ED12108

Building Students Skills with Design Computation + Fabrication

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Learning Objectives

- PROMOTE COMPUTATIONAL DESIGN SKILLS. Learn how institutional adoption of various computation methods and techniques transforms conception and content.
- HELP STUDENTS WITH FUTURE CAREERS. Hear how these advanced skills help meet the expectations of the current climate in practice, particularly the design sector.
- FACILITATE DIGITAL FABRICATION IN BUILDING DESIGN. Learn how digital fabrication is facilitated through Revit and visual programming.
- INCORPORATE PARAMETRIC MODELING INTO THE CLASSROOM. Learn how various courses specifically assign parametric modeling in an architectural curriculum.

Description

Computational design enables architects to design parametrically, using visual programming to automate design processes and simulate, script, customize the parameters of, and generate design solutions—making it easier to explore ideas and innovate. Design practices big and small are turning to computational design to solve problems in new ways. Students with experience in computational design have a distinct advantage in their careers. Hear how Autodesk Dynamo is helping the next generation design structures and buildings and create using digital fabrication.

Your AU Experts

Danelle Briscoe *received her Master of Architecture degree from Yale University (2002) where she was awarded the Eero Saarinen Design Excellence Award. Her Bachelor of Architecture degree is from the University of Texas at Austin with Honors (1995). Her ten years of work experience includes being a designer at Frank Gehry Partners, LLP, designer at Marmol+ Radziner LLP (both in Los Angeles) and UT resident at Centerbrook Architects (in Connecticut). She has exhibited work in Axis Gallery, Tokyo (2002), the 2004 ICFF in New York, the MAK Center in Los Angeles (2004), Objectspace solo show in Auckland, New Zealand. In addition to numerous conference and journal publications, she has more notably published her book, titled Beyond BIM: Architecture Information Modeling, in October 2015 by Routledge Taylor & Francis.*

Introduction

Academic Integration Case Studies

A new generation of design computation systems affords opportunities for new design practices. This calls for potentially new teaching requirements and methodologies in design education. Case examples from the following courses taught in various settings will demonstrate experience and outcomes of this exposure to design computation and fabrication.

Core Curriculum
These courses are deemed critical requirements for the architectural education context. Studio is the primary driver in an architectural education so introducing such advanced skills requires careful positioning and specific methodology for successful outcomes. Case studies come from several studio starting in 2009 to present ranging from introductory to advanced settings. Additionally, a graduate drawing course explores computational design through Dynamo as the means to achieving advanced geometry and control.

Elective
Electives in an architectural curriculum allow students to direct their degree in ways that the core curriculum may not prescribe. As such, these courses tend to research more in depth, push boundaries and explore alternative ways of thinking. Since 2007, I have offered an elective that focuses on Building Information Modeling as a design and fabrication tool.

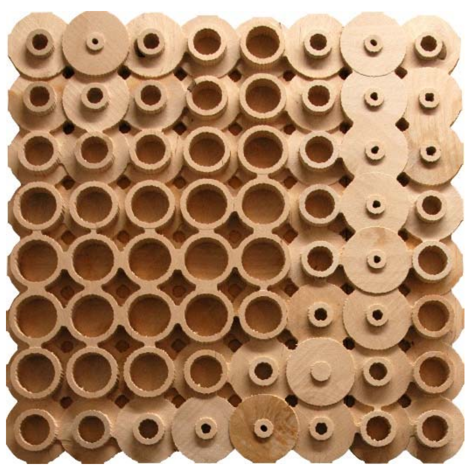


FIGURE 1: JUDSON GARWOOD
BEAUTY + THE BIM ELECTIVE 2010
UT AUSTIN SCHOOL OF ARCHITECTURE

Independent Research
My own research as an academic has been afforded multiple grants to explore the use of BIM and advanced computation with a specific focus on materiality and more recently the incorporation of living systems in architecture.

Background
I come from a generation of designers that remembers the card catalogue and experienced first-hand the inception of computers in the design studio. At the tail end of my undergraduate studies in 1995, architectural practice was struggling with the birth of CAD—hatch patterns were crashing the files, sheets were abundant with discrepancies, and drawing count proliferated. Later in graduate school (Y2K), fabrication technologies, such as laser-cutters and CNC tools, were just starting to be put in place.

Practice
I learned the benefits of the highly coordinated master model approach to design from Frank Gehry, the undisputed leader in parametric design and construction, with whom I worked and studied for several years. Time was also spent working for Marmol Radziner in Los Angeles on high-end residential housing. It was at this practice that I was introduced to Revit and BIM as a way of thinking for design.

Academia
I first started teaching the do's and don'ts of Revit 2008 to young Kiwis at Unitec Institute of Technology in Auckland, New Zealand. Since 2009, I have held a position at the University of Texas at Austin and also taught summer courses at the Architectural Association in London, University of Auckland, and most recently Huazong University of Science and Technology.

Publication
In the 10+ years since practice experiences, much has changed. Humans have undeniably become vehicles for data. From fuel bands to cell phone usage, data is being generated and behavior is tracked in the (ostensible) service of a better understanding of our lives and the planet we live on. And that information is becoming increasingly a part of what energizes our design work. Speculating where BIM will go, beyond its current predominant provision to buildings and their elements, my sense is that the future will drive all this data and harvest it in new ways that we have yet to fully appreciate. My book, *Beyond BIM: Architecture Information Modelling* published by Routledge Taylor & Francis in October 2015, introduces a unique perspective on the use of Building Information Modeling (BIM) in contemporary architectural practice, but also advocates the BIM model as an active, essential, and currently under-explored agent in the advancement of innovative design.

Promote computational design skills
The purpose of computational design thinking is to create experiences that maximize student learning to advance the future of practice. Academic instructors/designers can begin by inserting this skill set in design process with defining educational objectives, continue with arranging learning and teaching activities and finalize the process with the development of representational outcomes.

Case Study 1: Core Curriculum Design Strategies
Importantly, studio project must blend computational and creative thinking.
The fundamentals of design should not be lost or overridden by the desire to learn the software. For this reason, I believe it is important to start small, with a design task that is achievable and allows for creative exploration by each student within some given constraints. Allocate specific methodologies and manageable outcomes.

Graduate Vertical Design-University of Texas, Austin, Texas, Fall 2009

- Wall sample exercise:
- Adaptive component to Conceptual Massing workflow in Autodesk Design Academy with final 3d printed output
- Laser cut models directly from Revit plan view profiles, using 123D Make for such extraction

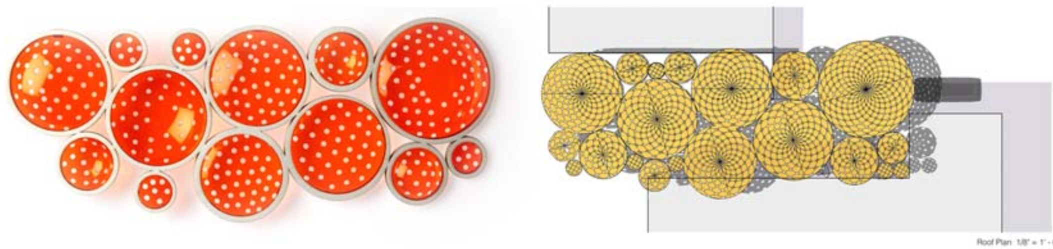


FIGURE 2: LAURA GRENARD
BIM +BY-PRODUCT STUDIO 2009
UT AUSTIN SCHOOL OF ARCHITECTURE

Advanced Design-Unitec New Zealand, Auckland, NZ, Fall 2013

- Test a bottom up design approach
- Use scheduling as a creative design endeavor
- ‘emergence’ of architecture and landscape information and patterns

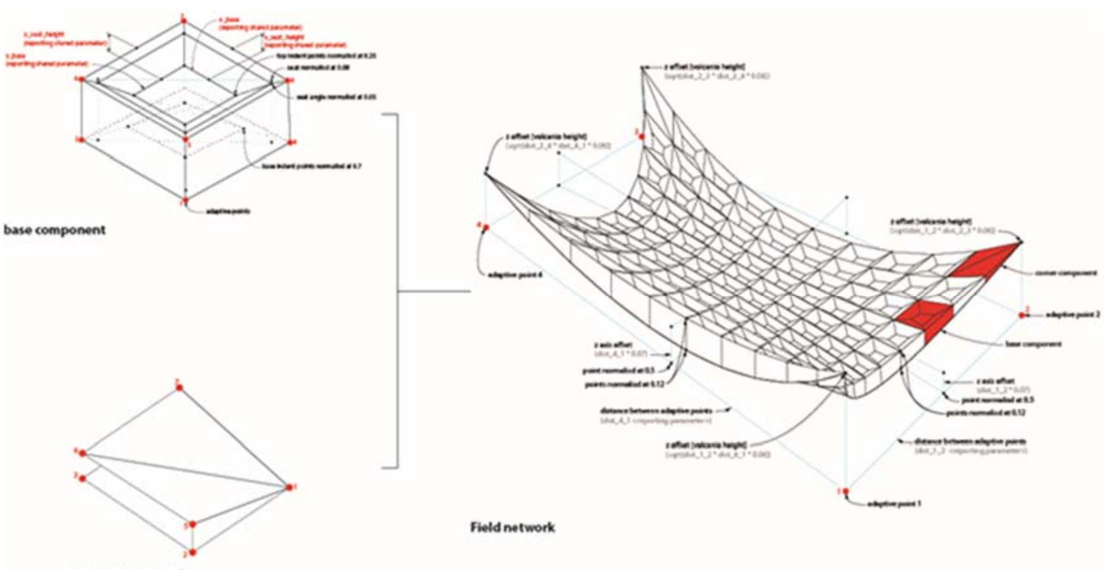


FIGURE 3: LAURA GRENARD
BIM +BY-PRODUCT STUDIO 2013
UNIVERSITY OF AUCKLAND SCHOOL OF ARCHITECTURE

Case Study 2: Precedent Research

Use design research, for instance case study documentation, as a way to initiate computational thinking and further design generation.

Advanced Design-University of Texas, Austin, Texas, Fall 2010

- Parametric precedent research becomes a design driver for further design development.
- Understanding Type and Instance parameter to control color and pattern of a metal facade.

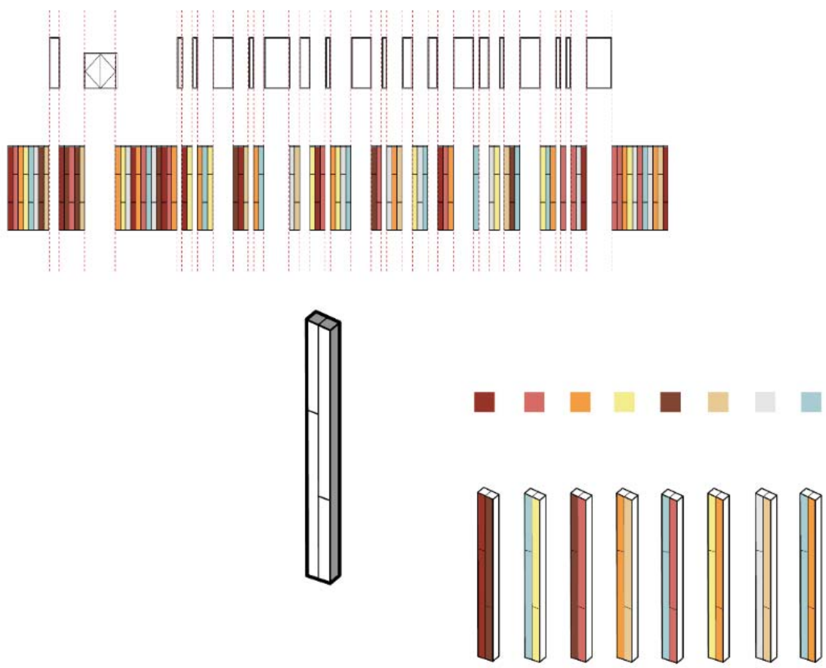


FIGURE 4: HANNAH ZHANG
ADVANCED DESIGN 2010
UT AUSTIN SCHOOL OF ARCHITECTURE

Undergraduate Third Year Design- University of Texas, Austin, TX, Spring 2014

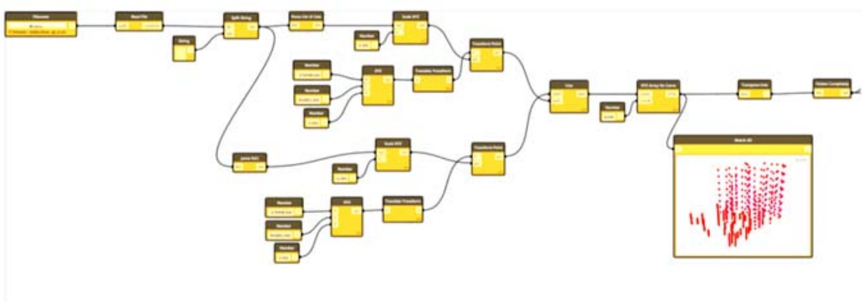
- precedent research of systems case study
- Formulaic syntax within Revit adaptive point capabilities
- Workshop setting within allotted studio hours

Help students with future careers

Case Study 1: Advanced computation for Specialist role in Practice
Practices are now integrating research into their design processes and services and current technological innovation and complexity of design processes are requiring more research and integration between specialists, such as computational design specialists, material consultants, and sustainability experts. These are all jobs that largely did not exist even 10 years ago. And these experts do not have an established body of knowledge to work from making education a force in developing these specializations.

Advanced Design- Unitec New Zealand, Auckland, New Zealand, Fall 2013

- Further advance skills in BIM for later course work
- To stay competitive, companies need to attract talent.
- Dynamo used with Processing and then output to 3d printer



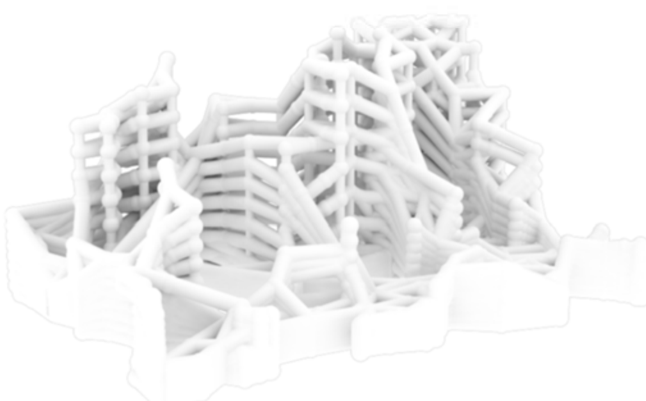


FIGURE 5: VINNI PIAGINI
ADVANCED DESIGN 2013
UNIVERSITY OF AUCKLAND SCHOOL OF ARCHITECTURE

Case Study 2: Competition functionality tested
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Advanced Design- Huazong University of Science and Technology, Fall 2015

- Rendering models for quick competition work
- Displaced views covey constructability for competition brief

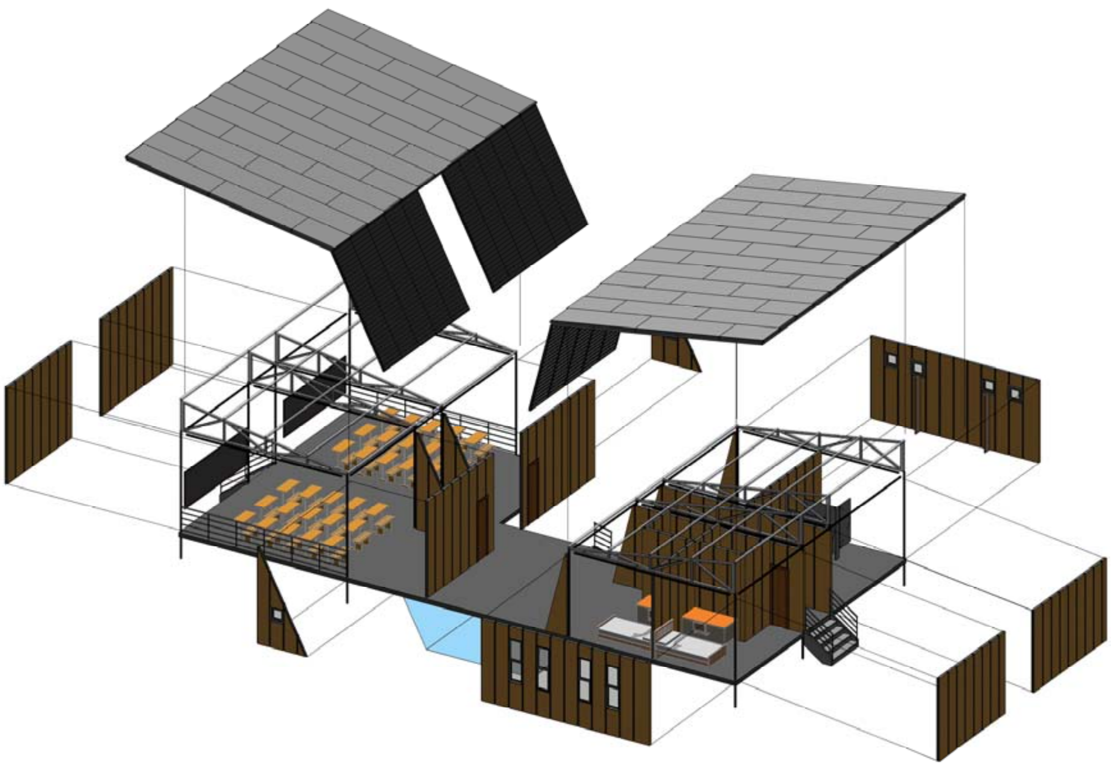


FIGURE 6: DONG LIANG
ADVANCED DESIGN 2015
HUAZONG UNIVERSITY SCHOOL OF ARCHITECTURE

Advanced Design- University of Texas Austin, Texas, Fall 2010

- 3d Printing models directly from Revit with STL exporter for competition studies

Case Study 3: Collaboration Independent Research

This research is an ongoing joint interest between the University of Texas at Austin and the City of Austin. Explore viability of a living wall system on an existing university owned parking garage on the West facing in hot and dry climate of Austin, Texas.

- Multiple stakeholders, collaboration with ecology
- Workflow tested with Revit functionality: Comma Separated Value, Precedent Research, Dynamo visual programming form finding and plant allocation

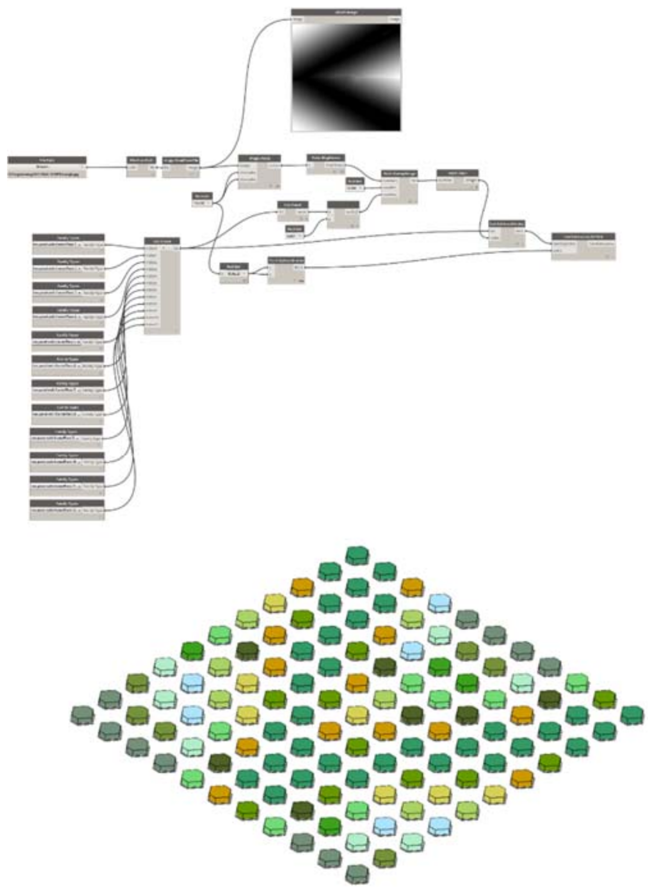


FIGURE 7: DANELLE BRISCOE
INDEPENDENT DESIGN RESEARCH 2013-PRESENT
UNIVERSITY OF TEXAS SCHOOL OF ARCHITECTURE

- 4D/5D/6D BIM: Marcus Hogue, UT's coordinator of irrigation and water conservation, uses a high-tech $2.1 million system to control 2,300 watering zones. In a state plagued by drought, the living wall system BIM will incorporate computerized monitoring devices on the cutting edge of water conservation. It will show what's being watered and how much is being used.
- Fabrication: 3d printing test modules, CNC milling, waterjet cutting trellis, future robotic assembly

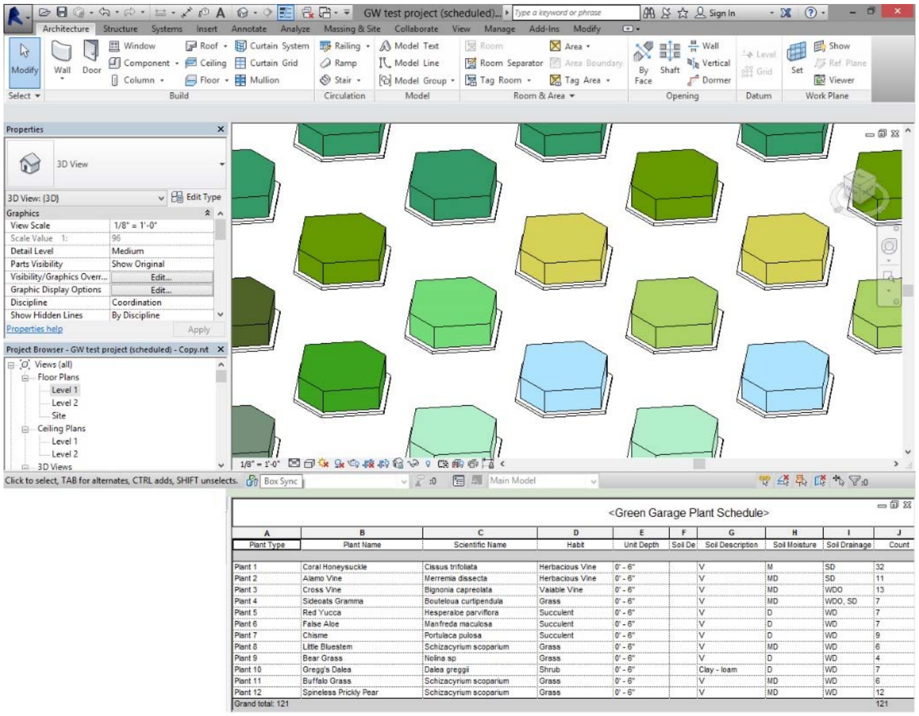


FIGURE 8: DANELLE BRISCOE
INDEPENDENT DESIGN RESEARCH 2013-PRESENT
UNIVERSITY OF TEXAS SCHOOL OF ARCHITECTURE

Facilitate Digital Fabrication in Building Design

Case Study 1: Elective

In elective courses, students are able to capitalize on the iterative thinking through a connected experience from digital design to physical prototyping enabled by BIM.

Beauty + the BIM- Unitec New Zealand, Auckland, NZ, 2005-2009 then University of Texas, Austin, TX, 2009-2010

Material (IN)formation- University of Texas, Austin, TX, 2011-2013

- challenging expectations
- 36"x36" CNC composition
- Investigates more in-depth material optimization, behavior and configuration

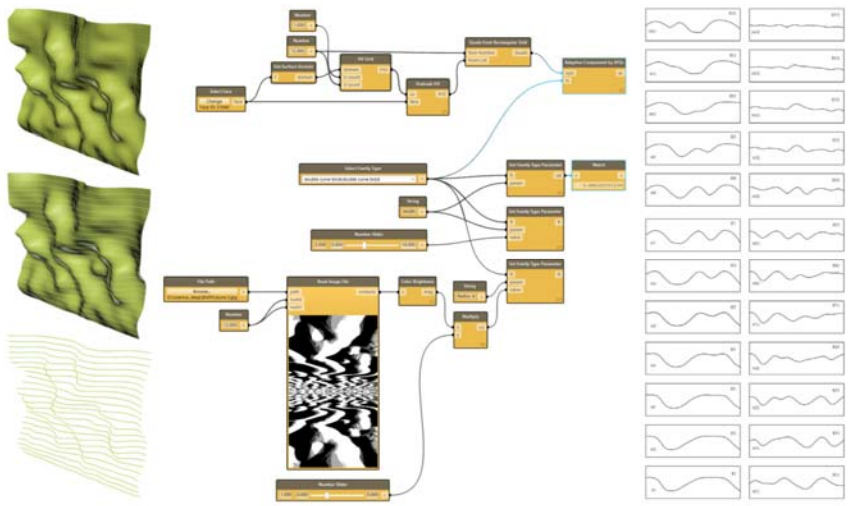


FIGURE 8: ETHAN BENNETT, JOHN CUNNINGHAM, APRIL NG
MATERIAL (IN)FORMATION 2012
UNIVERSITY OF TEXAS SCHOOL OF ARCHITECTURE

Case Study 2: Independent Research
Design research in 2010 used *Autodesk Revit* (BIM) to design, analyze and directly fabricate a full-scale limestone building mass. Tessellation promotes parametric design skills in conjunction with advanced water jet 5 axis (CNC) fabrication.

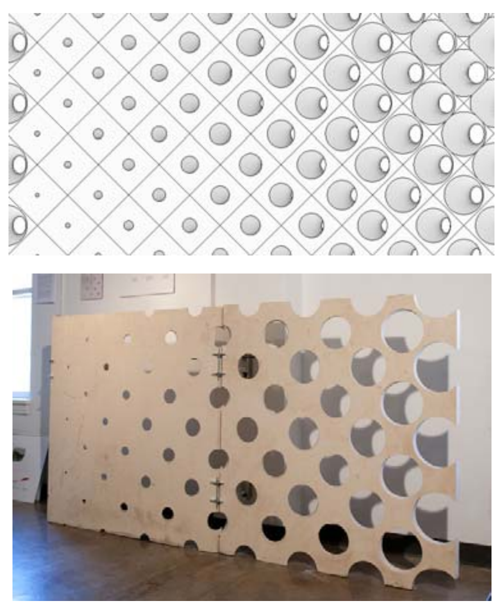


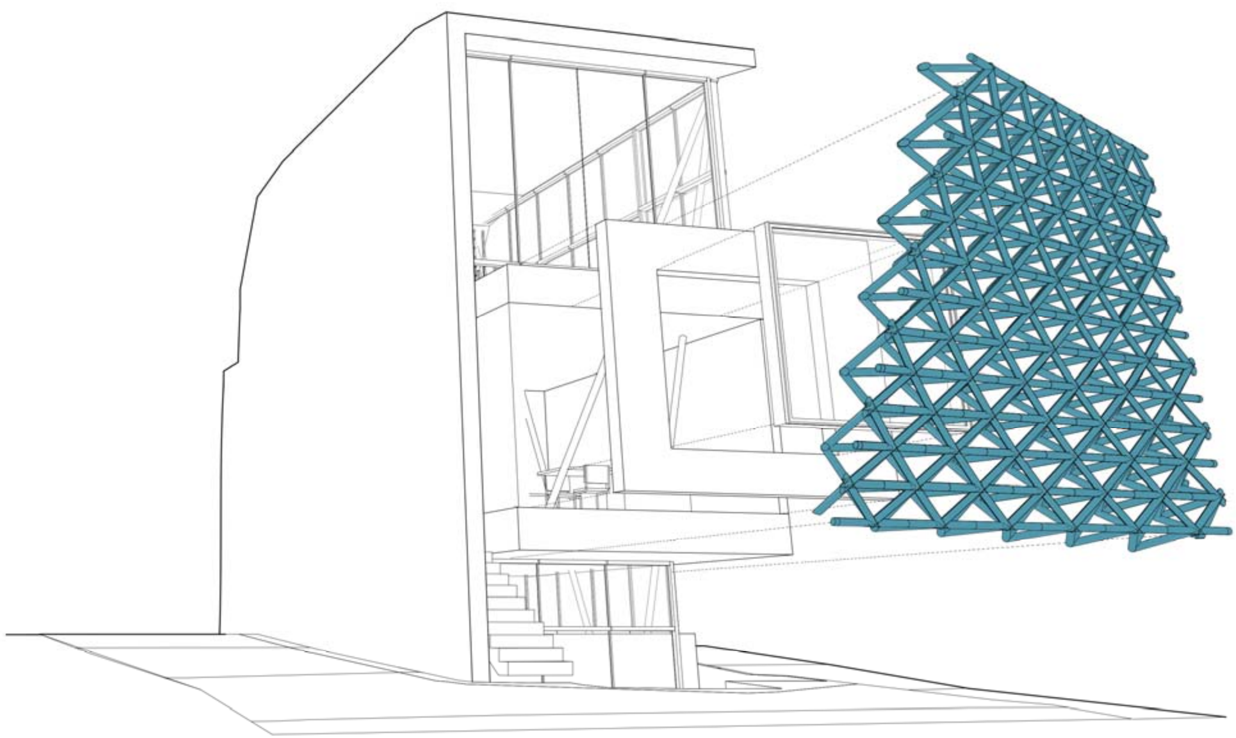
FIGURE 8: DANELLE BRISCOE
INDEPENDENT RESEARCH 2010
UNIVERSITY OF TEXAS SCHOOL OF ARCHITECTURE

Incorporate parametric modeling into the classroom

With the growing interest in computational thinking, the question becomes how to design the education for this specific thinking skill so computational thinking can be taught effectively. This section of the class focuses on the first phase of instructional design in which students plan for learning objectives that will eventually result in expected learning outcomes. It's the presenter's expectation that those interested in computational thinking will use this discussion as a starting point in their curriculum design and development for introducing computational design skills.

Case Study 1: Core Curriculum

- Other course courses, such as Visual Communication Studies, can be a great way to introduce BIM and computational exercises. Autodesk education features such as Tessellation Curriculum in Design Academy can be incredibly helpful beginning resources.



Case Study 2: Early core studios

The future of the core fundamental studios (i.e. first year design studios) should start with an understanding of parametric whole building energy analysis, configuring the Revit/Vasari model, and interpreting results from the analysis. A key feature to include would be Dynamo's "**Solar Analysis for Dynamo**," that focuses on understanding how solar radiation affects the building envelope.

Conclusions

- **Promote computational design skills** From the various methods using Autodesk Revit® and Dynamo shown, how can you introduce these new skills into courses and curriculum?
- **Help students with future careers** What is the call to action for future curriculums to help meet the expectations of the current climate in practice, particularly the design sector?
- **Facilitate digital fabrication in building design** how can relationships with fabricators be established early on in education using Revit and Dynamo visual programming.
- **Incorporate parametric modeling into the classroom** What is the most relevant and impactful for students; the design process, the data workflow process, or the project outcome or a combination of a few?