimized panel size that covers an appropriate shading area. A third rule defines a gap to the adjacent panels for maintenance and cleaning.

fig 1
A rendering of Phare Tower at La Défense, Paris, France
image copyright: Morphosis.

fig 2
A physical model of Phare Tower
image copyright: Morphosis.

Top-Down Rationalization Process

A bottom-up process is suitable for a "soft" constraint, i.e. – a constraint using continuous measurements as a target that can be minimized or maximized. For instance, the agent system for the diagrid targets the maximization of the smoothness of links. (This is done internally, by minimizing the total tensile energy in the physical simulation.) However, a bottom-up process is not suitable for a "hard" constraint, i.e. – a constraint using discrete measurements. For instance, when a hard constraint is used to limit a point's position on a grid within a tolerance, being 1 mm out of the tolerance is as unsatisfactory as 100 mm.

A rationalization process maximizing the repetition of unitized construction parts usually requires "hard" constraints, and therefore tends to become a top-down process. For the Phare Tower to function as a multi-tenant office building, for example, the glazing mullions must be on the interior office-planning grid, which is also used for constructing partition walls. So, we started out with the top-down process of projecting the orthogonal grid onto the faceted tower surface. Then, we redesigned the grid as an integration of both a radial and an orthogonal grid, which combined the grid and tower forms. In these processes a bottom-up algorithm was not used. Instead, we developed a computational tool to visualize the rationality of the geometry by color-coding the glazing panels. This process gave us rapid feedback that allowed us to flexibly revise the rationalization strategy.

Integration of Top-Down and Bottom-Up Processes

Contrary to the glazing rationalization, which is a top-down process, the diagrid rationalization was solved by integrating top-down and bottom-up processes. On the flat areas of the tower form, the rationalization process is top-down and the diagrid nodes are fixed on the grid. On the other areas, the diagrid is modeled by the agent algorithm that stitches together adjacent, flat areas. Because this algorithm can work with irregular boundaries, the patched, flat areas only redefine the boundaries for the algorithm to still smoothly connect patched areas of the diagrid without introducing a seam. In this way, the whole diagrid can achieve maximum rationality without sacrificing smoothness. During the value engineering process, the diagrid on the flat area was changed into vertical columns. However, the agent algorithm was still able to maximize the smoothness of the transition from the vertical columns to the diagrid on the double-curvature area of the tower form.

As practiced in this project, bottom-up processes offer additional possibilities for providing new solutions to the issues confronting contemporary architecture, as well as adding the flexibility to integrate with conventional top-down processes.

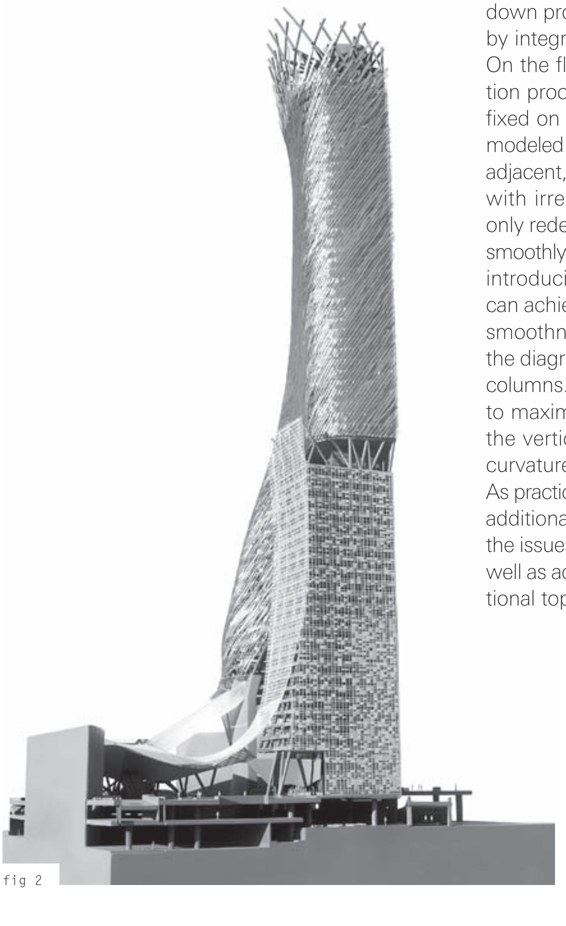

fig 2

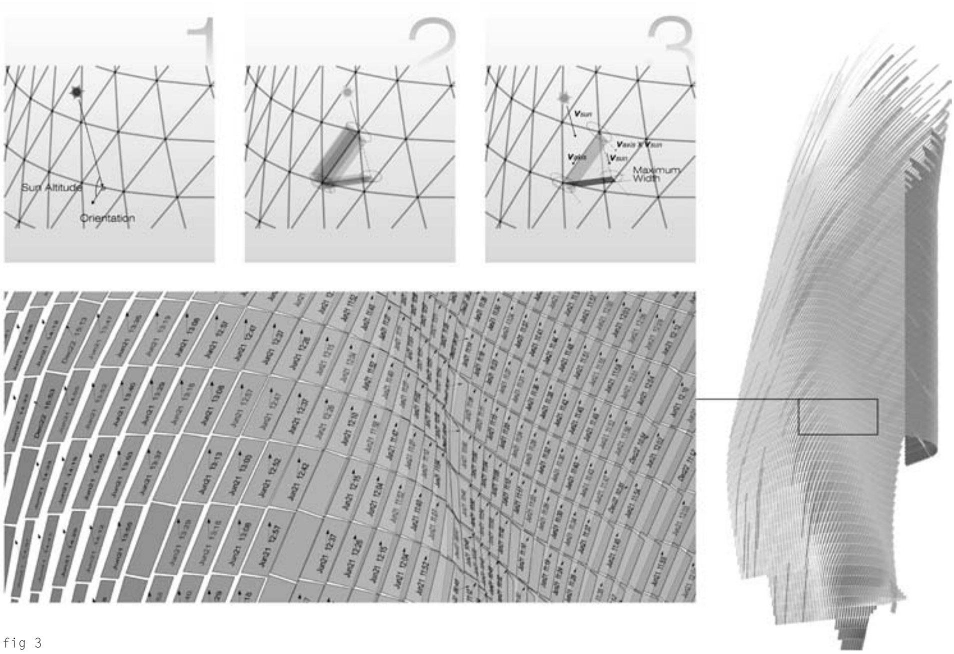
1
2
3
Sun Altitude
Orientation
Maximum Width

fig 3

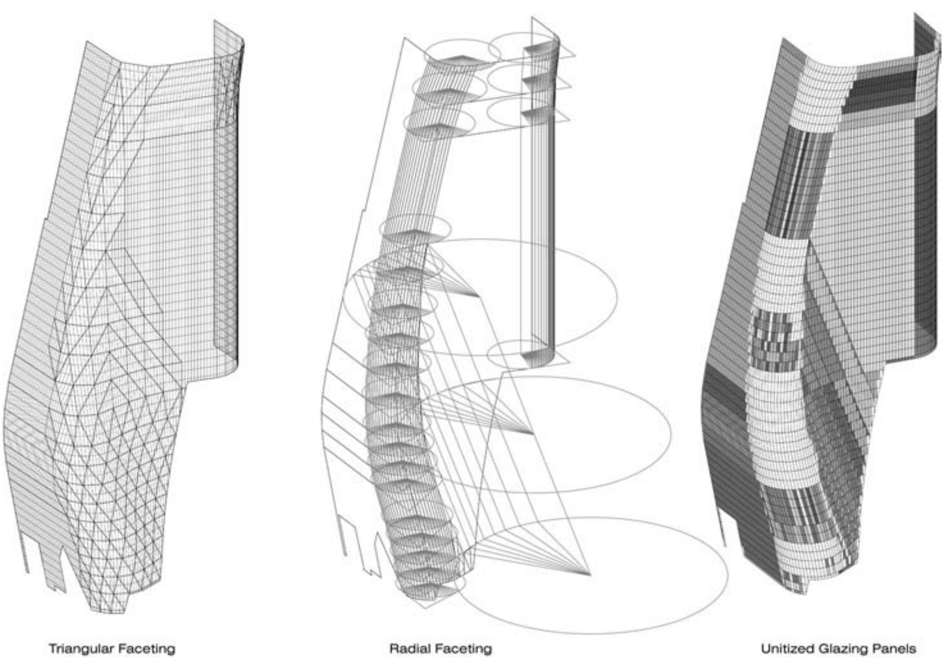
Triangular Faceting
Radial Faceting
Unitized Glazing Panels

fig 4

fig 3
The solar optimization algorithm measures the solar direction on each panel and finds the best orientation for each. The diagram shows the optimized solar orientation and its time and date.

fig 4
Rationalization of glazing panels by triangular and radial faceting. The glazing panels are color-coded to show different panel units.

fig 5
Unfolded glazing panels with color-codes and quantities.

fig 6
An agent algorithm simulating tensile behavior is applied on each phase of the evolution pushed by external and internal design factors.

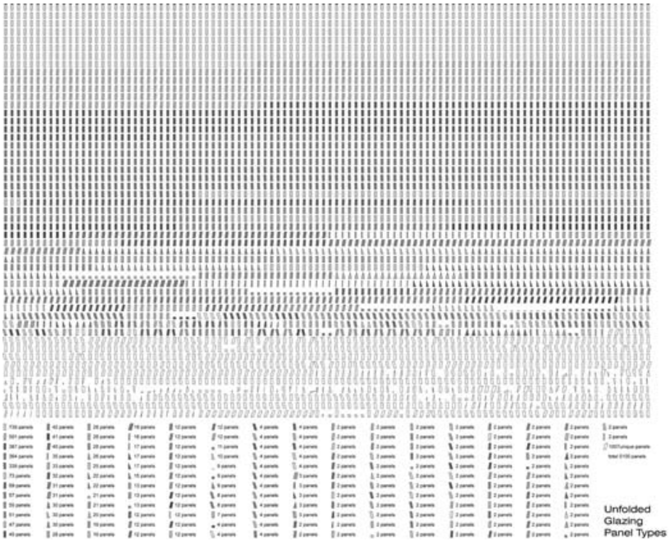

fig 5

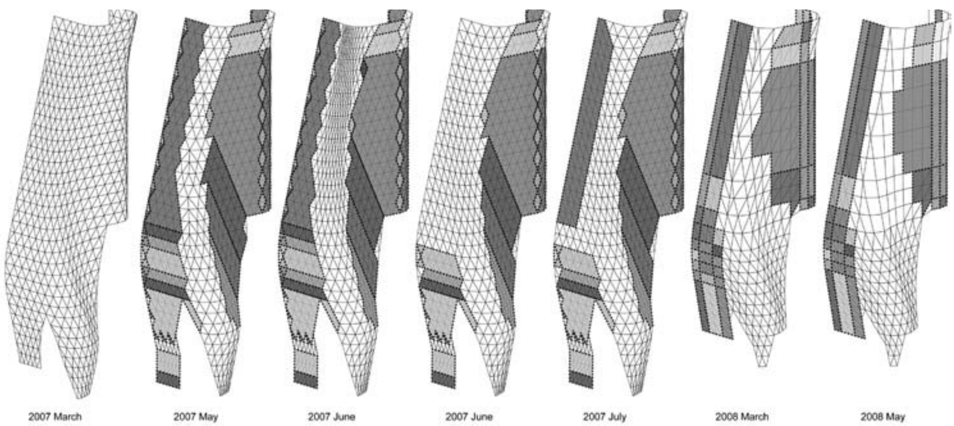

fig 6

Phare Tower
La Defense, France

Design
2006-2010

Construction
2013-2017

Morphosis Team

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Project Manager
Matt Grady

Project Manager through Design Development
Tim Christ

Project Manager - Competition
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Oger International

Consulting Architect
SRA Architectes

O-14

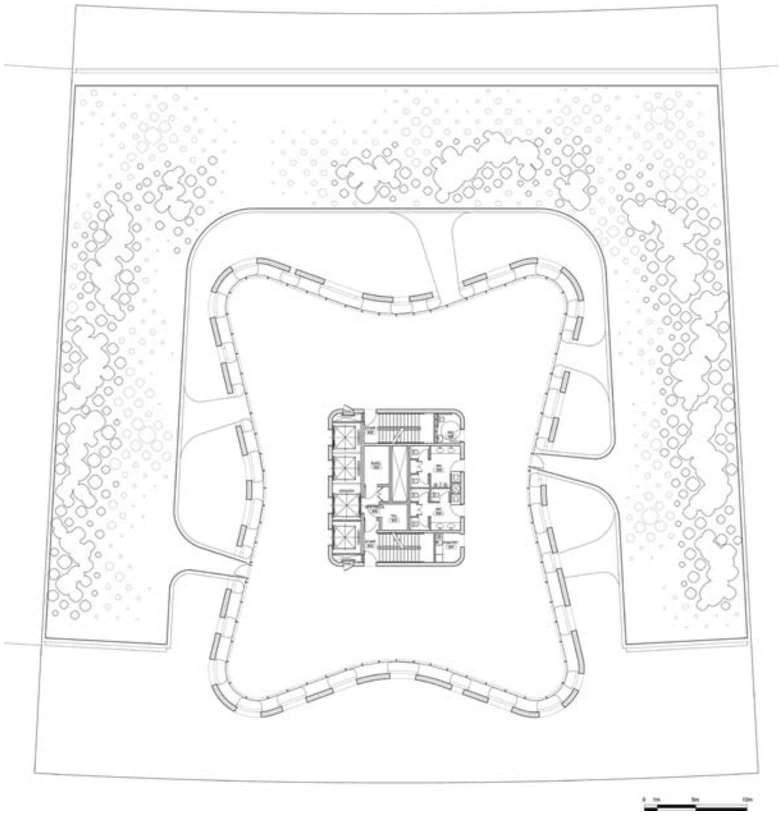
— **REISER + UMEMOTO**

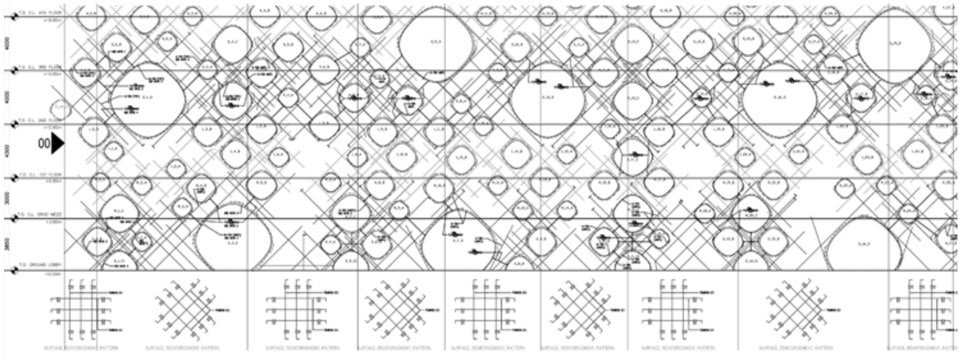
O-14, a 22-story-tall commercial tower perched on a two-story podium, broke ground in February 2007, and comprises over 300,000 square feet of office space for the Dubai Business Bay. O-14 is located along the extension of Dubai Creek, occupying a prominent location on the waterfront esplanade. With O-14, the office tower typology has been turned inside out – structure and skin have flipped to offer a new economy of tectonics and space.

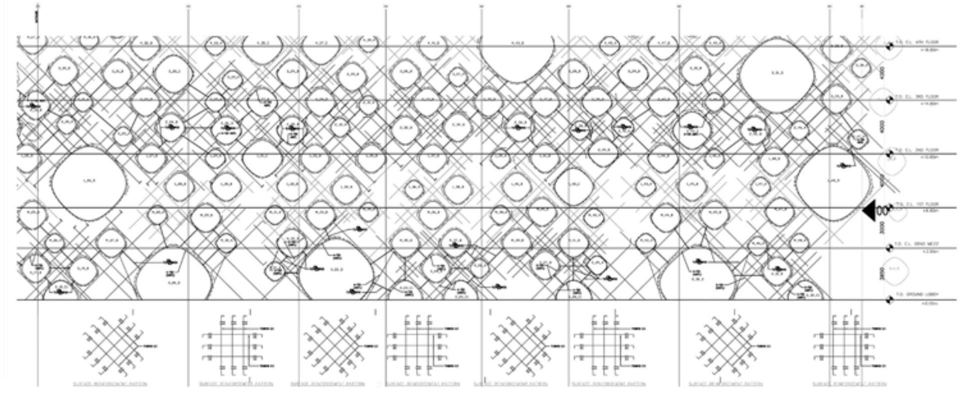
The concrete shell of O-14 provides an efficient structural exoskeleton that frees the core from the burden of lateral forces and creates highly efficient, column-free open spaces in the building's interior. The exoskeleton of O-14 becomes the primary vertical and lateral structure for the building, allowing column-free office slabs to span between it and the minimal core. By moving the lateral bracing for the building to the perimeter, the core, which is traditionally enlarged to receive lateral loading in most curtain wall office towers, can be minimized for only vertical loading, utilities, and transportation. Additionally, the typical curtain-wall tower configuration results in floor plates that must be thickened to carry lateral loads to the core. Yet, in O-14, these can be minimized to only respond to span and vibration. Consequently, future tenants can easily arrange the flexible floor space according to their individual needs.

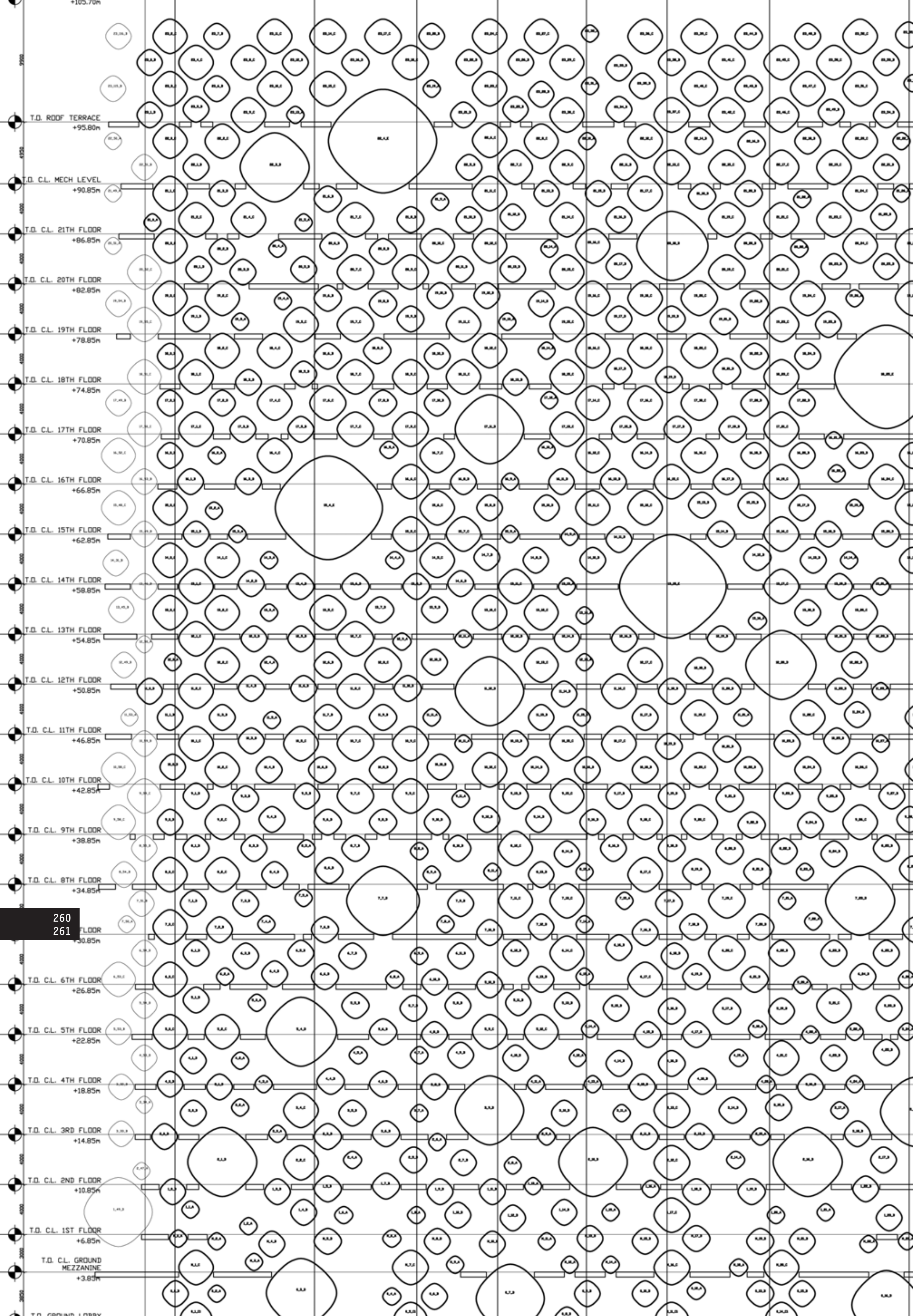
The main shell is organized as a diagrid, the efficiency of which results from a system of continuously varied openings that maintain a minimum of structural members by adding materials where necessary, and subtracting where possible. The efficiency of this modulation enables the shell to create a wide range of atmospheric and visual effects in the structure without changing the basic structural form, while still allowing for systematic analysis and construction.

The project has generated extraordinary international interest in the architectural press, as it is among the few innovative designs to be constructed in the sea of generic office towers defining Dubai's building boom. In October 2008, O-14 was featured in *Impossible City*, an hour-long television documentary produced by CBS News and aired in the US on the Discovery Channel. In May 2009, the tower's concrete structure was completed and the building was topped out, making O-14 one of the first towers to appear in the skyline of Business Bay, Dubai. In spring 2011, the building was fully opened to the public. A monograph on O-14 entitled *O-14: Projection and Reception* is forthcoming this fall; it will be published by the Architectural Association.








+105.70m
T.O. ROOF TERRACE
+95.80m
T.O. C.L. MECH LEVEL
+90.85m
T.O. C.L. 21TH FLOOR
+86.85m
T.O. C.L. 20TH FLOOR
+82.85m
T.O. C.L. 19TH FLOOR
+78.85m
T.O. C.L. 18TH FLOOR
+74.85m
T.O. C.L. 17TH FLOOR
+70.85m
T.O. C.L. 16TH FLOOR
+66.85m
T.O. C.L. 15TH FLOOR
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T.O. C.L. 12TH FLOOR
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T.O. C.L. 11TH FLOOR
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T.O. C.L. 10TH FLOOR
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T.O. C.L. 9TH FLOOR
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T.O. C.L. 6TH FLOOR
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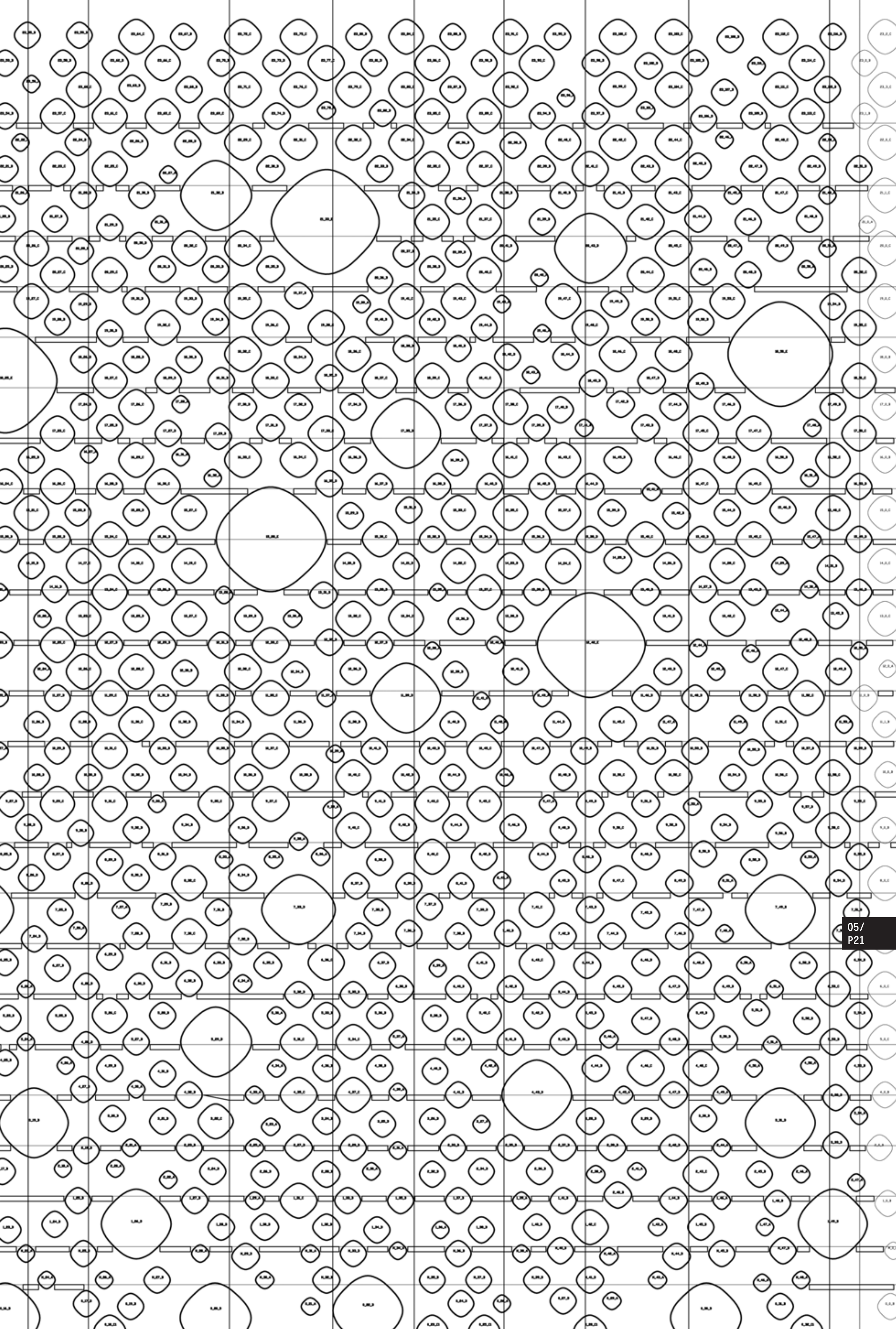
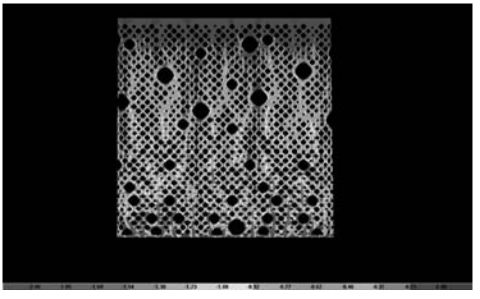
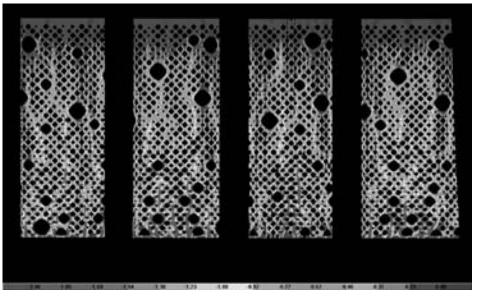
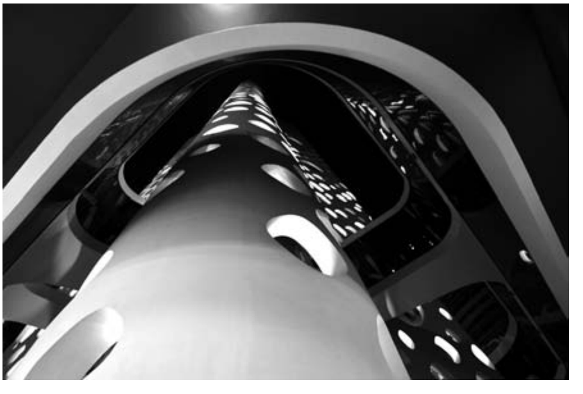
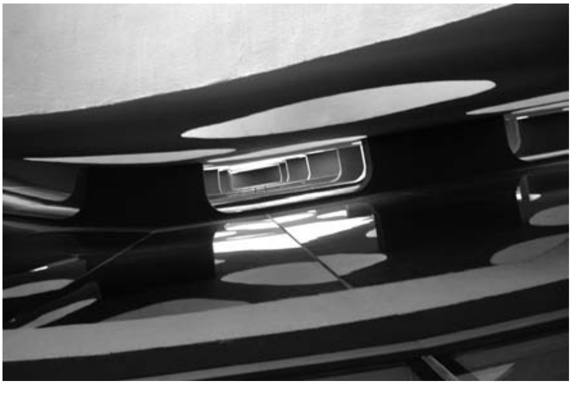
T.O. C.L. 5TH FLOOR
+22.85m
T.O. C.L. 4TH FLOOR
+18.85m
T.O. C.L. 3RD FLOOR
+14.85m
T.O. C.L. 2ND FLOOR
+10.85m
T.O. C.L. 1ST FLOOR
+6.85m
T.O. C.L. GROUND
MEZZANINE
+3.85m
T.O. GROUND LOBBY

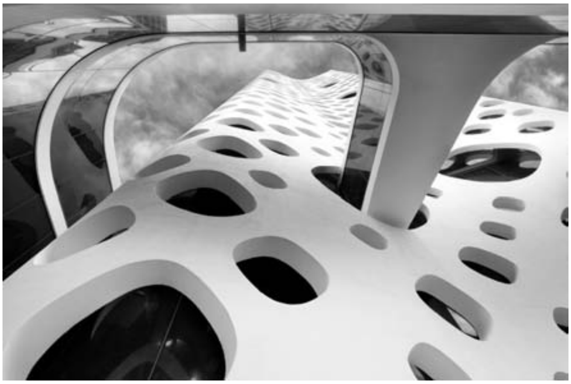












O-14
Dubai, United Arab Emirates 2006

Construction: 2007-2010
Size: 31,400 sq. m
Type: office
Structure: perforated concrete

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Lighting Concept Design
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Client
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General Contractor
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Dubai, UAE

SELF-ORGANISED BODIES

— ROLAND SNOOKS / KOKKUGIA

The research agenda of "Self-Organised Bodies" explores the emergence of a volatile, topological, and organizational order from the non-linear interaction of components at a local level. This approach is posited in opposition to the contemporary, tectonic treatment of components as elements that are subservient to a stable ordering device, such as surface.

This volatile strategy emerged from Kokkugia's ongoing development of behavioral design methodologies, which draws upon the logic of swarm intelligence and operates through the self-organization of multi-agent systems. These methodologies operate by encoding simple, local architectural decisions within a distributed system of autonomous computational agents. It is the interaction of these local decisions that self-organizes design intention, giving rise to a form of collective intelligence and emergent behavior at the global scale. Such behavioral formation represents a shift from "form being imposed upon matter" to "form emerging from the interaction of localized entities within a complex system." As a result, the component is re-conceptualized as the body of the agent, with the complex interactions of their skeletons giving rise to ornamental affects and woven tectonics. These two aspects are explored through the parallel research projects entitled "Swarm Matter" and "Woven Composites."

"Swarm Matter" explores the generation of ornamental geometries through the agent-based formation of emergent hierarchies and non-linear patterns. The conditional decision-making embedded within the components avoids the need for an a priori distinction between various tectonic elements, and begins to dissolve normative architectonic hierarchies. This project is an investigation into creating a constantly shifting relationship between line, component, and surface. While there are no hierarchies encoded into the "Swarm Matter" project, hierarchies arise as an emergent property of the system. This project is concerned with both the emergence of figure from the complex order of a field and the dissolution of the figure into abstraction. The component has no base state. Instead, it adapts to its conditions. While local moments of periodicity may occur, a definitive reading of the component is resisted through its continual negotiated transformations. Similarly, symmetries, although not inherent to the system, may emerge from specific interactions of components.

"Woven Composites" explores the generation of complex topology, woven-fiber surfaces. A multi-agent algorithm was developed to generate coherent emergent topology, operating through the local responses of agents to the manifold condition of their neighbors. The interlinked agent bodies form the woven fiber structural core of a composite surface. This represents a shift from considering surface to be uniform, to treating surface as an emergent assemblage formed through the interaction of a high population of fibrous bodies. The relationship of these agent bodies shifts, from a pseudo-knitted condition to a loose weave, based on their specific conditions and the local curvature of the surface. Likewise, the surface fluctuates from a thick weave – the manifestation of which are closer to shallow foams than surfaces – to weaves that almost entirely compress onto the plane of the surface. The resulting formations hover between structure and ornament, leveraging the expressive capacities of redundant material.

fig 1
Woven Composites: woven roof study plan.

fig 2
Woven Composites: woven body tectonic study.

fig 3
Woven Composites: agent body fabric detail.

fig 4
Woven Composites: woven roof study.

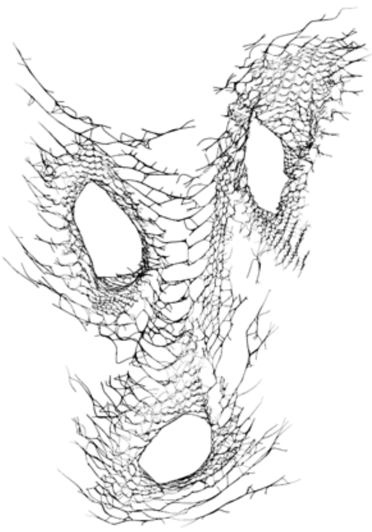


fig 1

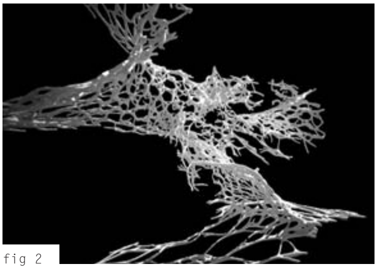
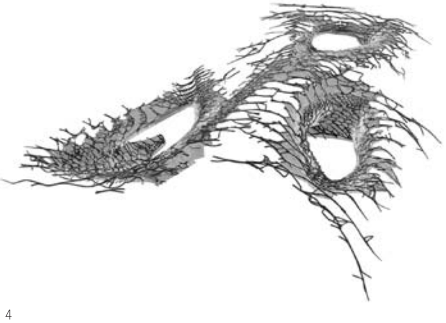


fig 2



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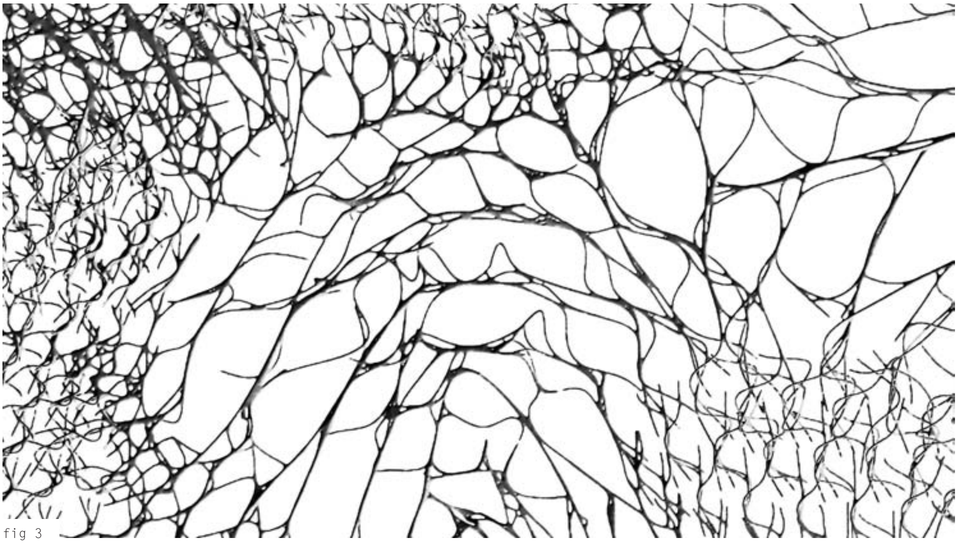


fig 3

fig 5
Swarm Matter: ornamental detail.

fig 6
Swarm Matter: self-organised field.

fig 5

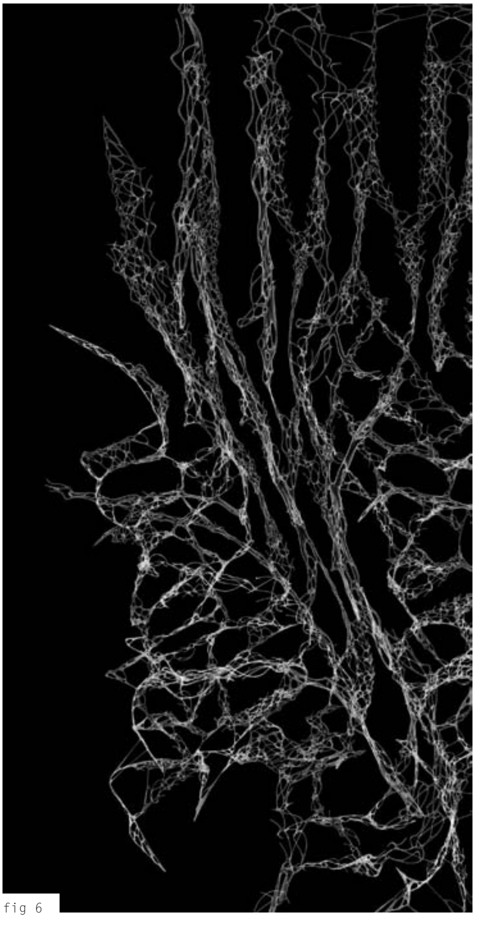
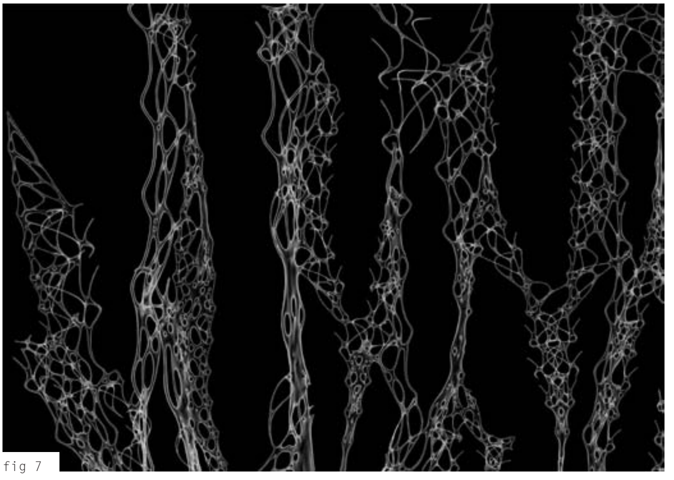


fig 6

fig 7
Swarm Matter: detail of emergent conditions.

fig 8
Swarm Matter: detail of emergent conditions.

fig 9
Swarm Matter: ornamental detail.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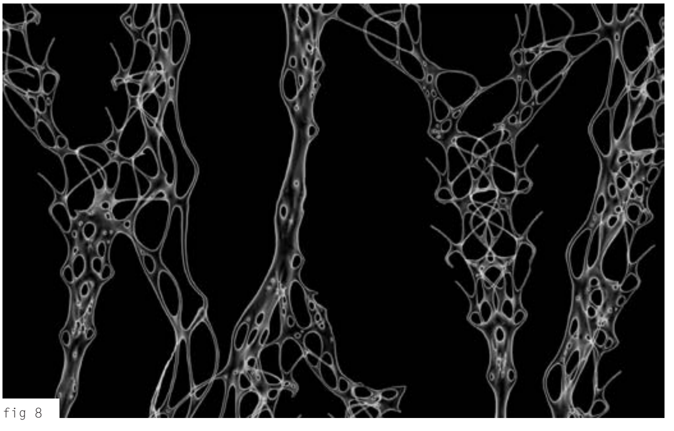
fig 8

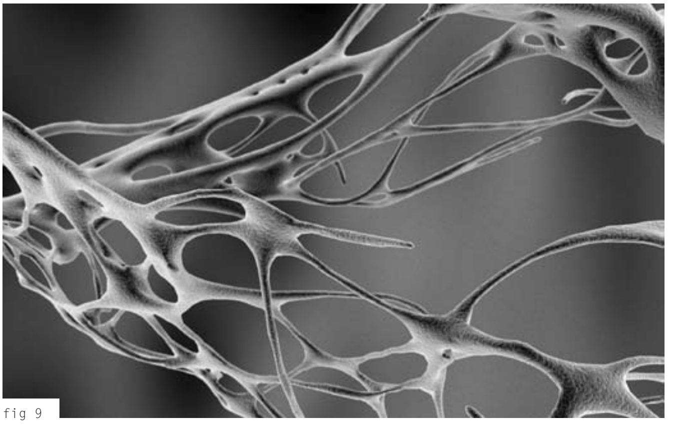
fig 9

Self-Organised Bodies
Roland Snooks

Agent Weave
Kokkugia | Roland Snooks 2012

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Roland Snooks
Adrian Cortez
Michael Murdock
Michael Ferreyra

Swarm Matter
Kokkugia | Roland Snooks 2009

Design Team
Roland Snooks
Pablo Kohan

FEELING MATTER IN THE HYLOZOIC SERIES

— PHILIP BEESLEY

The Hylozoic Series of interactive sculptures attempt to offer an anatomy of subtle boundaries that expand the physiology of individual human bodies. They ask the question: might it be possible to suspend judgment about what is "me" and what is clearly not? Rather than weakness, the ambivalence implied by such a suspension can have an enabling quality. This space is rendered as a transitional field,[1] a material and emotional place of interaction.[2] (fig 1)

fig 1
Elevation, Hylozoic Series: Sibyl, Biennale of Sydney, 2012.

The filtering layers of hovering environments employ delicate laser-cut snap-fit polymer, metal, and glass components. The combinations of interlinking components make a hybrid anatomy similar to condensing layers within a diffusely layered cloud of vapour. Deliberate weakness allows force shedding in these composite assemblies. Brought to the edge of stability, raw material moves to the limit of bounded form. Material turbulence is offered as a primary design quality that oscillates between expressive imagery and objective performance.

The conception of this work implies a world far from starkly defined borders. New imaging techniques can reveal potent layers of ephemera surrounding the human body. High-definition thermal cameras could be used to illuminate a landscape of furled plumes, passing inward and outward through our breathing bodies. This technical observation seems kin to the radiant vision of a medieval painter, rendering thickened auras around divine figures. Yet for all the implied potency of these sources, the design of this work does not grasp human power and domain. Rather, the project seeks awareness of the gentlest of impacts: air circling around the body; disturbances in ambient magnetic fields caused by our own movements. Interactions like these render legible subtle phenomena latent in an expanded field.

Textile Systems and Diffusion

The components that make up these structures are designed for potent interaction. Replacing traditional design equations that prefer clarity and power, the design attempts new qualities of deliberate fragility. Structural instability becomes a virtue that enables the pursuit of resonance and sensitivity. Design of this work is guided by integrating weakness into individual components. Large stresses on the environment are absorbed and dissipated within interlinking structural mesh-works.

1
The concept of the transitional field is from the psychologist D. W. Winnicott, *The Child and the Outside World* (London: Tavistock, 1957).

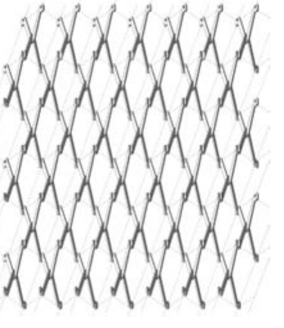
2
Text from this essay appears within Philip Beesley, Feeling Matter: Empathy and Affinity in the *Hylozoic Series* in "A Matter of Feeling"(Meta.Morf 2012), edited by Espen Gangvik. (TEKS, 2012).

The organizing systems of the Hylozoic topology are guided by variation, flexibility, and order. In contrast to design principles favoring optimal equations where maximum volume might be enclosed by the minimum possible surface, the structures seen in the Hylozoic environment prefer diffuse, deeply reticulated skins. These forms turn away from the minimum surface exposures of pure spheres and cubes as they seek to increase their exposure and interchange with the atmosphere. By combining hexagonal and Penrose arrays and by allowing for the reconciliation of twisting and warping in three dimensions, warped foam-like fabrics appear. The resulting geometry suggests the ability to both handle structural forces and invite circulation and component organization, which indicates a potential for multiple-function systems. (figs 2-6)

Embedded Intelligence

The microprocessor-based interactive system embedded within the Hylozoic environment includes both centralized and distributed organization. This organization emulates "subsumption" architecture, a behavior-based control strategy used to enable automated reflex-like links between sensing and actuation without involving centralized processing. In human physiology, subsumption can be seen in bundled ganglia such as the sensitive clusters within elbows, knees, sternum and pineal that cause muscular reflexes automatically, before the brain is notified of sensory events. Within the sculpture a central communication system enables neighborhood behaviors and global behaviors, and all nodes within the sculpture listen to just one channel while all nodes send messages out on different channels. This is complemented by a distributed translator node outside the sculpture that listens to all of the nodes in the sculpture and sends filtered and translated messages back to all of the listening nodes. (fig 7)

fig 2
Hylozoic chevron diagrid system.



Living Systems

The presence of protocells in the Hylozoic environment allows for a primitive, metabolic system to emerge within the sculpture. Protocells are simple models of living cells made from inorganic ingredients that exhibit some properties of living cells by performing functions such as metabolism, movement, replication, information, evolution, and self-assembly. Embedded within flasks, protocells produce a buffered environment where liquids heavier and lighter than water are set up as scaffolds. A state akin to weightlessness is achieved in the space where the two densities meet – a balanced environment in which chemicals can precipitate, vesicles can form, and viscous systems can emerge. The resulting system allows viewers to experience the protocells as a display of an architectural, lymphatic network. The adaptive chemistries within the wet system capture traces of carbon from the vaporous surroundings to build delicate, structural scaffolds. Engineered protocells are arranged in a series of embedded incubator flasks. Bursts of light and vibration, triggered by occupants moving inside the work, influence the growth of the protocells by catalyzing the formation of vesicles and inducing secondary deposits of benign materials. Sensors monitor the health of the growing flasks and provide feedback to influence the behavior of the interactive system surrounding the viewer.
The development of protocell chemistry within this series is still at a very early stage within the Hylozoic series. Physical qualities now seen in development imply layers of expanded physiology surrounding each viewer. The cloud of chemistry emitted from a viewer can become a tangible medium for architecture. (figs 8-9)

Could this kind of transitional field offer emplacement in the world? Past traditions of place-making might speak of strong, stable boundaries, but this work does not claim the earth to be either a stable resource for the framing of human territory, or a prosthetic apparatus for the extension of power. Instead, the transitional field is fraught with ambivalence and riddled with oscillation. This speaks to the porosity of our own subjective boundaries and the composite nature of our identities. This might offer a fertile starting point for reimagining the shape of a renewed public architecture.

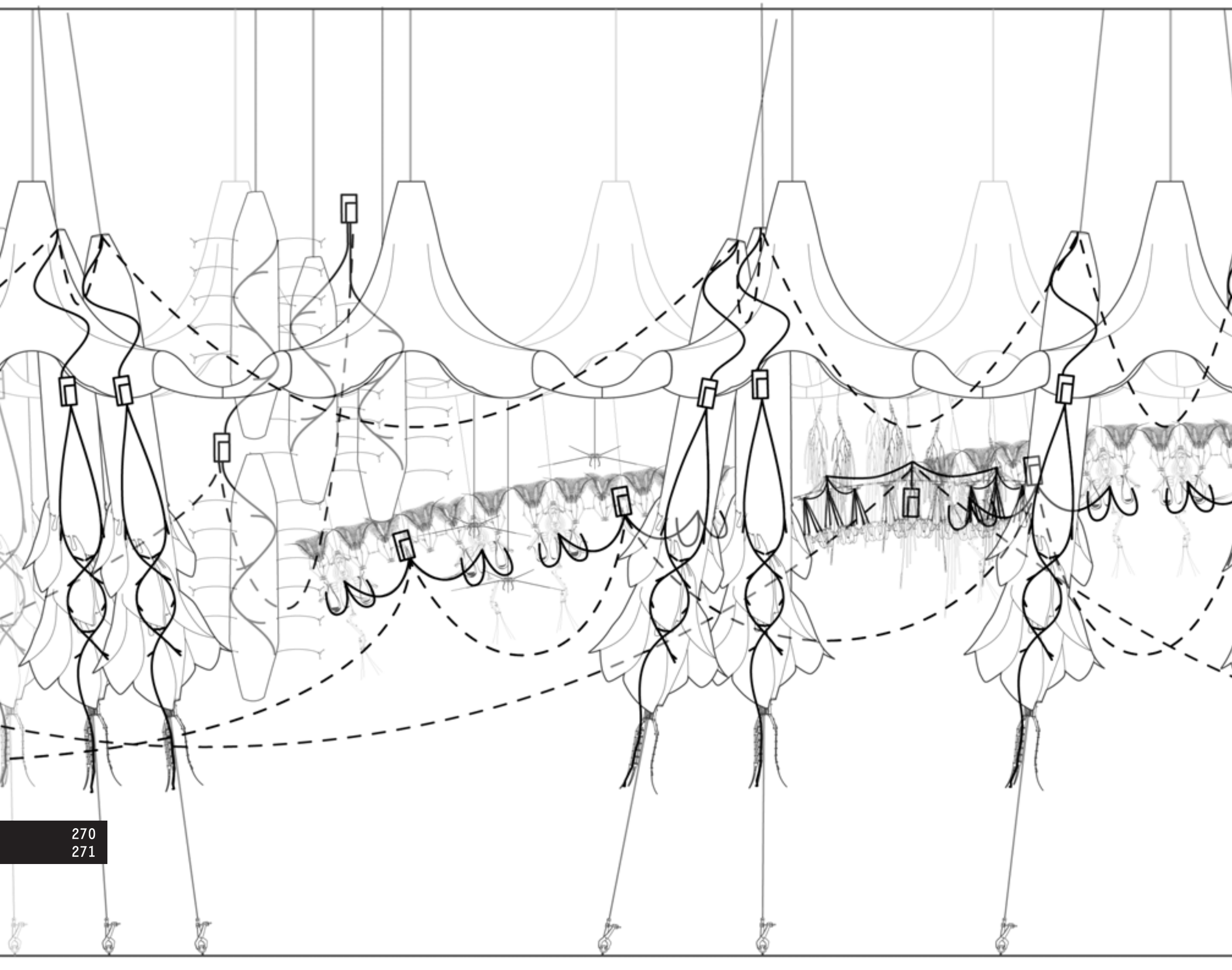


fig 3

fig 3
Outer veil grid plan, Sargasso, Toronto, 2012

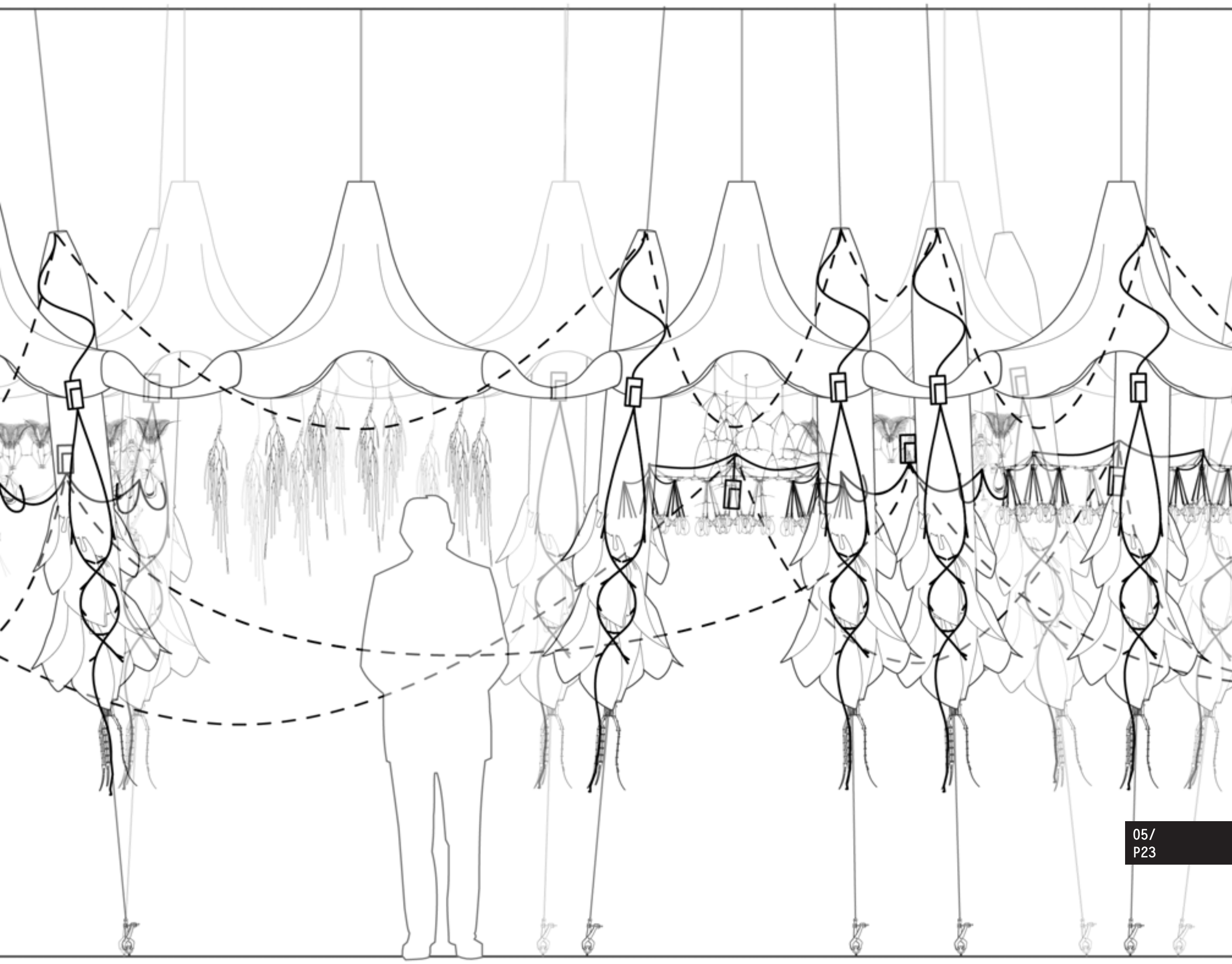


fig 4
Rhombic grid plan.

fig 5
Detail of rhombic grid plan.

fig 6
Detail of outer veil grid plan,
Sargasso, Toronto, 2012.

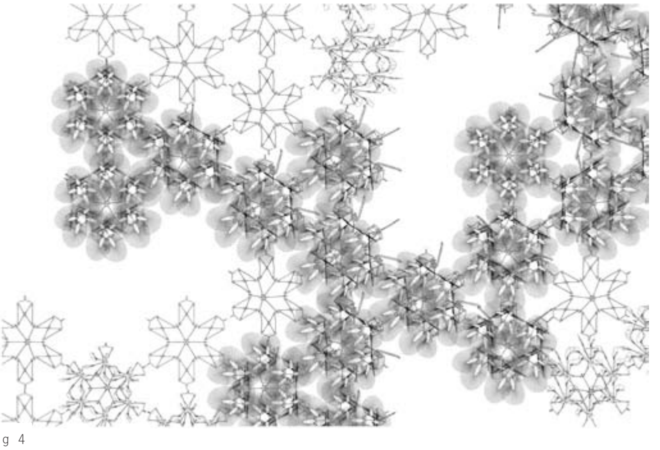
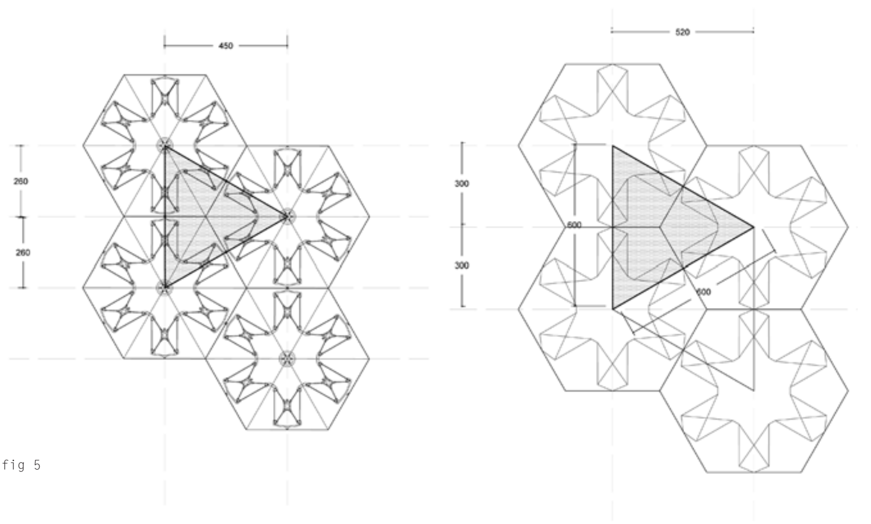


fig 4



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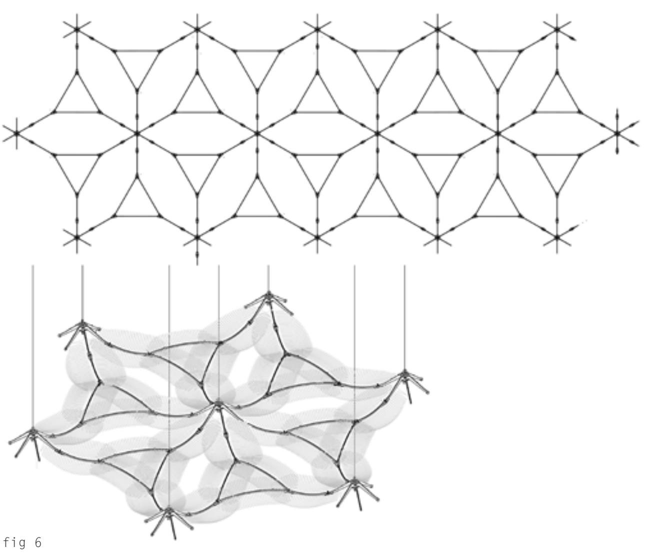
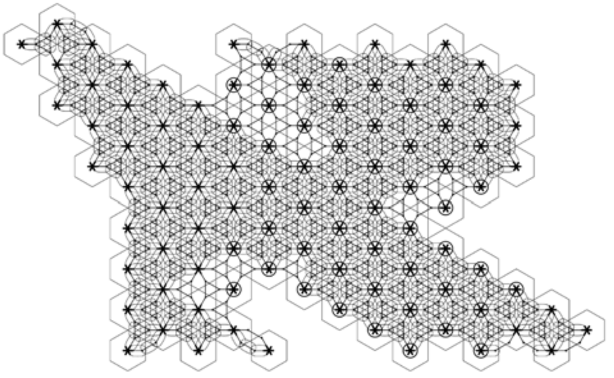


fig 6



Outer Layer – West Section

fig 7

fig 7
Schematic drawing of the Hylozoic Series interactive network, Venice, 2010.

fig 8
(captions included w figure)

fig 9
Protocell detail.

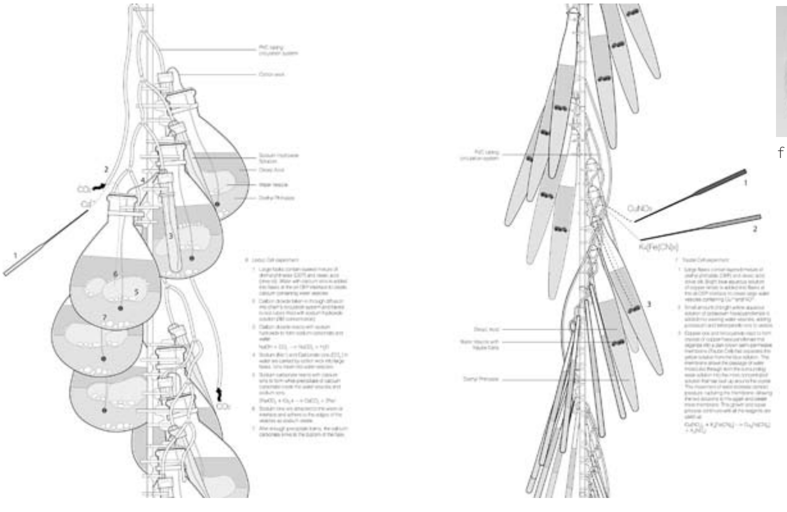


fig 8

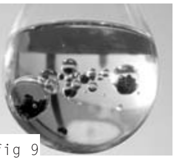


fig 9

<u>Hylozoic Series: Sibyl</u>
18th Biennale of Sydney, 2012

Artist
Philip Beesley

Collaborators
Rob Gorbet
Mark-David Hosale
Rachel Armstrong
Alain Baril
Philippe Baylaucq

PBAI Core Team
Jonathan Tyrrell
Martin Correa
Sue Balint
Eric Bury
Brandon DeHart
Susanne Eeg
Pedro Garcia
Andrea Ling
Elena Moliotsias
Leonor Munoz
Anne Paxton
Adam Schwartzentruber
Mingyi Zhou

<u>Sargasso</u>
Luminato Festival, Toronto, 2011

Artist
Philip Beesley

Engineering
Rob Gorbet

PBAI
Eric Bury
Elisabeth van Overbeeke
Carlos Carrillo Duran
Zachary Fluker
Hayley Isaacs
Liav Koren
Jonathan Tyrrell
Anne Paxton
Kristie Taylor
Erica Yudelman

Consultants
Laird Macdonald
Rachel Armstrong
Brandon DeHart

<u>Hylozoic Ground</u>
Venice Biennale of Architecture, Canadian representative, 2010

Artist
Philip Beesley

Collaborators
Rachel Armstrong
Rob Gorbet

PBAI Core Team
Hayley Isaacs
Eric Bury
Frederica Pianta
Adam Schwartzentruber
Jonathan Tyrrell

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COALESCENCES OF MACHINE AND MATERIAL COMPUTATION

— ACHIM MENGES

Computation, in its most basic meaning, refers to the processing of information.[1] In this way, both machinic processes operating in the binary realm of the digital, as well as material processes operating in the complex domain of the physical, can be considered computational. While there is a strong bias toward the former in contemporary design, sporadic investigations of the later have also occurred in architecture. What has rarely been explored, though, is the largely unchartered territory where machine computation and material computation potentially overlap, where they don't simply co-exist, but intensely interact in the design process. Operating at this overlap entails integrating material information – that is, behaviors originating in materiality and constraints emanating from materialization – in design computation. It suggests a conception of material not as a passive receptor of shape, as emblematic for current approaches to computational design, but as an active generator of form, which enables the exploration of novel, performative capacities and architectural possibilities within a morphogenetic design paradigm.[2] Information, formation, and materialization are inherently related in living nature. Through their complex reciprocities, the processes of biological-becoming arise. The relation between an organism's underlying information set, the genotype, and its manifest form unfolding from its interaction with specific environment, the phenotype, has been extensively studied. Initially, evolutionary biology seemed to propose that the genetic code is the primary determinant for what natural systems are actualized from an infinitely vast space of possibilities. However, as knowledge about genomic information accumulated, we began to recognize that it is not the only driver in the genesis of biological form. With the understanding of the genome as the definite blueprint for biotic construction rapidly eroding in light of recent scientific findings, the critical importance of material processes is becoming recognized.[3] It is ever more apparent that evolution operates within material constraints, meaning that the palette of possible formations is both genetically *and* physically defined. Moreover, nature substantially capitalizes on material innate capacities: biological systems extensively utilize local material interactions, which is a form of physical computation giving rise to self-organizing structures and emergent forms. The large numbers of known, pattern-forming phenomena of non-living nature that occur in biological systems provide strong evidence for this.[4] In nature, instructive code and material construction constitute an integral relation.

In contrast to the reciprocities characteristic of natural systems, in architecture, the relation between information, formation, and mate-

1
Terzidis, Kostas. *Algorithmic Architecture*. Oxford: Elsevier Architectural Press, 2006.

2
Menges, Achim. "Material Computation: Higher Integration in Morphogenetic Design." *Architectural Design* 82 (2012): 14-21.

3
Mueller, Gerd and Stuart A. Newmann. *Origination of Organismal Form: Beyond the Gene in Developmental and Evolutionary Biology*. Cambridge: MIT Press, 2003.

4
Ball, Philip. "Pattern Formation in Nature: Physical Constraints And Self-Organizing Characteristics." *Architectural Design* 82 (2012): 22-27.

fig 1

fig 1
Wood microfibrils.
Electron micrograph of an exposed portion of the secondary layer (S2) of a wood cell wall showing the microfibrils that have a major influence on wood's material properties and behavior. Wood is often described as a natural-fiber composite, with its cellulosic microfibrils functioning like "fibers" embedded in a "matrix" of lignin and hemicelluloses.
Copyright: BRE

rialization is typically linear and, at least with regard to the genesis of form and its materialization, one-directional and hierarchical. Whereas material plays an active role in the generation of biological form, in architecture it is most commonly conceived as a passive receptor of otherwise determined shape. Thus far, the advent of widespread and increasingly ubiquitous use of machine computation in architecture had seemingly very little effect on this condition. While the integrative character of computational design has been extensively utilized for the inclusion of programmatic, structural, environmental, or economic information, material information is hardly ever considered, let alone employed, as a generative driver. It seems as if the age-long predominance of shape-oriented representational design techniques based on explicit geometry and their direct, conceptual extension in most contemporary CAD packages still preconditions contemporary design thinking. Even in otherwise progressive and behavior-oriented design approaches, materiality is still conceived as a passive property of shape and materialization understood as being subordinate to the creation of form.

Another reason for the lack of materially informed design computation may be the difficulty of developing appropriate design methods capable of navigating the narrow path between under-determining material specificity, which leads to a lack of rigor and, consequently, operativeness, and over-constraining material properties and boundary conditions, resulting in both the premature convergence of, and the lack of, exploratory potential. For the identification of an operative and explorative methodological spectrum, two precursors of employing material computation in design may be relevant.

One the one hand, Josef Albers' material studies for his *Vorkurs* at the Bauhaus (Dessau) and, later, at the Black Mountain College (North Carolina) established a precedent for the possible enrichment of design processes through material experimentation. Albers rejected established processes of materialization based on professional craft knowledge, claiming that they stifle invention. Instead, he identified material behavior itself as a creative domain for developing new modes of construction and innovation in architecture.[5] The material studies, which were undertaken as a vital part of his courses, were conceived not as scalar models or representations of cerebral constructs or ideas, but as temporary un-foldings of material behavior in space and time. In the designer's hands, these un-foldings carried multiple possible futures and bore hitherto-unsought design potentialities.

On the other hand, Frei Otto's extensive series of experiments at his institute at the University of Stuttgart, employing what he called

5
Horowitz, Frederick A. and Brenda Danilowitz. *Josef Albers: To Open Eyes*. New York: Phaidon, 2009.

form-finding methods, may serve as an example of the other end of the spectrum, of an instrumental material-informed design approach. Otto investigated a vast number of different material systems, ranging from precisely defined structures such as grid shells, to naturally found granular substances such as sand, in order to study their self-forming capacities. He systematically studied their behavioral characteristics to find specific forms, which were manifested as the equilibrium state between external forces and internal restraints acting upon the system.[6] These experiments should not, as is often the case, be confused with the extremely precise and elaborate physical, structural models that followed later in the planning process, like the photometrically analyzed cable nets for the roof of the Munich Olympic stadium. In contrast to these models, which employed physical computation as a means of engineering verification, Otto's initial studies were exploratory inquiries into the possible points of departure for developing architectural designs through material behavior, rather than through the determination of form and space.

Considering the overlap between machine and material computation as a potential domain of both architectural enquiry and technological innovation requires, by nature, an interdisciplinary approach to design. However, in this context, it is critical to distinguish between material computation in architecture and material simulation in engineering. A call for materially informed computational design cannot simply be equated to a call for employing material simulation earlier in the design process, as the demands on, and characteristics of, design and engineering techniques are too different. Engineering simulation seeks determinability, precision, and, as a consequence, reduction to the known constituents and fundamental properties of a model, which requires all boundary conditions to be well defined. In contrast, in the decisive, early phases of architectural design, it is necessary to navigate a vast, open-ended design space, which requires explorative techniques capable of rapid generation, variation, evolution, and adaptation to continuously developing design intent – an advancing oscillation between searching and finding based on an expanding, yet naturally incomplete, set of information.[7] In this context, an interesting relationship between the notion of design space and the concept of "morphospace" in developmental and evolutionary biology can be established. Morphospaces serve as computational and conceptual tools that allow for describing, as well as relating, the vast variance of organismal phenotypes.[8] They constitute the formal spaces defined by multidimensional axes, each of which corresponds to a variable parameter of morphology, and also underlie the prominent notion of adaptive landscapes within the discourse of evolutionary biology. Of particular interest here is the distinction between the empirical morphospace, a retroactive space defined by the mapping of all known variation, and the theoretical morphospace, a prospective space of all possible variability.[9] The conception of a computational design space as the theoretical morphospace defined by multifaceted variables of material information – comprising, as mentioned before, behaviors originating in materiality and constraints emanating from materialization, which can, in turn, be navigated and explored through generative computational design techniques, has been investigated as one design approach possibly operating at the intersection of material and machine computation. Two of our projects deriving from the related design research will be briefly described below. One project concentrates on materiality and the related morphospaces of material behavior, while the other focuses on materialization and the related machinic morphospaces.

Elastic bending is a familiar material behavior we have all experienced. In structural engineering, it is conventionally considered a mode of failure. Interestingly, it can sometimes increase structural performance by inducing other modes of so-called "bending-active" stability. However, as it is also the reciprocal relation between the acting forces of elastic (de)formation, its resulting form and emerging performance cannot be captured and explored within the established repertoire of architectural

6 Otto, Frei and Bodo Rasch. *Finding Form – Towards an Architecture of the Minimal*. Stuttgart: Edition Axel Menges, 1996.

7 Ahlquist, Sean and Achim Menges. "Computational Design Thinking," in *Computational Design Thinking* edited by Achim Menges and Sean Ahlquist, 10-29. London: John Wiley and Sons, 2011.

8 Mitteroecker, Philipp and Simon Huttegger. "The Concept of Morphospaces in Evolutionary and Developmental Biology: Mathematics and Metaphors." *Biological Theory* 4 (2009): 54-67.

9 Eble, J. Gunther. "Developmental and Non-Developmental Morphospaces in Evolutionary Biology." *Santa Fe Institute Working Papers* 99-04-027 (1999).

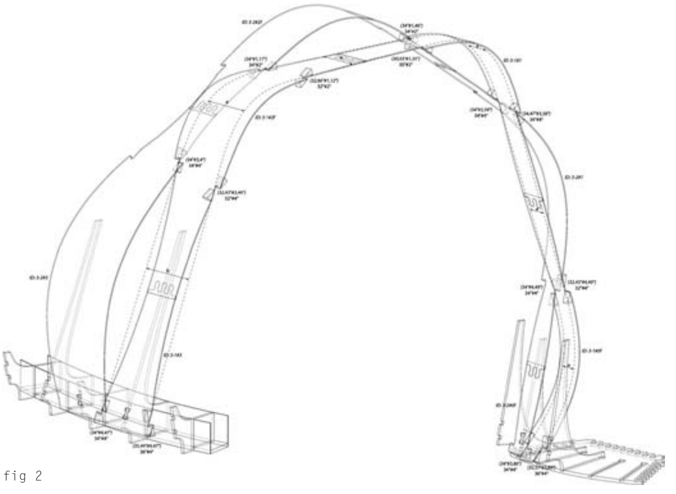


fig 2

fig 3

fig 2
ICD/ITKE Research Pavilion 2010, Institute for Computational Design (Prof. Achim Menges) and Institute of Building Structures and Structural Design (Prof. Jan Knippers).
Based on the elastic material behavior and the characteristics of the employed robotic manufacturing processes a construction system is developed through integrative computational design processes.
Credit: ICD/ITKE University of Stuttgart

fig 3
ICD/ITKE Research Pavilion 2010, Institute for Computational Design (Prof. Achim Menges) and Institute of Building Structures and Structural Design (Prof. Jan Knippers).
Inside the pavilion the toroidal space can never be perceived in its entirety, leading to a surprising spatial depth that is further enhanced by the sequence of convex and concave undulations of the envelope.
Credit: ICD/ITKE University of Stuttgart / Photo: Achim Menges

design techniques. As such, very few examples of elastically bent architectures exist. They either belong to vernacular architecture – like the bent-reed bundle, “Mudhif” houses of the Madan people, which were built by combining local experience and tacit knowledge with procedural, rather than planned, building instructions,[10] or they form part of the few physically form-found structures, such as Frei Otto’s elastically formed wooden lattice shells.[11] Hence, our research project aimed to further the architectural potential of bending-active structures[12] by integrating material computation with computational design, advanced engineering, and robotic fabrication. Our work culminated in the construction of the *ICD/ITKE Research Pavilion 2010,*[13] which was a collaborative undertaking by the Institute for Computational Design and the Institute of Building Structures and Structural Design at the University of Stuttgart. (fig 1)

With the goal of employing material behavior for the construction process, rather than only for abstracted design models, this project commenced with a series of experiments investigating the self-forming capacity of thin plywood lamellas. Due to its specific material make up, wood can be described as a natural-fiber composite, with its cellulosic microfibrils functioning like “fibers” and the lignin and hemicelluloses constituting a “matrix.” Wood also shares a number of properties with synthetic composites, such as glass-fiber-reinforced plastics, which are characterized by relatively high strain at failure; that is, relatively low stiffness combined with relatively high structural capacity, which lends itself to a construction technique based on the bending of wood.[14] While plywood counterbalances the anisotropic behavior that wood also shares with synthetic composites, it maintains the characteristics of elastic bending. (figs 2-4)

By carefully calibrating between physical form-finding and computational form generation, a novel, bending-active system was explored. This system consisted of robotically manufactured, planar plywood strips

10
Oliver, Paul. *Dwellings: The Vernacular House World Wide.* London: Phaidon Press, 2003.

11
Hennicke, Jürgen. *IL 10 Gitterschalen: Grid Shells.* Stuttgart: Karl Krämer Verlag, 1975.

12
Lienhard, Julian, Simon Schleicher and Jan Knippers. “Bending-Active Structures: Research Pavilion ICD/ITKE,” in *Taller Longer Lighter - Proceedings of the International Symposium of the IABSE-IASS Symposium* edited by David Nethercot and Sergio Pellegrino. Madrid: The International Association of Shell and Spatial Structures, 2011.

13
Menges, Achim, Simon Schleicher, and Moritz Fleischmann. “Research Pavilion ICD/ITKE,” in *Fabricate: Making Digital Architecture* edited by Ruari Glynn and Bob Sheil, 22-27. Waterloo: Riverside Architectural Press, 2011.

14
Menges, A., “Material Resourcefulness - Activating Material Information in Computational Design,” *Architectural Design*, 82 No. 2, 34-43.

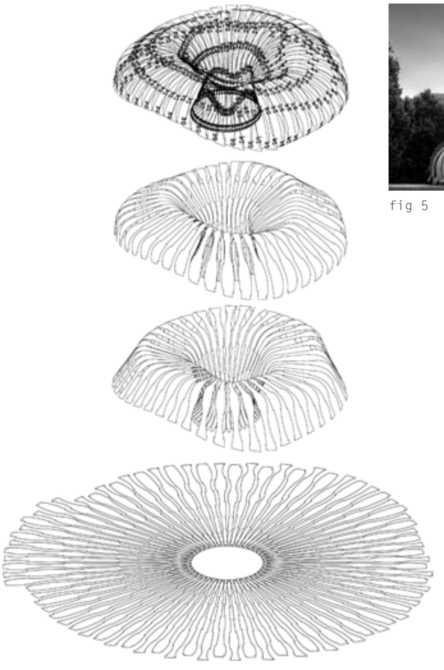


fig 4

fig 5

fig 4
ICD/ITKE Research Pavilion 2010, Institute for Computational Design (Prof. Achim Menges) and Institute of Building Structures and Structural Design (Prof. Jan Knippers).
The combination of the pre-stress resulting from the elastic bending during the assembly process and the morphological differentiation of the joint locations enables a very lightweight and materially efficient system, using only 6.5 millimeter thin birch plywood sheets.
Credit: ICD/ITKE University of Stuttgart

fig 5
ICD/ITKE Research Pavilion 2010, Institute for Computational Design (Prof. Achim Menges) and Institute of Building Structures and Structural Design (Prof. Jan Knippers).
The ICD/ITKE Research Pavilion 2010, an experimental bending-active structure, is located at the city campus of University of Stuttgart.
Credit: ICD/ITKE University of Stuttgart / Photo: Achim Menges

that were connected to form alternating sequences of elastically bent and tensioned regions. The crucial morphological feature of oscillating joint-point locations was computationally derived so that the distribution of local weak points did not compromise the global structural performance, which led to a distinct envelope articulation. Furthermore, by differentiating joint locations in combination with the pre-stress resulting from elastic bending in the assembly process, a highly performative structure emerged: the entire envelope, which was spatial skin and loadbearing structure in one, was realized using only extremely thin (6.5 mm) birch plywood strips. As a result, the structure was surprisingly simple to construct on site: the pavilion materially computed its form entirely by itself as an intricate network of joint points spatially mediated by the plywood lamellas' elasticity.[15] For this project, then, embedding material characteristics and behavior into an explorative, computational design process enabled the unfolding of an unique architectural space, while allowing the construction to remain extremely effective with employed material resources.

Using exactly the same material, birch plywood, our second research project shifted the focus from the morphospace of materiality and related behaviors to the processes of materialization and the related exploration of machinic morphospaces.[16] Anticipating a profound change in wood fabrication, which would entail a shift away from the linear file-to-factory modes of CNC production to the more reciprocal models of fabrication and design – as facilitated by increasingly generic production robots, this project aimed to uncover potential areas of innovation specific to robotic fabrication, while still respecting traditional woodworking acumen. Following a large number of experiments, robotically fabricated finger joints were identified as particularly interesting: the computer-controlled production of differentiated finger joints enabling the connection of wood sheets of different thicknesses at different angles is

15
Fleischmann, Moritz, Jan Knippers, Julian Lienhard, Achim Menges, and Simon Schleicher."Material Behaviour: Embedding Physical Properties in Computational Design Processes." *Architectural Design* 82 (2012): 44-51.

16
Menges, Achim, and Tobias Schwinn. "Manufacturing Reciprocities." *Architectural Design* 82 (2012): 118-125.

currently unique to robotic wood fabrication. Further, the high degree of kinematic freedom of the seven-axis robotic machine opened up a vast space of possible plate structures, which begged the question of how this morphospace could be explored and populated in particularly promising areas. One possibility was to use biomimetic design methods, in which the theoretical, machinic morphospace of buildable plate structures would be overlaid with, and filtered through, the morphospace of biological plate morphologies. This approach was tested through the design and construction of a second research pavilion. As before, the work was undertaken as a collaboration between the Institute for Computational Design and the Institute of Building Structures and Structural Design at the University of Stuttgart. This time, however, the project also involved biologists from the Competence Network Biomimetics group. (figs 5–7)

Robotically fabricated finger joints share a wide range of interesting characteristics with their more-traditionally fabricated counterparts. For instance, they provide for form-and-force-fit joints that embed the logic of connection within the plate itself, thereby avoiding the need for additional mechanical fasteners or connection elements. As a result, they are particularly versatile in withstanding shear forces. However, they are, quite obviously, relatively weak when exposed to tension or bending moments. This contrast presents a considerable challenge for the design of finger-joint plate structures. To address this issue, we took inspiration from the field of biology.

In biology, plate structures exist, like the plate skeleton of the sand dollar – a species of echinoids belonging to the order of Clypeasteroida. Although the individual calcite plates of this skeleton are only connected to each other by finger-joint-like stereom projections, nature evolved highly performative plate structures that translated all acting forces into normal and shear stresses – thus almost entirely avoiding bending moments at these connections. For our project, key morphological features of the sand dollar's plate articulation, arrangement, and topology were identified and translated into generative design rules. In turn, these rules were informed with the constraints and affordances of the robotic fabrication process, which resulted in a computational design tool capable not only of rapidly navigating the remaining design space, but also of deriving all the required robot-control codes – a prerequisite for producing the pavilion's 850 geometrically distinct plates and over 100,000 finger joints. The resulting lightweight, modular wood shell not only demonstrated its performative capacity by using only extremely thin (6.5 mm) plywood for all the plates, but also articulated both an interior space – which was characterized by the perforation of the skin's inner layer, as was required for assembly, and an interstitial space – which emerged from the local separation of inner and outer envelope.

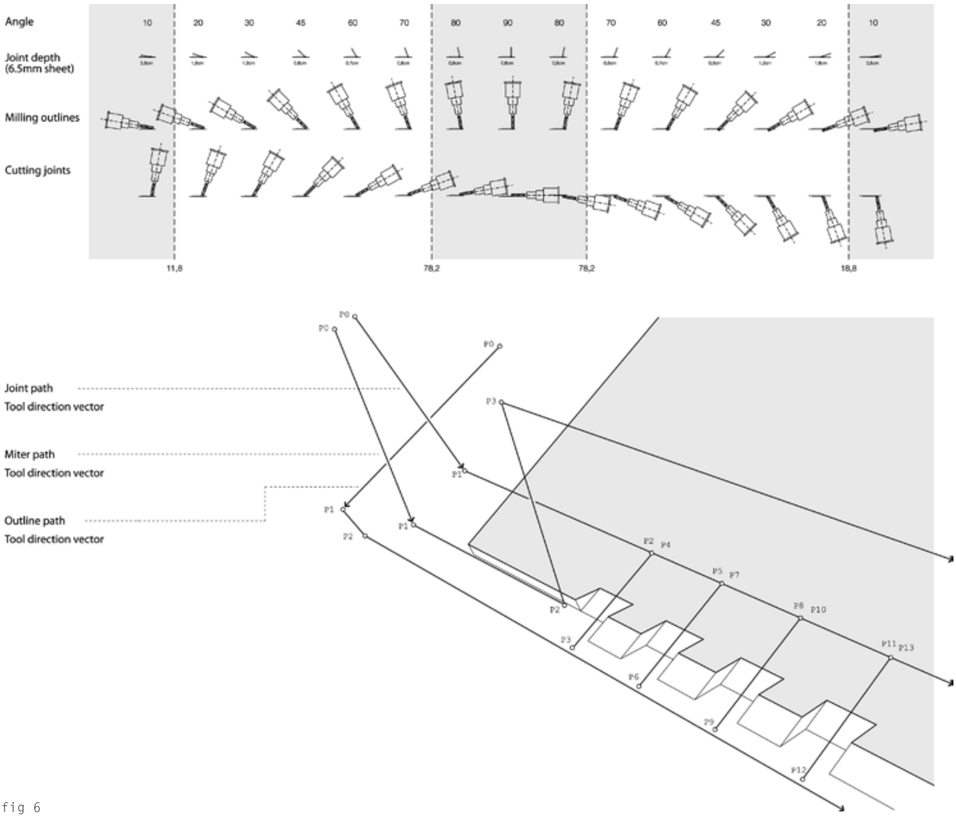
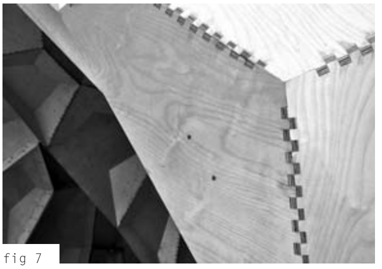


fig 6

fig 6
ICD/ITKE Research Pavilion 2011, Institute for Computational Design (Prof. Achim Menges) and Institute of Building Structures and Structural Design (Prof. Jan Knippers).

The inherent material and milling constraints together with the geometry of the spindle entail the critical constituents for defining the machinic morphospace of the seven-axis robot for finger joint production.
Credit: ICD University of Stuttgart



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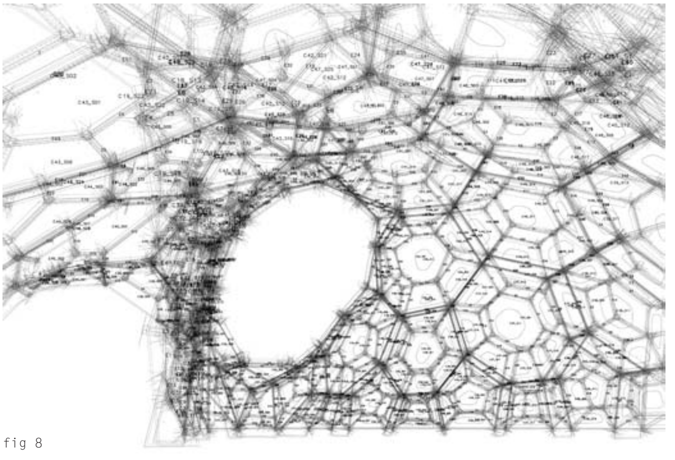

fig 8

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ICD/ITKE Research Pavilion 2011, Institute for Computational Design (Prof. Achim Menges) and Institute of Building Structures and Structural Design (Prof. Jan Knippers).

The inherent material and milling constraints together with the geometry of the spindle entail the critical constituents for defining the machinic morphospace of the seven-axis robot for finger joint production.
Credit: ICD University of Stuttgart

fig 8
ICD/ITKE Research Pavilion 2011, Institute for Computational Design (Prof. Achim Menges) and Institute of Building Structures and Structural Design (Prof. Jan Knippers).

Spatial mapping of the robot control code for the fabrication of more than 850 geometrically unique parts connected by more than 100,000 unique finger joints.
Credit: ICD University of Stuttgart

fig 9
ICD/ITKE Research Pavilion 2011, Institute for Computational Design (Prof. Achim Menges) and Institute of Building Structures and Structural Design (Prof. Jan Knippers).

The robotically prefabricated plates are assembled into building modules. Due to the performance of the bionic morphology all modules could be built from extremely thin sheets of plywood (6.5 mm).
Credit: ICD/ITKE University of Stuttgart / Photo: Achim Menges

Material (in)Formation
Coalescences of Machine and Material Computation
Achim Menges

ICD/ITKE Research Pavilion 2010, Stuttgart

Institute for Computational Design
Prof. Achim Menges

Institute of Building Structures and Structural Design
Prof. Jan Knippers

Scientific Development
Moritz Fleischmann
Christopher Robeller
Karola Dierichs
Simon Schleicher
Julian Lienhard
Diana D' Souza

Concept & Realisation
Andreas Eisenhardt
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Thomas Irowetz
Oliver David Krieg
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Peter Meschendoerfer
Leopold Moehler
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Konrad Zerbe

ICD/ITKE Research Pavilion 2011, Stuttgart

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Prof. Jan Knippers

Scientific Development
Markus Gabler
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Steffen Reichert
Tobias Schwinn
Frédéric Waimer

Concept & System Development
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Boyan Mihaylov

Detail Design, Fabrication & Construction
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Solmaz Fahimian
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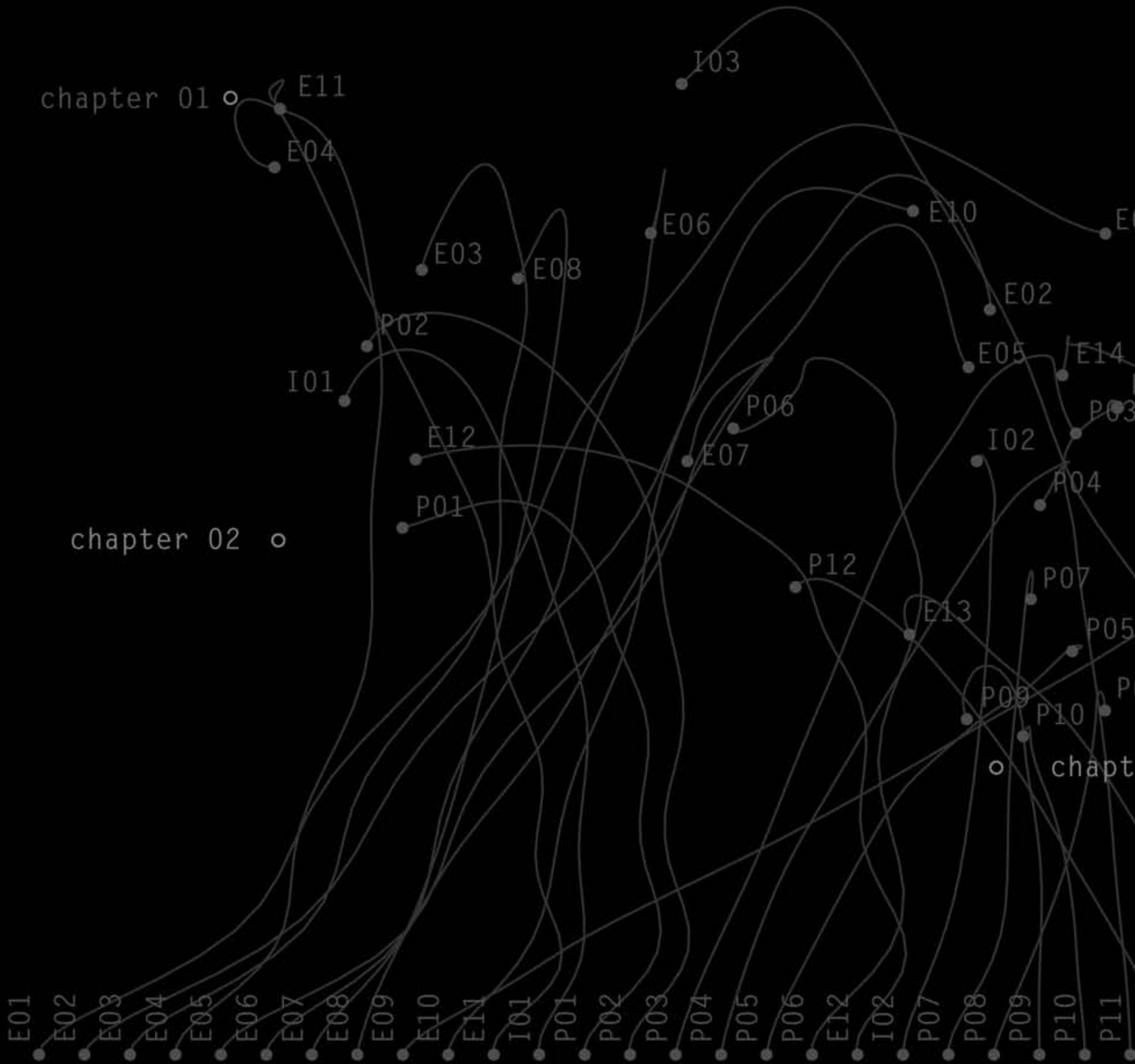
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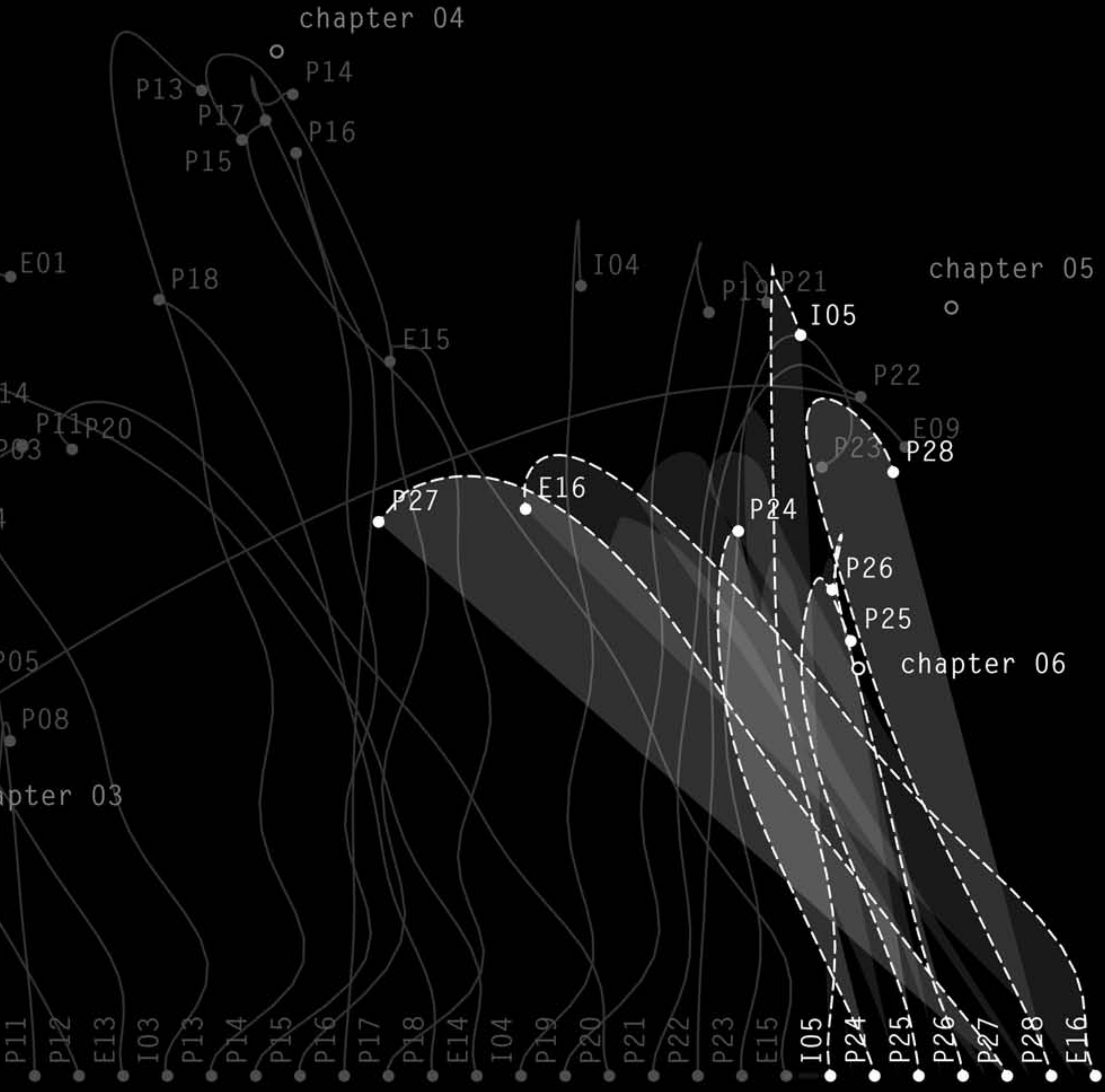
INFORMATION AFFECT



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INTERVIEW: GREG LYNN

— WITH PABLO LORENZO-EIROA AND AARON SPRECHER

01 *Through your collaborations with partners spanning the range from engineers and industrial designers to media-technologists, your practice has always been distinguished by its trans-disciplinary approach. How do you envision the role of the architect in these teams? What is your approach in terms of sharing information and influencing the course of a project?*

GREG LYNN

I think there are two changes: the first in role and the second in scope.

The change in role, first of all: the architect is able to take on more risk, responsibility, and control of the design and construction process through the use of higher-fidelity 3D digital documents from ever-more 3D digital design processes. This might result in buildings with: more creative integrity, more efficient and less litigious design and construction processes, an increase in the architect's role by absorbing construction management responsibilities, and perhaps higher profits in exchange for the increased risk and responsibility.

Secondly, the change in scope: other industries are becoming more industrialized and vertically organized and they are realizing that they need someone like an architect to manage design, manufacture, and management in their companies. For example, a car architect who is able to produce a design and construction document set for a unique car using standardized methods and components is inevitable for the auto industry. The variations in finishes, configurations, and specifications in a typical automobile is already exceeding the capabilities of customers, dealers, fulfillment centers, and manufacturers. As a result, the skill set of architects is already being explored as the bridge between customer and factory. Engineers and designers do not possess the skill set to design and document a complex unique assembly made from industrial products. This goes for everything from shoes to transportation; there will be architects inserted into these industries first as directors of design and secondly as actual participants in the design and production chain. A variety of companies, like Nike for example, have people running their design teams who were trained as architects.

02 *Theoretical understanding of formal organization, relative to animation, has opened up a new paradigm based on the topological understanding of form, dynamic parameters, deformation, and the implicit multiplicity of computed iterations. This created a dynamic diagram, which arrayed a field of equally valued solutions and deconstructed the idea of the definitive, static object. The resulting, new paradigm in architectural representation anticipated the end of design based on drawing and the beginning of informed formal manipulation. How different is this concept of form from your current understanding, i.e. – form informed by materials, composites, and fabrication?*

GREG LYNN

The fundamental principle of composites is that the geometry of the form is related to, but not coincident with, the structure, construction pattern, and orientation. The era of a spline or polygon model being converted into structure by following the geometric lineaments as one would do with a geometric grid is soon to disappear. The wire frame translation of geometry into

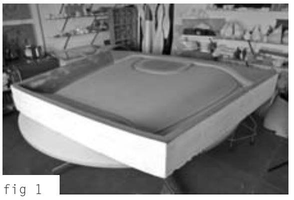


fig 1

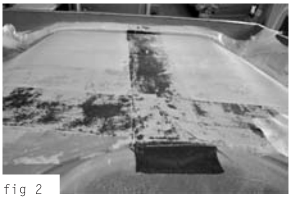


fig 2


fig 3


fig 4

fig 1
Using an in-house CNC router, Lynn's office is making many of the molds to be supplied to the builder for use in the construction of the boat. In addition, the interior furnishings are being fabricated on CNC-shaped foam molds like this in Lynn's office, and will be supplied to the builder painted and ready for secondary bonding into the central hull.

fig 2
Layers of carbon cloth, woven e-glass cloth, and, in areas needing additional stiffness, unidirectional carbon fiber is impregnated with epoxy resin and laid into the mold, finished side down. After the first skin has been placed, CNC-cut foam cores are placed on top, and then a second skin of cloth and fiber layers are placed in predetermined orientations.

fig 3
The laminated cloth and core is layered with peel ply, allowing resin to flow through it. There is also a breather cloth that both absorbs the additional epoxy resin (which is parasitic weight) and promotes the even distribution of pressure under vacuum. Finally, the layers are encapsulated in a sealed bag with tape and put under vacuum pressure while curing, ensuring a lightweight and strong part.

fig 4
The finished parts are minimally sanded (due to the CNC molds), primed, and weighed. Because of the vacuum bag process and the use of CNC cut molds, the entire composite interior, including a double berth, two couch berths, chair, galley kitchenette, stairs, ten shelves and a bathroom, weighs only slightly more than 100 lb.

structural expressionism or façade patterns is both very dated and very amateurish at this moment. For twenty years, digital design tools were used to create complex geometries that were then used like grid lines to define surfaces and structure. Parametricism is the last gasp of this era. Instead, finite element analysis (FEA) in other fields shows the logic of composite construction where load paths are obliquely related to geometry, but not reducible to simple isoparms and triangular boundaries. One need not literally build in composites to be tired of diagrids, spaceframes, and triangulated building skins at this point. It is more a transition from simple translation of geometry into construction elements, to a more expert understanding of the lack of redundancy between wireframe and construction logic.

03 *In your various projects, forms are generated out of a response to forces that exemplify an iterative condition. Your essays from the 1990s describe this condition both in terms of our perception of phenomena in nature and the way the sciences have propelled models that reinforce the dynamic, rather than static, condition of reality; potential rather than ideal forms. How would you define the form in an architecture of chemistry? After defining the curvilinear form as an expression of technology, what would be a form that exemplifies chemical operations?*

GREG LYNN

My personal use of the term "chemical" is against the term "mechanical," and it expresses my preference and desire to celebrate glued, bonded, and welded methods of assembly in favor of the fetishism of mechanical attachment. Cars, planes, sporting equipment, even appliances have jettisoned crude mechanical hardware in favor of glued joints, and it is really only architects that still get excited about a nut and bolt today.

04 *In your recent article titled "From Tectonics to Cooking in a Bag," you approach the architectural object as a result of chemical processes rather than purely mechanical procedures. In this context, how do you envision the transfer of information from the computed model to the object? Or, in other words, should architects reconsider their design methods while developing "chemical architecture"?*

GREG LYNN

Frankly, it is more about striving for the details of construction to have some integrity with the design process, rather than inventing new design techniques.

05 *Your work has always been influenced by new fabrication technologies and material use. Considering performance as a function of accuracy, what would be the limits of such performance in architecture? Is the notion of performance different in architecture than in other fields, like engineering, e.g. – naval and aeronautical engineering?*

GREG LYNN

The major difference is that a building is not the result of a vertically organized processes. Instead, it is one of the last horizontally organized and un-integrated, expensive products left. Soon, the building industry will be radically reorganized by technology, like so many other industries recently. It must be acknowledged that as the building process becomes more vertically integrated, the "services" of the architect are diminished in both scope and value. We are doing less and are paid less for what we do. In other fields, the role of the designer, architect, and engineer have been maintained – as well as the fact that the builder and developer are more responsible and involved in the design process. The aerospace or naval architect and engineer are not providing services, but are acting as members of a design and fabrication team. Their relationships with the developer/builder is not antagonistic, and their relative scope and value have not been diminished the way they have for architects in the building industry.

06 *Considering this interface between the virtual platform and the physical processes of fabrication, at which stage are intrinsic properties of material and fabrication methods integrated within your design protocol? How do you negotiate between the various types of information (morphological, structural, material, etc.)?*

GREG LYNN

Everything I design, from the very first instance, is imagined in a material. I do not work with geometry in an ideal way, but am always starting with some idea of material and construction before anything ever gets sketched. This may be limiting, but it is the way I think and design.

07 *In her essay "Freshness," Sylvia Lavin considers the optical dimension of your project for Alessi to be more important than its material quality. Would this perceptive dimension be a potential criteria in the development of a "chemical architecture"?*

GREG LYNN

I find it hard to have a visual or formal dimension to an object without acknowledging weight, texture, color, and other material qualities – not to mention ergonomics and addressing the space or object for anyone interacting with it or inside it.

08 *One of the legacies of your philosophical approach to the virtual was rooted in the understanding of the potential for new representation techniques in computation and how they informed a new discipline by considering digital architecture as a question in itself. This was supported by an intellectual research that produced books such as* Animate Form*, other writings, and experimental projects. How do you understand these initial questions that pushed for the digital as a project in itself, rooted in virtual forms, relative to the current revolution that you have been pursuing in fabrication?*

GREG LYNN

Currently, I am very concerned with literal movement and the plethora of robotic buildings that are suddenly around us. In *Animate Form*, I had imposed a moratorium on moving objects for myself in favor of movement around objects. I had thought it was too simplistic and literal to reduce animation media to the role of designing moving projectiles and transforming objects. But, now I have to admit that a sensibility in culture is willing these moving environments into being. People expect their cities and buildings to literally move for a variety of reasons. Right now, it is mostly the spectacle of motion in places like Las Vegas. But, more and more, I am seeing large, building-scale robotics being explored. It is due, partially, to the ability to think it using animation software, and secondly, because now everyone is expecting a more dynamic "real" world to go with their media experience.

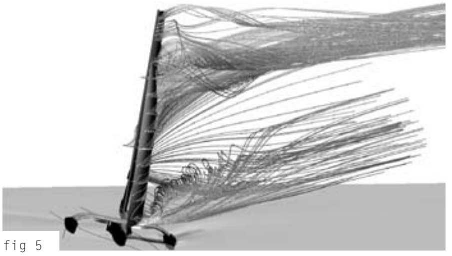


fig 5

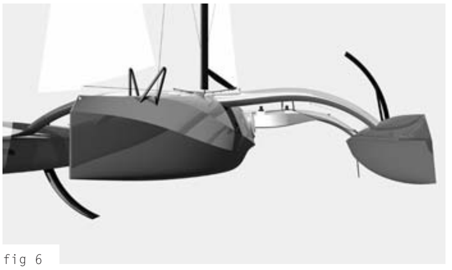


fig 6

fig 5
Coupled Hydro-Aero-Dynamic CFD Simulation using a Reynolds Average Navier Stokes (RANS) solution with incoming viscous turbulent flow around the sails and mast, with wind shear profile combined with submerged hull drag analysis (with viscous boundary effects), Free-surface capturing analysis (sea level boundary between air and water), and multiphase turbulent viscous flow calculation. Image courtesy of CFD Max.

fig 6
Early rendering of exterior of the trimaran showing the design surface language. Image courtesy of Courouble Design & Greg Lynn FORM.

GF 42.5' TRIMARAN

Greg Lynn and Frederick Courouble first worked together on a pair of large multihulls for use at an island resort in Abu Dhabi. The client's brief was to design an innovative-looking pair of boats with luxurious interiors that would be high performance in use but, in the case of the powered catamaran, use very little energy for propulsion. After working together on these two boats for the tourism industry, they decided to collaborate on the design of a much smaller, higher-performance sailing trimaran that combined a comfortable interior with the ability to sail at racing speeds. Everything about this project was an experiment, in one way or another, from the typology of the boat to the collaboration of the design team, and from the design tools used for its optimization to the construction process itself. The experimental agenda included the following ambitions: first, to explore the potential of composite construction for buildings by learning about its principles in the mature industry of race boat construction; second, to apply numerical fluid dynamic tools from the aeronautic industry in an even more advanced way by combining two separate fluids (air and water) under the same computer model; third, to bring a new design and styling sensibility to another industry that models objects explicitly as surfaces, rather than as frames or structural grids; and finally, to use the fabrication methods recently implemented in the building industry in order to realize a new language of surfaces both inside and outside the boat.

Once the brief describing the boat's approximate length, width, weight, and sail plan had been defined, Courouble's background in both aerospace engineering and yacht design prompted him to suggest that a combination of aero- and hydro-dynamic numerical analysis should guide the design of the project. For this reason, he worked with Naimish Harpal of CFD Max, who had just developed a coupled hydro-aero-dynamic computational fluid dynamic (CFD) simulation method. During the design

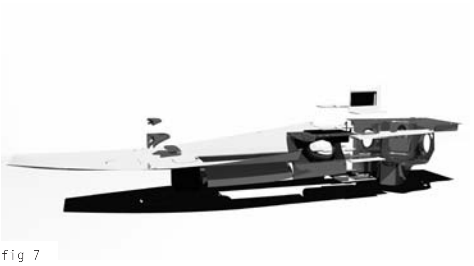


fig 7

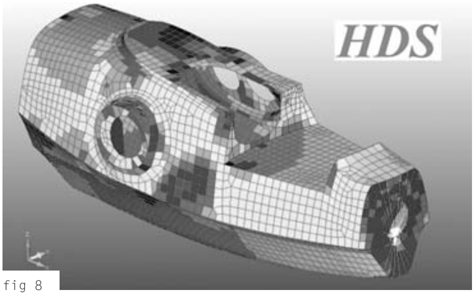


fig 8

fig 7
Early rendering of the interior volumes, furnishings, and ergonomics of the central hull. Image courtesy of Courouble Design & Greg Lynn FORM.

fig 8
Visualizing torsional and bending stresses as they are effected by window and doorway openings, using finite element analysis of the central hull of a trimaran. Image courtesy of HDS Design.

process, digital models were constantly moving between Fred, Greg, and Naimish as they were revised for performance, optimization, styling, and predicted dynamic responses when the models were subjected to differing flows and forces in the digital simulation medium of the CFD software. During this process, non-performance-enhancing design decisions were fed by Lynn into an optimization loop, where these decisions could be exploited, modified, or rejected on the basis of their predicted performance. The design elements that were modulated in this process included the interior volumes and furnishings of the central hull, the sinuously creased surfaces of the three hulls, the sword-shaped prow of the bow (front of the boat), the twisted joint between the hull and the deck, the twisted bow-shaped curves of the supporting arms between the hulls and floats, and lastly, the protruding volumes for the window and door openings. These surfaces were being merged within this novel, numerical approach, which is driven by considerations of lightness, strength, and efficiency. Because a trimaran is extremely sensitive to dynamic loads, especially of the waves at high speed, it was very important to be able to predict the dynamics of the design at every step.

High-speed, wind-powered vessels such as this require strength and stiffness with minimum weight. Because of the curved and chinned shapes of the design, only a composite structure could have complied with the structural requirements. Carbon-fiber was chosen as the woven and uni-directional structure for the composite. Given both the surface geometry that had been designed and the decision to build the carbon-fiber shell out of two skins separated by a foam core, there were two essential structural-design tasks: one, the design of the stiffening bulkheads required to make the shells into a monocoque structure; and two, the orientation of the laminate, cloth structure of the inner and outer skins of the shells. Because of his experiences with ocean-racing trimarans and composite engineering in general, Hervé Devaux was enlisted to work

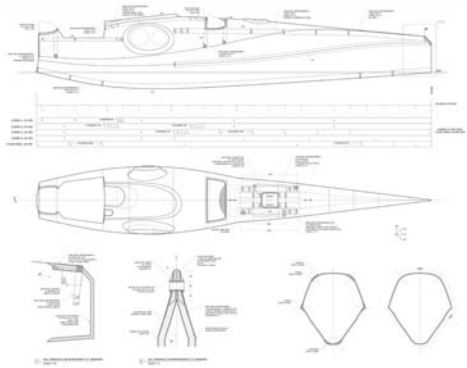
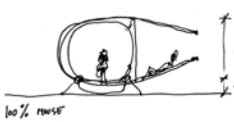


fig 9

fig 9
Laminate schedule drawing showing the central hull of the trimaran and the orientation of woven and uni-directional fiber cloths. Image courtesy of Courouble Design & Greg Lynn FORM.

fig 10
Sketch section through the volume showing the three living surfaces of the ‘C’ shaped surface. Greg Lynn FORM©, 2012

fig 11
Sketch of the circular track that allows the volume to rotate through 270 degrees of vertical motion.



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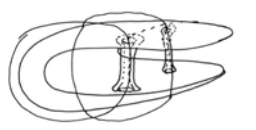


fig 11

with Courouble on the carbon structure of the boat. The first step was the analysis of the stresses and loads on the structure of the boat using FEA. Unlike the conventional situation of building design, for which the lineaments defining a surface or volume are used as the centerlines of construction, here, the orientation of the structure along load paths and in patches has little to do with the curves actually used to define the surfaces. Rather, the design of the boat’s shape is driven by the aforementioned fusion of formal language with performance optimization, while the location and orientation of structural fibers is determined by FEA of the stresses on the surface.

Rv (Room Vehicle) Prototype: The Surface Meets The Machine

Because of contemporary digital communication, entertainment, and the intelligent control of machines, the world expects more from today’s physical environment. Mobility and high performance must be calibrated with a reduction in footprint and efficiency. The bespoke comfort of a one-of-a-kind, specified automobile is merging with the living room couch and television, where every place aspires to be a first-class, flat-bed seat with color temperature and intensity-controlled lighting, internet access, and on-demand entertainment.

In order to move, robotic motion from industry is brought to the motion types germane to reclining furniture. However, in the case of the mechanical or robotic reclining lounge chair, by placing all of the leisure functions at just arms’ reach away from a stationary seat, the activities of living and the occupant’s musculature tend to contract to a stationary point. Despite the action and dynamism of the minivan lifestyle, which is replete with sport, design, and professionalism, most still equate the recliner with sedentary consumption:

“…comfort like the armchair quarterback…
…fashion like tomorrow’s top designers…

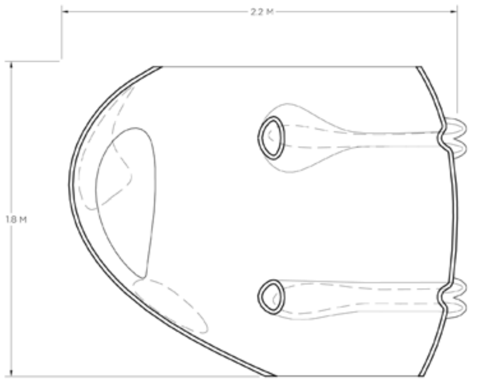


fig 12


fig 13


fig 14

fig 12
Plan drawing.
Greg Lynn FORM©, 2012

fig 13
The RV Prototype, rendered view from above.
Greg Lynn FORM©, 2012

fig 14
The RV Prototype, rendered side view in three superimposed orientations.
Greg Lynn FORM©, 2012

…flexibility like the soccer Mom…
…quality like the octogenarian who remembers 'how things used to be made'…
…precision like the surgeon.
…because you're comfortable with the best."

Copyright 2011 Barcalounger® Corporation

The RV Prototype brings intelligent movement and compact comfort to the living space as an alternative to over-inflated "McMansions" by reducing footprint and material, while also bringing the enthusiasm and activity of a theme park, a hamster ball, an exercise machine, a natural landscape, or sporting equipment to the human living sphere. The living space does not move around you to make you comfortable. Instead, you are rolled and must climb, tumble, traverse, and spelunk across the ergonomic surface like a mountain goat, a Pilates disciple, a Parkour Tracuer, or wannabe Spiderman. To be movable, instead of a baronial interior of luxury materials, the materials and construction methods of the RV Prototype replace masonry and steel with lightweight, high-strength cloth bonded to either a wood or cork core. To be affordable and responsible, the 60 square meter living space is distributed across the surface of the interior, rather than just across the floor – thereby reducing the literal and energy footprint.

Lightweight
By building in cloth structures, which have been made rigid with glue, we are able to orient materials at the fiber scale for construction. Looking at the materials and construction logic of boats, planes, and Formula One cars, it is possible to build large-scale structures that are incredibly light and strong. Whereas the weight of a 60 square meter pavilion made in wood, steel, glass, or brick is measured in millions of pounds, that of

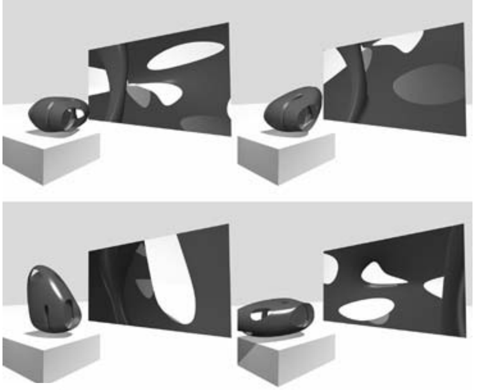


fig 15

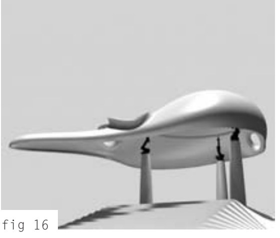


fig 16

fig 15
Installation: Rendering showing 1:5 scale moving model with synched video rendering from the interior.
Greg Lynn FORM©, 2012

fig 16
Competition proposal for an interactive robotic entry pavilion for the 2012 London Olympics, designed in collaboration with Christian Moeller.
Greg Lynn FORM & Christian Moeller©, 2009

a carbon-reinforced composite structure like this is measured in only thousands – less than 1/1,000th the weight of conventional construction. So, a square meter of carbon fiber can cost 1,000 times more than a similar square meter of brick, but still be comparably priced. Once they are light enough, these building elements can be moved and manipulated with very little effort.

Robotic

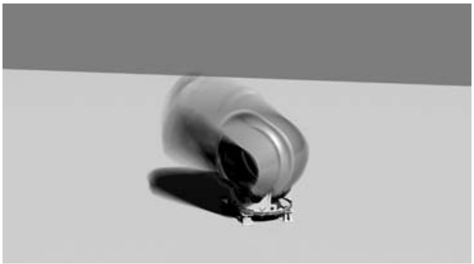
Actuation and control by digital processes is infiltrating objects at a variety of scales. The foundation of the RV Prototype is a slab on grade construction with four raised rolling pivots that allow the house to be rolled through the "Z axis." These rolling points of support are located on a revolving ring that allows the structure to be rotated through the "X & Y axes."

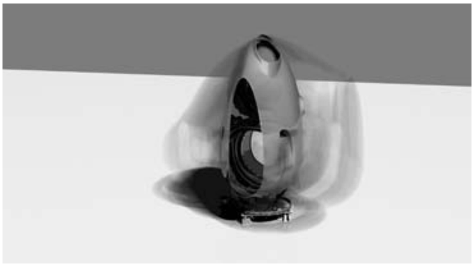
High Performance

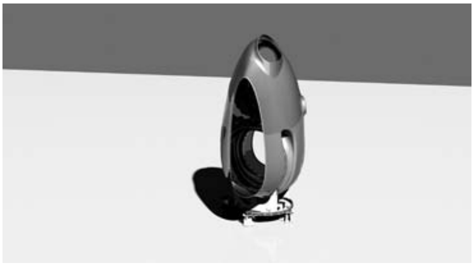
We expect our environments to have some of the same qualities as the other technologies that have insinuated themselves into our lifestyle. Moving, adaptable, dynamic, bespoke, and intelligent objects surround us from transportation to clothing, and from entertainment to communications. High performance is not the same as function. Today, performance is related to desire more than to a common benchmark of use.

A Palais of Surface Area

Within the footprint of a cottage lives a villa's worth of surfaces. Quite simply, you sleep on the ceiling, bath on the wall, and live on the floor. The RV Prototype rotates through 270 degrees of vertical motion and 360 degrees of motion in the ground plane. Within the footprint of 40 square meters is over 100 square meters of livable surface. In this case, less volume is more surface.







Swarovski Carbon Crystal Sails
Design Miami, 2009

Design
Greg Lynn FORM

Membrane Design and Construction
North Sails, Minden, NV

Crystal Pattern Placement
Swarovski, Wattens, Austria

Construction of support frame
Kreysler Group, American Canyon, CA

RV Prototype
2012

Design
Greg Lynn FORM

Construction of 1/5th scale model
Greg Lynn FORM
Eric Leishman
Sean Boyd
Curime Battliner
Andrew Raffle

Trimaran
2010-2012

Concept Design
Greg Lynn FORM

Naval Architecture
Frederick Courouble

Structural Engineering
Hervé Devaux

Rig Design
Torbjorn Linderson

ECOPRESSURES

— MATIAS DEL CAMPO, SANDRA MANNINGER / SPAN

Ecological pressures and architectural modes of organization in space have formed a bond throughout the history of the discipline, with the difference today being the level of understanding of the problem triggered by the enhanced resolution, visual as well as technological.

The application of parametric tools in combination with simulation software results in opportunities to observe the behavior of architectural bodies under ecological pressure. Simulation in architecture has reached a point where the simulation itself is no longer considered to be just a tool to check and test the finished result of a design process, or to understand its behavior within an ecological condition. Instead, simulation has become a tool of design on its own. Architectural desires and obsessions of design are now fused with high-resolution information maps and diagrams informing the design.

This design technique, which emerged due to the simple fact of increased resolution within contemporary computational capabilities, is driven by the desire to find a differentiated, alternative approach to surface population techniques. It is accomplished mainly by applying a twofold method of oscillating between tactics of component accumulation and massing.

In particular, the component-driven investigation is informed by environmental pressures. These pressures serve as a testing bed for the behavior of architectural bodies and their economy of form. To this extent, the design of individual components proves to be crucial, as the simplicity of the components forms the trajectories of the universal, intricate reaction triggering the surface population and the efficiency of the design. Taking these two instances into consideration (surface population and the architectural body under environmental pressure) there is a twofold result in the design process. The Austrian pavilion at Shanghai Expo 2010 is an example, from the author's body of work, which illustrates the design process. The origin or genotype of the Pavilion was a prism describing the surface demanded by the competition brief. Using a Python script in the topological model software TopMod, a series of over 100 phenotypes of the Pavilion was created: a genealogy driven by the inherent qualities, and the programmatic demands of the competition brief on the one side and by the sensibilities and desires of the authors on the other side. The multiple results can be organized in a cladistic diagram (fig 1) that describes the relationship of each individual of the family to each other in terms of potentialities, performance, and morphology.

In a second step the specific environmental pressures started to warp and deform the topological body. The central space of the pavilion was explored in terms of its acoustic performance, and optimized to serve as a small concert room. Form, surface articulation, height and curvature were used in order to bend and shape the acoustic reverberation of the space.

The results of these explorations oscillate between considerations of performance as an aspect of rationality and performance as an instance of theatricality, affect, and emotional response. A moment of design exactly positioned at the border between focused, sharp conditions and the vague, nebulous effect. The authors are massively interested in the possibilities of intricacy, chromatic effects, and the sublime as a source of inspiration of architectural solutions capable to radiate and trigger moments of tension, awe, and even terror; a binary system of architectural design which enters a conversation oscillating between rational technique and cultural expression in a simultaneous fashion.

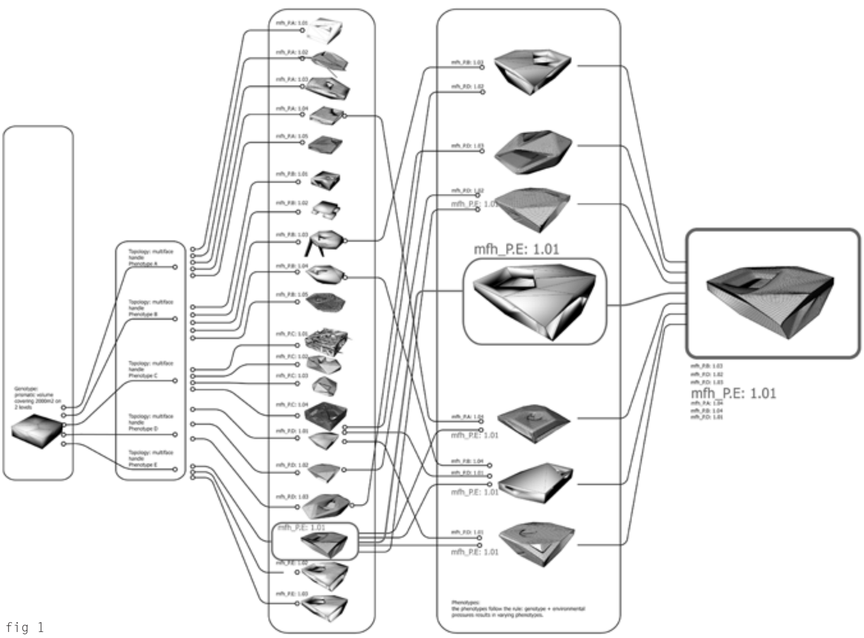


fig 1

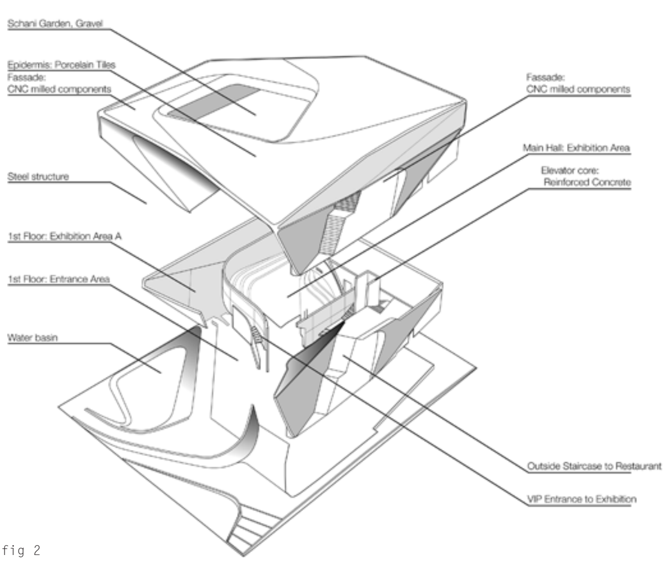


fig 2

fig 1
The diagram depicts the genealogy of the Austrian Pavilion. Based on the volumetric extension of the Pavilion a series of mutations, triggered by a Python script, defines the form of the project.
© SPAN (Matias del Campo & Sandra Manninger) 2010

fig 2
Axonometric view of the Austrian Pavilion, Shanghai Expo 2010, depicting the layers of Poché forming the subdivision of the space.
© SPAN (Matias del Campo & Sandra Manninger) 2010

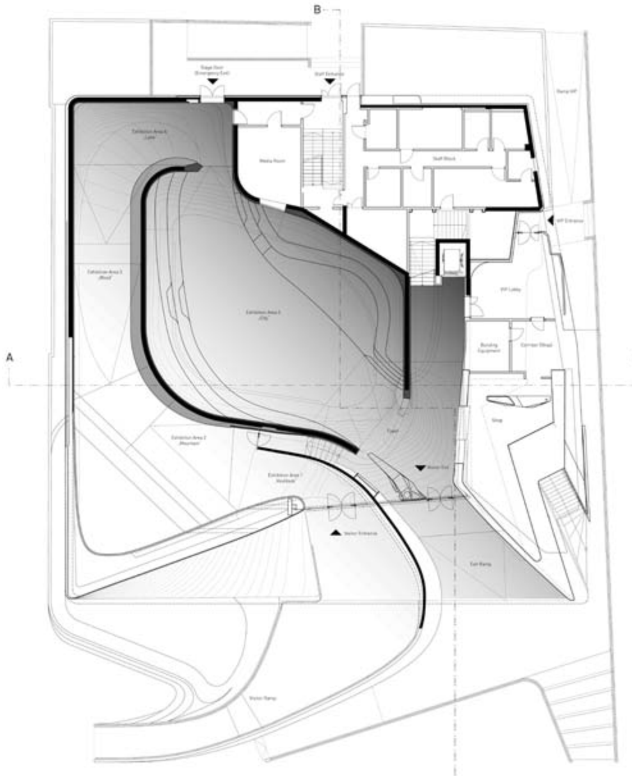
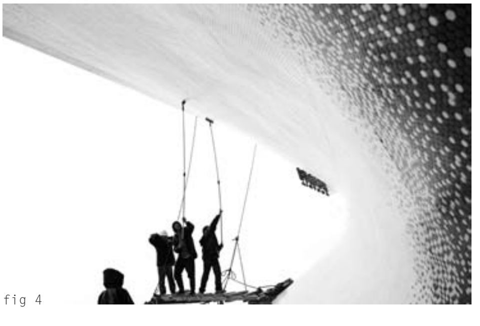


fig 3

fig 3
Ground floor of the Austrian Pavilion, Shanghai Expo 2010. The central space forms the concert hall area, the core of the design intention. The topological model expands to create Poché spaces between the central space and the exterior epidermis of the building, forming the additional elements of the program such as exhibition areas, shop, and back of house area.

fig 4
The gradient coloration envelope, comprised of porcelain tiles, covers the entire building. Bird’s eye view of Austrian Pavilion Shanghai Expo 2010 by SPAN (Matias del Campo & Sandra Manninger) and Arkan Zeytinogleu, Vienna.

fig 5
The topological envelope covers also the outside stairs ascending to the restaurant and VIP Area. The façade is made of CNC milled components, clad in porcelain. Austrian Pavilion Shanghai Expo 2010 by SPAN (Matias del Campo & Sandra Manninger) and Arkan Zeytinogleu, Vienna.



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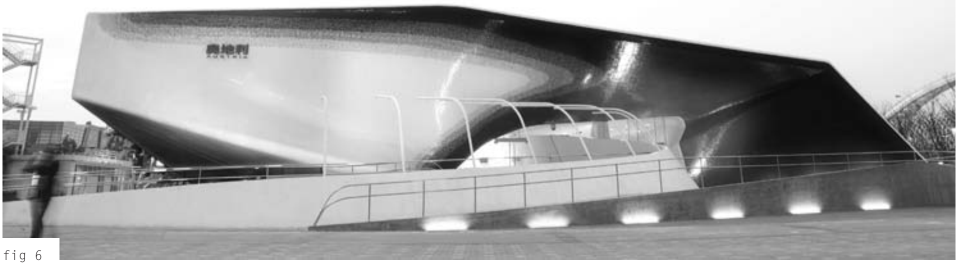

fig 6

fig 7

fig 8

fig 9

fig 10

fig 6
A continuous ramp leads toward the recessed entrance of the building, creating a seamless connection between interior and exterior. Austrian Pavilion Shanghai Expo 2010 by SPAN (Matias del Campo & Sandra Manninger) and Arkan Zeytinogleu, Vienna.

fig 7
The VIP Bar.

fig 8
Detail of the CNC milled furniture design of the Expo Pavilion by SPAN (Matias del Campo & Sandra Manninger) and Arkan Zeytinogleu, Vienna.

fig 9
The shop-desk follows the same rigorous, topological design concept as the rest of the building.

fig 10
The top floor offers a bar area. All the additional components of the building, such as the bar and the furnishing follow the same topological design sensibility. Austrian Pavilion Shanghai Expo 2010 by SPAN (Matias del Campo & Sandra Manninger) and Arkan Zeytinogleu, Vienna.

fig 11
The entrance ramp is covered by a sweeping canopy to protect the queue area from the sun. Austrian Pavilion Shanghai Expo 2010 by SPAN (Matias del Campo & Sandra Manninger) and Arkan Zeytinogleu, Vienna.

The Topology Of Sound
Austrian Pavilion at the Expo Shanghai 2010
Competition 12/2008, 1st prize
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fig 11

INVOLUTIONS AND ATMOSPHERES

— MICHAEL YOUNG

Drawing Series – 8 Recorded Manifestations – Spring 2010

Our work began by positing a set of properties for the graphical notation of tangent and normal vectors:

- Vectors tangent to a curve provide an instantaneous trajectory. Through the iterative subdivision of a control polygon, these tangents construct the simulation of a NURBS (Non-Uniform, Rational B-Spline) curve.
- Vectors normal to a curve can be extended to the center of a circle that best approximates the curvature at that point.
- Notating a curve through lines tangent to it visualizes the tectonic structure of its digital construction along a parameter.
- Notating a curve through lines normal to it visualizes a system of measurement internally consistent with the instantaneous variation of curvature.

Applying these properties to our work led us to arrive at two conclusions. One, these notations allow the manipulation of control points defining a curve to be much more explicit. The control of a curve in a digital environment is less about its position in space – something that a circle or arc depends upon due to its center point – than it is about controlling the trajectory of a vector. The points that one "draws" with NURBS curves are not on the curve itself. Instead, these points direct vectors that establish a control polygon, within which a curve will be simulated as the limit condition of iterations of subdividing tangents. Or, in simpler terms, the designer is more directly manipulating potentials rather than positions.

Two, the act of graphically notating lines tangent and normal to a curve gives visualization to relationships beyond the curve object itself. Though these notations may consist purely of quantitative data inherent in the curve, the resulting aggregation of vectors begins to produce aesthetic qualities. The variable change of curvature is less that of a signifying shape, and more that of an accumulation, densification, or intensification of marks. These notations clearly articulate the manner in which a curve is increasing or decreasing its rate of change. Furthermore, as multiple curves accumulate, either as lines on a surface or as the history of transformation of a single curve (the difference is aesthetically negligible, though conceptually important), the vectors take on a field condition; they become mappings of fluid movements – a dynamic notation of atmosphere.

These conclusions prompted us to undertake the production of the series of drawings entitled *Involutions and Atmospheres*. The drawings consist entirely of straight lines. They are built though vectors tangent and normal to sets of removed curves. These removed curves are generated as interpolations between three guide curves. The variables we manipulated in each drawing are:

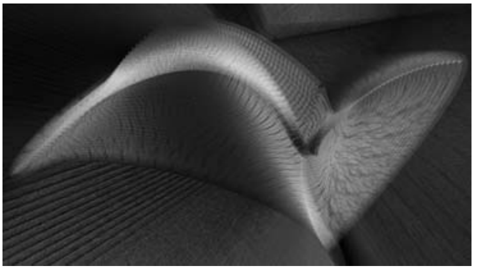
1 Vector trajectory within control polygon of each guide curve.

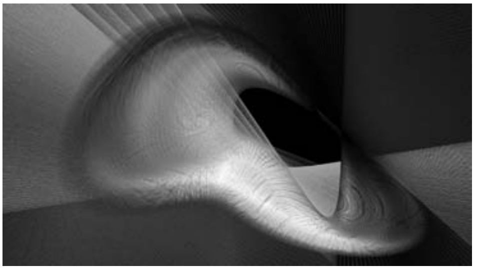
2 Quantity of linearly interpolated curves between guide curves.

3 Quantity of divisions along each curve for tangent and normal vector notation.

4 Quantity of length given to each tangent and normal vector.

5 Hue and value number attributed to each vector

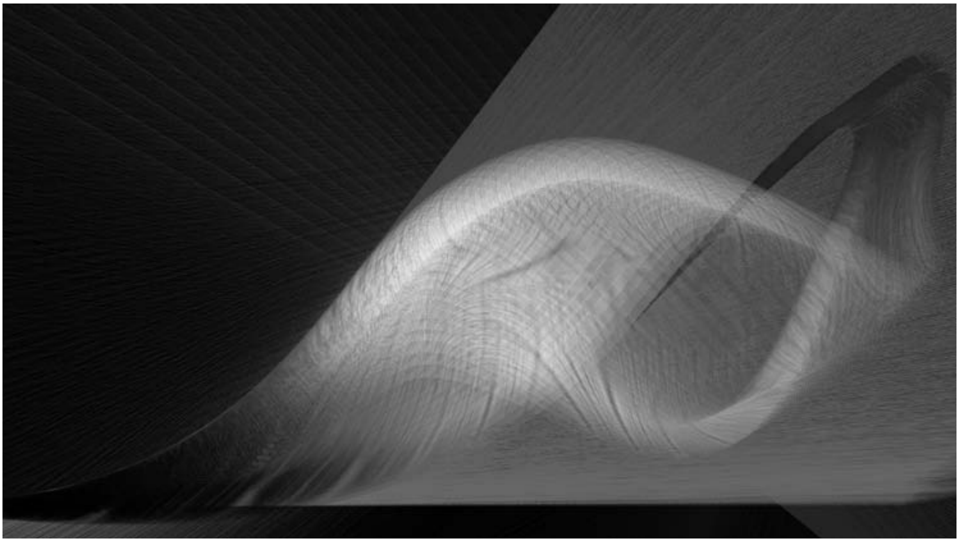


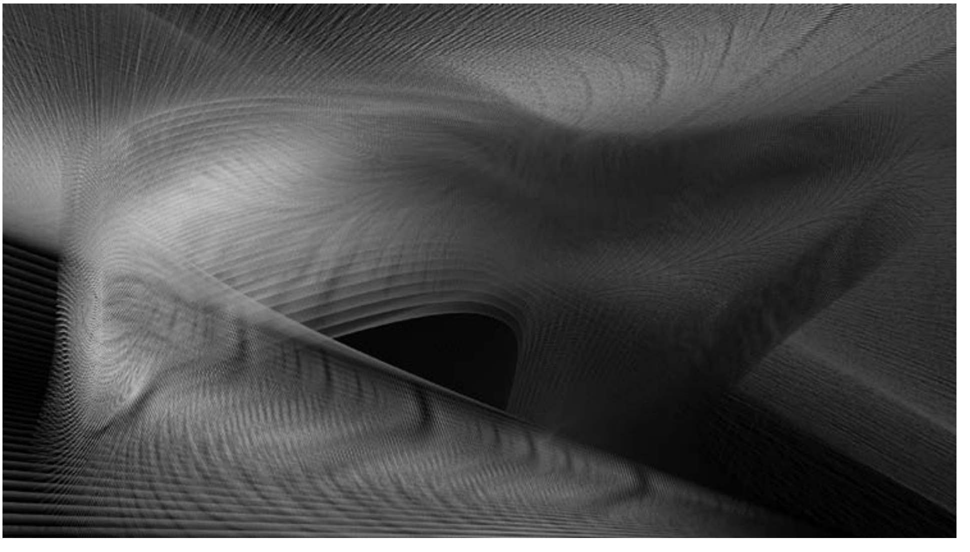


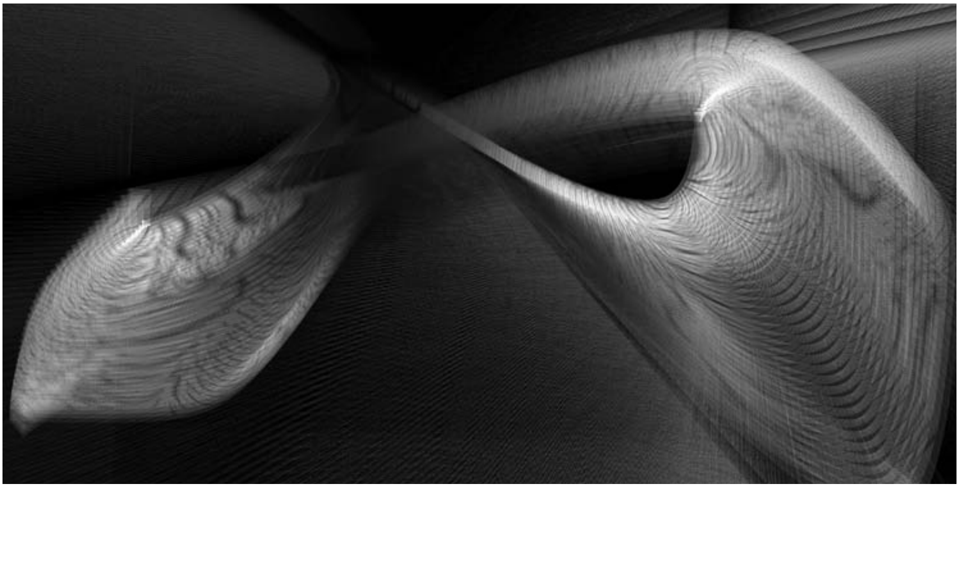
It is important to consider the mode of interface that we, as architects, use when manipulating our representations. As previously suggested, a circle regulated by a compass leaves a residue of graphite or ink as an index of its movement on a medium such as paper. This action structures a mode of interface. One of the ubiquitous conditions of digital interface is the ability to control variables along a gradient between parameters. (The range of these parameters corresponds to the boundary conditions of the mathematical equation.) This is true of NURBS curvature, as all curves in this category are parametrically defined entities. But, it is also true of software such as Adobe Photoshop, where color, contrast, saturation, brightness, etc. are controlled as a gradient variation between parameters. How this interface affects our conceptual and aesthetic judgments as architects and designers is of crucial importance for our investigation. To design a curve with a compass, for instance, is to consider the importance of the position of its center. To design a curve with a NURBS definition, however, is to consider the importance of the trajectory of the vectors defining its beginning and end – and, subsequently, the gradients of variation between these two vectors. Each interface structures and constrains the manner in which the resulting curve may be manipulated, thus affecting the manner in which one designs.

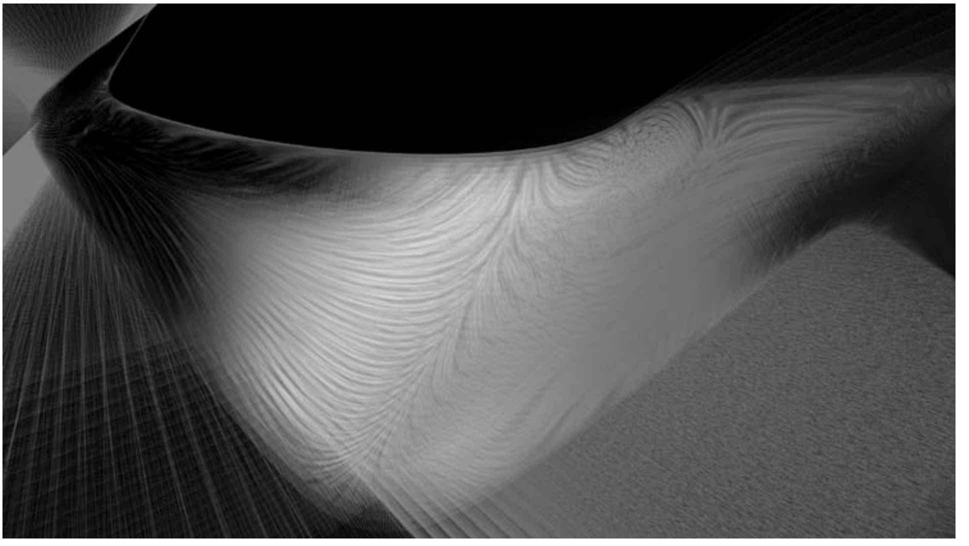
The drawings included here are developed out of the interrelations of subtle variations in the gradient controls responsible for the visual output of tangents and normal vectors. They evoke questions such as: What is the balance of density for the vector notations that can still allow for the legibility of each line? Where, and to what effect, do secondary moiré patterns begin to emerge out of the overlapping of shifting trajectories? How can these secondary patterns begin to be controlled? How does color involve itself as a gradient of hue or saturation in relation to the dynamic of density of line? How does a collection of vectors begin to accelerate a sensation of movement? What balances of interferences and overlaps can begin to create a sense of depth?

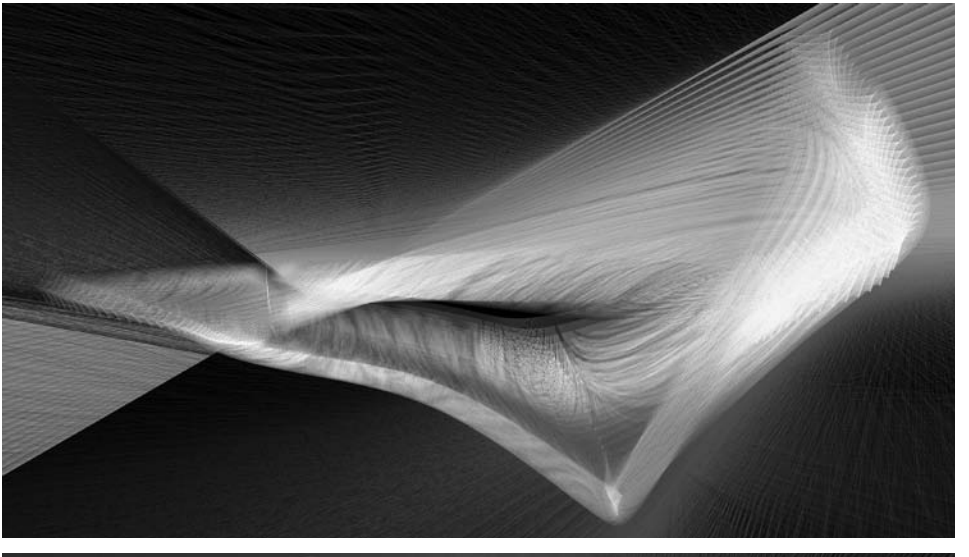
These are esthetic questions. Currently, a great deal of research is being performed on the data funneling into the parametric definitions that we, as architects, use in our design models. It is time, then, for us to also ask questions about the aesthetic effects that can be generated out of these definitions.

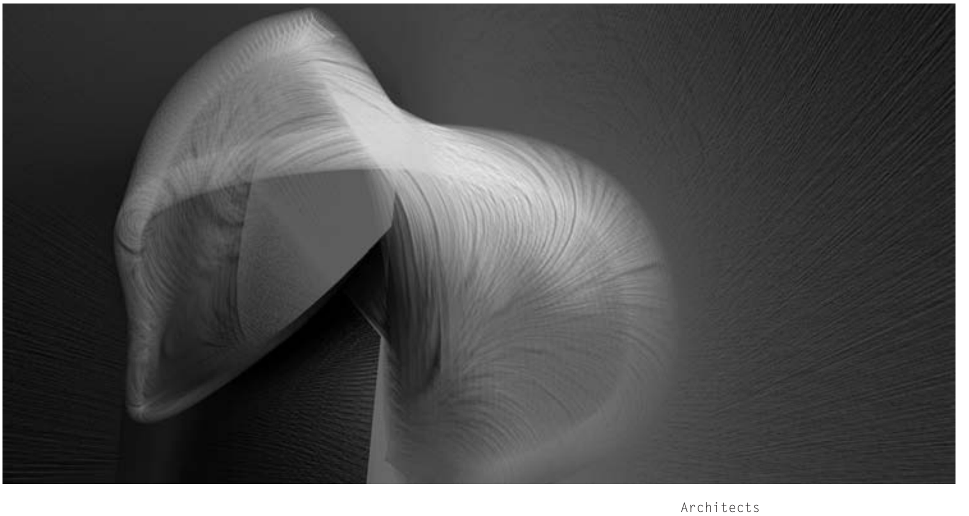












Architects
Young & Ayata

THE WOLFSONIAN SATELLITE PAVILION: LINCOLN ROAD CAPACITORS

— ERIC GOLDEMBERG, ANDREW SANTA LUCIA AND NAOMI SCULLY / MONAD STUDIO

The Wolfsonian Satellite Pavilion in Lincoln Road, designed by MONAD Studio (Eric Goldemberg + Veronica Zalcberg), links elements from Art Nouveau resources and artifacts at The Wolfsonian-FIU Museum in Miami Beach to compose its own brand of "Nouveau Pulsation."

For Art Nouveau, the perceived "perfection" of nature lies in the circumstantial reason for the formal development of a plant or rock. Accordingly, the movement created objects embodying an inherent duality, including subsections of singular characteristics within a larger, homogeneous body. Today, technological advancements are able to instill this duality in a space with both curvilinear *form* and *pathway* relationships to a conceptually larger frame of reference. This relationship is particularly relevant to the hot and breezy environment of Miami.

For this project, MONAD Studio created scalar node locations along a more complex circuit field of the pavilion. Splines of the pavilion incorporate flows of the public through cavities that both absorb and engage people as an assembly of dancers in the body of an animated hybrid form – thereby indexing time, decay, and regeneration of phenomenal thoughts, and paralleling the contemplation of "perfect form" by Art Nouveau. As well, the "fear of being touched" by formally assembled crowds and the tectonic circuitry produced by means of possible groping or pick-pocketing influenced the configuration of spaces. Finally, the pavilion towers maintain the evolutionary dialectic of the Art Nouveau duality as an event of pedestrian access.

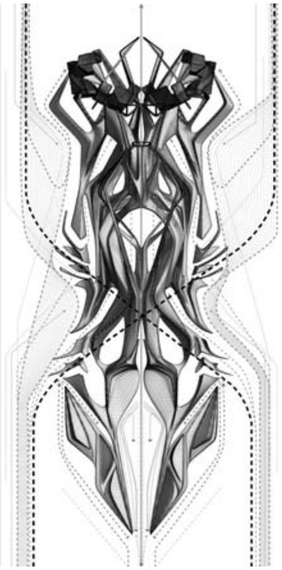
Miami's Lincoln Road acts as a pedestrian artery for the area, traversing from Washington Avenue in the east to Alton Road in the west, and linking retail structures like restaurants, bars, studio and gallery spaces, and even a theater and performing art center, thereby creating a dia-electrical urban landscape. In response to this existing site condition, our project addresses the urbanity of site with an all-inclusive canopy and amphitheater, in order to transition the public into and out of the pavilion through a "construction of horizons," i.e. – an *implementation* of transitional viewports between elements of the canopies' infrastructural connective tissue.

Programmatically, the project organizes an amphitheater, gallery, food court, and vestibule with multiple entrances through both striated and braided plates. These plates overlap in the interior to create a unified, internal circulation, while the exterior of the plates forms a seamless, commercial flow for pedestrians just passing through. As such, the plates act together like an electrical capacitor, integrating and filtering people as they savor their experiences in the total energy body of Lincoln Road. The resulting urban and spatial development of the area can then be forged from the relationships between the wills and actions of the inhabitants at various scales: through individual, group, or collective actions that are expressed in spontaneous forms of politicized organization.

A "construction of horizons" is a strategy to actuate the positions of affected zones through a symbiosis with the cityscape. This strategy is embodied in the musculo-skeletal body embedded into the city streets, which instrumentalizes public matter as a map by sinuously informing a metaphoric public organ. The city thus becomes a form of spatial settlement, whose organic heterogeneity accommodates different interests with respect to its physical occupation.

The transmission of viscous aggregates attracts and dissipates crowds to create shifting rhythms of expansion and contraction in the main axial spaces, a process we define as "pulsation." Through the pavilion, this process thrives as a choreograph-free dance of networked filters and hyper-charged valves. As such, it extends the experience of the pavilion through a series of time-dependent elements and atmospheric occurrences, like feedback soundscapes, that charge the space with an auditory index of time. This feedback of the public interest acts a social thermometer of the living city.

The crowds act as a collective circuit of variable motion through both the interior and exterior of the capacitors, and can therefore be characterized as a total flux of energy, or soul. Further, the capacitors formally transition elements in an informed awareness of space and time between the existing construction and the sensible development of the urban character. Thus, the Lincoln Road Capacitors can be seen to harness energy and transform it into both the ornamental decisions of form and subsequent distributions of people. Seen this way, it is clearly critical for the production of spatial forms, in the process of urban formation, to expose its own conflicts of interest by deriving from the existing social structures of interaction.

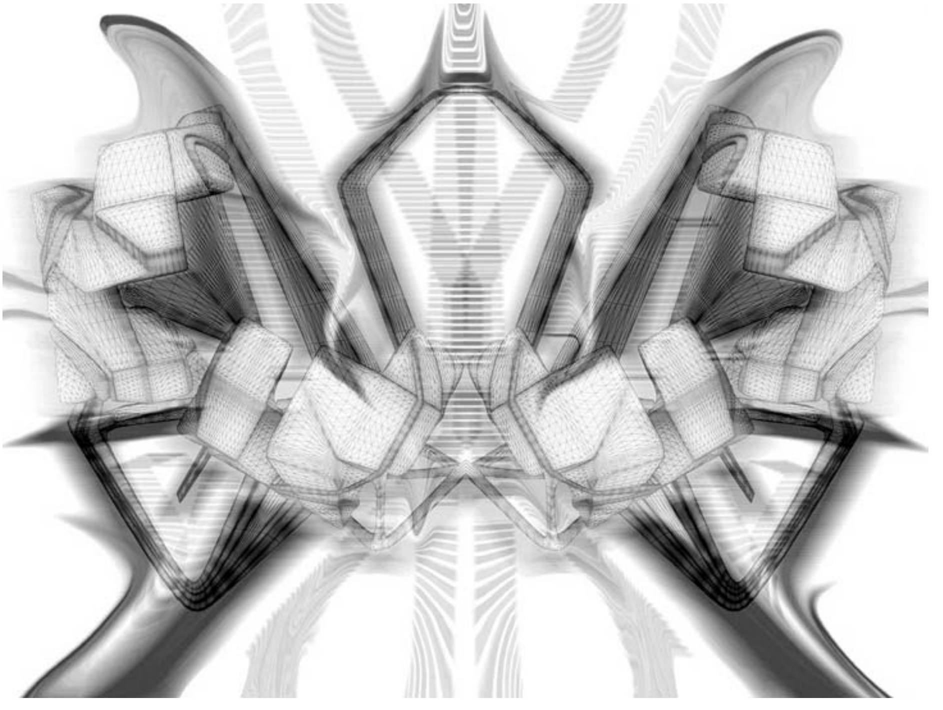


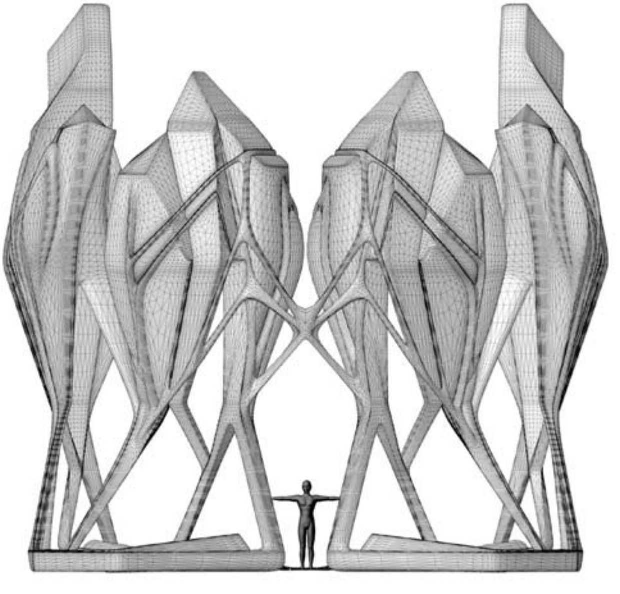
In our project, transformations from structure to space, and even to organization, feed back into the adaptive programs of the site. As a result, the project's conceptual and physical juxtapositions parallel one another, thus incorporating the process of learning about its underlying systems as a history lesson in a gallery setting. The project's conceptualization of display also helps users understand the context and memory of an object. Indeed, the capacity of the project's spatial organization to educate, formalize, and encourage the translucent layering of energy allows it to relate to the everyday life of its viewers by processing their spatial experiences as part of the display.

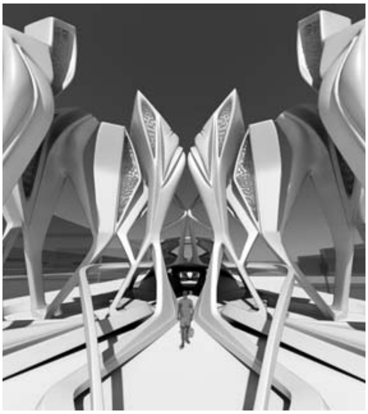
Intersecting architecture and human movement requires us to simultaneously address the environmental, social, cultural, historical, and political aspects of a city. Their symbiotic patterns lay the conceptual foundations for the development of public phenomena that history and historical processes can metabolize – in order for urban art and architecture to digest such fundamental nutrients. Newly abstracted units collide and interfere with one another through acts of fusion, as in a kiss, transferring the transdisciplinary awareness, human sensitivity, and additional dimensions of information that are inseparable from any living city. This enhances the already inseparable bond between the public and its city. In our project, the capacitors' massive, proliferated structure integrates individuals on the move, so they may act in unplanned procession, and thereby celebrate the active presence of their cycle of movement, of unrest.

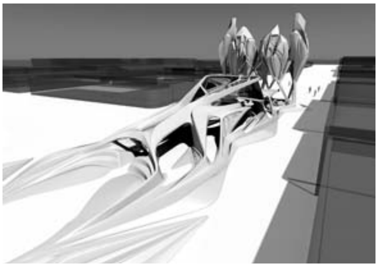
Further, the interiority of the capacitors is challenged by the openness of the structural system, which consolidates a sheltered space for activities. The exterior amphitheater was designed by MONAD to latch onto the existing canopy-stage, or band-shell, by Morris Lapidus, thereby creating an integrated solution for the urban alignment of fountains, awnings, and proximal landscapes. Our amphitheater gently slips underneath Lapidus' structure, echoing its X-pattern and launching the oblique circulations characterizing the project. The resulting public amenity creates an even stronger extension of the project, transforming it into a landmark by appealing to a wider diversity of the public during both the day and night.

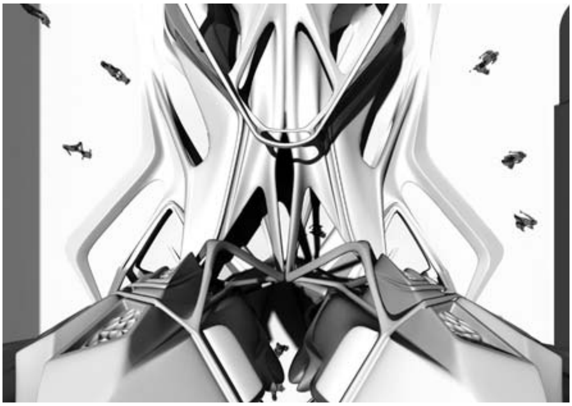
In our project, historical processes act on the urban atmosphere, forming and adapting the streets to reflect the passions of the public. Its volume pushes an overlapping strand outward and back toward the east, braiding with Lapidus' major chords from Lincoln Road. Its tail-end dissipates into an ephemeral space for education and discovery. As an urban catalyst, our addition to the urban sequences of Lincoln Road infuses the dynamic entanglement of public events with an energy that can only be described as vibrant, funky, and sensual.











The Wolfsonian Satellite Pavilion – Lincoln Road Capacitors
MONAD Studio / Eric Goldemberg + Veronica Zalcberg

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Veronica Zalcberg

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Claudio Vekstein

AN ARCHITECTURE *DES HUMEURS*

— FRANÇOIS ROCHE

The groundwork for the architecture of *humeurs* – a double-entendre meaning both mood and fluid – is a re-reading of the contradictions inherent in the expression of desires, both those that traverse public space (through the ability to express a choice by means of language, on the surface of things), and those that are underlying and, perhaps more disturbing, are just as valid. By means of the latter, we can appraise the body as a desiring machine with its own chemistry – dopamine, hydrocortisone, melatonin, adrenaline, and other molecules secreted by the body itself that are imperceptibly anterior to the consciousness these substances generate. Thus, the making of architecture is inflected by another reality, another complexity: that of the acephalous body.

An architecture of *humeurs* means breaking into language's mechanism of dissimulation in order to physically construct misunderstandings. Here, a station for collecting these signals is offered. It makes possible the perception of these chemical variations and the capture of changes in emotional state, so as to affect the emitted geometries and influence the construction protocol.

The humeurs collection is organized on the basis of interviews that make visible the conflict, even schizophrenia, of desires: between those secreted (biochemical and neurobiological) and those expressed through the interface of language (free will). Mathematical tools taken from set theory (belonging, inclusion, intersection, difference, etc.) are used so these "misunderstandings" produce a morphological potential (attraction, exclusion, touching, repulsion, indifference, etc.) as a negotiation of "distances" between the human beings who are constituting these collective aggregates.

These relational modes are simultaneously elaborated within the residential cell and on the periphery, adjacent to its neighbors. The multiplicity of possible physio-morphological layouts based on mathematical formulations offers a variety of habitable patterns in terms of the transfer of the self to the other – and to others.

The purpose of these mathematical processes is to achieve an incremental and recursive optimization (ex-local, local, and hyper-local) that simultaneously calculates and designs support structures for physio-morphologies. Forms are fabricated only by successive iterations linking, by physically and structurally coagulating, the interstices between morphologies so they support each other. The calculations satisfy precise inputs, with constraints based on the characteristics of the materials used, like initial conditions, dead loads, transfer of forces, and the intensity and vectorization of forces.

A construction protocol that can deal with complex, non-standard geometries through a process of secretion, extrusion, and agglutination, this protocol frees the construction procedure from the usual frameworks that are incompatible with geometries constituted by anomalies and singularities. The development is a secretion-and-weaving machine, which can generate a vertical structure by means of extruding and sintering (full-size 3D printing) a hybrid, raw material (bio-plastic-cement) that chemically agglomerates to physically constitute the computational trajectories. This structural calligraphy works like a machinist's stereotomy, which is comprised of successive geometries according to a repetitive protocol. This machine is both additive and formative. It is called Viab02.

fig 1
Machine detail.

Finally, the development of a viscous, adherent, and secretable material to produce morphologically complex structures (a material and procedure similar to the contour-crafting developed with the Behrohk Khoshnevis Lab at USC for the "I've heard about" project). This is a bio-cement component, a mix of cement and bio-resin developed by the agricultural polymers industry to make possible the control of parameters like viscosity, liquidity, and polymerization, and thereby produce chemical and physical agglutination at the time of secretion. The mechanical expertise of this material is made visible through constraints of the rupture induced by traction, compression, and shearing.

Animist, vitalist, and machinist, the architecture of humeurs re-articulates the need to confront the unknown, in a contradictory manner, by means of the computational and mathematical assessments giving rise to "Multitudes," and as the premise for a relational organization protocol.

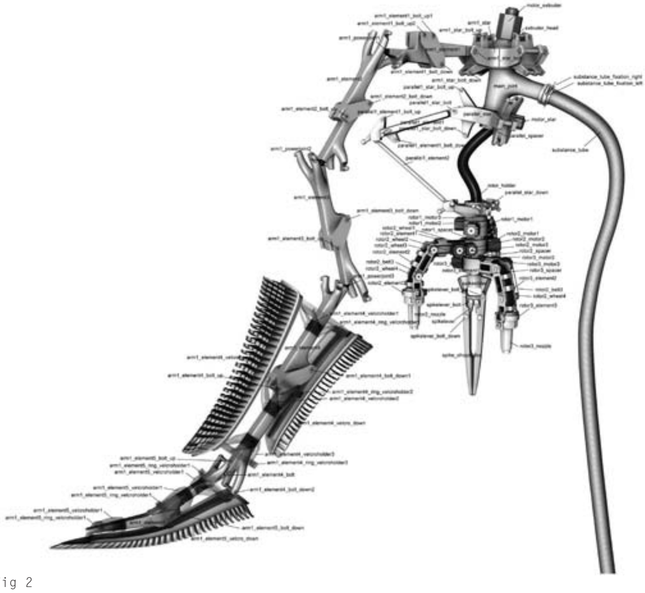


fig 2

1
In the sense of Antonio Negri. See below the fragment from Michael Hardt's Empire, 2004:

"The Communards defending their revolutionary Paris against the government forces attacking from Versailles roam about the city like ants in Rimbaud's poetry and their barricades bustle with activity like anthill. Why would Rimbaud describe the Communards whom he loves and admires as swarming ants? When we look more closely we can see that all of Rimbaud's poetry is full of insects, particularly the sounds of insects, buzzing, swarming, and teeming. 'Insect-verse' is how one reader describes Rimbaud's poetry, 'music of the swarm'. The reawakening and reinvention of the senses in the youthful body – the centerpiece of Rimbaud's poetic world – takes place in the buzzing and swarming of the flesh. This is a new kind of intelligence, a collective intelligence, a swarm intelligence, that Rimbaud and the Communards anticipated."

fig 2
From physio to algorithm(s) 001.

fig 3
From physio to algorithm(s) 002.

fig 4
Formule mathematique d'optimisation.

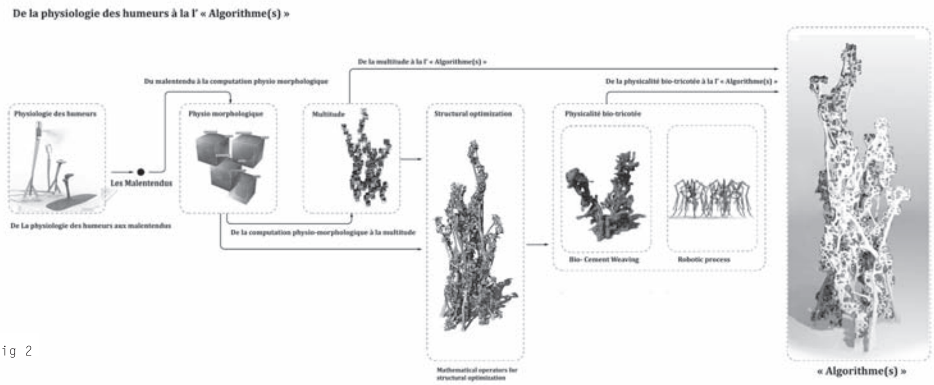


fig 2

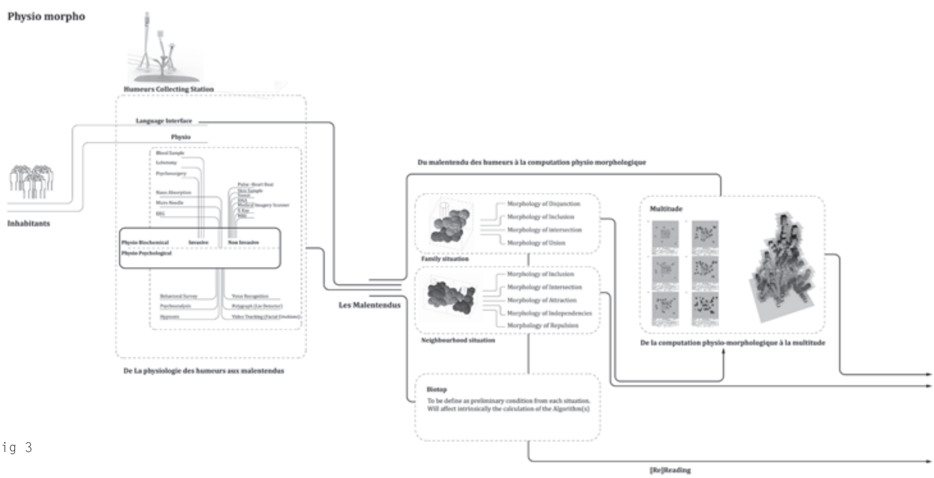


fig 3

$$\begin{cases} \dfrac{\partial \psi}{\partial t} + V|\nabla \psi| = 0 \\ \dfrac{\partial J}{\partial \omega}(\omega)\cdot\theta = -\displaystyle\int_{\partial\omega} (Ae(u)\cdot e(u))\,\theta\cdot n\,ds \quad\longrightarrow\quad V(x) = Ae(u)\cdot e(u)(x) \quad \forall x \in \partial\omega. \end{cases}$$

fig 4

fig 5
Humeurs Collecting Station.

fig 6
EmitCrvs.

fig 7
Process d'aggregation morphologiques.

fig 8
©PhaseOnePhotography 20.

fig 9
Nanoreceptor.

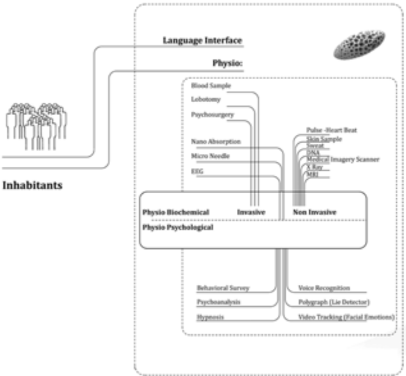


fig 5

Humeurs Collecting Station

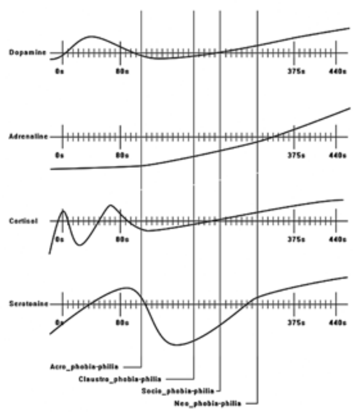


fig 6

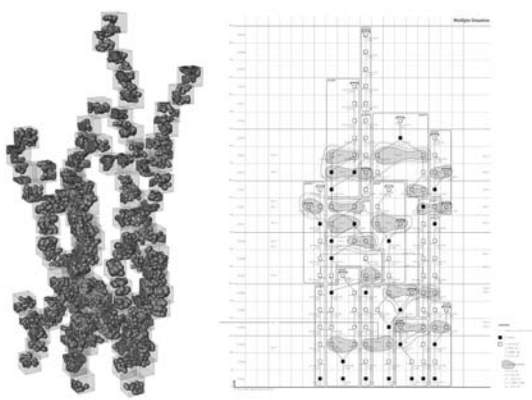
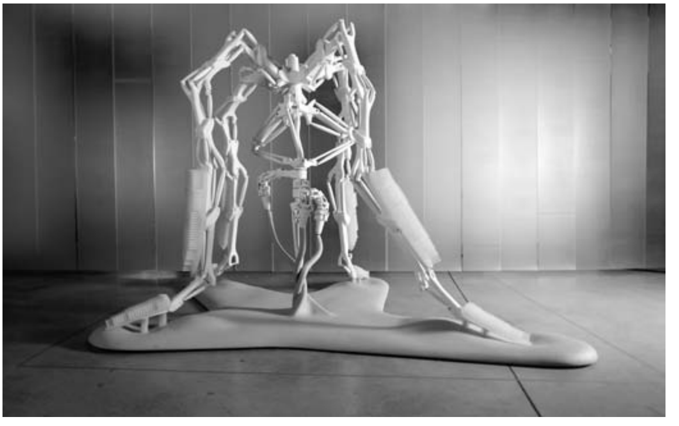
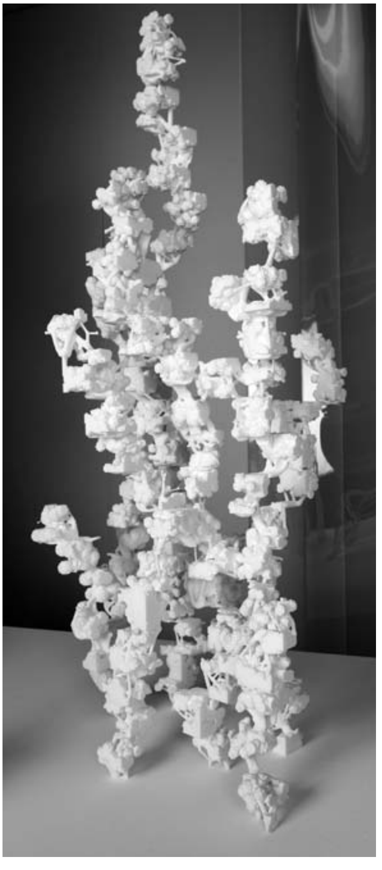


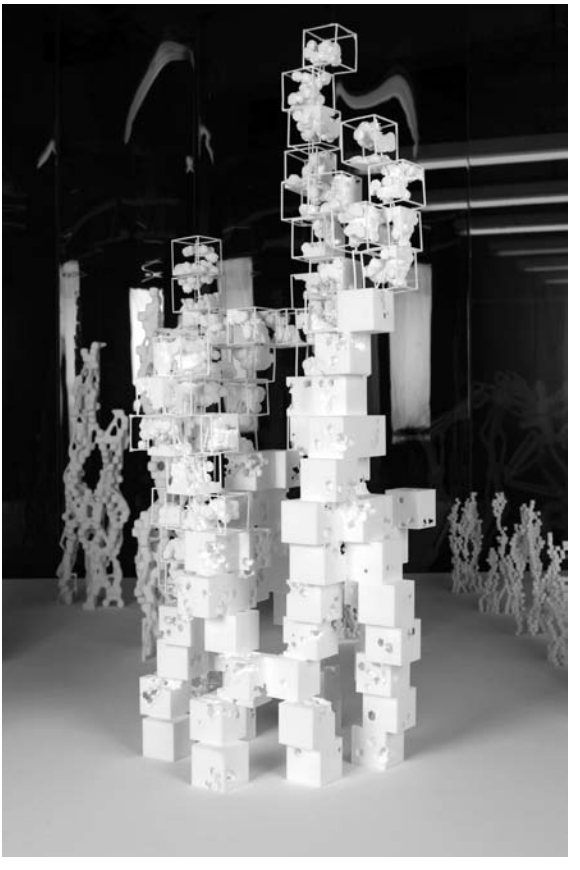
fig 7

fig 8

fig 9







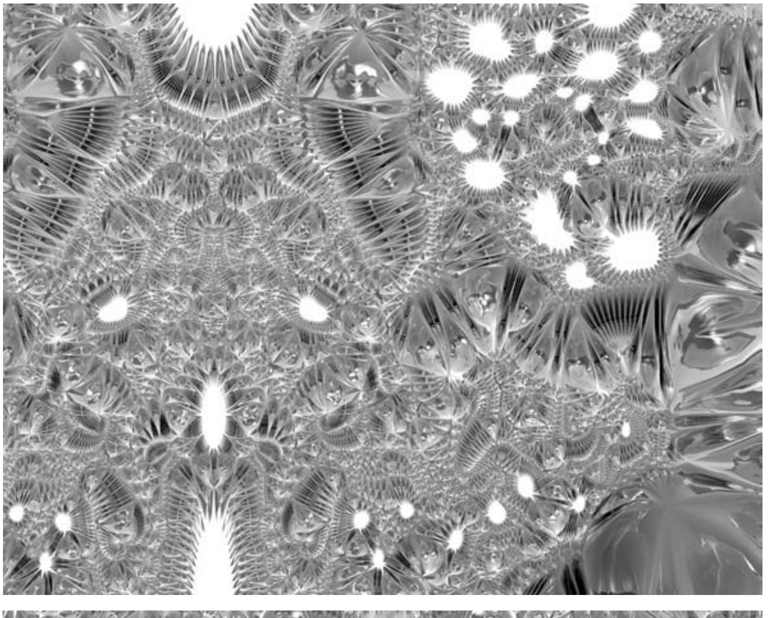
KLEX

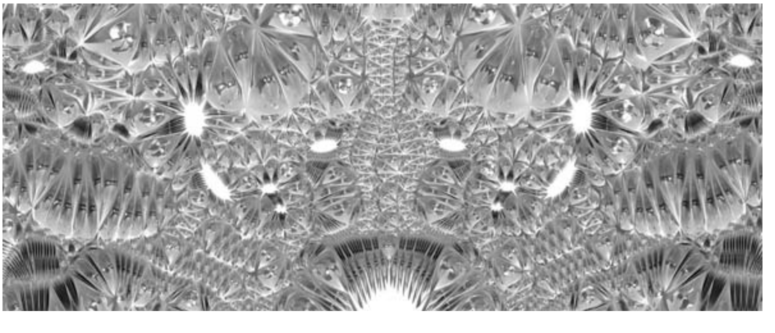
— RUY KLEIN

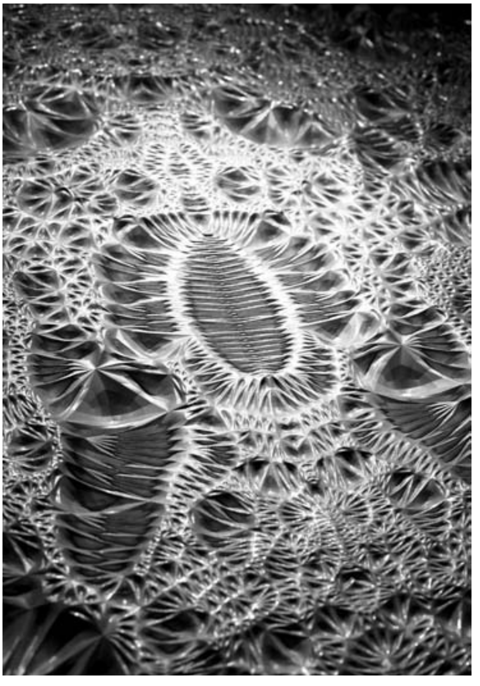
Nicknamed "Klex" as a high school student due to his love of making inkblots, Hermann Rorschach went on to develop a set of ten klecksographies in his *Psychodiagnostik* (1921) as a tool for measuring an individual's psychological disposition. Though still controversial, it is widely used as a psychometric tool. As a device for initiating a controlled hallucination, the symmetrically reflected klex (stain) is devoid of meaning, but is capable of sustaining what seems to be an infinite range of projected meanings.

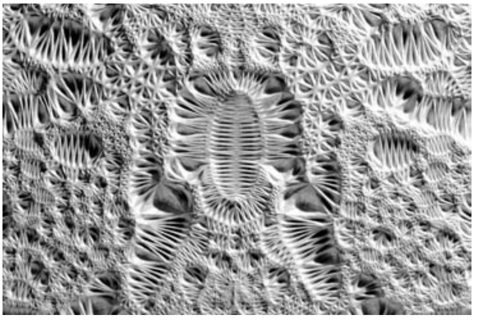
Taken as a compositional principle, klecksography provides an interesting model for examining the vague imbrications of sensation, perception, and conception in the architectural object. The fabrication experiments incorporate three compositional features from the klecksographic model. First, it incorporates an extreme multiplicity of discrete surface elements. These elements vary in size, ranging from structural to ornamental capacities. Second, bilateral symmetry is used to provide figuration and consistency. Last, great attention is given to the finish of the surface. Luster, coloration, and reflectivity amplify the horizon of affects. Neither meaningful nor meaningless, the Klex is an apparatus for sensations.

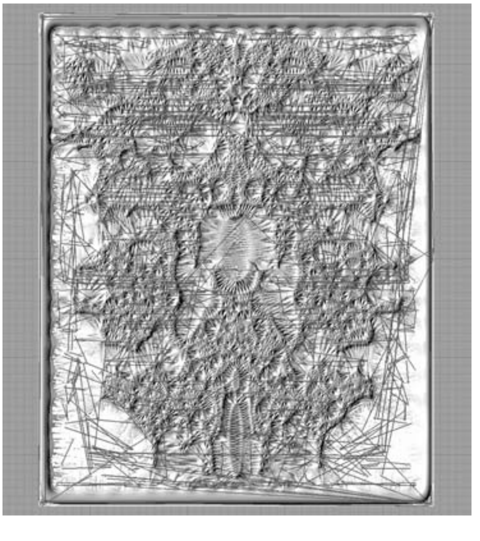
The fabricated prototypes explore the bleeding edge of digital fabrication techniques: large panel (Klex 1) experiments with adaptive tessellation techniques for CNC milling. Though CNC milling is now a fairly mature fabrication technology, the digital modeling techniques used for CNC output are still relatively undeveloped. Klex 1 incorporates a novel digital modeling procedure incorporating subdivision surfaces in the place of NURBS. Mesh files with extremely large polygon counts are extracted from subdivision surface models, and are iteratively refined and conditioned through custom scripts. This shift in digital geometry allows for an efficient management of an extreme degree of intricacy otherwise impossible with NURBS geometry. In contrast to the digital modeling experiment of the large panel, the smaller blocks (Klex 2, 3, & 4) experiment with processes of material formation. Though we have seen a rapid evolution of 3D-printing processes, their applications have primarily been in the production of scaled prototypes. These prototypes are fabricated by EOS GmbH, a pioneer in using 3D-printing for (moldless) manufacturing. The blocks are 3D-printed in alumide, a composite aluminum-nylon powder that is melted with a high-energy laser. This material provides a high degree of compressive strength and unusual elastic properties. Conceived as digitally fabricated "bricks," the blocks are designed to tile seamlessly.

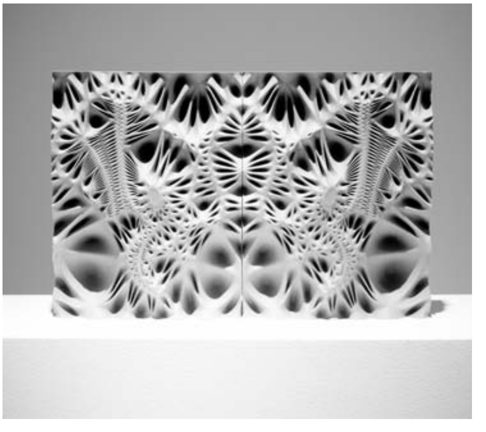


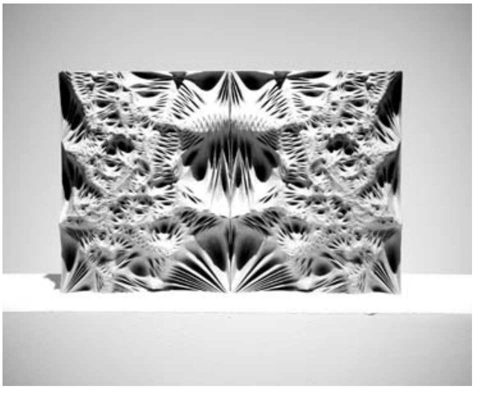








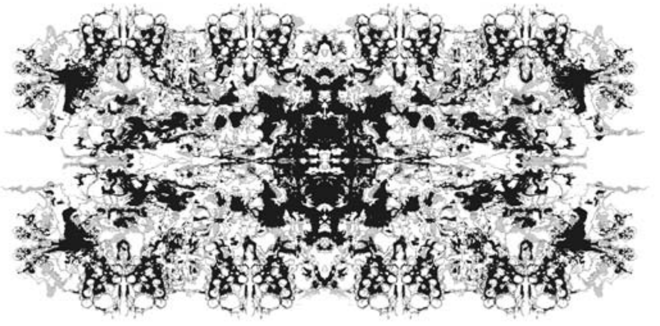


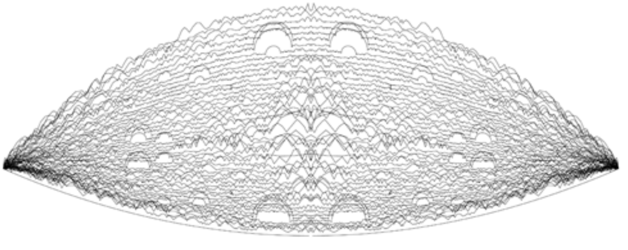


<u>Klex</u>
Ruy Klein
David Ruy
Karel Klein

EOS GmbH
Andrew Snow
Alex Dick

Parrish Industries
Drura Parrish, Rives Rash





Klex 1
Dimensions
4’ (w) x 5’ (h) x 4”(d)

CNC milled high-density foam,
ChromaLusion Finish

Fabricated by
Parrish Industries

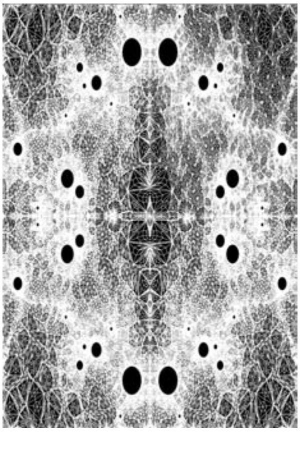
Klex 2, 3, & 4
Dimensions
1’-3” (w) x 10” (h) x 3” (d)

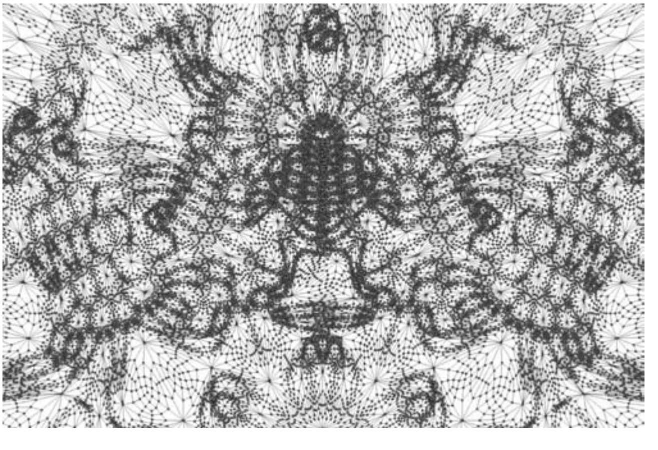
Alumide, aluminum/nylon composite,
Silicone finish
E-Manufactured on the EOS P 100

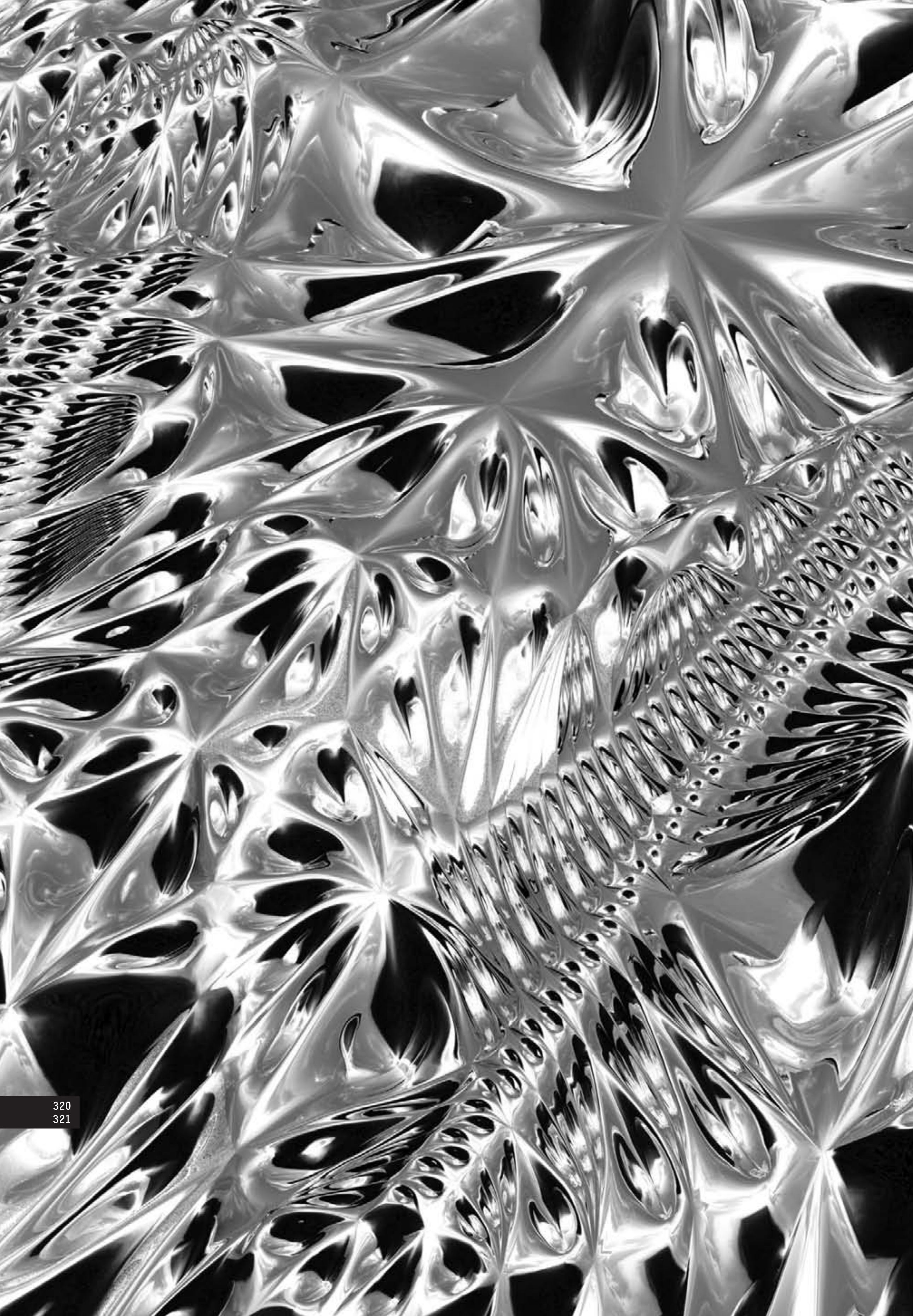
Klex
Ruy Klein
David Ruy
Karel Klein

EOS GmbH
Andrew Snow
Alex Dick

Parrish Industries
Drura Parrish
Rives Rash







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ON THE SURFACE: NOTES TOWARD AN ARCHITECTURE OF AFFECT

— MARTIN BRESSANI

Architecture's materiality is always composite, made up of visible and invisible forces. When these forces, or energies, set up superficial, unfocused, haptic sensations, architecture acquires an affective resonance. Architecture's tactility suggests particular muscle movements and enhances certain sensory activities, thereby conditioning social and cognitive processes. For some time now, architects, designers, and film directors have been exploring these forces through their attention to surface and ornament, and they have demonstrated how figures and affects can emerge from the material of buildings. Through their markings and skillful manipulation of material composition, they have been extracting expressions of embedded energies. (fig 1)

Architecture is most fully able to engage its cultural setting when understood "ornamentally." Ornament, as used here, does not refer to "merely" applied objects, as some entrenched bias would have it, but to a type of positioning of the beholder whereby surface consciousness is emphasized – thus bringing attention to how architecture makes itself present. (fig 2) Through the ornamental lens, the way a building "appears" becomes the central concern, rather than the way it is objectified. In this sense, we could say that architecture, as ornament, dwells in lightness, in the air, in the atmosphere. Such vaporousness corresponds to the volatility inherent to the movement of information that characterizes our contemporary world. We can now be said to dwell within an "informational weather," to use the metaphor coined by Michel Serres.[1] Gaseous or aerial substances thus offer interesting images when reflecting upon the notion of an architecture "in formation." Aerial architecture, however, should not be conceived in the narrow terms of manipulating climate. If it is to be synchronized with the informational atmosphere in which we breathe, it must instead generate affect. (fig 3) The contact between individuals and their architectural "milieu" – the informational membrane between them, is indeed entirely mediated by affect. As ornament, then, architecture is about setting up flows of virtualities and developing a special affective potency akin to that of a haunted house. It is this kind of surface potential that the emotive discourse in architecture ought to emphasize, i.e. – how materials become endowed with spectral virtues.

1 Michel Serres, Atlas (Paris : Éditions Julliard, 1994). See the chapter "Temps du monde".

The Virtue of the Surface

Probably one of the most entrenched confusions when discussing contemporary digital culture is the idea that the virtual should be thought in opposition to material reality. *Virtus*, in its original meaning, denoted force and power. The word still carries this connotation when we speak,

fig 1

fig 1
Ridley Scott, with production designers Arthur Max and Hans Rudolf Giser. Sets for the film Prometheus. 2012. Source and Credits: MoviePictureDB.

for instance, of the medicinal "virtue" of a plant. What is virtual, therefore, is actually what exists as potential. Affect, lodged in the membrane separating inside and outside, is paradigmatic to such a virtual realm, standing as pure potential between sensation and action. What is missing in a virtual world is not reality, then, but actuality. Gilles Deleuze, who was otherwise not a major thinker of contemporary media, made this distinction in *Difference and Repetition*:

We opposed the virtual and the real: [but] this terminology must be corrected. The virtual is opposed not to the real but to the actual. The virtual is fully real in so far as it is virtual.... Indeed, the virtual must be defined as strictly a part of the real object – as though the object had one part of itself in the virtual into which it plunged as though into an objective dimension.[2]

The virtual, understood as virtue, describes the realm of potential, which is what allows the world to be understood as a project. Since we – humans – live our lives as projects, we may say that we always have, and always will, dwell amongst virtualities. So, instead of pitting the virtual against the real, we must recognize the former as the very basis upon which all our actions are based. It is thanks to the existence of virtualities that we can claim to share anything at all, that the world constitutes an "ornament" in which we dwell.

These observations may not seem very useful if we set ourselves the task of grappling with the specific character of our contemporary world. That is, if the virtual is inherent to our humanity, what does it mean for our environment to undergo a rapid process of virtualization? Are we becoming more human than before? In a sense – yes, but with the proviso that the virtual must be plunged within an affective substrate.

When we consider the dynamics of the world today, we confront a rather odd reversal of perspective. Instead of bringing the virtual into the actual, as I discussed when describing the normal process of living a human life, we are now witnessing the reverse movement: the actual is being transformed into the virtual. Using Facebook, for instance, mutates or transposes social relations into a virtual plane; what was once actual enters the virtual realm of our computers. It is tempting to describe this process as a form of de-realization, as if the social relations conditioned by Facebook and other digital networks are merely illusory. But, doing so would be succumbing to the same bias that declares ornament to be a non-essential part of architecture. Virtualized sociability, however dematerialized they may be, are just as real as traditional, social relations. In fact, such networks make social relations even more invasive and

2
Gilles Deleuze, *Difference and Repetition* (New York: Columbia University Press) 208-209.

fig 2

fig 2
Meng Li, project for a library in Montréal, exterior rendering, School of Architecture, McGill University, 2009. Source and Credits: School of Architecture, McGill University.

consequential than they have ever been, as their role in current political demonstrations have amply demonstrated around the world.

Two things ought to be said of the process of virtualization we are witnessing today. First, by moving from the plane of the actual to that of the virtual, the virtual becomes re-structured by the tools and software of virtual platforms. Once virtualized, any specific phenomenon or experience may be de-contextualized in terms of geography, even though it remains very much contextualized by the tools and software sustaining its virtual life. Second, once virtualized, our life migrates to the surface. (fig 4) I mean this in a literal way: the worlds that are deployed on our screens have no depth. Using Facebook is just navigating a surface. The surface may simulate depth, but there is no corresponding reality on the other side of our monitors. Our new flat-screens make this thinness ever more obvious: our virtual world exists merely as a plane. Even meeting friends on Facebook is literally a superficial experience: everything resolves itself on a screen. This may lead to experiences that are traditionally understood as having depth – falling in love and getting married, for instance. However, the experience of Facebook itself is still a product of surface relations. In Facebook, as with any virtual platform, depth is only an optical illusion.

Such an eclipse of depth, so well exemplified by our digital tools, is not merely a technical matter, but a pervasive, cultural situation. Through the rapid process of virtualization, many of our experiences have been de-territorialized, losing the spatio-temporal coordinates necessary for depth to be sustained. Arguably, any form of life or historical existence has its own spatio-temporal coordinates. Birds live in a different spatio-temporal world than ours, as did medieval Christians. Today, we have created a form of existence that dwells on the surface. Increasingly, our world is without weight and without roots. The images shown by our media, the configuration of ideals conveyed by current politics, the forms of knowledge available on the Internet – none of these possess the slightest hint of depth. Everything collects to the surface.

This surface structures a new practice of everyday life. We no longer do a single thing at a time, we choose speed at the expense of scrutiny, we cover great distances without stopping, and we read, see, and listen to innumerable things, but only as fragments. Thanks to the Internet, the architect now has available, at his or her fingertips, the largest architectural album ever made. At the same time, he or she does not need to know where these buildings are, what occasions gave rise to them, or even what they consist of – apart from the surfaces shining on their screen.

fig 3

fig 3
Diller Scofidio + Renfro,
Blur building, Yverdon-les-Bains,
2002.

This amalgam of behavior generates new forms of perception, wherein simultaneity and superposition are sovereign. The resulting mutation, from depth to the surface, is probably the most fundamental and threatening characteristic of the new world emerging around us. Living superficially means living in the world of the characters in Tarantino's film *Pulp Fiction*, for whom the current instant reigns supreme, and whose lives are marked by barbarism and general insignificance. This is also the type of world that generated the current financial crisis, whereby our whole economy fell prey to traders' computer gaming.

But, does such a pessimistic portrait necessarily form the whole picture? Does virtualization and de-territorialization imply renouncing the noble side of things? While virtualization does put into question traditional definitions of identity, does it necessarily entail disembodiment? Can life at the surface actually offer opportunities?

Isn't the surface hopeless only to those who cling to the epistemological myth of depth? Western metaphysics stems from the conviction that the true meaning of things dwells below the surface, in a hidden crypt, and protected from the obvious thanks to secret stairways and the surrounding darkness. In this view, meaning can only be disclosed through patience and effort. Therefore, the seeker of knowledge has to go back in time and dig inside things, in order to eventually discover that what appears to be one thing is, in fact, another. To enter the holy of holies, Western philosophers had to take leave of the world of appearance, passing beyond the surface into an inner world. Even beauty, thanks to neoplatonic thought, was thought of as something deep, to be conquered through some mysterious agency. Indeed, the affective realm was highly suspect, as it seemed antithetical to cognitive functions.

Though the enterprise of knowledge carried through such rhetorical strategy was successful in many ways, it was not always satisfying or salutary. Rather, in the words of Hannah Arendt, it has forced the ground of appearances into the open so that man, a creature fitted for and dependant upon appearances, lost his natural home.[3] Being, once made manifest, overruled appearances. It is, of course, this very configuration of knowledge that spurred the process of virtualization in the first place – as if the ultimate fulfillment of Western metaphysics, i.e. the world of technology, led us back to the surface, but to a surface now deprived of any depth.

The question, then, is whether the abolishment of depth causes meaning to disappear altogether, or whether it simply makes meaning rise to the surface. Seen in this light, the emergence of superficiality as

3
Hannah Arendt, *The Life of the Mind*, vol. 1 (New York : Harcourt, 1978). See the section titled "Appearance."

fig 4

fig 4
Olaf Eliasson. The Weather Project. Tate Modern, London. 2003-2004. Source and Credits: Courtesy Olaf Eliasson.

the locus of significance may hold some promise. The familiar appeal for depth could be reversed: we must concentrate on appearance; we must become superficial. It seems a valid point of departure, insofar as it returns meaning to the fact of being in the world, and the surface being the site where we and the world meet. "Since we live in an appearing world," wrote Hannah Arendt, "is it not much more plausible that the relevant and the meaningful in this world of ours should be located precisely at the surface?"[4]

An Architecture of the Surface

But, what would an architecture of the surface be? First, we must assume that there is no inherent rupture between human embodiment and technical mediation: we must forge contact with the domain of information, whereby digitization works with and within sensibilities. (fig 5) Our aim would be to catalyze the production of affect by working on the interface between the domain of information and the human body, i.e. – the human-embodied experience. By de-problematizing the role of technologies in the process of creation, the affective turn in architecture may thereby undertake a move away from the "digital" as a separate theme of inquiry.

More crucially, we must understand the role of affect in the contemporary world. By affect, I mean the investment of energy that anchors people in particular practices, identities, and meanings. Affect, as a pre-semantic topography of sensations, is a psychic energy that emotionally binds people to their world. Recent cultural theory has increasingly accounted for the fact that affect is amongst the central categories of understanding communication and practices in our information-based society. In fact, our postmodern condition can be characterized by a surplus of affect.[5] With the eclipse of grand narratives, and with the de-territorialization of the world that comes with virtualization, it is through affect, or affective maps, that people know where and how they can become absorbed into the world and, hence, into their lives. According to Lawrence Grossberg's work on popular culture, we now live within affective alliances rather than simply following normative social roles, as Foucault would have it. "Everyone is constantly located within a field of the popular," writes Grossberg, "for one cannot exist in a world where nothing matters."[6] It is the affective investment in particular sites that bonds particular representations and realities. Architecture's role, therefore, is to mark spaces with a principle of excessiveness, demonstrating not only that we care about certain places, but also exemplifying how we care about them.

4
Arendt, *The Life of the Mind*, vol. 1, p. 27.

5
Brian Massumi, *Parables of the Virtual: Movement, Affect, Sensation* (Durham and London : Duke University Press, 2002) 27.

6
Lawrence Grossberg, *We Gotta Get Out of this Place. Popular Conservatism and Postmodern Culture* (New York and London: Routledge, 1992) 84.

fig 5

fig 5
Ridley Scott (film director), Syd Mead (concept artist), Lawrence G. Paull (production designer), and David Snyder (art director). Still from the film *Blade Runner*, 1982. Source and Credits: MoviePictureDB.

Such language of affect may be associated, falsely, with a return toward the privacy of our interiority, and thus fall back upon traditional notions of subjectivity. In fact, affect is a pre-subjective domain precisely located between inside and outside: we live within affect, and affect lives through us.[7] It becomes the ground of a life lived on the surface, amongst appearances.

The source of architecture's power will then be identified by the way space comes to play a role in people's affective lives. This role can be made visible as the coherence of a work of architecture deriving from the affective relationships it sets up and how they allow or resist integration within people's passionate landscapes. That is, if we assume a certain physicality to affective transmission. According to the late feminist theorist Teresa Brennan, affects are real entities like ghosts that pass through the air from bodies to bodies. She describes them as scents, as perfumes, as the transformation of hormone into pheromone.[8] Indeed, when it comes to affects, the boundaries of our bodies are breached, and our space is invaded with passionate currents crystalizing sensations in and around us.

When considered as ornamental surfaces, buildings become the generator of atmospheres rather than concepts. No longer about building sensational bodies – moving away from "e-motive styling" to use the clever expression coined by Kas Oosterhuis[9] – affect has to do with tactility, the only one of the five senses present in the whole body. Affect therefore brings into play the much more complex set of ambient, cathectic energies relating to physical and psychological states – but qualified by specific contexts. As a result, the architect must re-assume the older role of experimenter in the field of visual and tactile phenomena, and explore the possibility of creating suggestive effects that are comparable to music. The arts of today, concerned as they are with the interrelationship between sound, movement, color, and spatial form, are able to draw upon a wealth of techniques to makes us feel that the air is touching things, or that the space between things is being touched. Is it possible for architecture to lay claim to these experiments in the same way, and thereby to regain the power once held by sacred architecture? The aim would not be to construct a false sense of community, but to be able to impute ourselves once again, without hesitation, into our surroundings. The outside world, our own bodies, other people, and material things are a set of forces – a series of processes – that we must envisage as being coordinated with each other, as being partners, rather than being exclusive to humans.[10] Present conditions prevent this wider relationship with

7
I refer to the classic definition of affect by Guattari and Deleuze; see, among other sources, Gilles Deleuze and Félix Guattari, *What is Philosophy ?* (New York: Columbia University press, 1994). Originally appeared in French in 1991. See also Mark B. N. Hansen, "Affect as Medium, or the Digital-Facial-Image," *Journal of Visual Culture*, August 2003, vol. 2, no. 2, p. 205-228.

8
See Teresa Brennan, *The Transmission of Affect* (Ithaca: Cornell University Press, 2004).

9
See Kas Oosterhuis, *Hyper Bodies. Towards an E-motive Architecture* (Basel, Boston, Berlin: Birkhaüser, 2003).

10
Timothy Morton, "Architecture without Nature," *Tarp Architectural Manual*, Spring 2012. p.20.

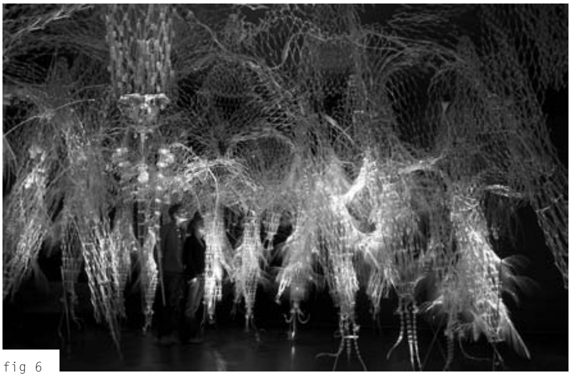


fig 6

fig 6
Philip Beesley, Hylozoic Soil, Musée des Beaux-Arts, Montréal, 2007. Source and Credits: Courtesy Philip Beesley.

objects, as every beholding of the outside world must entail a projection from the inside. Such are still the limits of modern consciousness. Yet, aesthetic apprehension, as always, has increased its scope insofar as it has a greater apprehension of otherness, of the uncanny. Indeed, artists have traditionally given imaginative value to the otherness of the outside world. They are most apt for charging the surface with meaning, because they are the only ones to trust appearances and know that everything is played out on the surface.

fig 1

330
331

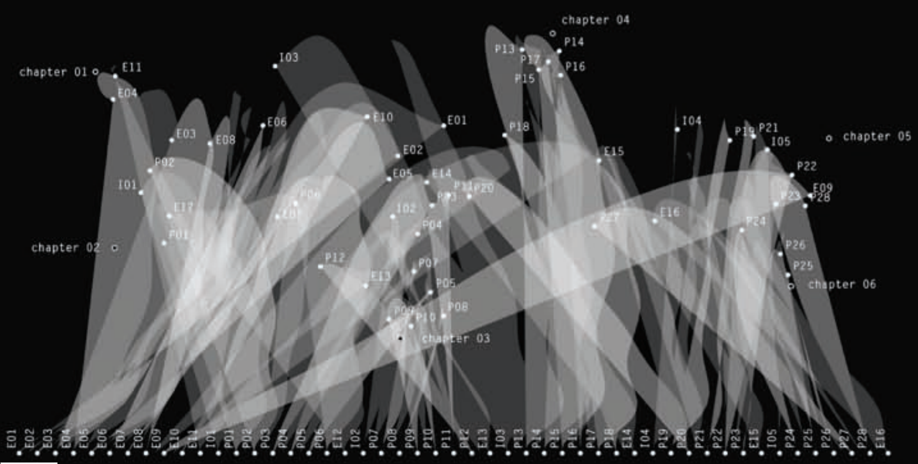
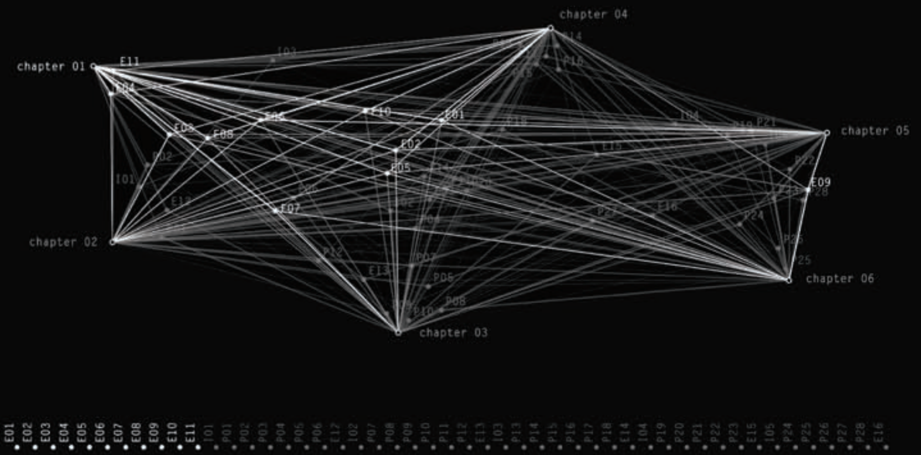


fig 2


chapter 01
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E09

fig 3

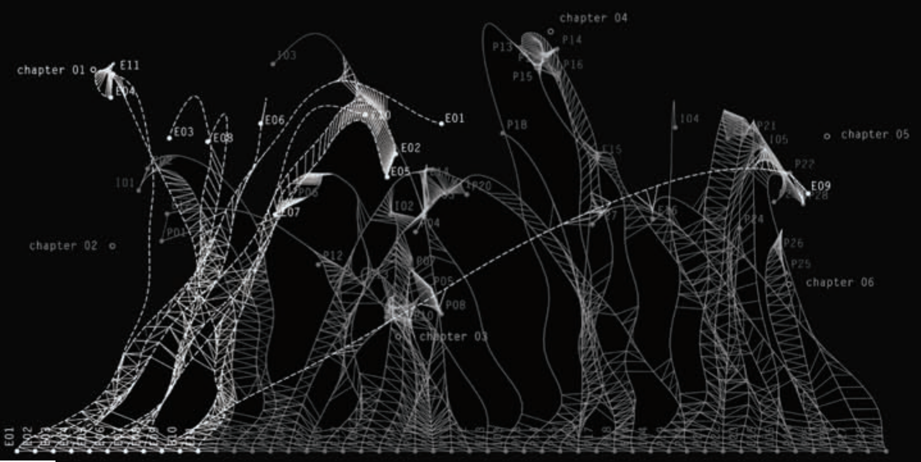
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fig 4

GROWTH AND ECOLOGICAL DATA VISUALIZATION

— JOHN CARPENTER AND CHANDLER AHRENS

The *Growth and Ecological Data Visualization* project serves as chapter breaks in this book, but more importantly, creates an ecosystem to visualize the relationships of the author contributions (to each other and the chapters) in *Architecture in Formation*. This project is the latest iteration of John and Chandler's work into computation as a means to grow form-based systems in artworks and data visualizations.

One of the predecessors to this research, *fields_SE* by John Carpenter (fig 1), is an interactive artwork that was installed at Young Projects at the Pacific Design Center (Los Angeles, September 2011). The installation explores the complexity of growth in fields: every time the artwork is run, a plant system grows in response to growth cues in both the virtual environment and physical gallery space. As the system takes shape, user movement data is fed (in real time via a Kinect sensor) as gusts of wind into the field. Though the types of plants in the system remain the same, the changing growth factors and user data result in unique compositions every time the artwork is run.

fig 1
fields_SE is an interactive artwork installed at Young Projects at the Pacific Design Center in Los Angeles, September 2011 by John Carpenter.

fig 2
Linear sequential organization of papers, projects and interviews (E1, E2, etc.) along the bottom of the graphic defines the starting point for the growth of the vectors.

fig 3
Vector paths showing relationship of the chapters.

fig 4
Visualization of the repulsive forces between papers, projects, and interviews.

Where much of the growth in *fields_SE* is based on controlled but randomly seeded factors in the virtual environment, the growth of the chapter break graphics are driven by an analysis of the relationship between each paper and the chapters. This approach is the continuation of research by Chandler and John into the use of crowdsourced data as a generative design tool, where they propose that crowdsourced visualizations have a unique potential to reveal current trends of thought or idea patterns in the group that generate them. Visualizing the relationship of the community's knowledge base using data as a medium enhances the indexical project. In other words, data visualization inherently creates an index, quantitatively or qualitatively, of values generated by the community that formed the data. The relational aspect of multiple streams of information graphically reveals the values as gradients of similarity and difference. These gradients enhance our understanding of the complex nature of knowledge exchange in a community where proximity plays an important role in measuring magnitudes of difference.

Reviewing the author contributions, it struck us that the writings often explored multiple vectors of knowledge and were not easily confined to a single category or chapter. The graphics exploit these fuzzy boundaries as a way to communicate degrees of attraction toward predefined categories of knowledge. The classification of the book's specific chapter themes were given to us, so exposing the degree of relevance the papers and projects had toward those classifications became the subject of our exploration. As such, the chapter break graphics in this book attempt to visualize conceptual relationships between each of the authors' papers and the organizational principals of the book: Chapter 01 Structuring Information: Toward an Architecture of Information, Chapter 02 Information Interfaces: Data and Information, and so on. Furthermore, they seek to illustrate the relationship between each of the papers and the overall environment of the book. The goal of this work was to create a visualization that could be dynamically "grown" to indicate the complex intermingling of concepts and ideas throughout the book's environment.

Using *processing*, we developed an algorithm that defined each paper as a vector from a *linear* starting point (based on the page order in the book) into a non-hierarchical space that explored a more complex view of the paper's relationship to the book as a whole. (fig 2) The vector paths are influenced by both weighted attractions to each of the pre-defined chapters (fig 3); and a slight repulsive force to allow the paper to define its own space in the ecosystem. (fig 4) The relative magnitude of these forces is conveyed through their line weights. The surface, which is formed between each of the strands, is a projection of the papers' movement and the forces that drive the system, and the resulting form defines the centroid location for each of the chapters.

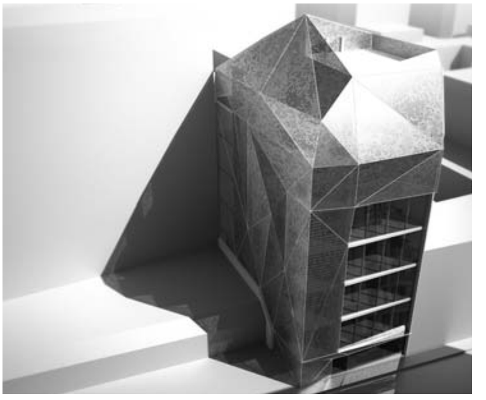
Creative Coding
John Carpenter

Design Concept
Chandler Ahrens
John Carpenter

Diagram Key

Paper	Author
E01	Pablo Lorenzo-Eiroa
E02	Aaron Sprecher
E03	Georges Teyssot
E04	Mario Carpo
E05	Patrik Schumacher
E06	Bernard Cache
E07	Mark Linder
E08	David Theodore
E09	Evan Douglis
E10	Rocker-Lange Architects
E11	Antoine Picon
I01	George L. Legendre
P01	Diller Scofidio + Renfro
P02	Mark Burry
P03	Yehuda E. Kalay
P04	Omar Khan
P05	Jason Kelly Johnson Future Cities Lab
P06	Alejandro Zaera-Polo Maider Llaguno Munitxa
E12	Michael Wen-Sen Su
I02	Alessandra Ponte
P07	Anna Dyson Bess Krietemeyer Peter Stark Center for Architecture, Science and Ecology (CASE RPI)
P08	Philippe Rahm
P09	Lydia Kallipoliti Alexandros Tsamis
P10	Neeraj Bhatia InfraNet Lab
P11	Jenny E. Sabin LabStudio
P12	Luc Courschene Society for Arts and Technology (SAT)
E13	Chris Perry
I03	Karl Chu
P13	Eisenman Architects
P14	Preston Scott Cohen
P15	Eiroa Architects
P16	Michael Hansmeyer
P17	Chandler Ahrens Open Source Architecture
P18	Andrew Saunders
E14	Alexis Meier
I04	Ciro Najle
P19	Nader Tehrani Office dA NADAAA
P20	Satoru Sugihara ATLV Thom Mayne Morphosis
P21	Reiser + Umemoto
P22	Roland Snooks Kokkugia
P23	Philip Beesley
E15	Achim Menges
I05	Greg Lynn FORM
P24	Matias del Campo Sandra Manninger SPAN
P25	Michael Young
P26	Eric Goldemberg Monad Studio
P27	François Roche
P28	Ruy Klein
E16	Martin Bressani
P29	John Carpenter Chandler Ahrens

BIOGRAPHIES



Chandler Ahrens completed his studies with an M. Arch. from the University of California Los Angeles in 2002. He received a B. Arch. from Savannah College of Art and Design with a minor in Electronic Design (digital design technologies) in 1995. He is currently an assistant professor at Washington University in St. Louis. He was previously appointed as a visiting assistant professor at Woodbury University in Los Angeles from 2011–2012. He is a co-founder and director of the Los Angeles office of Open Source Architecture, which is an international research and design architectural practice that has designed, fabricated and mounted several complex installations as well as designed commissioned projects. Chandler has worked for several large international architectural firms including nine years as a senior project designer at Morphosis Architects, where he was responsible for notable builds such as the New Academic Building at the Cooper Union in New York, Hypo-Alpe Adria bank in Udine, Italy and Phare Tower in Paris, France. His work has been extensively internationally published and he has lectured at various academic institutions including UCLA, USC, Cal-Poly Pomona, Tel Aviv University, RISD and the Technologico de Monterrey in Mexico. www.o-s-a.com

Philip Beesley is a professor in the School of Architecture at the University of Waterloo. A practitioner of architecture and digital media art, he was educated in visual art at Queen's University, in technology at Humber College, and in architecture at the University of Toronto. He also holds the position of Examiner at University College London.

Dedicated to expanding the role for the arts integrated within architecture, Beesley has worked in sculpture, next-generation digital media and cross-disciplinary experimental visual art for the past three decades. He has focused on public buildings accompanied by field-oriented sculpture and landscape installations, exhibition and stage design. His experimental projects in the past several years have increasingly worked with immersive digitally fabricated lightweight "textile" structures, while the most recent generations of his work feature interactive kinetic systems that use dense arrays of microprocessors, sensors, and actuator systems. These environments pursue distributed emotional consciousness and combine synthetic and near-living systems.

Beesley's publications include *Kinetic Architecture and Geotextile Installations 1995–2006* (Riverside, 2006/10), and *Hylozoic Ground: Liminal Responsive Architectures* (Riverside, 2010). His work was selected to represent Canada at the 2010 Venice Biennale for Architecture and he was recognized by the Prix de Rome in Architecture for Canada.

Neeraj Bhatia is an architect and urban designer from Toronto, Canada. His work resides at the intersection of politics, infrastructure, and urbanism. Neeraj is a co-director of InfraNet Lab, a non-profit research collective probing the spatial byproducts of contemporary resource logistics, and the founder of The Open Workshop, a design office examining the project of plurality. He has worked for Eisenman Architects, Coop Himmelblau, Bruce Mau Design, OMA, and ORG.

Neeraj has previously taught at Rice University, the University of Toronto, the University of Waterloo, and Ohio State University and is currently a visiting professor at Cornell University.

Neeraj received his Masters degree in Architecture and Urban Design from MIT where he was studying on a Fulbright Fellowship. Prior to that, he attended the University of Waterloo where he obtained a Bachelor of Environmental Studies and a Bachelor of Architecture.

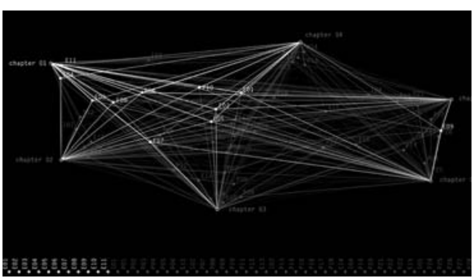
Martin Bressani is an architect and architectural historian teaching in the History and Theory program at McGill University's School of Architecture. He holds a Masters degree in the History and Theory of architecture from MIT, and a PhD in art history from the Université de Paris-Sorbonne (Paris IV). He held visiting professorships at MIT, Cornell, and Syracuse Universities and was a fellow at the Study Centre of the Canadian Centre of Architecture in 2003. He has published in many of the topical forums for architectural debates such as *Assemblage, Any Magazine, Log*, and has been on the editorial board of the *Journal of Architectural Education* and is on the board of the MIT journal *Threshold*. He has contributed essays to many books as well as publishing in scholarly journals such as the *American Journal of the Society of Architectural Historians* and the *Studies in the History of Art*, the French *Revue de l'art*, the German *Architectura: Zeitschrift für Geschichte der Baukunst*, the British *Art History* and the Canadian *Annals in the History of Canadian Art*. Bressani's central theme of research has been the organic metaphor in architecture, seeking to understand, through an interdisciplinary approach, the nature of the exchange between science and architectural thought and practice. He is also interested in the production of atmospheres or ambiances in architecture, with a concomitant focus on the notion of architectural affect. Though he has covered many historical periods and geographical areas, his privilege domain of study is French nineteenth-century architecture. His monograph on French architect and theoretician Eugéne-Emmanuel Viollet-le-Duc entitled *Surface into Depth* will appear at Ashgate in January 2014.

Professor **Mark Burry** has published internationally on three main themes: the life and work of the architect Antoni Gaudí in Barcelona, putting theory into practice with regard to "challenging" architecture, and transdisciplinary design education and practice. He has published widely on broader issues of design, construction and the use of computers in design theory and practice.

Professor Burry is the founding director of RMIT University's Design Research Institute (DRI) and Professor of Innovation in Spatial Information Architecture. DRI focuses on the challenges of urbanization and growing cities of the future.

As founding director of RMIT's state-of-the-art Spatial Information Architecture Laboratory (SIAL) he led the establishment of a holistic spatial design research environment dedicated to almost all aspects of contemporary spatial design activity. The laboratory focuses on collocated design research and undergraduate and postgraduate teaching with associated advanced computer applications and the rapid prototyping of ideas. The laboratory has a design-practice emphasis. As architect to the Temple Sagrada Família since 1979, his contribution to the project has been recognized in the prestigious award Diploma i la insignia a l'acadèmic corresponent and the title Il.lustrisim Senyor by the Reial Acadèmia Catalana de Belles Arts de Sant Jordi.

Bernard Cache, born in 1958, developed the concept of non-standard architecture in his book *Earth Moves* published by MIT Press in 1995. This concept was given the name OBJECTILE by Gilles Deleuze in his book on Leibniz: *The Fold*. In 1996, Bernard Cache founded the company Objectile together with his partner Patrick Beaucé in order to conceive and manufacture non-standard architecture components. He is currently dedicated to the reading of classical texts (such as Vitruvius' *De Architectura*, or Dürer's *Underweysung der Messung*) with the help of CAD CAM software. He teaches nomadically in many universities out of the French territory.



John Carpenter is an interactive digital artist and designer whose work explores natural systems and complex data and spaces. Based in Los Angeles, he works for Oblong Industries as a g-speak engineer and is a visiting professor in the Multimedia Arts Department at Loyola Marymount University. John earned his MFA from the department of Design | Media Arts at UCLA (2009) and has recently exhibited work at the 84th Annual Academy Awards, ACME. Los Angeles and Young Projects. John has also worked at Morphosis Architects, Synthesis Technology Integration, and the Biological Imaging Center at the California Institute of Technology. www.johnbcarpenter.com

Currently, John is a g-speak engineer at Oblong Industries, a visiting professor in Multimedia Arts at Loyola Marymount University, and an exhibiting artist at ACME., Los Angeles and Young Projects. Chandler is assistant professor of architecture at Washington University and partner of Open Source Architecture.

Mario Carpo teaches architectural history and theory at the School of Architecture of Yale University and at the École d'Architecture de Paris-La Villette. Mr. Carpo's research and publications focus on the relationship among architectural theory, cultural history, and the history of media and information technology. His award-winning *Architecture in the Age of Printing* (MIT Press, 2001) has been translated into several languages. His most recent books are *Perspective, Projections and Design* (2007, co-edited); a translation and commentary of Leon Battista Alberti's *Descriptio Urbis Romae* (2007, co-authored); a monograph on the work of Swiss architect Valerio Olgiati (2008, co-authored); *The Alphabet and the Algorithm* (MIT Press, 2011); and *The Digital Turn in Architecture, 1992–2012: An AD Reader*, forthcoming in the fall of 2012. Mr. Carpo's recent essays and articles have been published in *Log*, *The Journal of the Society of Architectural Historians*, *Grey Room*, *L'Architecture d'aujourd'hui*, *Arquitectura Viva*, *AD/Architectural Design*, *Perspecta*, *Harvard Design Magazine*, *Cornell Journal of Architecture*, *Abitare*, *Lotus International*, *Domus*, and *Arch+*.

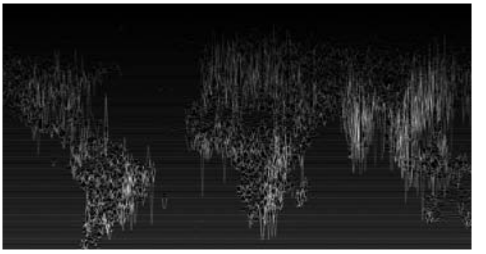
Exiled from the banana republic of Burma to the neon lights of Hong Kong, Karl Chu was a musician before acquiring architectural degrees in the US where he settled in the aftermath of the American Dream. Music being his passion, he sees architecture as the becoming alive of frozen music in the construction of possible worlds. It is only a matter of time, he feels, before the world will be subsumed and haunted by a planetary computing system that delimits as well as engenders the most varied of paradoxical exuberances and deficiencies. He is convinced that the ambitions of architecture should be synonymous with the aspirations for freedom, justice and the poetics of the sublime. He was the founding director of the Institute for Genetic Architecture at the GSAPP, Columbia University, and is a co-director of the Biodigital Program at the Universitat Internacional de Catalunya in Barcelona. In addition, he is a professor at the School of Architecture, Pratt Institute, New York, where he is developing genetic architecture along with its theory and philosophy. He has taught, lectured, published and exhibited internationally. Karl Chu is principal of the architectural studio METAXY.

Preston Scott Cohen is the Chair and Gerald M. McCue Professor of Architecture at Harvard University Graduate School of Design. He is co-editor with Erika Naginski of *The Return of Nature: Sustaining Architecture in the Face of Sustainability* (Routledge Press, 2012) and author of *Hyperbolic Museums* (forthcoming, 2012), *Contested Symmetries and Other Predicaments in Architecture* (Princeton Architectural Press, 2001) and numerous theoretical and historical essays on architecture. His work has been widely published and exhibited internationally and is held in numerous museum and private collections. Cohen's work has been the subject of numerous theoretical assessments by renowned critics and historians including Nicolai Ouroussoff, Robert Levit, Sylvia Lavin, Antoine Picon, Michael Hays, Terry Riley, Robert Somol, Hashim Sarkis, and Rafael Moneo.

The architecture of the firm Preston Scott Cohen, Inc. of Cambridge, MA exemplifies a new, highly disciplined alliance between architectural typology and geometry. His projects, commissioned by private owners, institutions, government agencies and corporations, involve diverse scales and programs including houses, educational facilities, cultural institutions, office and retail buildings, and urban designs. Awards and honors include the Academy Award in Architecture from the American Academy of Arts and Letters (2004), an Annual Design Review Award (2011), five Progressive Architecture Awards (1998–2011) and First Prize in the international competitions for several buildings completed or currently under construction including the Datong City Library (2008–2012), Taiyuan Museum of Art (2007–2012); and the Tel Aviv Museum of Art Amir Building (2003–2011).

Luc Courchesne is a pioneer in media art and design. From interactive portraiture to immersive experience systems, he has developed innovative approaches which have earned him prestigious awards such as the Grand Prix of the ICC Biennale 1997 in Tokyo, an Award of Distinction and several Honorary Mentions at Prix Ars Electronica in Linz, Austria, an exhibition at the Museum of Modern Art in New York, and participations in Wired's NextFest.

Luc Courchesne (http://courchel.net) is full professor at Université de Montréal (http://www.umonteral.ca), a founding member and current director of research at the Society for Art and Technology (http://sat.qc.ca), and member of the Royal Canadian Academy of Arts.



Diller Scofidio + Renfro is an interdisciplinary design studio that integrates architecture, the visual arts, and the performing arts. Based in New York City, the 90-person studio is led by three partners – Elizabeth Diller, Ricardo Scofidio, and Charles Renfro. In 1999, the MacArthur Foundation presented Ms. Diller and Mr. Scofidio with the "Genius" award for their commitment to integrating architecture with issues of contemporary culture. They were recently made fellows of the Royal Institute of British Architects and were inducted into the American Academy of Arts and Sciences. Other prestigious awards and honors received by DS+R include the National Design Award from the Smithsonian, the Brunner Prize from the American Academy of the Arts and Letters, an Obie for an off-Broadway theater production, and the AIA President's Award. In 2003, the Whitney Museum of American Art held a retrospective of the studio's work, recognizing the firm's unorthodox practice. Selected DS+R projects include: the *High Line* park in New York City; *Lincoln Center for the Performing Arts* Redevelopment Project in New York City; the *Institute of Contemporary Art* on the Boston waterfront; *Blur Building* in Yverdon-les-Bains, Switzerland; Brown University's *Creative Arts Center* in Providence; *The Broad Art Museum* in downtown Los Angeles; the *Museum of Image & Sound* in Rio de Janeiro; and the *Hirshhorn Museum Seasonal Inflatable Pavilion* on the National Mall in Washington DC.

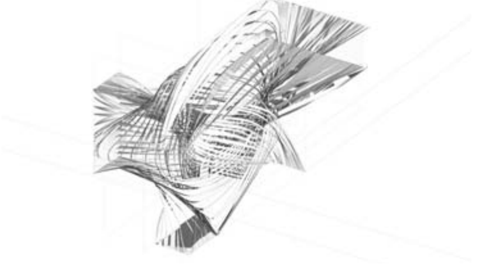
Installation and performance projects recently completed include: *Be Your Self* with the Australian Dance Theatre; *How Wine Became Modern*, an exhibition designed and co-created for SFMoMA; and *Exit* for Terre Natale, an exhibition accompanying the United Nations Conference on Climate Change (COP15) in Copenhagen.

Evan Douglis is the principal of *Evan Douglis Studio*; an internationally renowned architecture and interdisciplinary design firm committed to the practice of digital alchemy. The firm's unique cutting-edge research into computer-aided digital design and fabrication technology as applied to a range of diverse gallery installations, product design, commercial projects, urban redevelopment schemes and prefabricated modular building components has elicited international acclaim.

Douglis is currently the new Dean of the School of Architecture at Rensselaer Polytechnic Institute. Prior to this appointment he was the Chair of the Undergraduate department at the School of Architecture at Pratt Institute, an assistant professor and the director of the Architecture Galleries at Columbia University, and a visiting instructor at The Irwin S. Chanin School of Architecture at the Cooper Union.

Recognized for his innovative approach to design, Douglis' awards include: a NYFA fellowship, a Design Vanguard profile by *Architectural Record*, an *I.D. Magazine* Honorable Mention, a FEIDAD Design Merit Award, two finalist nominations for the North American James Beard Foundation Restaurant Design Awards, a selected fellow in the EKWC European Ceramic Work Centre's Brick Project Residency Program, an ACADIA Award for Emerging Digital Practice and more recently a Presidential Citation from the Cooper Union.

His publications include: *Architecture Now 5*, *Sign as Surface*, *10 x10_2*, *INDEX Architecture*, *The State of Architecture at the Beginning of the 21st Century*, the *ARCHILAB Exhibition Catalog: Naked City, Distinguishing Digital Architecture*, the *SAM catalog Re-Sampling Ornament*, the *AD* issues; *Protoarchitecture: Analogue and Digital Hybrids and Programming Cultures: Design, Science and Software*, *FURNISH: Furniture and Interior Design for the 21st Century* and *Digital Architecture Now: a Global Survey of Emerging Talent*. His book *Autogenic Structures* published by Taylor & Francis was released in 2008.



Eiroa Architects, NY-BA is an architecture firm based both in New York City and Buenos Aires. This studio has been integrating theoretical speculation and disciplinary expertise in different associations, with work ranging from academic research, through scholarships and publications, to architecture design in private and state commissions. EA's design philosophy is to constantly question assumed cultural structures with conceptual designs that focus on recognizing, and displacing, the most stable spatial organizations through topology. EA has been involved in the development projects in South America, the US, Europe, and on the Internet. In New York and Buenos Aires this office has designed, built, published and exhibited many projects, including: an infrastructure project with the Department of Transportation in NYC, a Public Shore Park in Vicente Lopez-North Buenos Aires, and residential buildings and houses. EA's building proposal for the World Trade Center was part of a research group organized by the *New York Times*. EA's practice Manifesto was part of FreshLatino at The Storefront for Art and Architecture; EA's environmental machine for soft landscapes was exhibited at the Disenny Hub Barcelona; and the studio's projects were presented at the VIII Venice Biennale, Pecha Kucha, as part of the Festival of Ideas for the New City curated by the New Museum NYC.
The studio is design lead by Pablo Lorenzo-Eiroa.
www.eiroaarchitects.com

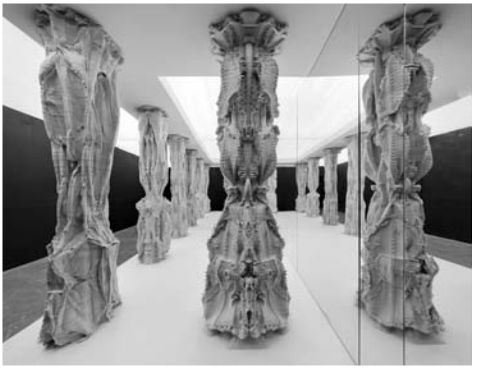
Peter Eisenman, an internationally recognized architect and educator, is founder and design principal of Eisenman Architects, an architecture and design office in New York City.

Among Eisenman Architects' award-winning projects are the Wexner Center for the Visual Arts and Fine Arts Library at the Ohio State University in Columbus, the Koizumi Sangyo Corporation headquarters building in Tokyo, and in Berlin, the Memorial to the Murdered Jews of Europe and IBA Housing at Checkpoint Charlie, each of which received a National Honor Award for Design from the American Institute of Architects. The firm's Aronoff Center for Design and Art, the University of Phoenix Stadium for the NFL Arizona Cardinals, and City of Culture of Galicia have each been the subject of hour-long television documentaries on PBS and the Discovery Channel. The firm's work is also the subject of many books, including the monographs *Tracing Eisenman* (Thames & Hudson, 2006) and *Peter Eisenman. Tutte le opere* (Electa, 2007). Many of Eisenman Architects' projects are the result of successful design competitions.

Mr. Eisenman is also a distinguished author and teacher. Among his many books are *Written Into the Void: Selected Writings, 1990–2004* (Yale University Press, 2007) and *Ten Canonical Buildings, 1950–2000* (Rizzoli, 2008), which examines the work of ten architects since 1950. Mr. Eisenman has taught at many universities, including Cambridge, Princeton, Harvard, Ohio State, and the Cooper Union in New York City. He is currently the Charles Gwathmey Professor in Practice at the Yale University School of Architecture.

Eric Goldemberg is principal designer at Monad Studio, Miami. He started his practice in Argentina and collaborated with Clorindo Testa on various projects. Goldemberg worked in New York for Peter Eisenman as senior designer for the City of Culture of Galicia, as well as heading international competitions on that firm. He was also project architect for Asymptote Architecture – Hani Rashid and Lise Anne Couture – developing the design for the Guggenheim Museum in Guadalajara, the Crematorium in Schiedam, Holland, and the Penang Master Plan in Malaysia. He has a Master of Science in Advanced Architectural Design from Columbia University. Goldemberg taught studios and seminars at Pratt Institute, Columbia University, and IAAC (Institute for Advanced Architecture of Catalonia), Barcelona. He is currently the digital design coordinator and full-time professor at Florida International University, teaching graduate studios and advanced digital seminars focusing on digital fabrication. He has lectured around the world in AA London, ETSAB and IAAC Barcelona, Columbia New York, UP Puerto Rico, SCA, UBA, Di Tella, and Palermo in Buenos Aires. www.monadstudio.net.

Veronica Zalcberg is principal designer at Monad Studio, Miami. She is an architect from Argentina, with a Master of Science in Advanced Architectural Design from Columbia University. In New York, Veronica worked for United Architects (Greg Lynn, Alejandro Zaera Polo + Farshid Moussavi, Jesse Reiser + Nanako Umemoto, Ben van Berkel and Caroline Bos, Kevin Kennon and Imaginary Forces) on the prestigious World Trade Center Competition and ECB World Bank Competition. She currently leads the product design and furniture design initiatives at Monad Studio, as well as sharing creative duties with Goldemberg in all projects. She is also a painter: her work was exhibited at Art Basel Miami venues in the last four years. Zalcberg taught design studios at Columbia University and New Jersey Institute of Technology. www.monadstudio.net



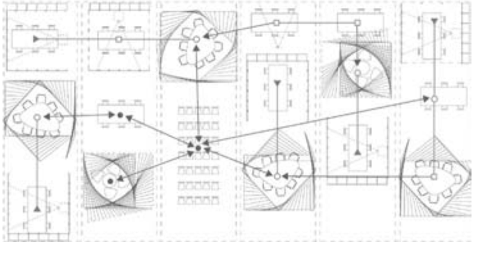
Michael Hansmeyer is an architect and programmer who explores the use of algorithms and computation to generate architectural form. He lectures at the Swiss Federal Institute of Technology's (ETH) architecture department in Zurich. He holds an MBA degree from Insead Fontainebleau as well as a Master of Architecture degree from Columbia University. He previously worked with McKinsey & Company, J.P. Morgan, and at Herzog & de Meuron architects.

Jason Kelly Johnson is a founding design partner of Future Cities Lab, an experimental design and research office based in San Francisco, California. Working in collaboration with his partner Nataly Gattegno, Jason has produced a range of award-winning projects exploring the intersections of design with advanced fabrication technologies, robotics, responsive building systems and public space. Mr. Johnson's work has been published and exhibited worldwide. In 2012 the Hydramax project was exhibited at the SFMOMA and the Datagrove project was a featured installation in the Zero1 Art and Technology Biennial. Most recently he was awarded the 2011 Architectural League of New York Young Architects Prize, and the 2008–2009 Oberdick Fellowship at the University of Michigan TCAUP, and the 2009 New York Prize Fellowship at the Van Alen Institute in New York City. Mr. Johnson has previously taught at the University of Michigan (Oberdick Fellow 2008–2009), the University of Virginia, the University of Pennsylvania and currently at the California College of the Arts (CCA) in San Francisco. Jason Kelly Johnson (b. 1973) was born and raised in Canada. He received his Master of Architecture degree from Princeton University, and his Bachelor of Science from the University of Virginia.

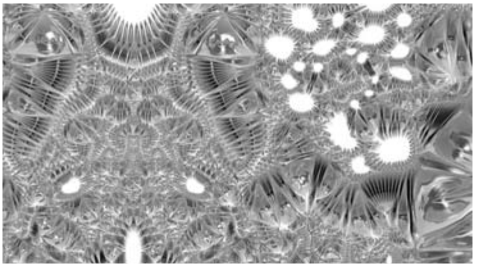
Yehuda E. Kalay is Dean and holder of the Henry and Merilyn Taub Academic Chair at the Faculty of Architecture and Town Planning at the Technion, Israel Institute of Technology, since October 2010. From 1992 to 2010 he was professor of architecture at the University of California, Berkeley, where he also co-founded and directed the Berkeley Center for New Media. Prior to his tenure at Berkeley, for ten years Professor Kalay taught in the department of architecture at the State University of New York at Buffalo. He is a founding member and past president of ACADIA (Association for Computer Aided Design In Architecture), and former co-editor-in-chief of Automation in Construction (Elsevier, UK).

Professor Kalay received his B.Arch and MSc degrees in Architecture from the Technion (Israel), and PhD from Carnegie Mellon University (Pittsburgh, USA).

Kalay's research focuses on digital design, collaboration and design visualization. He has published more than 100 scholarly papers and eight books, the most recent of which are: *Collaborative Working Envi-ronments for Architectural Design* (Palombi, 2009), with Prof. Carrara of the University of Rome, Italy; *New Heritage: Cultural Heritage and New Media* (Routledge, 2008), with Prof. Kvan of the University of Melbourne, Australia; and *Architecture's New Media* (MIT, 2004).



Omar Khan is the Chair of the Department of Architecture at the University at Buffalo, where his research and scholarship spans the disciplines of architecture, installation/performance art and digital media. Khan's projects and teaching explore the intersection of architecture and pervasive computing for designing responsive architecture and environments. At Buffalo he co-directs the Center for Architecture and Situated Technologies and is an editor of the Situated Technologies Pamphlet Series. He received his Bachelor of Architecture degree from Cornell University and a Master in Design and Computation from MIT, where he was a member of the Aesthetics and Computation Group at the MIT Media Lab. He has exhibited nationally and internationally including the Incheon Digital Art Festival (Korea), Urban Screens Melbourne, ZeroOne San Jose, Storefront for Art and Architecture, the National Building Museum and the Urban Center. He is a fellow of the New York Foundation for the Arts and has received grants from the New York State Council on the Arts and the Department of Education. He is also co-principal with Laura Garófalo of Liminal Projects, an architecture and design office.



Ruy Klein examines contemporary design problems at the intersection of architecture, nature, and technology. The devastating technological changes of the last century have opened up new territories where artificial and natural systems share vague boundaries. As architecture grapples with new synthetic domains, Ruy Klein pursues new possibilities for design by negotiating the uncertainties of a contemporary material practice radically altered by technology. Over the past decade, Ruy Klein has conducted a sequence of projects focused on the advancement of new design technologies in conjunction with the cultivation of new aesthetic experiences and a renegotiation of architecture's meaning structures. The mutual imbrications of historically incompatible material regimes govern the sensibility of the work where attention is fixed on the sublime horizon that is now interlaced with feral technologies.

Ruy Klein is widely published and exhibited. Winners of multiple design awards and recognized internationally as one the foremost speculative practices in architecture today, the practice is currently pursuing completion of its first building commissions while continuing its extended research into digital fabrication. The directors, David Ruy and Karel Klein are both currently teaching at the Pratt Institute GAUD.

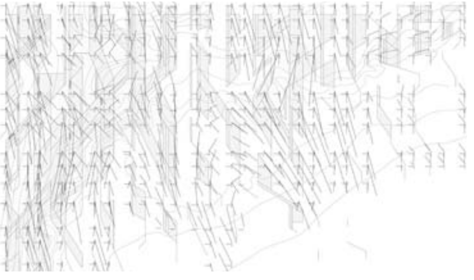
George L. Legendre is a partner at IJP, a London-based practice exploring the natural intersection between space, mathematics, and computation. He is Associate Professor In Practice at Harvard Graduate School of Design. Legendre graduated from the Harvard Graduate School of Design in 1994 and served as lecturer and assistant professor of architecture there from 1995 to 2000. Prior to founding his practice, he was visiting professor at ETH Zurich (2001), Princeton University (2003-2005), and unit master of Diploma Unit 5 the AA School of Architecture in London (2002-2008).

To date IJP has won a competition to cover a central London Street with 1,000m^2 of glass (with Adams Kara Taylor), and completed Henderson Waves, a 1,000-foot-long bridge located in Singapore (with RSP). It recently served as delivery architect for the Bat House, a high-tech, sustainable shelter in West London. In 2007, the influential trade weekly *Building Design* elected the three-year-old firm as one of the top five practices in Britain led by principals under the age of 40. IJP has won 13 awards or award shortlists since its inception and was profiled in *The New Arcadians: Emerging UK Architects* (Merrell 2013) as part of the future vanguard of the profession in the United Kingdom. IJP's quirky work has appeared in 50 different publications, including theory reviews (*ARQ* Cambridge University, JAE), science journals (*The New Scientist*, Spektrum der Wissenschaft), architecture and engineering trade publications (*Ingenia* Royal College of Engineering, Building Design, AD), international mass media (*The New York Times*, *The Financial Times*, *The Wall Street Journal*, *GQ*, *Gastronomica*) and radio and television, (*National Public Radio*, *CBS on Sunday*). A regularly published essayist, Legendre has written *IJP:The Book of Surfaces*, as well as *Bodyline: the End of our Meta-Mechanical Body*. He guest-edited a special issue of AD Magazine on the *Mathematics of Sensible Things (2011)*. His latest research opus, *Pasta By Design*, was published by Thames and Hudson in 2011.

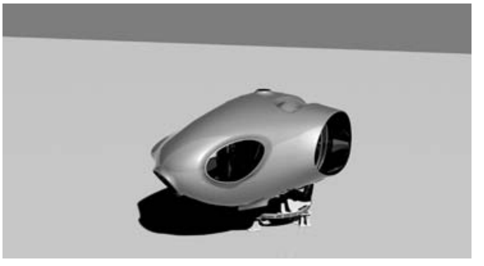
Mark Linder is associate professor in architecture and Chancellor's fellow in the Humanities at Syracuse University. He has taught as a visiting professor at the University of Michigan, Harvard, University of Illinois-Chicago, Rice University, IIT, RISD, and UCLA.

He is the author of *Nothing Less than Literal: Architecture after Minimalism* (MIT, 2004) and is currently at work on a book entitled *Three Easy Mieses: That's Brutal, What's Modern?* on the alternative mid-century modernisms of Alison and Peter Smithson, Walter Segal, and John Hedjuk.

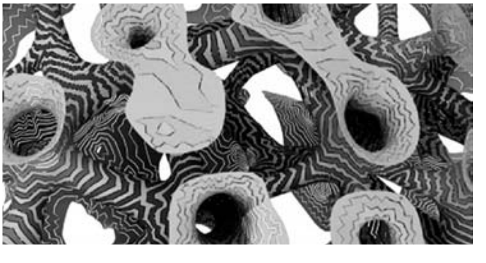
He has lectured throughout the US and Europe, and participated in numerous symposia and conferences, including "What I Did Next" at Princeton (2012), ACADIA (2010), "Just Add Urbanism" at UCLA (2010), "Expertise" at Tel Aviv University (2009), "Architecture as Craft" at TU-Delft (2009), "The Work of Glen Seator" at The Getty Institute (2002), and "Things in the Making" at MoMA (2000). He has contributed chapters to *Strategies of Architectural Thinking* (1992), *Autonomy and Ideology: Positioning an Architectural Avant-Garde in America* (1997) and *Architecture School: Three Centuries of Architecture Education in North America* (2012). His articles have appeared in *Assemblage*, *AA Files*, *ANY, A+U*, *Design Book Review*, *Documents*, *Harvard Design Review*, *Hunch*, *Journal of Architectural Education*, and *Log*.



Pablo Lorenzo-Eiroa is a recognized scholar in the fields of art, architecture, computation, and theory. He is an associate professor adjunct, head professor and coordinator of architecture design and professor of digital representation at both undergraduate and graduate levels at The School of Architecture of the Cooper Union in New York City. He is the recipient of prestigious research grants, awards, and scholarships from institutions such as: Fulbright, Princeton University, The National Endowment for the Arts in Argentina, the University of Buenos Aires, among others. He has lectured at many institutions worldwide, has received many design awards and has published in different media. He has authored and edited several publications including: *Life in:formation* for the ACADIA 2010 conference at the Cooper Union in New York (co-editor and co-conference chair); *Instalaciones: Sobre el Trabajo de Peter Eisenman* after collaborating as a senior lead designer in more than ten projects for Peter Eisenman; *Analog and Digital Strategies Among Interfaces* (course publication); and developed relational digital drawings for the book *Solsona: Entrevistas*, by Ed. Infinito. He is the design principal of Eiroa Architects where he has been integrating theory and experimental practice in New York City and Buenos Aires. His projects were featured in the *New York Times*, Storefront for Art and Architecture, Pecha Kucha, Fresh Latino, Design Hub Barcelona, and in others institutions. www.eiroaarchitects.com



Greg Lynn is an innovator in redefining the medium of design through the use of digital technologies, and a pioneer in the fabrication of complex functional and ergonomic forms with Computer Numerically Controlled (CNC) machinery. His buildings, projects, publications, teachings, and writings have all been influential in promoting the use of advanced materials and technologies for design and fabrication. Today, even as design opportunities span multiple scales and media, his studio, Greg Lynn FORM, continues to define the cutting edge of design. Through his early studies of both philosophy and architecture, he was able to combine the realities of construction with a novel approach to design – thereby establishing himself as a prominent figure across many disciplines, and leading to collaborations with companies like BMW, Swarovski, Alessi, Vitra, Disney, and Imaginary Forces. In 2002, he left his position as professor of spatial conception and exploration at the ETHZ (Swiss Federal Institute of Technology, Zurich) to become Ordentlicher University professor at the University of Applied Arts in Vienna. He is also a professor at the UCLA School of Architecture and Urban Design, where he is spearheading the development of an experimental robotics lab. Finally, he has been the Davenport visiting professor at Yale University since 2000.

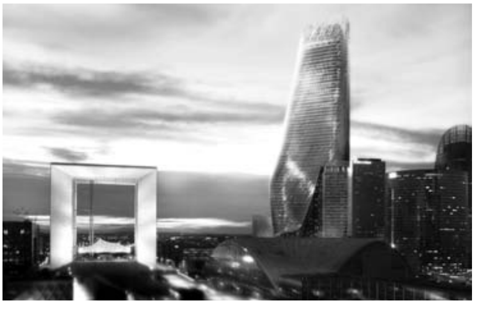


Alexis Meier graduated in architecture, whilst also holding a Master and a Ph.D. in Architectural Theory and Philosophical Aesthetics (University of Paris VIII). He is professor of architecture in the National Institute of

Applied Sciences of Strasbourg and lecturer in Strasbourg National Superior School of Architecture. He is invited professor at the University of Montreal (2010). He is a member of AMUP and LAVUE/ GERPHAU laboratories conducting research in the field of theory and practice of architectural design. He has collaborated with several architectural practices in France and abroad, among them, Peter Eisenman in New York to whom he dedicated his thesis and Renzo Piano in Paris. His work has been published in edited titles of architecture theory, and has also been presented in numerous international conferences.

Achim Menges, born 1975, is an architect and professor at Stuttgart University where he is the founding director of the Institute for Computational Design since 2008. In addition, he has been visiting professor in architecture at Harvard University's Graduate School of Design, at the AA School of Architecture in London and at Rice University in Houston. He graduated with honors from the AA School of Architecture where he subsequently taught as Studio Master of the Emergent Technologies and Design Graduate Program from 2002 to 2009 and as Unit Master of Diploma Unit 4 from 2003 to 2006.

Achim Menges' practice and research focuses on the development of integral design processes at the intersection of morphogenetic design computation, biomimetic engineering and computer aided manufacturing that enables a highly articulated, performative built environment. His work is based on an interdisciplinary approach in collaboration with structural engineers, computer scientists, material scientists and biologists. Achim Menges has published several books on this work and related fields of design research, and he is the author/coauthor of numerous articles and scientific papers. His projects and design research has received many international awards, has been published and exhibited worldwide, and form parts of several renowned museum collections.



Founded in 1972, **Morphosis** is an interdisciplinary practice involved in rigorous design and research that yields innovative, iconic buildings and urban environments. With founder Thom Mayne serving as design director, the firm today consists of a group of more than 40 professionals, who remain committed to the practice of architecture as a collaborative enterprise. With projects worldwide, the firm's work ranges in scale from residential, institutional, and civic buildings to large urban planning projects. Over the past 30 years, Morphosis has received 25 Progressive Architecture awards, over 100 American Institute of Architects (AIA) awards, and numerous other honors.

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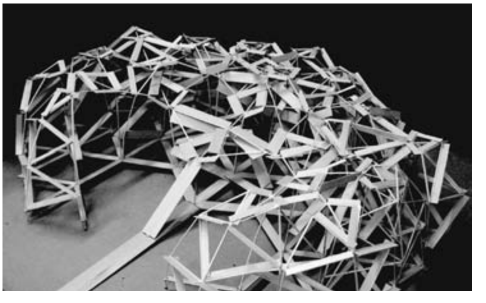
Satoru Sugihara is a principal and founder of a computational design firm ATLV. Prior to starting his firm, he worked as a computational designer at Morphosis Architects for five years. He also worked as an architectural designer at DR_D and Greg Lynn FORM, and as a researcher in media arts at the International Media Research Foundation. He is currently a faculty member of SCI-Arc, teaching scripting. He also taught scripting at Woodbury University and Tokyo University of the Arts. He received his M.S. in computer science from Tokyo Institute of Technology in 2001 and his M.Arch. from the UCLA in 2006.



Ciro Najle, architect and researcher, is the Dean of the School of Architecture and Urban Studies at Universidad Torcuato Di Tella, design critic at the Harvard University GSD, former director of the Landscape Urbanism Graduate Design, and diploma master at the Architectural Association in London. He has taught at various architectural institutions worldwide, including Cornell, Columbia, the Berlage Institute, the Universidad Politecnica Santa Maria in Valparaiso, and the Universidad de Buenos Aires. Director of GDB General Design Bureau, architectural office and multidisciplinary laboratory of research, and previously of Mlab Machinic Laboratory, material research laboratory in Chile, and of MID, Young Architect of the Year Second Prize in London 2001, his work was exhibited at the Museum of Contemporary Art in Denver, LeLaboratoire Paris, the Prague Biennale of Art and the Beijing Biennale of Architecture, where he was curator of the London Pavilion. His work was published in *Quaderns*, *After the Sprawl*, *Oris*, *Architectural World*, *UR*, *Egg*, *Esquire*, *Plot*, *Summa*, and *2G Monographs* on FOA and MGM. He was coeditor of the books *Tokyo Bay Experiment* and *Landscape Urbanism: A Manual for the Machinic Landscape*, with Mohsen Mostafavi, and is currently working on the books *Material Discipline* and The *Generic Sublime*.

Open Source Architecture is an international research group founded by Chandler Ahrens, Eran Neuman, and Aaron Sprecher. With offices in Los Angeles, Montreal and Tel Aviv, Open Source Architecture undertakes architectural tasks that range from object design to large-scale building while engaging in diverse expertise considering that design activity is foremost linked to current technological conditions. The main emphasis is placed on investigating new modes of spatiality and materiality made available through the accelerated changes occurring in our contemporary culture, technological and environmental conditions. Since its inception, Open Source Architecture has completed experimental projects such as I-grid (Los Angeles, 2007), ParaSolar (Tel Aviv, 2009) and the Mellor-Balter residence currently under construction (Los Angeles, 2013). In recent years, Open Source Architecture's projects and essays have been widely published in journals such as *AD* magazine, *306090,* and *EDA*; exhibition catalogues such as MAK Los Angeles and Tel Aviv Museum of Art; and in several books. Open Source Architecture's prototypes and architectural models are part of the FRAC Centre collection in Orleans (France). www.o-s-a.com

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Chris Perry is a principal of pneumastudio and assistant professor at the Rensselaer School of Architecture where he is director of the Geofutures Post-Professional Program.

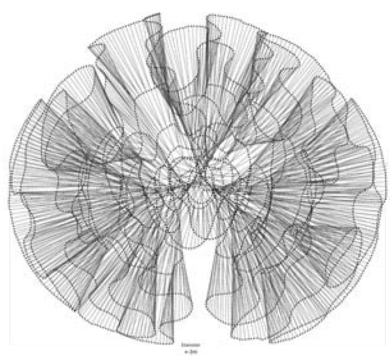
Situated between the fields of landscape and architecture, pneumastudio has exhibited work at the Design Museum in Barcelona and New York University's Gallatin School of Individualized Study. Publications include *Architectural Theories of the Environment*, *Goes Soft: Bracket 2*, and *Post-Sustainable: Blueprints for a Green Planet*.

Prior to co-founding pneumastudio in 2011, Perry was a principal of the design collaborative servo, whose work has been exhibited at such prominent venues as the Venice Architecture Biennale, the Centre Pompidou, the Wexner Center for the Arts, the Cooper-Hewitt National Design Museum, and SFMoMA.

Prior to joining the faculty at Rensselaer in 2011, Perry was the Louis Kahn visiting assistant professor at the Yale School of Architecture. Since 2000 he has taught at a variety of prominent architecture schools, including Columbia University, Cornell University, the University of Pennsylvania, Rice University, and the University of Toronto.

Perry is a fellow of the MacDowell Colony, co-editor of *Collective Intelligence in Design*, and has published written work in a wide variety of architecture journals and books, including *Yale Perspecta*, *Architectural Design*, *Architectural Review*, *Bracket*, and *The Digital Turn in Architecture: 1992–2012*.

Antoine Picon, is the G. Ware Travelstead professor of the history of architecture and technology at Harvard Graduate School of Design where he also co-chairs the doctoral programs. He holds simultaneously a research position at the Ecole Nationale des Ponts et Chaussées. He has published numerous books and articles mostly dealing with the complementary histories of architecture and technology, among which are: *French Architects and Engineers in the Age of Enlightenment*, *Claude Perrault (1613–1688) ou la curiosité d'un classique*, *L'Invention de L'ingénieur moderne*, *L'Ecole des Ponts et Chaussées 1747–1851*, *La ville territoire des cyborgs*, and *Les Saint-Simoniens: Raison, Imaginaire, et Utopie*. Published in 2010, Picon's most recent book, *Digital Culture in Architecture,* proposes a comprehensive interpretation of the changes brought by the computer to the design professions.

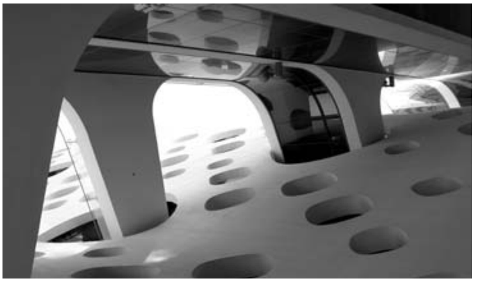


Alejandro Zaera Polo Graduated with honors from the E.T.S. of Architecture in Madrid, Spain, and obtained a Master in Architecture with Distinction (MARCH II) at the Graduate School of Design, Harvard University. He worked for the Office for Metropolitan Architecture in Rotterdam, before establishing Foreign Office Architects in 1993 in London. He started AZPA after the dissolution of FOA as a legacy practice. Besides his professional practice, Alejandro is the Dean of Princeton School of Architecture, and was the Dean of the Berlage Institute in Rotterdam. He has been visiting professor at Yale, Columbia, and UCLA and was a unit master at the Architectural Association in London. He has been a frequent contributor to professional publications such as *El Croquis*, *Quaderns*, *A+U*, *Arch+*, *Log*, *AD* and *Harvard Design Magazine*.

Maider Llaguno Munitxa obtained her master degree in architecture with distinction from GSAPP, Columbia University and ETSASS/ETSAB in Spain. While studying architecture, she started her studies in broadcasting and communications at the University of the Basque country and in summer 2010 she was part of the New York University Interactive Telecommunications program. From 2006 until 2009 she worked at Foreign Office Architects in London. She is currently the Bilbao/SanSebastian AA visiting school director and scientific assistant at the Institute of Technology in Architecture at the ETH in Zurich where she is doing her PhD research.

Alessandra Ponte is full professor, École d'Architecture, Université de Montréal. She has taught history and theory of architecture and landscape at Pratt Institute (New York), Princeton University, Cornell University, Istituto Universitario di Architettura (Venice), Queensland University of Technology (Australia) and ETH (Zurich). She has written articles and essays in numerous international publications, published a volume on Richard Payne Knight and the eighteenth-century picturesque (Paris, 2000) and co-edited, with Antoine Picon, a collection of papers on architecture and the sciences (New York 2003). For the last five years, she has been responsible for the conception and organization of the Phyllis Lambert Seminar, a series of colloquia on contemporary architectural topics. She has organized the show *Total Environment: Montreal* 1965–1975 (Canadian Centre for Architecture, Montreal, 2009); and collaborated on the exhibition and catalogue GOD & CO: *François Dallegret Beyond the Bubble* (AA School, London, November 2011: ETH, Zurich, May 2012; ENSBA, Paris-Malaquais, September, 2012). She is now completing a series of essays on North American landscapes for a book entitled *Maps and Territories*, (AA, London, 2013).

Philippe Rahm is architect, principal in the office of Philippe Rahm Architects, based in Paris, France. His work, which extends the field of architecture from the physiological to the meteorological, has received an international audience in the context of sustainability. In 2002, he was chosen to represent Switzerland at the 8th Architecture Biennale in Venice, and was one of the 25 Manifesto's Architects of Aaron Betsky's 2008 Architectural Venice Biennale. He was nominee in 2009 for the Ordos Prize in China and in 2010 and 2008 for the International Chernikov Prize in Moscow where he was ranked in the top ten. He has participated in a number of exhibitions worldwide (Archilab, Orléans, France 2000; SF-MoMA 2001; CCA Kitakyushu 2004; Centre Pompidou, Paris, 2003–2006 and 2007; Manifesta 7, 2008; Louisiana museum, Denmark, 2009; Guggenheim Museum, New York 2010). In 2007, he had a personal exhibition at the Canadian Centre for Architecture in Montreal. Mr. Rahm was a resident at the Villa Medici in Rome (2000). He was headmaster at the AA School in London in 2005–2006, visiting professor at the Mendrisio Academy of Architecture in Switzerland in 2004 and 2005, at the ETH Lausanne in 2006 and 2007, at the School of Architecture of the Royal Danish Academy of Fine Arts of Copenhagen in 2009–2010, in Oslo at the AHO in 2010–2011. He holds currently the Jean Labatut Professorship in Princeton University, USA. He has lectured widely, including at Harvard School of Design, Cooper Union, UCLA and the ETH Zürich. He is working on several private and public projects in France, Taiwan, Italy and Germany. His recent work includes, in 2011, the first prize for the 69ha Taichung Gateway Park in Taiwan, an office building of 13000 m^2 in La Défense in France for the EPADESA; a convective condominium for the IBA in Hamburg, Germany; the white geology, a stage design for contemporary art in the Grand-Palais on the Champs-Elysées in Paris in 2009 and a studio house for the artist Dominique Gonzalez-Foerster in 2008. Monographic books include *Physiological Architecture* published by Birkhaüser in 2002, *Distortions*, published by HYX in 2005, *Environ(ne)ment: Approaches for Tomorrow*, published by Skira in 2006 and *Architecture Météorologique* published by Archibooks in 2009.



Jesse Reiser received his Bachelor of Architecture degree from the Cooper Union in New York and completed his Masters of Architecture at the Cranbrook Academy of Art. He was a fellow of the American Academy in Rome in 1985 and he worked for the offices of John Hejduk and Aldo Rossi prior to forming Reiser + Umemoto with partner, Nanako Umemoto. Jesse is a professor of architecture and director of graduate studies at Princeton University School of Architecture and has previously taught at various schools in the US and Asia, including Columbia University, Yale University, Ohio State University, Hong Kong University, and the Cooper Union, and has lectured widely at various educational and cultural institutions throughout the US, Europe, and Asia.

Nanako Umemoto received her Bachelor of Architecture from the Cooper Union in New York in 1983, following studies at the School of Urban Design and Landscape Architecture at the Osaka University of Art, and formed Reiser + Umemoto with partner, Jesse Reiser in 1986. Nanako has taught at various schools in the US and Asia, including Columbia University, the Cooper Union, Harvard University, Hong Kong University, Kyoto University, and the University of Pennsylvania, and she has lectured widely at various educational and cultural institutions throughout the US, Europe, and Asia. She is currently a visiting professor at the EPFL in Lausanne, Switzerland.

Reiser + Umemoto, RUR Architecture, PC, an internationally recognized multidisciplinary design firm, has built projects at a wide range of scales: from furniture design, to residential and commercial structures, up to the scale of landscape, urban design, and infrastructure. Reiser + Umemoto published the *Atlas of Novel Tectonics* in 2006, and recently released the Japanese edition in 2008. They have recently won two international competitions: the Taipei Pop Music Center and the Kaohsiung Port Terminal, both scheduled to begin construction in 2012. O-14 a 22-story exoskeletal office tower has recently been completed in Dubai, which has received numerous international honors, including the Concrete Industry Board's 2009 Award of Merit and the American Council of Engineering Companies' 2009 Diamond Award.

The work of Reiser + Umemoto has been published and exhibited widely, and the firm was awarded the Chrysler Award for Excellence in Design in 1999. Jesse Reiser and Nanako Umemoto received the Academy Award in Architecture by the American Academy of Arts and Letters in 2000. In May of 2008, they were awarded the Presidential Citation from President George Campbell of the Cooper Union for outstanding practical and theoretical contributions to the field of architecture, and in April 2011 they were honored with the John Hejduk Award, also from the Cooper Union.

François Roche is the president of the laboratory of research / new-territories, co-founder and principal of R&Sie(n)[1] / studio of architectural practices / Paris, co-founder of [eIf/bÐt/c][2] / Institute for contingent scenario / Bangkok and guest research professor in master class at Columbia-Gsapp / New York.

He is based mainly in BKK, [eIf/bÐt/c], sometimes in Paris, R&Sie(n), and at fall time in NY, Gsapp

Through these different structures, his architectural works and protocols seek to articulate the real and/or fictional, the geographic situations and narrative structures that can transform them. www.new-territories.com

1 R&Sie(n) was founded in 1993 by François Roche (Paris) and Stéphanie Lavaux (Réunion), Gilles Desevedavy (France)

2 [eIf/bÐt/c] was founded in 2011 by François Roche (Paris) and Camille Lacadée (1986, Bordeaux)

Ingeborg M. Rocker is associate professor of architecture at the Harvard Graduate School of Design. She teaches in the core architecture studio sequence and gives courses and seminars on contemporary architectural theory.

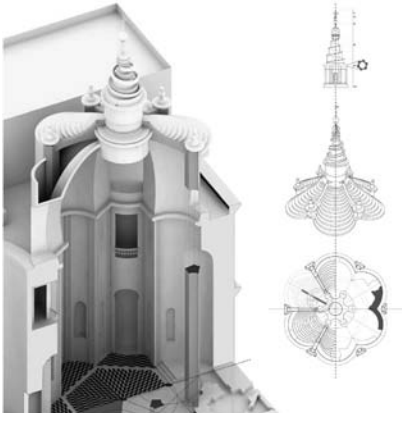
Rocker received the Diploma in Architecture (summa cum laude) from the Rheinisch-Westfälische Technische Hochschule Aachen, the MS in Advanced Architectural Design (with distinction) from Columbia University, and the Master of Arts from Princeton University. She has taught at Princeton and at the University of Pennsylvania and was a visiting scholar at the Humboldt University in Berlin (2001–2002).

Rocker concluded her PhD dissertation at Princeton, entitled "Emerging Structures: Information Aesthetics and Architectures of the Digital Medium." Her theoretical work is devoted to questions regarding the impact of media on the perception, production, and thinking of architecture, and has been published in numerous international magazines and books.

As a designer and teacher of design, she deploys computer modeling as a tool for giving form to theoretical hypotheses in a didactic way. During the period 1996–1999 she was project architect at Eisenman Architects in New York. Since 2005, with Christian J. Lange, she is a principal of Rocker-Lange Architects, an internationally operating design firm based in Boston and Hong Kong.

Jenny E. Sabin's work is at the forefront of a new direction for twenty-first-century architectural practice — one that investigates the intersections of architecture and science, and applies insights and theories from biology and mathematics to the design of material structures. Sabin is an assistant professor in the area of design and emerging technologies in the Department of Architecture at Cornell University. Sabin taught design studios and seminars in architecture at the University of Pennsylvania from 2005–2011. She is principal of Jenny Sabin Studio, an experimental architectural design studio based in Philadelphia. She is co-founder of LabStudio, a hybrid research and design network, together with Peter Lloyd Jones. She was a founding member of the Nonlinear Systems Organization, a research group started by Cecil Balmond, where she was senior researcher and director of research. Sabin holds degrees in ceramics and interdisciplinary visual art from the University of Washington and a master's of architecture from the

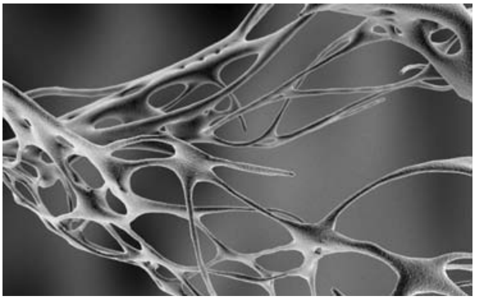
University of Pennsylvania, where was awarded the AIA Henry Adams first prize medal and the Arthur Spayd Brooke gold medal for distinguished work in architectural design, 2005. Sabin was recently named a USA Knight Fellow in Architecture, one of 50 artists and designers awarded nationally by US Artists.



Andrew Saunders is an assistant professor of architecture at Rensselaer Polytechnic Institute in New York. He received his Masters in Architecture from the Harvard Graduate School of Design. He has significant professional experience as project designer for Eisenman Architects, Leeser Architecture, and Preston Scott Cohen, Inc. He has taught and guest lectured at a variety of institutions, including Cooper Union and the Cranbrook Academy of Art. In 2004 he was awarded the *SOM Research and Traveling Fellowship for Masters of Architecture* to pursue his research on the relationship of equation-based geometries to early twentieth-century pioneers in reinforced concrete. His current practice and research interests lie in computational geometry as it relates to emerging technology, fabrication and performance. He is currently working on a book using parametric modeling as an analysis tool of seventeenth-century Italian Baroque architecture.

Patrik Schumacher is partner at Zaha Hadid Architects and founding director at the AA Design Research Lab. He joined Zaha Hadid in 1988 and has since been the co-author of many key projects, including MAXXI – the National Italian Museum for Art and Architecture of the 21st Century in Rome.

Patrik Schumacher studied philosophy, mathematics, and architecture in Bonn, London, and Stuttgart, where he received his Diploma in Architecture in 1990. In 1999 he completed his PHD at the Institute for Cultural Science, Klagenfurt University. In 1996 he founded the "Design Research Laboratory" with Brett Steele, at the Architectural Association in London, and continues to teach in the program. Since 2004 Patrik Schumacher is also tenured professor at the Institute for Experimental Architecture, Innsbruck University and guest professor at the University of Applied Arts in Vienna. In 2010 and 2012 he published the two volumes of his theoretical magnum opus *The Autopoiesis of Architecture*. His lectures and essays in architectural theory are available at www.patrikschumacher.com. In 2002 Patrik Schumacher curated "Latent Utopias – Experiments within Contemporary Architecture" and he is currently planning the exhibition "Parametricism – The New International Style."



Roland Snooks is a partner of the experimental architecture practice Kokkugia, and teaches architecture at RMIT University, Columbia University and University of Pennsylvania. Roland has previously directed design studios and seminars at the Pratt Institute, SCI-Arc, UCLA, USC and Victorian College of the Arts. Roland's design research is focused on emergent design processes involving agent-based techniques. This research is the focus of the forthcoming publication *Swarm Intelligence: Architectures of Multi-Agent Systems*.

Roland holds a B.Arch with honors from RMIT University and a Master in Advanced Architectural Design from Columbia University, where he studied on a Fulbright scholarship. Roland is currently a PhD candidate at RMIT University. He was named the Australian Curator for the 2008 and 2010 Beijing Architecture Biennials.

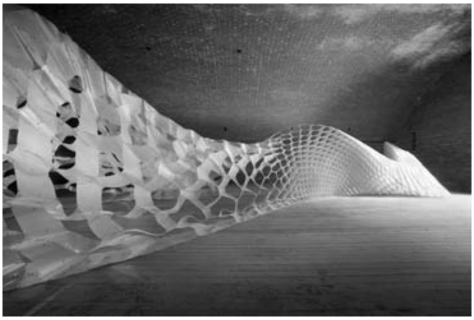
Kokkugia's research agenda is focused on the exploration of generative methodologies developed from the complex self-organizing behavior of biological, social, and material systems. It is a networked practice, with offices in New York, Melbourne, and London, operating through design, research, and teaching.

SPAN was founded by Matias del Campo & Sandra Manninger. The work of SPAN explores the opportunities present in the morphologies of advanced design techniques as the point of departure for the design of architectural conditions, simultaneously exploring the discursive implications of the individual projects. Inherent qualities such as spatial articulation, components, organization, structure, and circulation form the ground for a variety of speculations on novel spatial conditions. The sensorial and spatial experiences co-notated with the manifold qualities of contemporary, algorithm-driven approaches – from their topological qualities to the distribution of components and patterns forming the structural body – are scrutinized for their architectural qualities. The practice investigates how intensive forces, including solar radiation, weather systems, acoustic forces, and wind pressures can be used as means of formation for architectural bodies.

The design agenda of the office does not exclude any typology or scale, from product design to urban design. In recent years the focus shifted toward public, cultural buildings and designs as well as interior and exhibition designs. It has a special interest in advanced ecological design. The office is specialized in the design and fabrication processes of advanced architecture; the experience in this field serves as a proof of the capabilities to deal with highly intricate architectures, and to make them reality.

The practice has won numerous competitions and honors such as the Prize for Experimental Tendencies in Architecture. Among SPAN´s best known designs is the Austrian Pavilion for the Shanghai Expo 2010. Matias del Campo, and SPAN co-founder Sandra Manninger, additionally focus on teaching architecture design in such schools as the Dessau Institute of Architecture, and the University of Applied Arts in Vienna. Currently Matias del Campo is teaching architecture design at UPenn, the University of Pennsylvania. office@span-arch.com

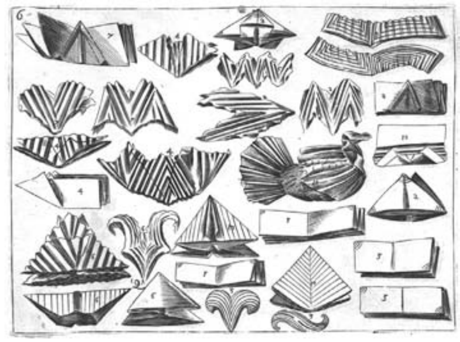
Aaron Sprecher is assistant professor at the School of Architecture in the Faculty of Engineering, McGill University since 2008. In parallel, he is co-founder and partner of Open Source Architecture, an international collaborative research group that brings together leading international researchers in the fields of design, engineering, media research, history, and theory. He completed his graduate studies at Bezalel Academy of Art and Design (Israel) and the University of California Los Angeles (UCLA). His research and design work focuses on the synergy between information technologies, computational languages, and automated digital systems, examining the way in which technology informs and generates innovative approaches to design processes. His essays and projects have been published internationally in journals such as *306090*, *AD magazine*, and *Esempi di Architettura*; books such as *Performalism* (Routledge, 2012), and *Softspace – From a Representation of Form to a Simulation of Space* (Routledge, 2006); and exhibition catalogues such as *Art & Architecture* (FRAC Centre, forthcoming 2013). Aaron Sprecher is co-curator and co-editor of the exhibition and publication *The Gen(H)ome Project* (MAK Center, Los Angeles, 2006), design curator of *Performalism* (Tel Aviv Museum of Art, 2008) and more recently co-chaired the ACADIA 2010 conference at the Cooper Union, New York. His research on the synergy between evolutionary computational principles and fabrication processes is currently supported by several grants from the Canada Foundation for Innovation and the Social Sciences and Humanities Research Council. Aaron Sprecher leads LIPHE Research at McGill University, a leading design research laboratory in Canada. Aaron Sprecher trained as an architect in Brussels, Jerusalem, Amsterdam, Paris, and Los Angeles. www.o-s-a.com



Nader Tehrani is a professor and head of the Department of Architecture at MIT SA+P. He is also principal and founder of NADAAA, a practice dedicated to the advancement of design innovation, interdisciplinary collaboration, and an intensive dialogue with the construction industry.

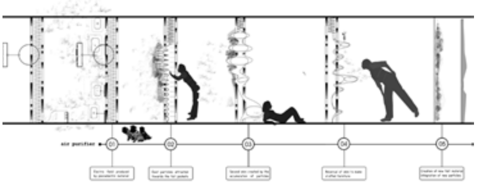
Tehrani received a B.F.A. and a B. Arch from the Rhode Island School of Design in 1985 and 1986, respectively, and continued on to the Harvard Graduate School of Design where he received his M.A.U.D in 1991. Tehrani has also taught at Harvard Graduate School of Design, Rhode Island School of Design, Northeastern University, Georgia Institute of Technology where he served as the Thomas W. Ventulett III Distinguished Chair in Architectural Design, and Otis College of Art and Design where he served as a Donghia Designer-in-Residence.

Tehrani's work has been recognized with notable awards, including the Cooper Hewitt National Design Award in Architecture (2007), the American Academy of Arts and Letters Award in Architecture (2002), and thirteen Progressive Architecture Awards. He has also been honored with the United States Artists Fellowship in Architecture and Design (2007) and the Architectural League of New York's Young Architects Award (1997).



Georges Teyssot has taught at the I.U.A.V. (Venice, Italy); at Princeton University's School of Architecture (USA), and at the GTA in the Department of Architecture at Zurich's ETH. Presently, he is professor at Laval University's School of Architecture (Quebec, QC, CA). He has authored and edited many volumes, including one on *Interior Landscapes* (New York, 1988); and another on *Die Krankheit des Domizils* [The Disease of the Domicile], (Wiesbaden, 1989). He has directed a collective volume with Monique Mosser, entitled *The Architecture of Western Gardens* (Milan, 1990; Cambridge, MA, 1991; Paris, 1991, 2002; Stuttgart, 1993); republished under a new title, *The History of Garden Design* (New York, 2000). He has written the introduction to the volume of Diller + Scofidio, *Flesh: Architectural Probes* (New York, 1995; reprint, 2011). He was the curator with Diller + Scofidio of an exhibition on *The American Lawn. Surface of Everyday Life*, at the CCA (Montréal, 1998), and the editor of a volume on *The American Lawn* (New York, 1999). Presently, he is publishing a volume entitled *A Topology of Everyday Constellations* (Cambridge, MA: The MIT Press, forthcoming, spring 2013); and a booklet on *Walter Benjamin. Les maisons oniriques*, [Walter Benjamin's Oneiric Houses], (Paris, 2013).

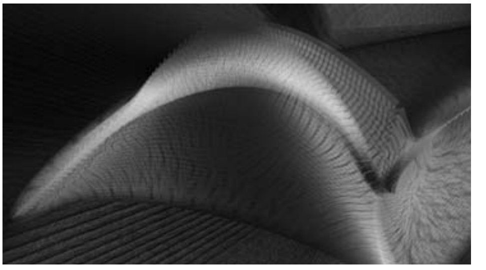
David Theodore, Trudeau scholar and SSHRC fellow, is a doctoral candidate in the History of Architecture, Medicine, and Science at Harvard University. He recently taught in Montreal in the School of Architecture, McGill University, and in the Department of Design, Concordia University. He has co-published on the history of medicine and architecture in *CBMH*, *Social Science & Medicine*, and *Scientia Canadensis*. An active design journalist and critic, he is a regional correspondent for *Canadian Architect*, a contributing editor at *Azure*, and a contributor to *The Phaidon Atlas of 21st-Century World Architecture*.



Alexandros Tsamis is an architect and engineer, currently an associate professor and head of the graduate program in the School of Design at Adolfo Ibanez University in Santiago, Chile. He holds a Diploma of Architecture and engineering from AUTh in Greece and a SMArchS & Ph.D. from MIT in design and computation. Previously, Tsamis has taught design and visual representation at MIT and Ohio State University. Tsamis is also the recipient of several awards in international architectural competitions, including a first prize in the London Architecture Gallery International Competition in 2008, a first prize in the Gillette Landmark International Design Competition, and an honorable mention in the Design of Ephemeral Structures for the Athens Olympics of 2004. His work has been published and exhibited internationally.

Lydia Kallipoliti is an architect, engineer and theorist, currently an assistant professor adjunct at the Cooper Union and at Columbia University in New York; also a senior associate at the Cooper Union Institute of Sustainable Design. Kallipoliti holds architecture degrees from AUTh in Greece, MIT and a Ph.D. from Princeton University. She is the editor of "EcoRedux: Design Remedies for a Dying Planet," a special issue of *Architectural Design* (AD) magazine and the founder of *EcoRedux*, an innovative online non-profit educational resource for ecological experiments in the post-war period. EcoRedux received an honor at the 14th International Webby Awards and a silver medal in the W3 awards by the International Academy of Digital Arts and Sciences. Her design and theoretical work has been published internationally, including *Architectural Design*, *Dogmus*, *the Journal of Architectural Historians*, *Log*, *Pidgin*, *Praxis*, *Thresholds*, *306090* and exhibited widely, including the Byzantine Museum of Greece, the Design Museum of Barcelona, RIBA, the Storefront for Art and Architecture in New York and the Venice Bienalle.

Michael Wen-Sen Su is visiting assistant professor in the School of Architecture at the Pratt Institute in Brooklyn, New York, where he is coordinator and instructor of undergraduate thesis. His research and design interest is "Machinic Architecture," i.e. – architectural theories and practices explicitly processing information, in the broadest sense of the word. Left brain-wise, he is a graduate of the California Institute of Technology and Columbia University, where he conducted research on magnetic confinement fusion on the HBT-EP tokamak; right brain-wise, he is a graduate of the Cooper Union and Princeton University, where he is completing a dissertation on the interchange between science and architecture in the early works of R. Buckminster Fuller. Michael founded the architectural practice and exhibition space "1 of N" in 2012.



Michael Young is an architect and educator practicing in New York City, where he is a founding partner of the architectural design practice Young & Ayata. Their design work and research has been exhibited nationally and internationally. Michael is an assistant professor at the Cooper Union where he currently teaches design studios and seminars focused on geometry and representation. In addition he teaches studios and seminars in the graduate schools of Yale University, Columbia University, and Princeton University. His drawings have been exhibited at the Storefront for Art & Architecture, New York; the WUHO Gallery, Los Angeles; LOT Gallery, Lexington, Kentucky; the DHUB, Barcelona, Spain and are featured as part of the Drawing Center's Viewing Program. In addition to teaching & practicing, Michael is invested in writing, research, and experimentation on issues concerning esthetics and architectural mediation.

Kutan Ayata is an architect and a design critic practicing in New York City. He is the co-director of the architectural design studio Young & Ayata, which explores novel formal and organizational trajectories in architecture and urbanism. Currently, Kutan is an adjunct assistant professor at Columbia University in GSAPP, teaching advanced drawing and representation; and at Pratt Institute in GAUD, teaching graduate thesis. Prior to forming Young & Ayata, he worked at the offices of Friedrich St. Florian and Reiser + Umemoto. Kutan was a fellow at Princeton University School of Architecture and earned his Masters of Architecture degree in 2004 as a recipient of the Suzanne Kolarik Underwood Thesis Prize. He received his Bachelor of Fine Arts in Architecture in 1999 from Massachusetts College of Art in Boston. He is a registered architect in the Chamber of Architects in Turkey.

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ACKNOWLEDGMENTS

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To my parents and my papap.
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