This essay, composed for the publication *Contemporary Digital Architecture: Design and Techniques*, occupies the field of computational design theory. The text is accompanied by, and serves to position, a series of case study architectural projects designed by the authors.

’Inorganic Speciation’ contributes a number of new concepts and analytical frames extending core architectural themes in relation to algorithmic design processes. The concept of typology is combined with that of speciation to understand, describe and model the genesis of architectural form. Similarly, a trajectory of material computation and form-finding, traced through historical projects, is extrapolated to demonstrate the potential of incorporating multiple inputs into computational systems of negotiation. Finally, abstract notational systems are discussed as tools for the meta-analysis of architectural production.

Conceptual and methodological limitations are at least as significant as material limitations in the production of architecture. The three key conceptual apparatus here discussed: typology, form-finding and abstract notational systems each offers both a bridge between contemporary processes and the past and a means towards the accelerated evolution of the discipline.

The publication ‘Contemporary Digital Architecture: Design and Techniques’ is the largest survey to date presenting ‘the latest developments in the field of architecture as it has been reshaped by the use of digital technologies’. Over 200 projects are represented. The 20-page section featuring the essay and case study contributions from supermanouvre is the largest devoted to any single design practice.
Supermanouvre + Kokkugia
Morphogenic Lattice

A collaboration between supermanouvre and kokkugia, this project is an experiment in the effects created by morphogenic algorithms. These algorithms are designed to generate ornamental distortions within geometry through the internal logic of cellular automata. A technique where a population of self-similar elements in space continually change their state based on the states of their neighbors in a feedback loop, giving rise to emergent patterns. The project is driven by a series of encoded procedures which build a hex-grid cellular automata and a network of springs which drive the distortion of the more geometrically complex surface. The springs respond to the changing CA states and enable a non-hierarchical distortion of the network through the use of an individual CA cell cracks through its neighbors influencing the geometry beyond its immediate adjacency.

Design: Dave Pigram, Roland Snooks
Thanks to: Cary Clarke

DAVID PIGRAM, IAIN MAXWELL
Supermanouvre

2010002470
Original creative work

pages 208 & 209
"Supermanceuvre + Matter Design
Supermatter"

"Supermanceuvre" is both a continuation of supermanceuvre’s broader research interest into systemic processes of formation, and an assessment of the capacity of contemporary prototyping technologies to elaborate thousand-year-old processes of fabrication.

Conceived as a family of objects cast in bronze, Supermanceuvre explores the algorithm as a gene-typical morphology, where similarity across the collective is instilled through the instructions of assembly embedded within the algorithm as it operates on a discrete set of geometric aggregates. The input of geometry enables a speculation of each resultant object as the rules of growth and assembly are applied to the specific geometric constraints and potentials of connection particular to each aggregate primitive. Through changing either one of the primitives or the generative rules of the Lindenmayer (L-system) combinational algorithm itself, differentiation across the population can be instantiated. The resultant objects are indexed to both the rules and geometric laws of aggregation, and as such the character of latitude is enacted.

In this end, the project facilitates a shift to a new definition of the architectural model to be inclusive of computational methodologies of spatial, formal and material distribution. In realising the final cast objects, some of the computational process were selected for rapid prototyping (SLA). Those outputs were then used as positive forms in the preparation of casting moulds, a process which combined an accurate translation of the formal character and intrinsic detailing of the digital model with the specific material behavior of lost wax and then formed bronze.

Project team: David Pigram, Wei McGart, Iain Maxwell,
Paulina Austrin, Zach Johnson-Winners,
Brandon Clifford

2010002470
Original creative work

pages 212 & 213
Supermanouvre

Proto-Synthesis & Trabeculae

The two projects, Proto-synthesis and Trabeculae, are here presented as a pair and respectively illustrate the geometric and phenomenological aspects of supermanouvre's design approach.

Proto-synthesis (the genotype) is not a singular design project or curated artefact, rather it is an algorithmic strategy for the elaboration of a topologically rich and highly networked architecture. It is also the generic or operative framework for the latter architectural project - Trabeculae. Put here, Proto-synthesis has not been encoded with specific programmatic protocols to engender a specific programmatic effect and therefore remains typologically free, and capable of multiple possibilities. Within the system, the very construction of architecture: position, scale, displacement, density, thickness, length and so on, are deeply embedded within the decision-making mechanisms of the algorithm, and are stimulated through input (internal logic and the discrete sampling and feedback of internal) within the local environment.

Trabeculae (the phenotype) is an instantiation of the Proto-synthesis algorithm, achieving specialisation enabled through embedding qualitative programmatic, situational and environmental design aspirations toward the manipulation of the central atrium office core. Replacing the traditional operation of repetitive extraction, the heliostat-like branching system actively seeks out those areas within the mutating envelope with greatest access to daylight. Parking and swaying in response to varying light conditions the atrium is thus conceived as a site-specific network that traverses intelligently and freely from one façade to another. The atrium becomes the defining element of differentiation within otherwise conventional office-floors spaces.

Within the atrium a second order proliferation of the same system at a finer scale develops a structural meshwork - the Trabeculae. The swellings and conglomeration of this topologically free structural network within a network accommodate meeting & function rooms, bridges and communication nodes as well as supporting the atrium glazing.

Project team: Dave Pigram, Iain Maxwell, Brad Atherhberg, Eddie Hewitt, Jared Onofreed, Matthew Hall, Susan Thrall.
DAVID PIGRAM, IAIN MAXWELL
Supermanouvre

2010002470
Original creative work

pages 220 & 221
Supermanouvre

Inorganic Speculation: Matter, Behaviour and Formation in Architecture

Form is the primary instrument through which architecture engages with the world. It is firmly held position that motivates supermanouvre to develop custom methodologies of formation that allow for the explicit and open-ended negotiation between multiple architectural intentions and the complex milieu within which they will operate. These methodologies are algorithmic in nature, primarily digitally generated, and extend the capacities of the form finding tradition within architecture through a deconstruction of its processes from the limits of physics, enabling a broader examination of the number and nature of new design paradigms. The abstract notation underlying these algorithmic strategies enables a meta-analysis of the formal processes, which has an accelerating influence on their evolution, as experienced within other fields of intellectual and artistic discourse. Through the application of algorithmic notation, the conception of form-production within design shifts from Issey Miyake’s applications of typology to the specification of variable architectural models. Architectural form is conceived with organisation across multiple scales (programmatic, material and structural) embedded in a complex feedback loop with the forces, events and beliefs that simultaneously drive and are driven by them. The description of formation through causal processes (morphogenesis) has been convincingly articulated by N. J. S. Thompson. He posited that 'form' could no longer be understood as an isolated, inert, or solely generative event but rather a generative process of transformation negotiated through an organism's internal constitution (RNA) and its adaptation to its environment (via the sampling of environmental, physical or material forces (feedback)). The gift of form is both a "vapor of the force" that gave rise to it, and a critical, selective and adaptive process through which morphology seeks its 'geometric' nature and attains a higher order of specialization. The more stable or recurrent of these specializations can be understood to have achieved the level of 'speciation'. Matter, like architecture, is traditionally conceived of as being, an underestimated that generally extends to all things lacking the motivations for life. In accordance with the contemporary understanding of formation, as exhibited in complex systems, as the topology of the system, its network of connections (physical, virtual or both), remains open and is able to self-organise. The perception of architecture as a collective organisation driven through multiple agencies is more akin to the dynamics of complex natural systems than to conventional models of design. For this reason, supermanouvre is consciously drawn to the modelling of the algorithmic processes that underlie biological and chemical phenomena, as opposed to the simulation of pre-existing geometries found within nature. Such fixed references, serve only to limit the capacity of the design process before it has even begun. Our interest therefore, rests firmly in the description of behaviour such as growth and change, mechanisms of feedback, and the transformative agencies such entities synthesise as manifest through their evolution. This is a critical and conscious departure from graphological systems of representation, toward an active engage-ment with the protocols of "making" that exist deep within all complex systems. The algorithm becomes the operative medium (descriptive environment) through which intentions are first encoded, then translated and ultimately enacted. The application of algorithmic processes presents architecture with a set of descriptive and accelerating possibilities akin to those embedded within mathematics via its systems of abstract notation. Similarly, music enjoys rapidly enhanced evolution with each successive creation of new symbolic nota-tional systems. As John Holland has observed, 'people with a bit of effort can appreciate quite complex music, but there are musical subtleties that are difficult to convey without notation. The sophisticated composition of Bach, Beethoven, and Prokofiev depend on the disutility that produces that musical notation. To know music without notation is to know music without understanding the music and of the process of composition.' Here the defining frame of syntactical protocols enables rather than inhibits the expression of formal possibility. The figure, "a type of computational composition or technique of composition", famously adopted by Bach, is a prime example of cultural productions that are not constrained without symbolic grammar. Thus, notation enables a medium for the systematic meta-analysis not only of the artefacts themselves, composition or building, but also of the processes that have brought it into being. In short, it enables the revelation of theories that make, which can then form a foundation for the elaboration of a design methodology. Within architecture, it is our precise ability to relay, quantify and query design specu-lation and expectation through computable terms, that allows "architectural concepts" to be expressed as generative rules so that their evolution may be understood and adapted."
Advocating architectural form as a synthesis of internal motivations and their response to situation requires an expansion of the framework through which it is theorized. Analysis of communicative access and between architectural forms is crucial to their generation, evaluation and positioning. Historically, typology has been both a practical and theoretical apparatus to this end. Premising architectural organisation upon established typologies, however, can be a reductive and external practice that unnecessarily pre-conditions and limits the act of design. The difficulty is that established typologies have conventionally been viewed as fixed and are primarily articulated in programmatic and/or semantic terms without explicit reference to the forces and processes that generated them. There are exceptions, Santa-Maria Tachard, Kipnis and Frampton have each articulated models of typology that are active to varying degrees. What such models do not provide, however, is an adequate meta-analysis or operatic grammar through which a productive and empowering design methodology could be structured.

It is within this context that we advocate the adoption of an alternate conceptual framework, generative, "the evolutionary process by which new biological species arise." When applied to architecture, speciation offers a series of analytical tools and terms that redress the aforementioned deficiencies of typology and as such presents a more open and mutable vehicle through which to qualitatively architectural formation. Of particular value is the conceptual distinction between genotypical and phenotypical variation. Analyzing formalist processes and internal motivations separately in formal characteristics and content sensitive behaviors enables the discernment of a much larger and richer set of affinities between projects. Thus in turn allows for more sophisticated systems of evaluation of fitnesses, both for purpose (the traditional domain of type) and of adaptability to a host environment. Fitness is here measured not against assumed global orders, but in evidenced through the realization of a persistent, entirely local, and specialized instantiation of the genome. By advancing speciation over typology we do not seek to abandon the organizational diagrams of type, rather to enrich and elaborate them through their exposure to additional influence and the establishment of operative meta-models.

As a design practice, supermanouvre explicitly values richness and diversity and privileges complex and aporetic forms of order, the heterogeneous and flux of the outside-world are allowed collaborators in the design process. Organizational, spatial and material characteristics arise from a synthesis of their own network of internal logics and their environmental, social, political, cultural and technical contexts (both existent and designed). Architecture, seen in this way, is neither a natural scheme, mapping external influence without resistance, nor in an inert exercise in the explicit production of shapes without reference to their environments. Instead it is an active participant with agency across multiple domains. Algorithmic techniques enable non-hierarchical, non-linear and explicit negotiations between an enlarged set of architectural logics. Computation is employed to extend the form-finding traditions of architecture beyond the limitations of material substrates, while abstract notational systems enable a meta-analysis of the processes of form generation allowing them to be better understood, tuned and deployed, thus accelerating their evolution. Through the conceptual apparatus of speciation, fitness can be qualified through the persistence of specific formal differences, attained through the variability of deeply embedded architectural logics. Supermanouvre's work is dedicated to this critical exploration and inversion of strategies, methodologies and grammars of architectural formation.


Pipe Dreams" by Richard Reeder and Krista Ferrie. A series of prototypes fabricated with custom- built pipe bending attachments to KICKA EX-5, an robot arm utilizing custom written software. Research into Robotic Fabrication directed by David Pigram and Wei-Min Chen, University of Michigan, Taubman College of Architecture and Urban Planning.
Computer modeling, programming, simulation, imaging... these are just some of the techniques and aspects of this fascinating discipline featured in this book. The latest, most awe-inspiring projects in digital architecture have been brought together to make this volume an indispensable guide to all those working in or studying this ever-evolving field. The innovative and imaginative concepts are presented with full-color photographs that, along with texts from the authors themselves, help to fully explain the work and techniques employed. This will surely provide readers with an endless source of inspiration and a host of excellent ideas that can be used for future projects in digital architecture.
9 Introduction

10 Fabrication

118 Scripting

Contents

DAVID PGRAM, IAIN MAXWELL
Supermanouvre

2010002470
Original creative work

Supporting Evidence

Contents
228 Responding

272 Poetics

386 Bibliography