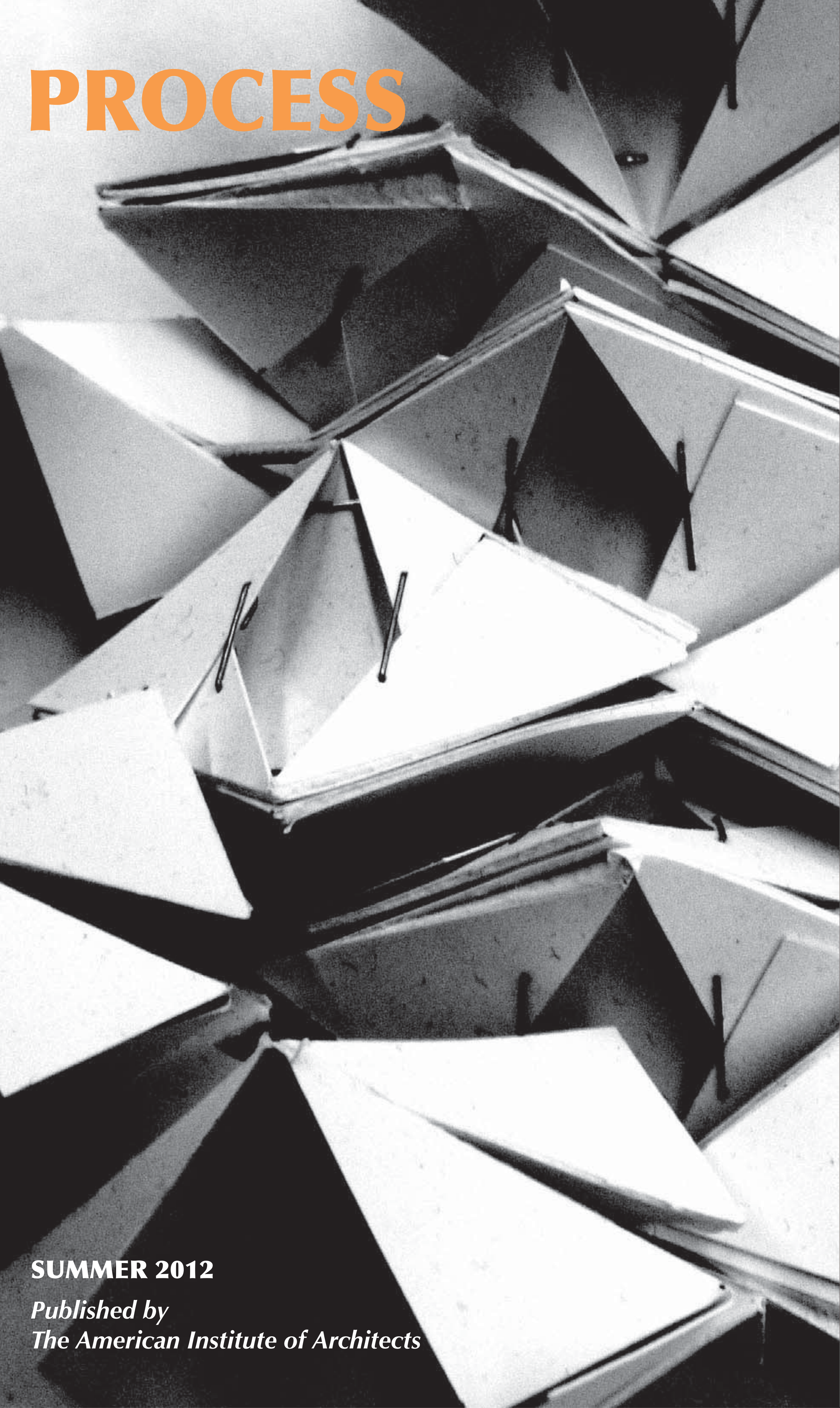
PROCESS



FORWARD 112

The Architecture and Design Journal of the National Associates Committee

SUMMER 2012

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COVER IMAGE
Aggregate Modulation Study Using Playing Cards by Wintress Cloud
Architecture Studio, Fall 2011, Prof. Gregory Marinic, University of Houston

SUBMISSIONS
Forward welcomes the submission of essays, projects and responses to articles. Submitted materials are subject to editorial review. All Forward issues are themed, so articles and projects are selected relative to the issue's specific subject.

Please contact the *Forward* Director, Olivia Graf Doyle, at olivia.grafdoyle@hmcarchitects.com if you are interested in contributing.

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FORWARD MISSION
To be the architectural journal of young, aspiring architects and designers of the built environment specifically targeting design issues.

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Finding Structure, published in the initial release, was removed due to a modification to the copyright holders publication criteria.

In this Issue

Topics: PROCESS

by Olivia Graf Doyle

"…when he could find no possibility of bringing calm and order into that arbitrary turmoil – he told himself (…) that the most sensible thing was to make every sacrifice if there existed even the smallest hope of thereby freeing himself…"

- Franz Kafka, *The Metamorphosis* [1]

As designers, we often look outside our own profession to literature, technology, culture, art, fashion and engineering to find inspiration for a discovery that is both structured and liberating. This issue of *Forward* explores the processes we follow and invent when learning, teaching and practicing design. To express our own values and beliefs, we explore these dualities and synthesize a design process by combining the ephemeral and permanent, the theoretical and practical, the ethereal and tangible. Some questions this issue seeks to answer include how we balance intuitive inspiration and rational analysis, how we recognize patterns and points of connection, and how we weigh the means to good design as well as methods? How might we create something that is simultaneously functional and an intellectual and aesthetic delight? How can we create a well-crafted and poetic prototype through a rigorous process of study and investigation? Where do our design skills and methods originate? How do we develop a cogent design philosophy?

Learned Process

In architecture school we are taught to look at and think about the world in new and compelling ways. Organizing principles such as composition, datum, grid, or focal point tied to an abstract or narrative concept can become a means to begin an architectural language. The design process includes techniques of synthesis and analysis, and our studies lead to proposals based on significant theoretical or experiential spatial qualities. As graduates, we are well versed in a process that places a premium on clarity of design concept and on the graphic description of concept via a concise, elegant, and poetic diagram.

Practiced Process

But what about the process of production; putting together a set of construction documents or a client presentation or a marketing proposal? As emerging professionals, we hope to use the guiding principles learned in school to carry us through the process of creation at work. Yet, those with considerably more experience in practice-based architecture can sometimes have completely different attitudes to design processes than that of the familiar academic method. What affects that change? Have they forgotten those principles and the strength of a cohesive concept, replacing that knowledge with budget consciousness, restrictions from clients and time constraints? Code analysis, feasibility and cost studies, sustainable strategies, consultant coordination, detailing and construction administration are also part of the process – perhaps a little less glamorous, but none-the-less an important part. An expanded set of

We must question our transformations and seek the advice of teachers, colleagues and mentors.

rules developed to guide a project from initial design through detailing to construction creates a sense of purpose and a connection. It begs the question of how time and experience affect the development of a personal design process, a process that encompasses production and project execution as well as clarity and richness of concept. A project with a big idea that is carried through from beginning to end creates a perception both ethereal and tangible.

Personal Process

Franz Kafka's *The Metamorphosis* describes the impossible occurrence of how the main character, Gregor Samsa, turns into a giant bug by a seemingly supernatural transformation that is missing cause or reason.[2] This represents that a transformative process is as likely to be informed by the unknown as it is by a more fixed or rational response. Unlike Gregor, we must question the changes that result, reflect on them, and seek the advice of teachers, colleagues and mentors. We continue to grow, learn, question, experiment, and evaluate. *Forward* seeks to do just that. Where do our design skills and methods originate and how do we develop our philosophies through an integral approach?

We should aim to find a personal process we can call our own.

A personal design process evolves over a lifetime and includes not only the development of the process itself but the path we take to enrich, inform, and personalize the process. It is that internal process of transformation that intrigues me. By remaining open to the exploration of new approaches and new ideas, we rejuvenate our design spirits. We learn what actually works and what doesn't, how to meld academia with practice, and that preferences are formed by personality and philosophy. The key to maintaining the link to our guiding design principles is to immerse ourselves in a process of continual personal and professional growth and transformation. We must seek to find a personal process we can call our own; one that is defined by our beliefs and experiences, while simultaneously drawing from the methods of others, whether from academic, professional, or alternative careers.

Art + Practice

A new series of illustrated architect monographs by Moleskine, called *Inspiration and Process In Architecture*, features notes, sketches and stories by four architects: Zaha Hadid, Bolles+Wilson, Alberto Kalach and Giancarlo De Carlo.[3] My fascination with diagrams is that they can describe a project in one glance. They are a visual document of the process of design. A beautiful diagram can be a work of art, tell the story of concept and at the same time reveal something very personal about the author: their thoughts and emotions. It is a tangible connection to a teacher, a student, a co-worker, a mentor, or an idol.

Theory + Science

Theoretical discoveries based on established or new principles, as well as innovations rooted in science, math or logic, dictate modified approaches to design. What we are taught, and what we learn, provides unexpected insights into both age-old methods and new philosophies. We must aim to make at least one new discovery, learn one new thing, every day.

Finally, we must remain open to the adoption of new tools and techniques. As architecture continues to evolve, computational and parametric strategies, digital fabrication and building information modeling are changing the way we view, observe and execute architecture and design. We should explore the multitude of different methods of creating; as designers, we are always learning, always evolving.

Teaching + Learning

How do we start the design process and how does it evolve into a building? The development of a personal design method begins in school—or even earlier—and continues over the course of a lifetime. The fundamental knowledge and experience gained in the early years of a career lays the foundation for our development and evolution as designers. The support we receive from colleagues and mentors aids in that development. As we test and alter our design process, the design process changes us.

Forward 112 raises a number of provocative questions about the nature of the design process and explores possibilities for design discovery. The articles describe a series of balancing acts, compelling cross-sections of thought and design process that direct us to look inward to our own balance of art and practice, theory and science, teaching and learning. Most importantly, the trajectory of a design exploration is, in and of itself, a personal process of change.

We transform our buildings, our students, our artwork, and ourselves.

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1. Franz Kafka, *The Metamorphosis and Other Short Stories* (New York: Dover Publications, Inc., 1996), 14.
2. Kafka, *The Metamorphosis,* 11-52.
3. "Inspiration and Process in Architecture," Moleskine, accessed June 19, 2012, http://www.moleskine.com/about_us/news/inspiration_and_process_in_architecture.php

Olivia Graf Doyle, Assoc. AIA
Forward Director
Olivia Graf Doyle joined the Forward team as an Assistant Director in 2011, and is excited to be taking on the role of Director for the 2012 and 2013 issues. Olivia is a Design Leader at HMC Architects in Los Angeles. She graduated with degrees in architecture and advertising from the University of Southern California. Olivia has worked on a variety of projects that range from medical to K-12 and university to interior architecture, in addition to being a contributer to her firm's internal blog. Outside of work, Olivia is actively involved with the local design community; was an Associate Director on the board of AIA Northern Nevada, started chapters of the Young Designer's Networking Group in Reno and Sacramento, and has been published in several architecture history textbooks.

DATA DRIVEN TRANSMUTATION

by Ming Tang; Aijla Aksamija, PhD; Jonathon Anderson; Michael Hodge

an Investigation of Performance Based Design and Adaptive Systems

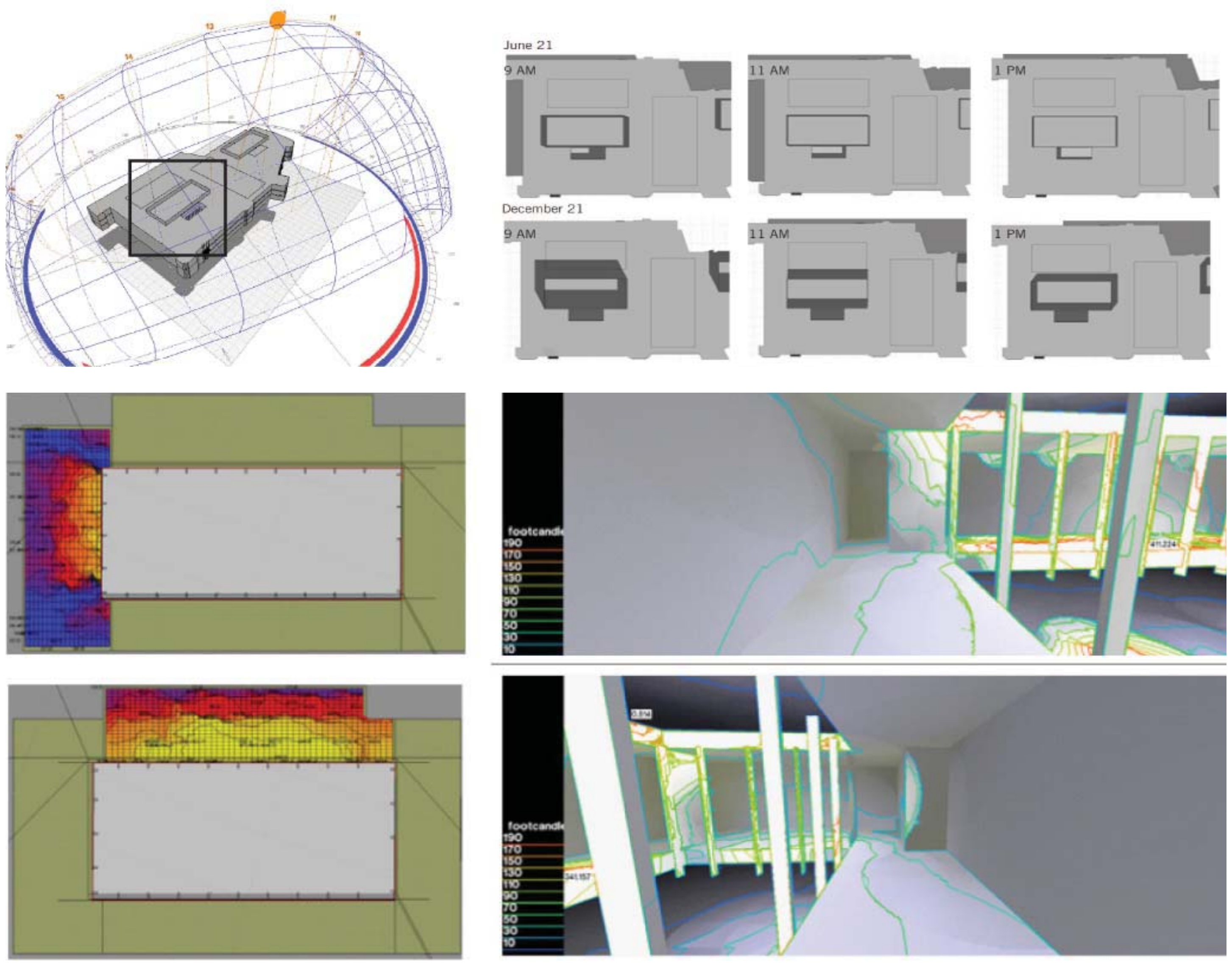

Image 01_Solar position and daylight simulations studies for interior light-well design; Right: Shadow studies and daylight levels within interior spaces surrounding the light-well. By Ajla Aksamija.

Performance-based design is a process where information and data-analysis augment prior design experience with the goal of improving the design decision-making process. For example, building performance analyses are an integral part of the design process for energy efficient and high-performance buildings. Information and data analysis aid the investigation of design options and simultaneously assess the environmental and energy impacts of design decisions (Augenbroe et al. 2004; Aksamija 2009; Wetter 2011).

Energy and thermal simulations, daylight studies, and solar exposure analysis are additional examples of performance-based design (Image 01), where the objective is to develop an energy efficient building. Thus, buildings are designed to improve overall building performance, reduce energy consumption required for the building's operation, and improve the comfort of the occupants. Quantifiable predictions and simulations can help in identifying strategies and methods to improve building energy efficiency and the overall building performance.

A design method that integrates energy, environmental, and other types of analysis at early design stages is the basis of performance-based design. The differences between this approach and those of traditional design methods are:

Traditional Method:

Is deficient because: (1) the method may include simplified assumptions based on rules-of-thumb that may be inaccurate; and (2) the method may not provide performance measurement/ evaluation of a certain design solution.

Building Performance-Based Design Method:

Has the ability to estimate the impact of a design solution since: (1) performance measures are investigated with actual quantifiable data and not rules-of-thumb; (2) the method uses detailed building models to simulate, analyze and predict behavior of a system; (3) the method produces an evaluation of multiple design alternatives (Aksamija and Mallasi, 2010).

A performance-based design process can be integrated with various generative and parametric design methods. Many architects have employed methods such as decision trees and rule based systems as a means of solving design problems. Some of the emerging aspects in contemporary architecture include the utilization of genetic algorithms in the design process, as well as the use of simulations and performance-driven design approaches to generate complex building forms that respond to environmental criteria.
Comparatively speaking, genetic evolution and transmutation are successful in biology,

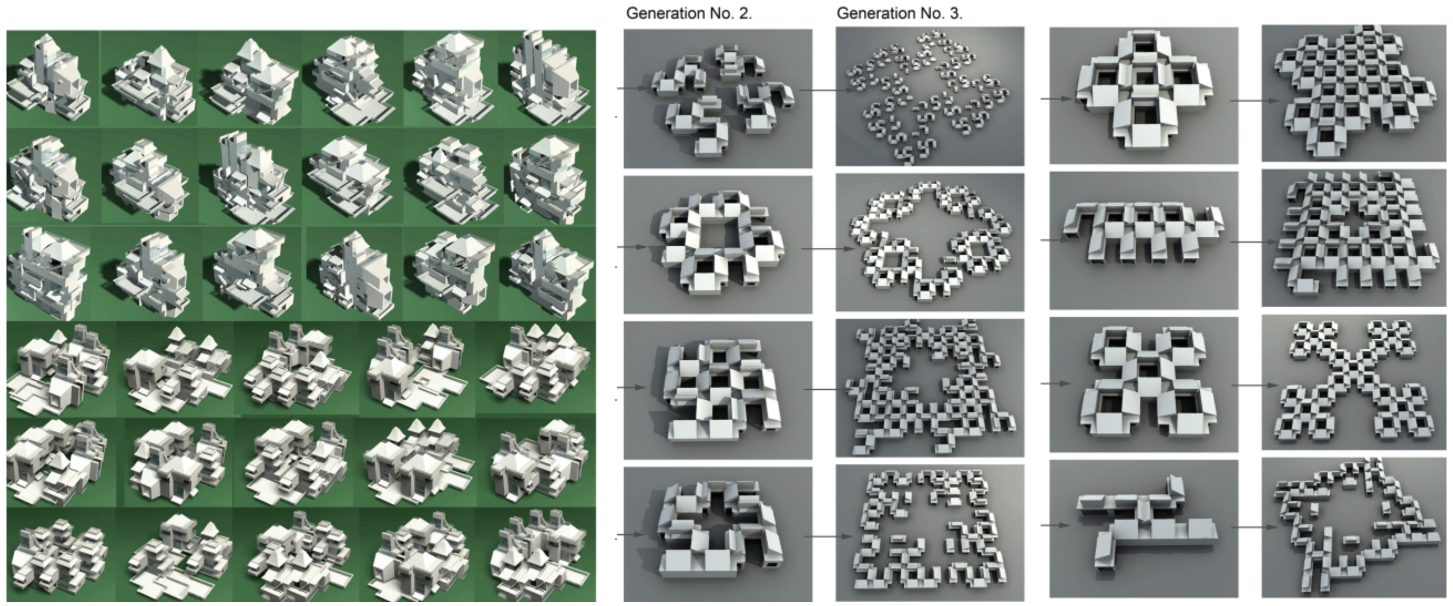

Image 02_Generative modeling with L-system. Left: house archetype. Right: courtyard archetype.

but the use of these processes in the architecture field is limited by a major constraint: the lack of a "shared body plan." As described by Manuel De Landa, a shared body plan is "a kind of 'abstract vertebrate' which, if folded and curled in particular sequences during embryogenesis, yields an elephant, twisted and stretched in another sequence yields a giraffe, and in yet other sequences of intensive operations yields snakes, eagles, sharks and humans."

In other words, by changing the proportions of the components in the shared body plan, various types of creatures begin to be generated. Manuel adds "…if evolved architectural structures are to enjoy the same degree of combinatorial productivity as biological ones they must also begin with an adequate diagram, an abstract building corresponding to the abstract vertebrate". (De Landa, 2001). Architectural objects may lack the common ancestors found in natural life forms that pass their shared body to offspring however, emerging digital tools and parametric design approaches offer flexibility and computational methods for the adaptation of architectural forms, geometries, and elements (Image_02). Coupled with performance-based design, this approach allows architects to develop forms, geometries and building forms using data that responds to environmental constraints. (Image_03).

Performance-Based Design and Prototyping

In 2011, the authors launched a collaborative research and teaching project between the University of Cincinnati, Perkins + Will's Tech Lab[1] and nD group[2], and the University of North Carolina at Greensboro. This collaboration was based on a close working relationship between academic institutions and the design practice. The primary focus was on the design and fabrication of adaptive building components generated through the use of performance-based design processes. The design process integrated computational tools, simulations, and fabrication techniques while responding to the criteria of performance-based design. This platform provided a method to investigate innovative design methods, observe the design development phases, implement novel fabrication techniques, and document the experimental results of introducing performance based design principles. Students explored computational methods for generating designs through in-depth studies of digital model generation and analysis, and design prototyping. Students applied a parametric design sequence associated with procedural modeling, performance-based decision making, and digital fabrication. Through the utilization of several digital design tools, including Galapagos engine in Grasshopper, MEL scripting in Maya, and Revit API, students explored parametric design approaches. The entire process relied on quantifiable performance data, coming from analysis applications, to influence and impact form, performance, and geometry.

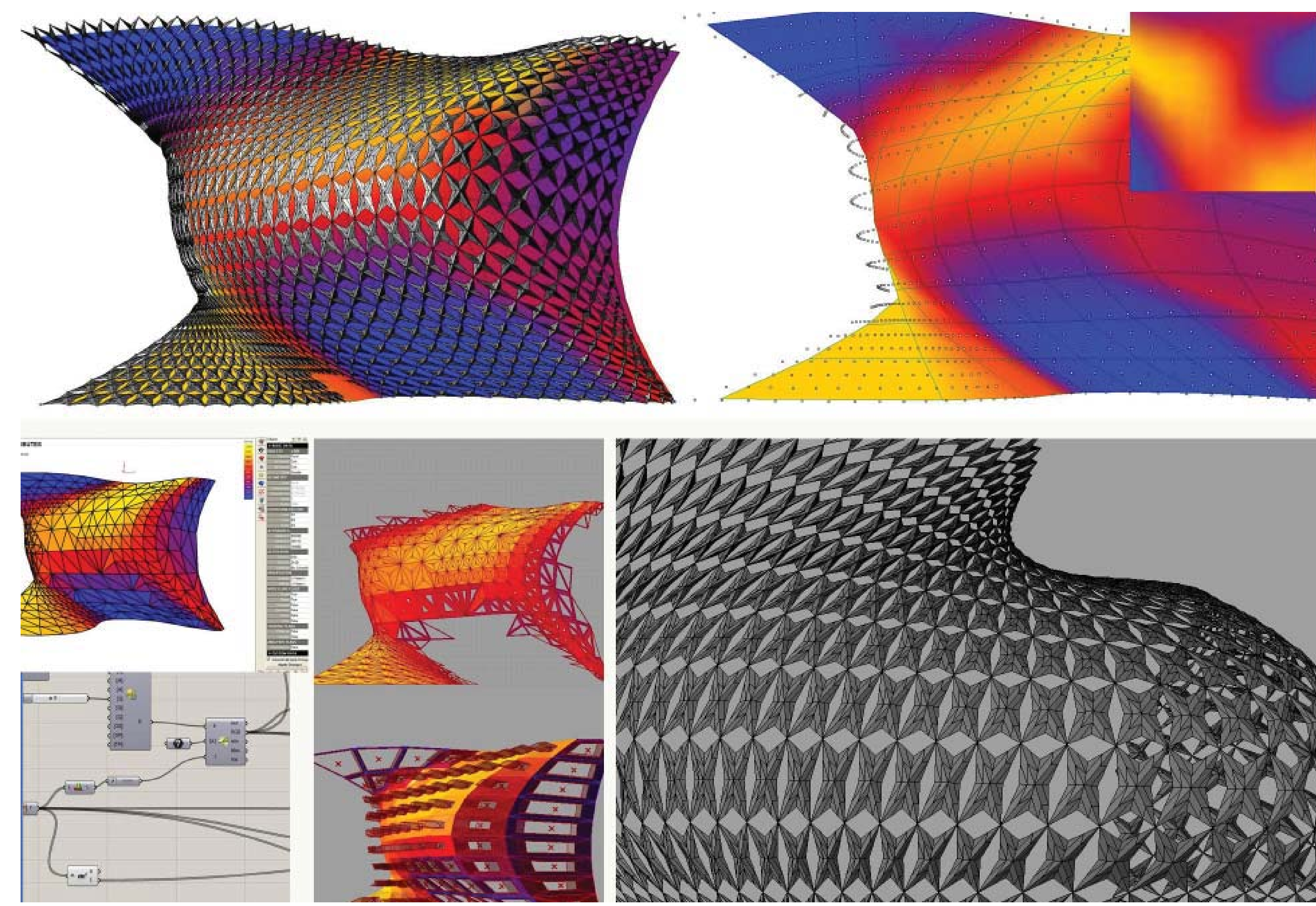

Image 03_The geometric morphing and transmutation of paneling system is interactively driven in real time by the solar access simulation. Tools: Rhino, Grasshopper, Geco, Ecotect, Maya.

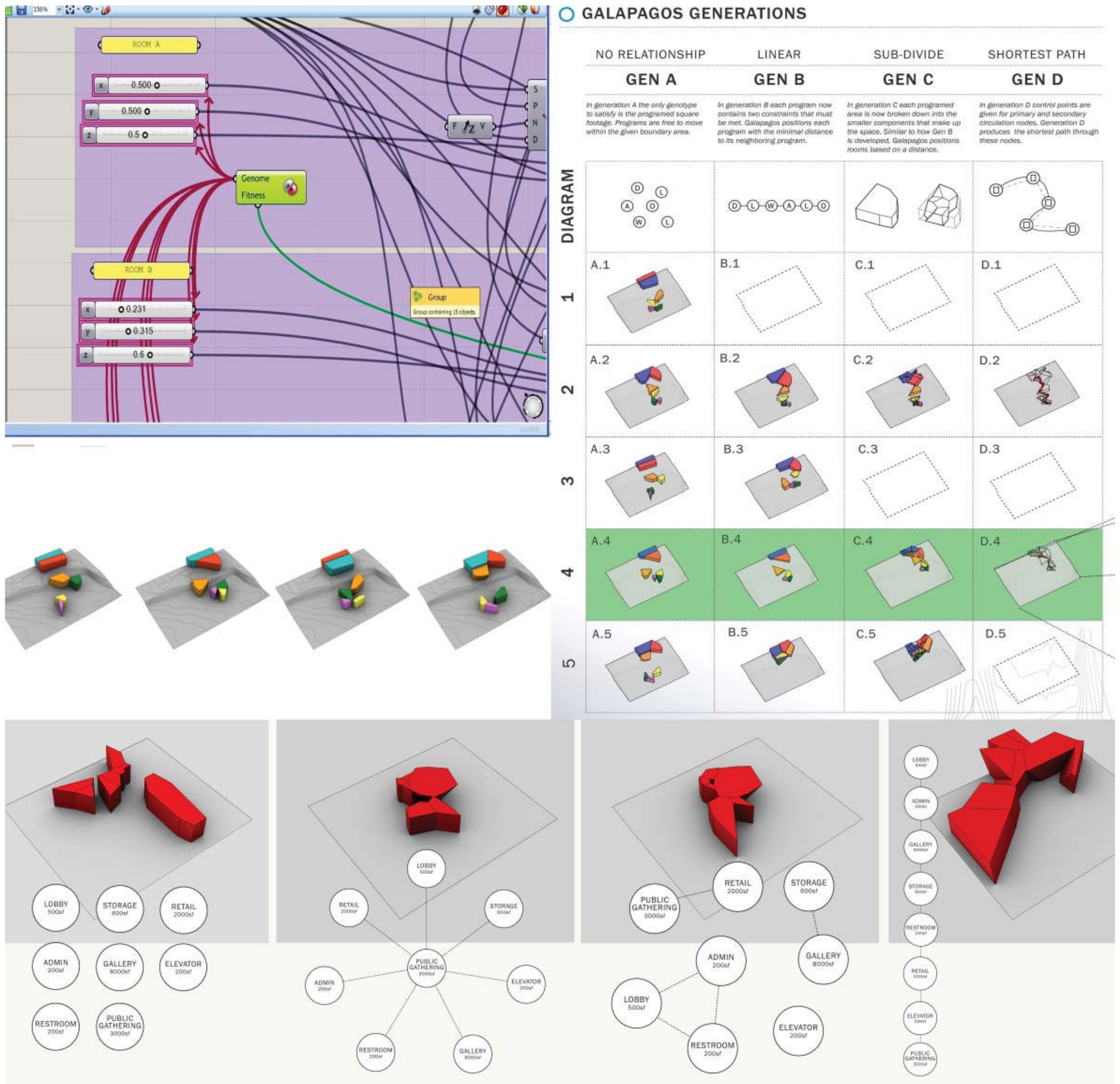

Image 04_Genetic Evolution computed with Galapagos. The massing diagrams are generated by a single Grasshopper script in conjunction with the Galapagos tool to produce multiple iterations. Each programmatic mass is defined by a set volume and distance or relationship to another program. The rules of predefined spatial adjacency create a score system for the evolution engine to compute.

Digital Prototyping

In these explorations, performance data is represented as sets of numbers illustrated and processed through computational methods. The relationship of performance data and building form were examined in real time. Digital models were the primary medium for representation and performance evaluation. Once a digital model was generated, the performance data was obtained through Vassari, Ecotect simulations and/or pre-defined rules in Galapagos. It is at this point that the performance-based design process acts as a system where the performance data drives parametric controls. As a result, the revised model and simulations are processed as a feedback loop until the intended level of performance is reached (Image_04). Instead of separating the design and analysis processes, the performance analysis became the driver for a set of iterations and form finding. For instance, students used a Revit Plug-in, developed at Perkins+Will, to generate a building skin based on the solar radiation patterns on each façade.

This proprietary plug-in allowed for use of analytical data, coming from applications such as Ecotect, to parametrically control BIM families in Revit (Aksamija et al., 2010). The data (e.g., incident solar radiation striking a surface) was imported into Revit through Excel spreadsheets. This data can be used to parametrically position and size shading elements, apertures, and other facade elements by manipulating geometry and properties of the Revit families. For example, solar radiation levels can drive the depth of a shading device or the density of the wire mesh across the building skin (Image_05).

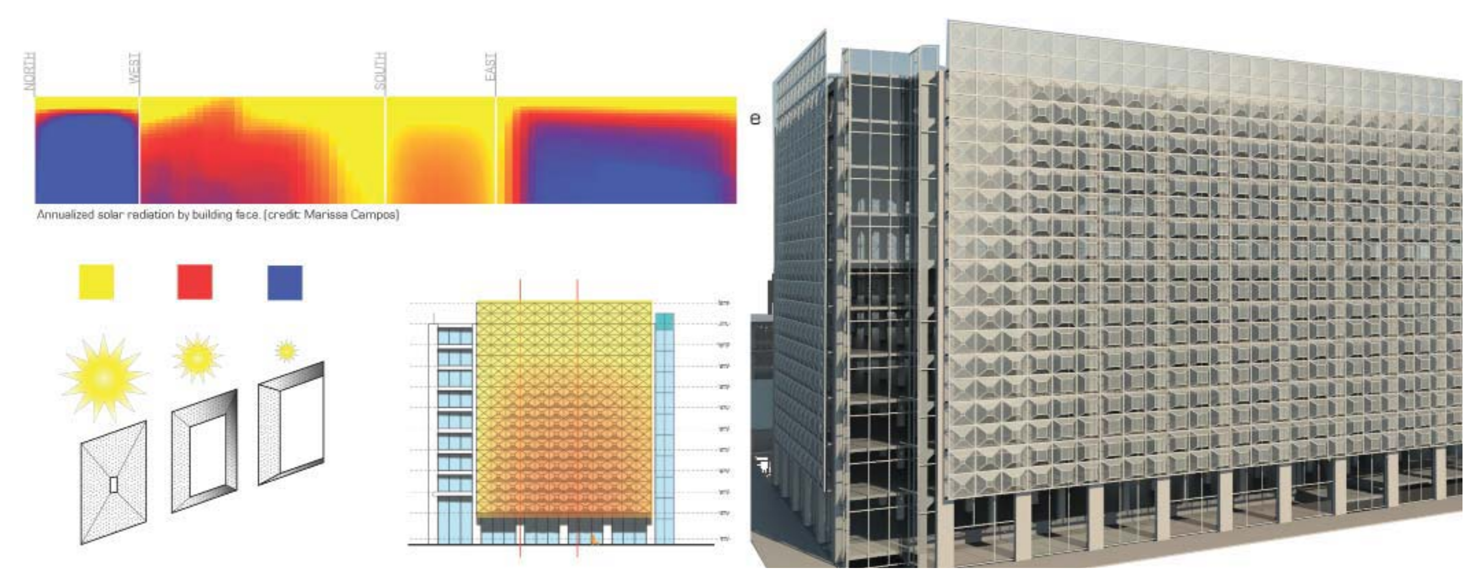

Image 05_Solar radiation data became the driver to make adaptive curtain wall system.

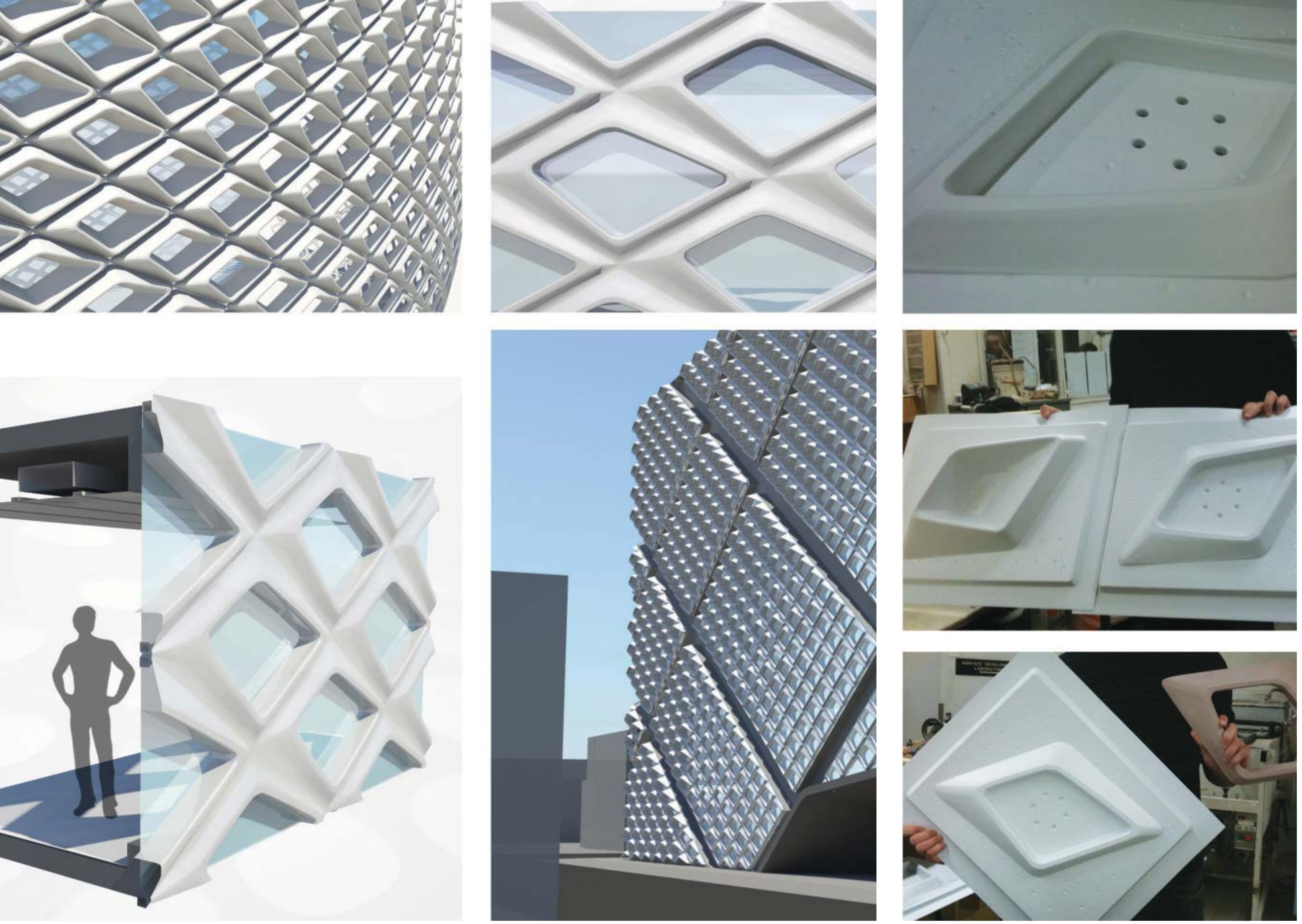

Image 06_Digital + physical prototyping, adaptive wall panel.

Physical Prototyping

The authors realized the necessity for expanding the performance-driven form seeking process into the physical realm through fabrication and physical prototyping. This integrated approach investigated how a large quantity of iterations can be filtered and selected based on the feasibility of fabrication. The essential values of architectural prototyping, such as the property of the material or size constraints of fabrication machines, often evolve into a process that we are coining “artificial selection”. The selection process yields a design that can be explored by a number of fabrication techniques, such as laser cutting, 3D printing and CNC milling.

This process, the synthesis of performance-based design and physical prototyping, is viewed as an investigation of varying scales, the creation of hierarchy within prototypes, and a platform for understanding the performance of parts in the context of an integrated whole. As a simplified representation of the actual design, the tangible artifacts facilitate constructability reviews. The process also served as a way to investigate manufacturing process and material properties such as tolerance, strength, and elasticity (Image_06). In some cases, the design solutions had to be modified during the fabrication phase to adapt to material properties (Image_07).

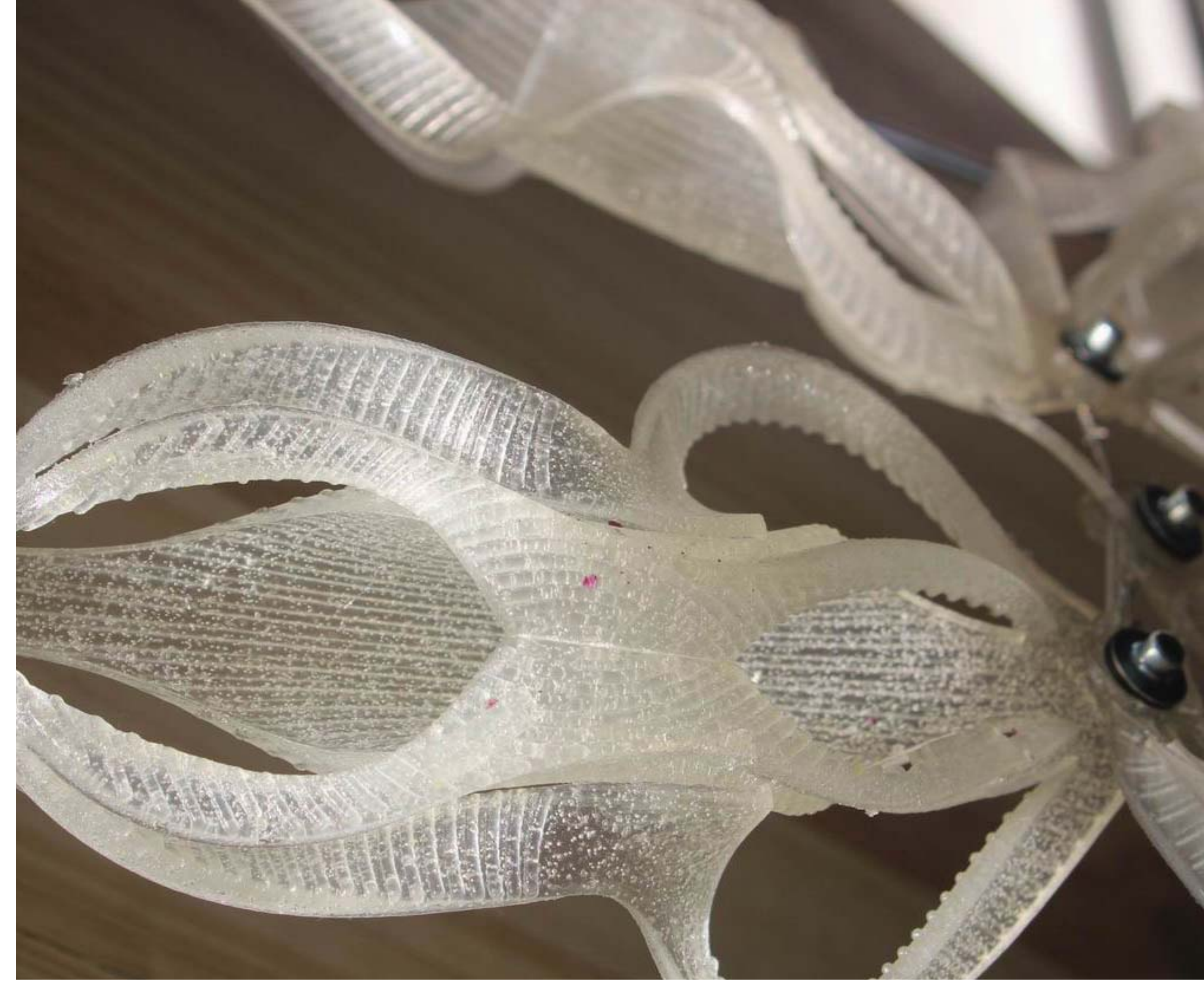

Image 07_A computer generated CNC milled high density foam mold serves as the casting medium for the flat-cast liquid urethane component. A tooling path is embedded in the mold to allow a subtle surface texture to capture and reflect light qualities.

Conclusion

The use of performance analysis to control an adaptive system is just one of many approaches for informing design decisions. Designers must understand the formation process that nature permits in order to define a generative system. As a simplified approximation of a complex system, both digital and physical prototyping methods were used to study the relationships of the parts to the whole. Digital prototyping provides a platform for testing and reworking the design until it reaches desired performance levels. Physical prototyping allows the analysis of material properties and behaviors under stress, vibration, and other forces. In our case, both processes combined were viewed as the performance driven design process. We feel that this process should be the foundation for decision-making in architecture, both in the academy and practice. We are continuing explorations around how these design approaches can be used to develop innovative and performance-driven design solutions.

Image Credits

Title Image_Graphic design by Joe Lawton, original background image by Ming Tang

Image 01_By Ajla Aksamija

Image 02_By Ming Tang

Image 03_By Ming Tang

Image 04_By George Faber, University of Cincinnati.

Image 05_By student Francis D'Andrea, University of Cincinnati

Image 06_By student Drew Newman

Image 07_By students Brian Ballok and Trevor Jordan, University of Cincinnati

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1. Tech Lab is an on-going program of Perkins+Will's Excellence in Execution Initiative to advance the performance of project designs, to improve design decision-making and documentation, and to inspire greater achievement in Perkins+WIll projects. The research agenda focuses on advanced and emerging building technologies, materials, high-performance buildings and computational design.

2. The nD group is a collective of individuals in Perkins+Will researching, promoting, knowledge management, and developing techniques and methods adapting computation to the design culture of Perkins+Will.

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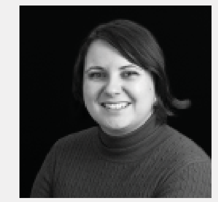
Ming Tang is the Assistant Professor at School of Architecture and Interior Design, University of Cincinnati. His multi-disciplinary research includes parametric architecture & urban design, fabrication, BIM, performance driven design, computation, virtual reality, algorithm & math & programming, GIS, simulation, interactive design and visual effects.

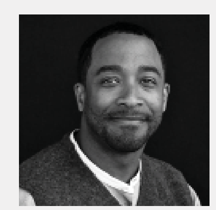


Aijla Aksamija, PhD, LEED AP BD+C, CDT

Dr. Ajla Aksamija leads Perkins+Will's Tech Lab, whose research objectives are to advance the performance of project designs, to improve design decision making and documentation and to promote commitments to sustainability, innovation, and value. Dr. Aksamija has worked on developing building analysis applications, implementation of novel materials in architectural design, and development of computational models. She has contributed to several books, has published numerous research articles, and has presented at international and national conferences.

Jonathon Anderson, MFA, ACADIA, IDEC, ACSA

Jonathon Anderson is currently an assistant professor of Interior Architecture at the University of North Carolina Greensboro. His work explores how industrial manufacturing and CNC technology influence the design process and the act of making architecture. He is a founding partner of the international design firm sur:FACE studio with offices in Greensboro, NC and Hangzhou, China. In 2011, Jonathon co-founded MADcubic – a research and experimental design firm.



Mike Hodge

Michael Hodge is a designer in the Atlanta office and a Design Technology Leader. He is involved in a number of firm wide initiatives where interdisciplinary approaches to design computation are being investigated and defined. He is the coordinator/moderator of a firm wide focus group titled nD. The group is an interdisciplinary think-tank, currently organized to bridge research and development as applicable to process-centric design approaches. The nD group is a collective of individuals in the firm researching, promoting knowledge management, and developing techniques and methods adapting computation to the design culture of the firm.