



Intersections Between the Academy and Practice

PAPERS FROM THE 2015 AIA/ACSA
INTERSECTIONS SYMPOSIUM

CONFERENCE CO-CHAIRS:

Gregory Kessler, FAIA, Washington State University
Stephen Vogel, FAIA, University of Detroit Mercy



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ISBN 978-1-944214-00-5

The American Institute of Architects
1735 New York Ave., NW
Washington, DC 20006
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Association of Collegiate Schools of Architecture
1735 New York Ave., NW
Washington, DC 20006
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2015 AIA/ACSA INTERSECTIONS SYMPOSIUM

Intersections Between the Academy and Practice:

Applied Research in Architecture Education That Advances Practice

Wednesday, May 13, 2015 | Atlanta, GA

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The Relationship of Form and Performance in Façade Design

Architectura autem constat ex-ordinatione, quae graece taxis dicitur, et ex dispositione, hanc autem Graeci diathesin vocitant, et eurythmia et symmetria et decore et distributione quae graece oeconomia dicitur. —Vitruvius¹

ABSTRACT

This article provides insight into how a concern for geometry and proportion has continuously influenced the design of building over time. The focus of the work included herein illustrates how environmental performance may be used as the principle organizing principle in the development of brise soleil systems. The examples presented have relied upon computational tools to understand the relationship between how iterative design developments of the building skin may evolve to improve levels of internal comfort.

INTRODUCTION

The context of this paper is found in an environment that aims to better bridge the academy and practice. What the authors provide in the following pages is a reflection of how undergraduate students are being guided to better understand how an architect might interpret and design for particular geographic and climatic situations. This is accomplished through both traditional and digital techniques that first aim to provide the foundation necessary to first analyze the geometric considerations for the building facade. The scope of these studies is limited to brise soleil systems and an interest in simulating and visualizing environmental performance. Prior to this, a reflection of the evolved criterion for the use of proportion and geometry is made to frame the shift in the way that several architects approached facade design with examples of contemporary practice. The basic structure of this discussion relies upon a light reflection of *form* and *function* in order to structure the conversation which is further filtered through the preoccupation with both the environment and computation. Though generally treated autonomously and independently of aesthetics, much value can be gained by considering synergetic possibilities. This paper will reveal what was learned from students that were required to conduct environmental simulations with the intention that they could better position themselves to become sensitive to urgent issues. Surveys have been conducted with the participants and the results have shown that students have embraced the prescribed methodology. A number of students have become interested in the classes to the extent that they have joined a small research group in which

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they are tutored and encouraged to engage in an exploration of digital tools to visualize, simulate, generate and fabricate. After several years of this work, one of the authors decided to pursue these interest in the private sector in a start-up. Several figures, both students and professors, have joined Velasco and formally established the company Frontis 3d which is a façade design, consultation and fabrication firm. It is used as a case study to illustrate the relation between the academy and practice in a way that veers from the design studio structure commonly utilized by architecture professors. The entrepreneurial spirit of this team has been bolstered by winning the Innpulsa competition which is providing matching funds for a variety of investments being made to better equip them.

MUSING: THE REPEATED RELEVANCE OF FORM AND FUNCTION

Referencing the writings of Vitruvius and his concerns two thousand years ago through the auspices of *firmitas*, *utilitas* and *venustas* has been and continues to serve as vital vocabulary for the framing and discussion of architecture. Alberti echoed this by using similar terms such as: *commode*, *firmitatem* and *gratiam* in his treatise developed during the Renaissance. The interest in developing formal harmony that responds to functional variables is seen in expressions, such as, *"Each part should be appropriate and suit its purpose. For every aspect of building...is born out of necessity, nourished by convenience, dignified by use, and only in the end is pleasure provided for."*² The term function and its role in determining form becomes much more explicitly treated in more recent times. Viollet-le-Duc stated, *"There is in every building, I may say, one principal organ – one dominant part – and certain secondary orders or members..... Each of these orders has its own function; but it ought to be connected with the whole body in proportion to its requirements."*³ Louis Sullivan eloquently and succinctly articulated these beliefs when he created the maxim, *Form follows Function* in the nineteenth century. Though Sullivan's philosophy was rather profound and encompassed the social and cultural roles of building, his aphorism has served as the catch phrase slogan for Modernist architects that chose to taper the scope to an interpretation that only considered the expression as a sort of pragmatic tectonic muse. More than a century later, the role of function as the determinant of the built work continues to be a much debated topic. In this paper we choose to channel this discussion through a description of exercises that question the form of the façade.

CONSIDERING TENDENCIES IN THE RHYTHM OF THE BUILDING FAÇADE

The analysis and critique of the building façade has consistently maintained noteworthy presence within architectural criticism over time. An architectural student is always taken back to the Greek Orders when introduced to the fundamentals of architecture as described by Vitruvius. The eurythmia (rhythmic geometry) of the Santa Maria Novella façade that dressed an existing Gothic structure has been and will continue to serve as Alberti's key achievement in that it serves to express the principles articulated in his classic architectural treatise *"De Re Aedificatoria"*. The principles of proportion have continued to be present in the architectural discourse as evidenced in the way Le Corbusier bridged 2000 years of anthropometric study by reflecting on DaVinci's Vitruvian Man and the golden ratio.⁴ He, of course, emitted his own contribution through his study of the French man which was synthesized in the Modular which was further westernized and refined in Modular 2.

These proportions were manifested architectonically by Le Corbusier in projects such as Unite d'Habitation, the Church of Sainte Marie and in the Carpenter Center where they served as an organizing principle for the geometric dimensions in both plan and elevation. With regard to the expression of a building in its exterior, the Greeks established an interface between nature and human society through the Doric, Ionic and Corinthian Orders. Whereas for Le Corbusier, the articulation of the brise-soleil facade systems was restrained to the Modular proportions. However significant these projects and practices

may be, they are only mentioned to introduce the notion that geometric rhythms have been and continue to be well thought out and contrived architectural maneuvers in the structuring, ordering and aesthetics of the facade.

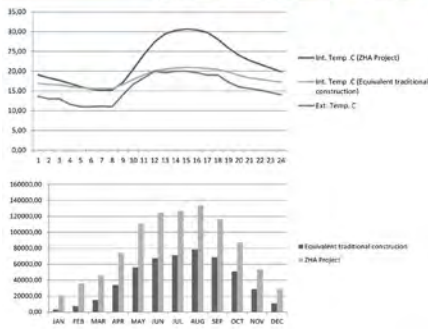
A continued interest in geometric rigor continues to be present in architectural practice and in contemporary façade development. However, the contemporary post-digital modulation of the façade rarely echoes the form of the human body so literally. Observing a plethora of strategies being deployed in practice leads us to believe that there is no dictum nor even a set of guides (let alone standards) for the contemporary discourse. Often modulation loosely reflects current local code related standards, such as floor to floor heights or the limitations imposed by manufacturing, transport and on-site installation. Another possible route, the one the authors have chosen to reconnoiter, is to explore the geometries that correspond to the solar path. In regards to the human body, a shift has occurred from an interest in the representation of its proportion and form towards a performative concern for it: Aiming to create improved levels of comfort while minimizing the reliance upon active systems of heating and cooling. While simply stated, it is this aim that has been a guiding light for those interested in responding the environmental crisis. This article will demonstrate how the authors are exploring the way to which form can be informed in façade design through basic energy modeling and solar radiation studies. This article seeks to bridge academia and practice by providing a narrative that illustrates the work being done with students, in research and in practice with the intention of providing a modest example of work from South America.



CONSIDERING PERFORMANCE

An interest in the relationship of computation and design process has become very evident over the past half century. In recent years issues such as; BIM, Shape Grammar, Parametric design, Digital fabrication, Robotics, Cybernetics, Virtual Reality, Surface, Scripting, Morphogenesis, etc. have been widely discussed. The scope of this article is limited to a discussion of a Performance based approach to design. This tendency considers how function determines form by contemplating the role of performance. In a 1984 edition of Yale's *Perspecta*, in an article titled "Critical Architecture: Between Culture and Form", K. Michael Hays argues against the dichotomy of either understanding architecture as being an instrument of culture or as architecture being an autonomous form in favour of the in-between that cuts across this opposition. The performance based approach to architecture is an in-between stance that neither limits the reading of architecture to

Figure 1: *Tecnologia V Facade Modulation Studies*: Spring 2014 & Graduate Project - Axonometric Drawings and Interior Perspectives
Fantolvo, Gonzalez, Leon & Tocancipa



cultural production nor to the formal operations of creating the autonomous architectural object.⁵ While both tendencies utilize iterative processes, the performance based approach addresses the complexity of the contemporary conditions more holistically which is fundamentally dynamic and non-discrete.⁶ Performance based architecture relies upon an iterative process that may incorporate simulation, analysis, optimization, visualization and fabrication in the generation of form.⁷

INTRODUCING STUDENTS TO THESE TOPICS AND EXPLORING WITH THEM

The issues contemplated in the previous section have been addressed in a variety of contexts by the authors. Participation in multidisciplinary university research projects that have utilized a parametric design process, building information modelling, simulation and evaluation and physical prototypes has been the first scenario. The results of this research then filtered into the undergraduate curriculum in required electives and thesis projects which has led to offering certificate courses open to practitioners. Furthermore, one of the authors has garnered a group of like-minded practitioners to pursue this in a start-up company that provides façade design services.

The methodology utilized in this research, both in the academy and in practice, has involved a literature review, the analysis of existing projects and the generation of design proposals. A focus of this work has involved the modelling, simulation of solar radiation, ventilation and daylighting with Ecotect and Design Builder. The aim has been to gather a sample from various regions of the world in which the comparison and evaluation of the performance of traditional buildings with the behavior of contemporary interventions informs design generation.

The analysis of buildings has proven to show stark results between design intent and design performance. As professors of architecture, it is necessary to explore and understand the fundamental differences of critical theory and instill a desire in the minds of our students enquiry that also encourages them analyze both the written and built work of practicing architects. As student research tends to be rather superficial, motivating students to develop critical thinking about the aforementioned issues is a challenge. Being that media sources privilege the graphic image, students often develop intrigue with the building presented solely based on aesthetic considerations. While aesthetics is an important aspect, a limited reading of architecture to this area neglects a multitude of other factors that influence the built environment and the experience therein.

Students chose projects that interested them, but were asked to choose contemporary projects in which they could illustrate the use of digital tools in the design and/or fabrication process. An expanded comparison of projects by Zaha Hadid Architects (Fig. 2) and of Norman Foster and Partners is being conducted to be used as a way to contrast Parametricism with Performance based design. This analysis relies heavily upon digital simulations to gain insight into building performance. Working within the classroom environment also leads to interesting discoveries in design learning. The observation of student behavior as well as written surveys have been used to gather information about the perception of the design process, how digital tools are used, and how an architect should address environmental design.

RESPONSE FROM THE STUDENTS

This research is not exhaustive nor conclusive, however the preliminary findings have revealed several discrepancies in the theory and practice being developed. These discrepancies cause the authors to reflect on the validity of such theories and encourage more work in the area of performance.

Figure 2: *Geometric and Energy Modelling of Abu Dhabi Performing Arts Centre - Zaha Hadid Architects*
L. Gallego, C. Diaz, A. Brakke & R. Velasco

As for the influence this project has had on the student participants, greater levels of confidence in rationalizing design problems has been witnessed. This has subsequently led to better clarity of the design problem and therefore higher levels of articulation in their projects. Excerpts from the surveys include comments, such as:⁸

“Permite mayor comprensión y precisión, sirve para organizar las ideas... se puede probar todas las ideas que tengan. Se afecta el diseño volviendo las ideas más reales.” —Pedro Villate

“.....desarrollo integral - generar simulaciones - visualizar - agiliza los procesos de fabricación - así que revolucionan totalmente el proyecto desde la planificación hasta su generación.” —Anatoly Murcia

“Es mas fácil y eficiente la representación de ideas y de demostrar los conceptos implementados. Además permite la implementación de nuevos elementos más complejos y hace posible su realización.” —Jaime Alfonso Olaya

It is the hope of the authors to provide material that serves as a study to substantiate the discussion of pedagogy in the architectural debate. Working with students and gathering feedback from the process has served to better understand how contemporary topics are being confronted by the future generation. Though architectural design may be addressed from a multitude of angles, we have found that computation and environmental issues continue to be marked by the students as important concerns. Studies such as this offer insight into how this intriguing contemporary discussion and the evolved relationship between form and function.



3

FRONTIS 3D: LINKING ACADEMIA TO PROFESSIONAL PRACTICE

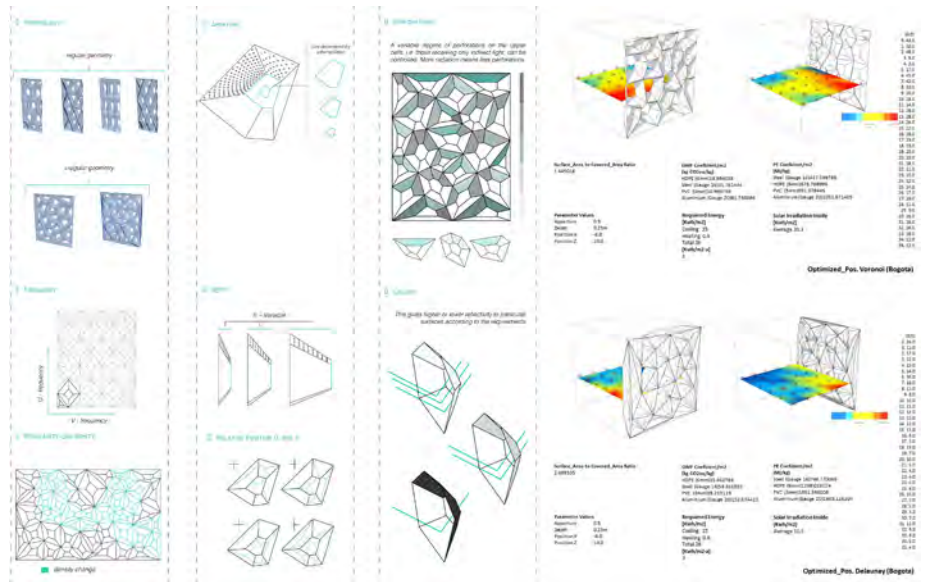
Frontis3D is a commercial company that designs, develops and produces special façade systems that minimize the energy consumption of buildings. The process incorporates design tools that allow manipulation of shapes and parameters of lighting and air conditioning (temperature control, humidity and air renewal), providing high performance in terms of environmental aspects.

The company’s history is tightly linked to academia. It started with a research interest which was focused on building envelopes. This was the theme its main founder had been exploring back from his undergraduate years, which became a thesis project and a PhD research study developed in the UK. Velasco returned to Colombia with this specialized knowledge and continued to work on this research agenda. Over time, façade systems were the subject of taught modules and research projects at several universities in Bogotá, where a network of interested students and colleagues was developed. The commercial project took almost 7

Figure 3: *Between Frontis 3d Brise Soleil System and Existing Structure*
(Photo:A. Brakke)

years to materialize, and included a number of former students and two students involved in the young research group as partners in the company at its founding. Right now, with three years in the market and some 15 projects built, the company has an important R+D basis that needs to keep developing, and for that reason, various ventures in partnership with academic actors are still being sought.

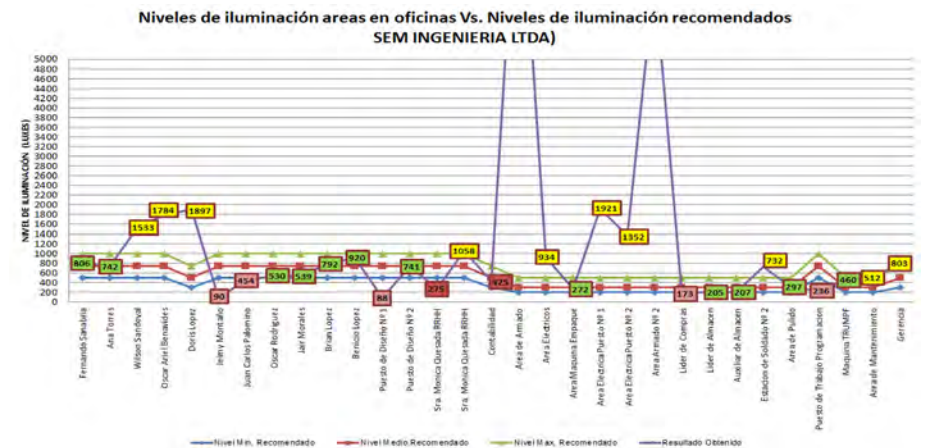
Besides providing high environmental performance, Frontis3D's custom made façade systems are also potential instruments of promotion and corporate identity thanks to the flexibility in the design process, the incorporation of elements of innovation from the customer's point of view which is achieved by using codesign as the main approach. An example of the company's work is the volumetric façade system developed for SEM Ingenieria, its manufacturing partner (Fig.3-6). For this project, long talks with the owners took place at the beginning of the design process, which subsequently became a list of parameters to include in a design definition that was then informed by simulation and optimization results based on daylight levels.⁹



The result was an attractive looking brise-soleil system that satisfied both the client's image requirements as well as the specific environmental conditions of the site. The development of this article involved interviews with several members of the Frontis 3d company as well as a post occupancy survey of SEM employees and a lighting analysis of the facade intervention.

Figure 4: Diagrams that illustrate design variables and simulations (Frontis 3d - R. Velasco)

Figure 5: Lighting Levels in SEM Facilities (Geosecuritas)



5



6

The report shows that the employees have a positive perception of the intervention. What it reveals is that the lighting levels are superior to the recommended levels (Fig. 4 & 5), however, this was the expected outcome which was communicated at the design stage. The clients made the decision to compromise optimal interior day lighting in favor of enlarged apertures that permit increased viewing toward the exterior streetscape. Maximizing affect while lowering material usage also played a part in the development of the voronoid modules. Ultimately the clients also did analyze the various geometric configurations in terms of aesthetic fitness.

CONCLUSIONS

Based on the literature review and case study analysis carried out in terms of research and developments in practice, we can attest to an evolved understanding of geometry and proportion. The design methodologies for façade systems that aim for high performance environmental solutions are far from mature, yet steadily improving. There are two main reasons for such growth: On the one hand, the need for better performing environmental systems to help cope with the current environmental crisis continues to have traction within the discipline and with society at large. The second reason is that the relatively recent advent and popularization of computational tools allows for a profound level of simulation that was previously unattainable without highly specialized engineers. In this context, the work shared in academia and practice may serve as a modest example to help build upon other research being conducted to promote the understanding of how brise-soleil systems improve the environmental performance of buildings. The bridging of the academia and practice through the case study of Frontis 3d also shows an entrepreneurial model that may serve as an example for others that opt for something other than the typical model of the design studio firm.

Figure 6: *Frontis 3d Brise Soleil System*
(Photo:A. Brakke)

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