Columbia GSAPP
A4686-1 | Spring 2017 | 505 Avery | Wednesdays, 7:00 pm-9:00 pm
Instructor: Ryan Luke Johns

Assembling All Sorts

Parametric digital design tools and computer-aided manufacturing have enabled a non-uniform, curvilinear and mass-customized architecture. While this conceptual plasticity[1] of the first digital turn has relieved architects of the monotony of the mass-produced detail, the apparent freedom of digitally fabricated architecture still remains bound to industrially produced, standardized components (blanks, bars, bricks and sheet stock) or isotropic plastics (3D printing, thermoforming). Designs are generated in a digital world of infinite possibility, and are wastefully materialized into a world constrained by the 4x8 sheet.

The assimilation of digital information and material properties (made possible by algorithmic design and robotic fabrication) has the potential to increase resource efficiency, while enriching the tactile, visual and performative aspects of architecture through the controlled application of material variation. In practice, however, this "digital materiality"[2] is often limited to components which are dimensionally uniform and selectively obtained—the uninformed brick[3] or grain of sand[4] already bear some resemblance to the pixel.

This seminar will focus on creating details and assembly techniques which derive their non-uniformity, in part, from irregular, "found" building materials. We will develop strategies for digitizing such materials, and methods of programming which allow for these digitized properties to be incorporated into the design. The course will involve the creation of digital and physical study models, and the development of a prototypical robotic assembly technique using the school's UR3 robot.

Course size is limited, and previous exposure to Grasshopper and/or some programming (Java/Python, etc) will be helpful for students.

Seminar Format:

This design seminar will operate as a combination of lab sessions, lectures and discussions, and will expose students to a large variety of software, tools, techniques and prior art. This exposure will sometimes take the form of tutorials, depending on class interest (demand) and skill level, but it is also expected that students will be proactive in discovering and engaging tools and techniques that are of specific interest to their project. This course has no prerequisites for graduate students, and it is probable that students will have a wide range of skill levels. While the course will focus on engaging computational tools, students should not assume that an initial deficiency in technical ability will exclude them from conversation.

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[1] Lavin, 2002
[2] Gramazio & Kohler, 2008
[3] Gramazio, Kohler & Willmann, 2014, pp. 66
[4] Ibid, pp. 286

Projects are never driven solely by technical expertise, but by excitement in the ideas behind them, and an ability to cobble together the tools at hand (or obtain new ones) in order to manifest and experiment with those ideas.

Class participation is essential. Students will be expected to engage in discussions around the projects of their peers, and may be asked occasionally to present on readings.

Assignments will be submitted as mandatory web postings, in order to allow for a variety of media (text, images, video, interactive content, etc) and to create a platform for continued conversation.

The final submission will consist of a short (1500-2000 word) research paper documenting the final project. As this project will be built upon knowledge achieved earlier assignments, it is assumed that some of the paper content can be adapted from the web postings. Throughout the semester, you will read academic papers on the subjects you are exploring (as recommended readings and through your own searches); It is expected that these will create a foundation for your work, and find their way into your postings and final paper in the form of references.

In order to facilitate higher level work, and to benefit from the variable toolsets of your classmates, group work will be encouraged.

Schedule:

January 18 - Course Introduction + Assignment 1 Introduction
January 25 - Robot Principles (Scorpion/Robots) + Project Proposal Discussion
February 1 - Introduction to Processing
February 8 - Material Morphospaces and Assembly Algorithms (Defining Material Properties)
February 15 - Sensing Object Properties (Kinect, OpenCV, Blob/Marker Detection)
February 22 - Sensing Design Decisions (HID, ControlP5, Image Detection)
March 1 - Sorting, Simulation & Classes
March 8 - Project Discussion
[Spring Break - March 13-17]
March 22 - Interactive Robot Control In Processing
March 29 - Sensing and Actuation (Custom Tools / Arduino)
April 5 - Feedback loops, Call-and-Response Actuation
April 12 - Assimilation (Discussion and Support with Final Project Development)
April 19 - Pre-Review and Workshop (Final Project Presentation TBD)

Last Day of Architecture Classes	4/21
Arch Studio Final Reviews	4/24-5/3
Arch Class Finals (exceptions only)	5/4-5/5

Selected References:

Brayer, MA and Migayrou, F (eds.). *Naturalizing Architecture*. Orleans: Editions HYX, 2013.

Brell-Cokcan, Sigrid, Braumann, Johannes (Eds.). *Rob|Arch 2012: Robotic Fabrication in Architecture, Art and Industrial Design*. Vienna: Springer, 2013.

Canizaro, V (ed) *Architectural Regionalism: Collected Writings on Place, Identity, Modernity, and Tradition*, Princeton: Princeton Architectural Press, 2007.

Denison, E. and Ren, G. Y. 'The Reluctant Architect: An Interview with Wang Shu of Amateur Architects Studio'. *Architectural Design (AD)* Profile No. 82, 2012, pp 122–129.

Feringa, J. 'Implicit Fabrication, Fabrication Beyond Craft: The Potential Of Turing Completeness in Construction.' *Proceedings of ACADIA 2012*. pp. 383-390.

Frazer J. *An Evolutionary Architecture*. London: Architectural Association, 1996

Gramazio F and Kohler M. *Digital Materiality in Architecture*. Baden: Lars Müller Publishers, 2008.

Gramazio F and Kohler M (eds) "Made By Robots: Challenging Architecture at a Larger Scale" *Architectural Design* (AD) Profile No. 229. John Wiley & Sons, May/June 2014.

Gramazio F, Kohler M, Willmann J (eds). *The Robotic Touch: How Robots Change Architecture*. Zurich: Park Books, 2014.

Gramazio F, Kohler M, Langenberg S (eds) *Fabricate*. Zurich: gta Verlag, 2014.

Johns R and Foley N. "Unfolding Topology: Bandsawn Bands" In: Menges, Leach and Yuan (eds) Robotic Futures. Tongji University Press, 2015.

Keller S and Jaeger H. 'Aleatory Architectures.' Granular Matter. Berlin: Springer-Verlag, 2016.

Kilian, A 2006 'Design Exploration through Bidirectional Modeling of Constraints.' PhD diss., Massachusetts Institute of Technology.

Kolarevic B (ed) (2003) Architecture in the digital age: design and manufacturing. Spon Press, New York

Lavin, S, "Plasticity at Work," in Mood River, Ohio: Wexner Centre for the Arts, 2002, pp 74-81

Lafreniere, B et. al. 'Crowdsourced Fabrication.' *Proceedings of the 29th Annual Symposium on User Interface Software and Technology* (UIST '16). New York: ACM 2016, pp 15-28.

Menges, A. (ed.): Material Computation – Higher Integration in Morphogenetic Design, Architectural Design, Vol. 82 No. 2, London: Wiley, 2012 .

McGee, W and Ponce de Leon, M (eds). *Robotic Fabrication in Architecture, Art and Design 2014*. Vienna: Springer, 2014.

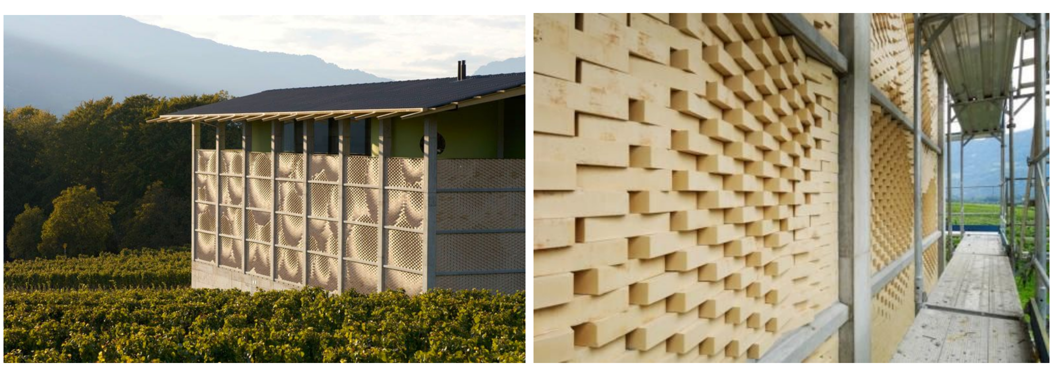
Oxman, N and Rosenberg, JL. 'Material-based Computation: An Inquiry into Digital Simulation of Physical Material Properties as Design Generators.' *International Journal of Architectural Computing* vol. 5, no. 1. (January 2007).

Wiener, N. *Cybernetics: or Control and Communication in the Animal and the Machine*. Cambridge: MIT Press, 1948.

The Wonderful Caddis Worm, Hubert Drupat, 1980-

Ningbo Museum, Wang Shu / Amateur Architecture Studio, 2008

SCI-Arc Blobwall, Greg Lynn FORM, 2009



Gantenbein Winery Facade, Gramazio & Kohler, 2006