Columbia GSAPP
A4686-1 | Spring 2018 | 505 Avery | Wednesdays, 7:00 pm-9:00 pm
Instructor: Ryan Luke Johns | Contact: ryan@greyshed.com

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, but is not required.

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. Projects are never driven solely by technical expertise,

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

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 or prepare questions for visiting guests (i.e. in robotics or preservation).

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. For your reference, past student work can be accessed online at the following links:

assemblingallsorts-sp17.tumblr.com   assemblingallsorts-fall16.tumblr.com   assemblingallsorts-sp16.tumblr.com

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 presentations 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.

The final project will be divided into two phases, with the large part of the semester focusing on the development of individual projects (1-2 people) which explore a novel robotic assembly method for materials of your choosing. Following the final review (a discussion & workshop with invited critics), one project—or a combination of projects—will be selected as the focus of a collective group exercise to develop a larger-scale installation. Final documentation of both projects must be posted to the course webpage prior to the grading deadline.

Schedule:
January 17 - Course Introduction + Assignment 1 Introduction
January 24 - Robot Principles (Grasshopper Control) + Project Proposal Discussion
January 31 - Introduction to Processing
February 7 - Material Morphospaces and Assembly Algorithms (Defining Material Properties)
February 14 - Sensing Object Properties (Kinect, OpenCV, Blob/Marker Detection, Sorting, Simulation, & Classes)
February 21 - Sensing Design Decisions (HID, ControlP5, Image Detection)
February 28 - Sensing and Actuation (Custom Tools / Arduino)
March 7 - Interactive Robot Control In Processing
[Spring Break - March 12-16]
March 21 - Feedback loops, Call-and-Response Actuation
March 28 - Final Review & Workshop for Individual Projects
April 4 - Assimilation (Discussion and Support with Final Project Development)
April 11 - Data Capturing and Representation

April 18 - Pre-Review and Workshop (Final Group Presentation TBD)

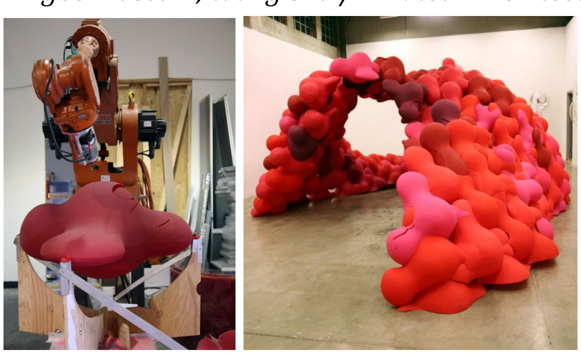
Last Day of Architecture Classes	4/20
Arch Studio Final Reviews	4/23-5/2
Arch Class Finals (exceptions only)	5/3-5/4

Selected References:

The Wonderful Caddis Worm, Hubert Drupat, 1980-

Gantenbein Winery Facade, Gramazio & Kohler, 2006

Ningbo Museum, Wang Shu / Amateur Architecture Studio, 2008



SCI-Arc Blobwall, Greg Lynn FORM, 2009

Selected Readings:

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 2014*. Zurich: gta Verlag, 2014.

Johns, R.L. and Anderson, J. "Adaptive Assembly: Collaborative Robotic Reuse in Construction" In: Zaera-Polo, A. and Anderson, J. (eds.) *Imminent Commons: The Expanded City*. Seoul Biennale of Architecture and Urbanism 2017. Actar Publishers, New York, 2017, pp. 332-343.

Johns R.L. 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.

Mollica, Z. and Self, M., "Tree Fork Truss: Geometric Strategies for Exploiting Inherent Material Form" In: Adriaenssens, S., Gramazio, F., Kohler, M., Menges, A. and Pauly, M. (eds.), *Advances in Architectural Geometry 2016*, Zurich, p.138-153.

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.