Graphic Imprints

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Editor

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The Influence of Representation and Ideation Tools in Architecture

Springer

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Preface

The book presented here is a compilation of articles collected under the title "*GRAPHIC IMPRINT. On the Influence of the Representation and Ideation Tools in Architecture.*" It is the result of the seventeenth biennial International Conference on Architectural Graphic Expression (EGA 2018), which was held in Alicante on the 30th and the 31st of May, and the 1st of June of the year 2018.

The book is organized into eight parts: an introductory couple of texts proposed by two of the keynote lecturers, Aberto Campo Baeza and Gernot Reither, and seven parts in accordance with the proposed tracks of the conference to entice a multifaceted reflection in relation to the conference's theme.

The main theme proposed for the 2018 EGA International Conference was conceived to foster the debate around the role that drawing and, more generically, representation and ideation tools have played in the development of architecture and its own language over time. The tool is not innocent; some of us tend to think that to a greater or lesser extent, it may influence the result that is obtained from it. In this sense, the conference seeks to claim the decisive role that design tools and drawing in particular have had throughout history in the evolution of architectural language itself.

Despite the instrumental nature of drawing within architecture, the influence that the development of representation systems and the different tools used by the architects during the project process have had in history proves that there is a fertile relationship between drawing and project, between graphic ideation and architecture. Most disruptive recent practices seem to challenge some of these relationships while generating other types of imprints in the architectural project, perhaps even more decisive in the final result. Thus, the reflection on the imprint that the graphic or other design tools may have on the project and, as a consequence, how these tools might have been able to influence in different ways the course architecture itself is still necessary.

Think, for instance, on the invention of perspective in the Renaissance and how the idea of perspectival space was addressed in the architecture of the time even if linear perspective was to be considered by some as a symbolic form of representation many years after the invention of its geometric basis. Or ponder on the

development of the systems of representation of architectural space with the appearance of the figure of the architect as a "substitute" of the master builder, a new trade with the ability to draw and anticipate the conceived architecture—the translational role of drawings with regard to architecture ever since, to use Robin Evan's suggestive metaphor. Reflect on the development of Borromini's drawing techniques introducing graphite drawings or on the development of descriptive geometry by Gaspard Monge; the precise ruin surveys were undertaken in the eighteenth century and their indisputable influence on revivalisms may have had little echo without such geometric development. Imagine the rich cross-relations between modern architecture and the avant-gardes such as the conception of space in Cubism or the use of axonometric projections in De Stijl, and years later among the Five Architects. Think on the relationship between Constructivism and the role of Lissitzky's Prouns or Chernikov's architectural fantasies with regard to some deconstructive architecture. Think on the continued use of diagrams from Durand to Eisenman or the emergence of 2D computer drawing and the digital stratification of information into layers and projects in strata such as Tschumi's La Villette Park. Consider also the significant change introduced by virtual modeling and the truly three-dimensional conception of architecture with blobs and folds—not a mere extruded space. Reflect on the development of scripting languages and parametric design, or on the topological notions applied to the concept of open form, algorithmic architecture and the natural counterpoint of digital manufacturing to enhance the materialization of this new digitally borne architecture: a *brave new architecture* addressing a new notion of materiality. Even the BIM conception with its new paradigm of representation and design based in a geometrically referenced database structure may involve significant changes in the final result of the design too.

The theme is therefore mainstreaming, multidisciplinary, while combining past and recent history, as well as digital future.

As aforementioned, the book is structured in an introduction, followed by seven different parts deriving from the seven conference tracks which proposed different topics and subtopics to promote a broad and ample debate pivoting around the conference's main theme:

Part II. Architecture and Representation

Architectural graphic narrative
Surveys and revivals
3D modeling and rendering
Digital surveys and tools

Part III. Representation Materiality and Digital Fabrication

Models, representation and ideation
Structural models and prototyping
Digital fabrication
CAD–CAM synergies
New materiality

Part IV. Cartographies, Mappings, City and Territory

Cartographing landscape
Urban mapping
Space syntax, flows and urban dynamisms

Part V. Projections and Architectural Space

Geometry and projections
Spatial syntax and architectural topologies
Reverse engineering

Part VI. Architecture, Phenomenology, Perception and Interaction

Perception and phenomenology
Visual thinking and architecture
Perception, orientation and cognition of architectural space
Interaction and architecture
Performative architecture

Part VII. Teaching Innovation and Research

Analysis and architectural design
Graphic representation, communication and narrative
Geometry, projections and spatial visualization
New technologies and digital processes

Introduction

Two of the keynote lecturers have proposed a couple of texts which, somehow, may introduce the reader into the conference's debate and the conception of a disciplinary tradition within architecture reflected on the architectural profession. Alberto Campo Baeza in his personal sought for beauty and a certain poetics of

light in space reflected through his architectural practice proposes us to delve into the preliminary phases of design and the role of ideation sketches in the prefiguration of the architectural design; in them, we may find "the seed of the entire project." Maybe with his generation, this magic relationship between drawing and project may have come to an end, once the digital revolution has taken over architectural daily practices. Gernot Riether, on the other hand, is a digitally conscious architect exploring the possibilities the new tools may offer, especially in relation to the convergence of CAD and CAM techniques which Kolarevic refers to. Maybe, the tradition of the master builders as the qualified trade to supervise the material production of architecture is now being favored again by architects progressively gaining control over these processes thanks to the use of digital fabrication techniques.

Drawing and Project

Drawing in order to design has been and still is a common practice in the profession, at least in the preliminary phases of the project. Regarding architectural ideation, drawing has been a vehicle of design thinking and the way to reflect through a graphic language by the designer. From drafts, sketch drawings and sketches to generative diagrams there is a whole repertoire of experiences that are part of these ideation mechanisms. However, the emergence of new technologies has, to some extent, defied such practices. For instance, the idea of stratification as a project strategy can be paralleled with the characteristic work in layers used in design software, a logical consequence of the categorization of information. However, the step of modeling rather than drawing implies a much greater leap. A further step may be envisaged in project strategies based on shape grammars. The development of parametric designs or form-finding strategies using algorithms and iterations is quite a revolution from a design point of view, probably the deepest in the course of architectural design history.

Drawing, Architecture and Representation

The drawing as a faithful anticipation of what it is about to be materialized with the necessary detail to communicate to third parties how should it be built has also undergone an evolution over time. Codification and graphic narrative have evolved to achieve the required precision and descriptive accuracy of the object to be constructed. Also to this respect, IT has implied a substantial change of the coordinates system; for example, in the capacity of renders to anticipate with hyperrealism the visual appearance of the projected architecture contributing to generate new architectural imaginaries. Likewise, the possibility of generating documents and plans from the 3D model, or the most evolved version of generating a database

structure file in a georeferenced system on the project itself in which the elements of the model are a faithful detailed representation of each of the real components of the project—the BIM—implies a substantial change in the project process.

But drawings are also to be understood as part of a reversible process and, accordingly, to be conceived as a faithful reflection of built architecture itself; typically a graphic survey. There is a whole tradition of drawings, treatises and canons in the history of architecture that show the importance of the drawing as a vehicle of diffusion of these standards. The development of printers and different etching techniques contributed greatly to the diffusion of architecture, especially of Renaissance, Baroque and Enlightening architecture.

In relation to archaeology and architecture, the role that surveys had in the resurgence of different revivals in certain periods proved to be decisive. Even the diffusion of architecture through photography in specialized publications continues today to mark trends and play a role perhaps analogous to that of the Renaissance and Mannerism treatises. Nowadays, the surveying techniques have hugely been developed using 3D scanners and digital photogrammetry that replace lines and planes by point clouds; this is another significant change introduced by ITs. There is also a parallelism between the classic taxonomy of drawings and images with vector and raster formats, respectively, in the digital domain.

Drawing, Representation and Physicality

Physical models conceived as three-dimensional representations of non-graphic nature have been commonplace in architectural practice for centuries. Sometimes as a prototype study of a particular structural behavior or simply as three-dimensional objects in miniature architecture have served as a project instrument. Its own materiality could establish a parallelism with the material of built architecture - think in the possibilities of conformation of the concrete or the case of Gaudí and the funicular models-. The possibility offered by recent practices comprising CAD and CAM techniques allow us to anticipate a promising future in terms of the possibilities that digital manufacturing may entail; many recent projects follow these kinds of design strategies, as Lisa Iwamoto has recently pointed out, generating new architectural imaginaries. Perhaps this convergence is one of the main contributions of the digital revolution thanks to the customized production series. In the realm of representation itself, the emergence of Fab Labs allows to advance in matters of prototyping on a non-industrial scale according to the means available at universities.

This revolution in progress has replaced drawings and plans by three-dimensional models and 3D prints, and by studying the behavior of certain materials with the incipient 4D printing technology.

Drawing, Mapping, City and Territory

The city as an extension of the architectural realm has also required drawing to materialize when it has followed a planning system for the development of its own growth. The territory has also been mapped and analyzed making use of projection and representation systems. Perhaps the emergence of geographical information systems in the management of cities and the territory has taken a new dimension in the understanding of complex problems that can now be analyzed in structured databases which allow relating many parameters. Even tools like Space Syntax or Foursquare allow to analyze traffic flows and activity or the urban preferences of the inhabitants with geolocation systems. This will undoubtedly contribute to the improvement of urban and territorial intervention projects in order to advance toward the emerging Smart Cities paradigm.

Drawing, Projectivity and Architectural Space

The evolution of descriptive geometry and projection systems throughout history also contributed to molding professional practice in certain periods. The difference between the value of the measure and the perspective distortion divided drawings into those that are used to construct and those that try to emulate the visual perception of the architectural space. In short: between parallel projection and central projection, the type of drawings that architects and engineers alike, on the one side, and painters, on the other, would be more fond of using depending on their goals as Alberti suggested in his *De Re Aedificatoria*. Painting and architecture evolved significantly during the Renaissance from this division, and, once again, the drawings were shapers of imagery and architecture itself. The very aesthetic contamination of the architecture of modernity and the avant-gardes of the early twentieth century are a further confirmation of the influence of the graphic tools—even interdisciplinary—in the evolution of architectural language. The new digital tools have fostered the construction of imaginaries that explore the possibilities of graphic narrative derived from its use generating what could be regarded as a new formal abstraction.

Drawing, Architecture, Perception and Interaction

The question of architectural perception and phenomenological issues has had followers in architectural criticism who have been concerned with the relations between the dweller and the work, between man and architecture. But there are also perceptual problems in the graphic language of architecture that pertain to its graphic representation, codification and narration. Eye tracking experiences

demonstrate a clear bias in the way our brain analyzes and processes visual information. Arnheim's seminal text on visual thinking and its subsequent architectural sequel also help to reflect on these issues in the architectural graphic expression field.

In this sense, this conference has encouraged the reflection on issues of perception and cognitive psychology in relation to architecture, and the graphic language which nurtures the discipline itself. From the relationship between perception and knowledge of space, on the one hand, to its material or virtual—or even mental—representation, on the other. Think, for instance, on spatial orientation, mapping, or visual-mental itineraries. Areas such as that of visual intelligence, present in the field of neuroscience research, can contribute to unravel the mental processes involved in the drawing mechanism of design and how, despite substantial changes introduced by new technologies, all of them recur to display interfaces of the conceived designs. The abstract codification of formal structures in parametricism clearly produce a defamiliarization on the architects' side; visual programming interfaces such as Grasshopper try to save the gap but everyone using them needs to periodically check in a display if the geometries defined through the script reach the design expectations.

The recent creation of the American Neuroscience for Architecture is witness to the growing interest in this interdisciplinary approach. In addition, new technologies have also explored the possibilities of interaction between architecture as an object, the environment and the subject that must inhabit it in what has come to be called performative architecture, both at the individual level and in the area of interaction and social networks.

Teaching Innovation and Research

Finally, although not originally proposed within the conference tracks, due a significant number of abstracts received related to this line of research and in agreement with the Scientific Committee, we decided to include a section dedicated to teaching innovation and research in architecture in accordance to prior EGA conference series scope. University should favor both, research and teaching innovation alike. Innovative pedagogy can also contribute to broadening research in an ample sense; this was the objective of this track which shows contemporary teaching innovative approaches and architectural pedagogy.

As with regard to the conference itself and the academic organization of the selection of papers, we have compiled here the texts that have been filtered through a blind peer-review process of abstracts and a second one of full papers by the Scientific Committee, comprising 27 international researchers, and the Peer Reviewers Committee, integrated by another 49 members from universities worldwide. Of the 250 abstracts that were originally submitted, we have collected all the full papers that were finally accepted for this publication and which are being presented here as original research in their field of knowledge, addressing the

conference's theme in accordance with the proposed topics. Parts I and II consistent with the EGA Conference series tradition have been the tracks receiving a greater number of contributions although, surprisingly to us, Part VI—which was new as a specific track—also had a significant acceptance. All the 137 full papers are in English, although they may have originally been written in one of the other languages accepted at the Conference, either Spanish or Italian, to reach a greater audience and potential attendants as well as promoting internationalization, one of the basic goals in this 2018 edition.

We believe this compilation of generously illustrated articles may now continue the new collection of books of international scope edited by Springer dedicated to architectural graphic expression as a field of knowledge in its own. A significant and increasing number of researchers from European and Latin-American countries have regularly contributed for over thirty-four years to set the basis of this area of knowledge related to the architectural discipline. The EGA Conference series that commenced in 1984 were in fact the base for the edition of the EGA journal, a highly reputed and indexed academic research journal specifically dedicated to the research on architectural graphic expression and architecture, edited since 1991, which will celebrate its 25th anniversary this year.

We expect the reader to indulge himself in the variety of proposals that are part of the contents of this book dedicated to the influence of the representation and ideation tools in architecture and their graphic imprint within the project.

Alicante, Spain Carlos L. Marcos
2018

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Keynote 1: When Most I Wink. On Drawings in Architecture

Alberto Campo Baeza

To see a World in a grain of sand,
And a Heaven in a wild flower,
Hold Infinity in the palm of your hand,
And Eternity in an hour.

How many times have I repeated this beautiful poem by William Blake to my students, trying to instill in them how much of the ineffable the best architecture has. "To see a World in a grain of sand" has quite a bit to do with what a diagram is in relation to the project that it explains to us. While the dictionary says that a diagram is a "graphic figure that explains a specific phenomenon," considering how complex constructed architecture is, we are surprised by the capacity of a diagram—such a small and simple drawing—to express so much. Like the grain of sand in relation to the world (Fig. 1).

I have written over and over again that architecture is a "built idea." And to build these ideas, one needs drawings that can express what and how this reality is. These

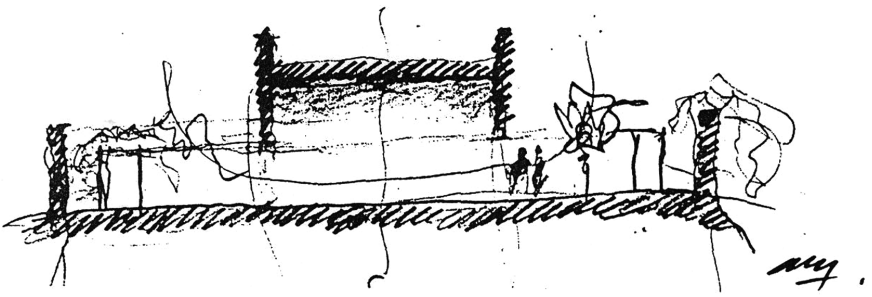

Fig. 1 Gaspar House (sketch section). Vejer de la Frontera, 1992

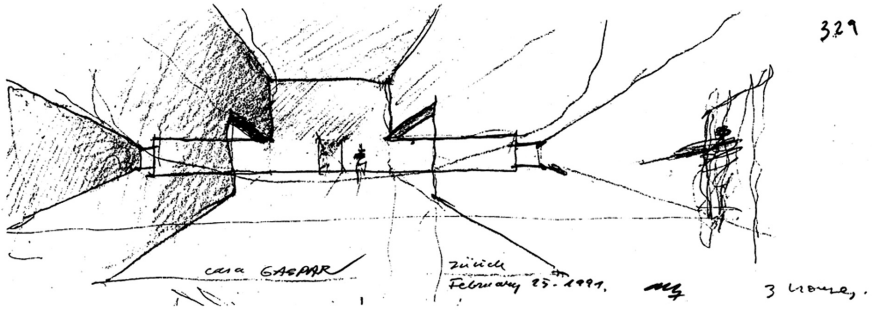

Fig. 2 Gaspar House (conceptual perspective sketch). Vejer de la Frontera, 1992

drawings are like "anatomical cross sections" of the new architectural body. They are the development of other simpler drawings that previously defined the project in a more general manner. And if we keep pulling on the thread, we reach a key moment: the beginning, with the appearance of very schematic, very synthetic drawings, which are the diagrams.

The diagram is the key drawing that contains within it the seed for the entire project. Like a fetus whose heart is already beating, that appears fully complete and when further developed will be born: that is the diagram in a work of architecture. In my architecture, diagrams have played a significant role.

And whenever I am asked for documentation for the publication of a project, I include diagrams to clearly explain my intentions (Fig. 2).

A diagram expresses the idea with great precision. It is the first concretion from thought to reality. When I draw a diagram, it seems as though my eyes are winking in the manner that Shakespeare describes so well at the beginning of his beautiful Sonnet 43:

When most I wink, then do my eyes best see,

For all the day they view things unrespected.

Keynote 2: Construction as a Creative Act. Design Build in the Digital Age

Gernot Riether, Director School of Architecture, Associate Professor, New Jersey Institute of Technology (NJIT)

Introduction

There are more than 100 architecture programs in the USA, but few of them have a design build program built into their core curriculum. The Architecture School at New Jersey Institute of Technology (NJIT) is one of them. In the 2nd year all students engage in a Design Build studio as part of their core curriculum, making students excited about the construction process early in their architecture education. In the 4th and 5th year students have another opportunity to engage in Design Build studios through NJIT's Option Studio sequence. This is possible through strong ties to industry such as the Masonry Contractors of New Jersey that are providing funding for NJIT's Design Build studios every year. In these studios students learn how to resolve conflicts collaboratively, engage in the making and learn about material properties and fabrication processes.

As an educator, I have taught and co-taught the Digital Design Build Studio at many different architecture schools throughout the USA. In this studio, we are testing new integrations of digital tools, techniques and methods. The purpose of this studio is to respond to a profession that has emerged over the past years at the intersection of design and construction. ARUP and many architecture consulting firms recognized that many architects could need help in translating ideas into systems that can be manufactured or build. As a consequence, they have over the past years absorbed a part of the design process that traditionally belonged to the architect. To provide students with the opportunity to also work in this growing profession it is important to learn the tools necessary and understand workflows that go beyond the abstract. As a result, students will be more flexible entering the practice that demands more expert architects. This paper will discuss a series of Digital Design Build Studios that I have taught or co-taught at Georgia Tech, Ball State University and Kennesaw State University.

AIA Pavilion

The pavilion was part of an annual art festival, organized by the AIA, the American Institute of Architects. The goal of the project was to activate otherwise forgotten urban spaces by injecting small pavilions into the city fabric of the French Quarter of New Orleans. Some spaces were hidden and difficult to reach, others were private property. The final pavilion was built in a private courtyard that was for one week—the duration of the event—turned into a public space (Fig. 1).

The form of the pavilion adapted to the courtyard. Its dramatic lighting drew people into the courtyard that was located deep inside the urban block, far from the busy street. In order to bring all the building components to the site through a very narrow alleyway, the envelope of the pavilion had to be tessellated into small triangles. Each of the PETG triangular panels was shaped to respond to the program of foundation, seating, window, structural elements, water collectors and planting pots. This created a total of 320 different variations.

To do that we used the malleability of the material that is a behavior typical for polymers. We combined the thermoforming techniques of vacuum forming, drape

Fig. 1 Interior of AIA Pavilion

forming and draping. Instead of using 320 different molds to form the 320 modules we developed a flexible mold that allowed us to produce all the different modules with one single mold. That way we were able to save most of the material that would have otherwise been required to produce large quantities of variations (Fig. 2) (Riether 2011).

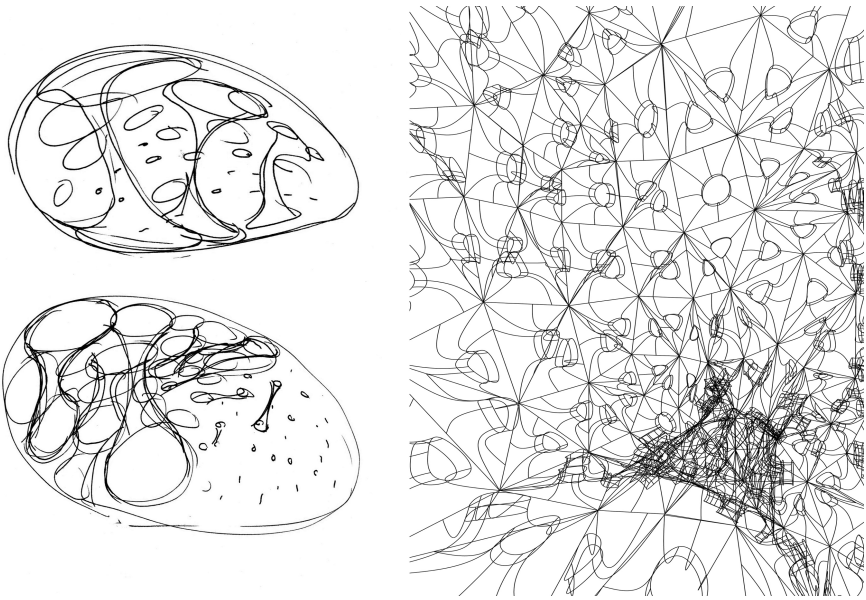

Fig. 2 Early sketches of AIA Pavilion and part of the wireframe of the final digital model

Nuit Blanche Pavilion

The pavilion was developed for the Nuit Blanche festival in Paris, France. The challenge was to develop a display for an interactive video installation by the artist Damien Valero. The skin was using the polymer's strength and its natural elasticity to self-stabilize a structure. This was achieved by building the cell from two parts that once connected to each other formed a double-layered prestressed surface (Fig. 3).

The skin integrated the infrastructure of the video installation such as projectors, sensors and cables. It was developed as a modular system that could be shipped, easily assembled and reconstructed at different interior and exterior spaces. The flanges of both parts were first bent and then connected to the neighboring cells. In that way the memory effect of the polymer was used to create tension between the modules. The stress that was built up within the surface by all flanges collectively formed the prestressed envelope of the pavilion (Fig. 4).

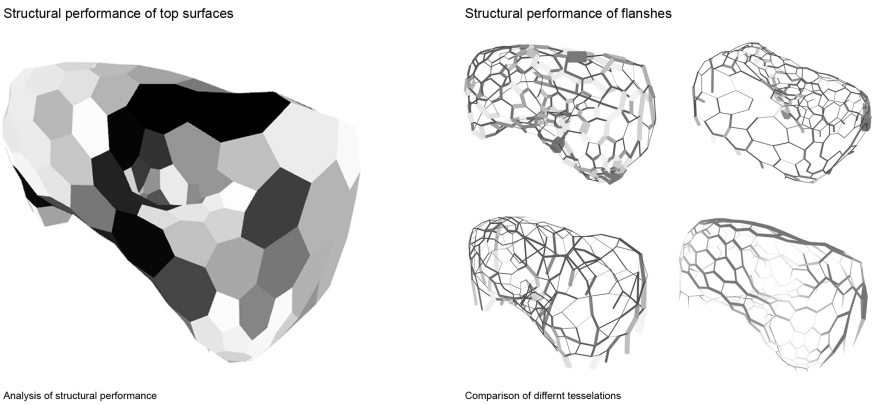

Fig. 3 Feedback from structural simulations of variations of the Nuit Blanche Pavilion

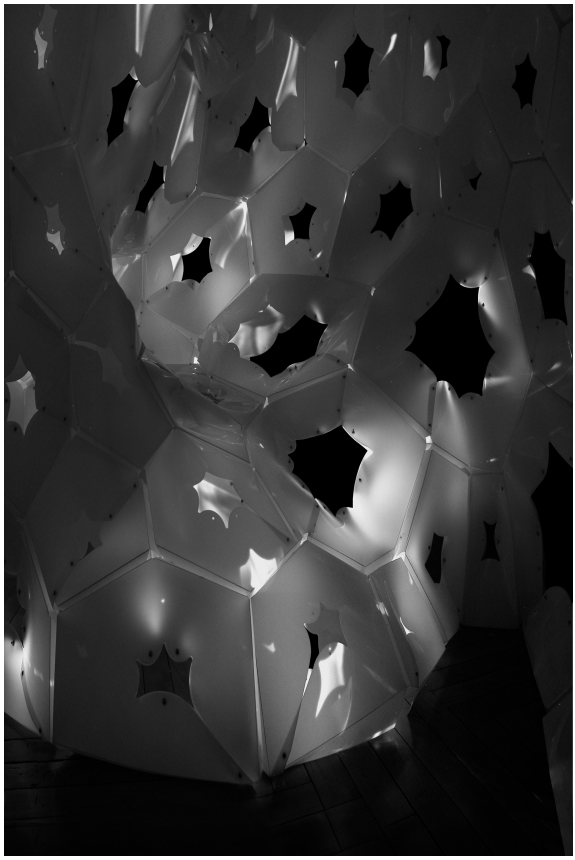

Fig. 4 Interior of Nuit Blanche Pavilion

To optimize the structural performance the size and geometry of the panel were related to the curvature of the overall form. In the final pavilion, different densities of hexagons and pentagons were used. This idea was inspired by the structure of exoskeletons of beetles. The parts and edges were numbered in the assembly sequence that allowed for a self-guiding assembly system that didn't require any additional drawings. This also allowed us to ship the unfolded parts to Paris and to involve a local team of students to help folding and assembling them on site in less than two days (Riether 2012).

Underwood Pavilion

The Underwood Pavilion resulted from a coalition with the Muncie Makes Lab. Its goal was to create a new permanent destination for hikers and cyclists in the postindustrial landscape close to Muncie, Indiana. Rather than rationalizing a given geometry into a tensegrity system, the intension of this project was to use simulation tools for a form-finding process. Individual modules were linked into a single tensegrity system. The final form emerged from changing the module's proportion and the configuration of the pattern causing a twisting and bending in the aggregate that was used to define the pavilion's spatial enclosure (Fig. 5).

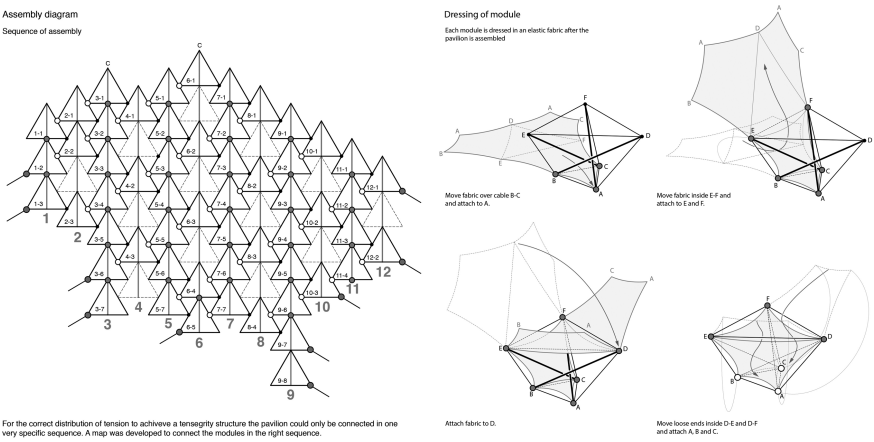

Fig. 5 The two drawings necessary to assemble the Underwood Pavilion

With all of the modules assembled on site, each individual module was fitted in an elastic fabric. The fabric enclosed the struts defining a minimal volume. Enclosing the compression struts with the fabric that was in tension created a perception of weightlessness, as the volumes visually appeared to not touch each other. Enclosing the modules with a fabric also suggests using the fabric structurally, an idea for future investigations.

The use of a parametric tensegrity structure had proven effective as a temporary structure because of its self-erecting behavior along with its ease and range of adapting its geometry. Simple details were developed to allow for a fast and accurate assembly process while maintaining the possibility of collapsing a mobile pavilion into lightweight bundles of cables and rods for easy transportation (Fig. 6) (Riether and Wit 2015).

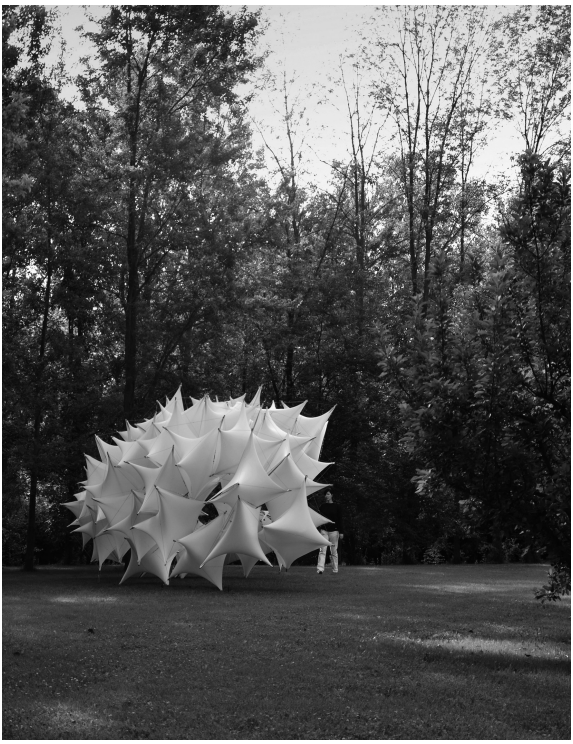

Fig. 6 Underwood Pavilion

Urban Blanket

Urban Blanket explores the possibility of thermoforming HI-MACS with the goal to save material in the fabrication process. The project was developed in partnership with Sandbox Crew, Midtown Alliance and Modern Atlanta in an effort to increase pedestrian traffic of public spaces in Midtown Atlanta. The project provides a type of physical public space for people using mobile digital devices. More than 20 people can simultaneously occupy Urban Blanket. Another goal of the project was to find new applications for HI-MACS and testing the material that is typically used for interior spaces in an exterior space.

In order to optimize the mold, we developed physical and digital models that simulated the material in its malleable condition. These models allowed optimizing the geometry against the mold that was made up of a minimum amount of points and lines. This process was guided by a complex set of different parameters: First: the proportions of the human body so that the landscape can cradle the person using digital devices, second: enough curvature to create enough tension in the material in its malleable state and preventing it from sagging between the elements of the mold and third: the unrolled geometry was nested on the available size of sheets without producing waste.

Individual 6 mm thick sheets were chemically bond and sanded to create a homogeneous solid. The hygienic properties unique to HI-MACS allowed us to use a white color for the furniture located in an exterior public space. The coalition between the school, material scientists at LG Hausys and the fabricators was crucial for the development of a novel fabrication workflow for complex HI-MACS surfaces and for the development of a prototype for a new application for HI-MACS in an exterior public space (Fig. 7) (Riether 2016).

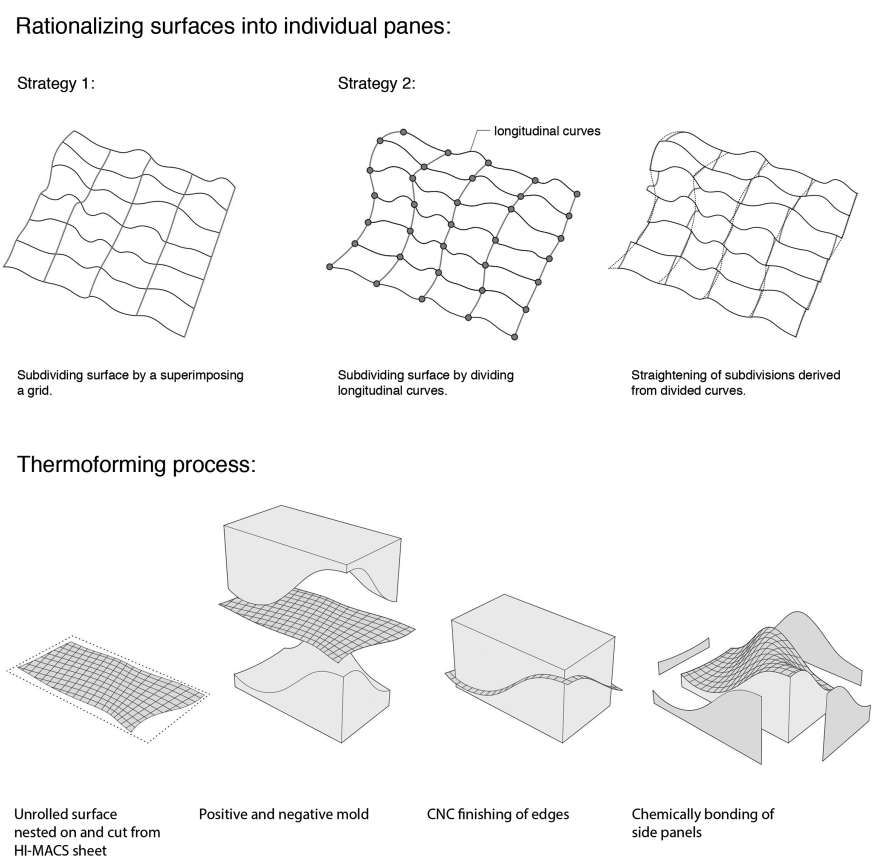

Fig. 7 Fabrication diagrams of Urban Blanket

Conclusion

The advances of digital tools and their accessibility to architects create a large spectrum of unexpected opportunities for architectural design, fabrication and production. The availability of these tools especially fabrication tools within architecture schools suggests a new approach for design build projects that prepares students for not only the practice of architecture but also a growing profession of consulting firms and "expert architects."

The AIA Pavilion illustrates how challenges of construction create a critical feedback that becomes a driving parameter of a design process. The Underwood Pavilion illustrates how architects can develop new design methods by integrating tools typically used by engineers into a design process to create a lightweight structure that might be implemented in larger long span structures. The Nuit Blanche Pavilion is testing a new structural system that can be used for an exhibition display for interactive art. The Urban Blanket illustrates how architects can engage with a material manufacturer in the development of a new prefabricated component to create a new type of public space and new application for their material (Fig. 8).

Fig. 8 Urban Blanket across Starbucks in Midtown Atlanta

The Digital Design Build Studio does not look at design and construction as two things but as a continuous process. It makes students excited of the construction process. It looks at construction as an integral part of the design process.

It promotes architects to not just design but also engage in the process of construction. It does that by providing a platform for students to collaborate with industry, fabricators and community organizations. Its goal is to graduate a new generation of more flexible practitioners (Riether 2016).

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