

Arch 619 Digital Fabrication – Materials and Methods of Production

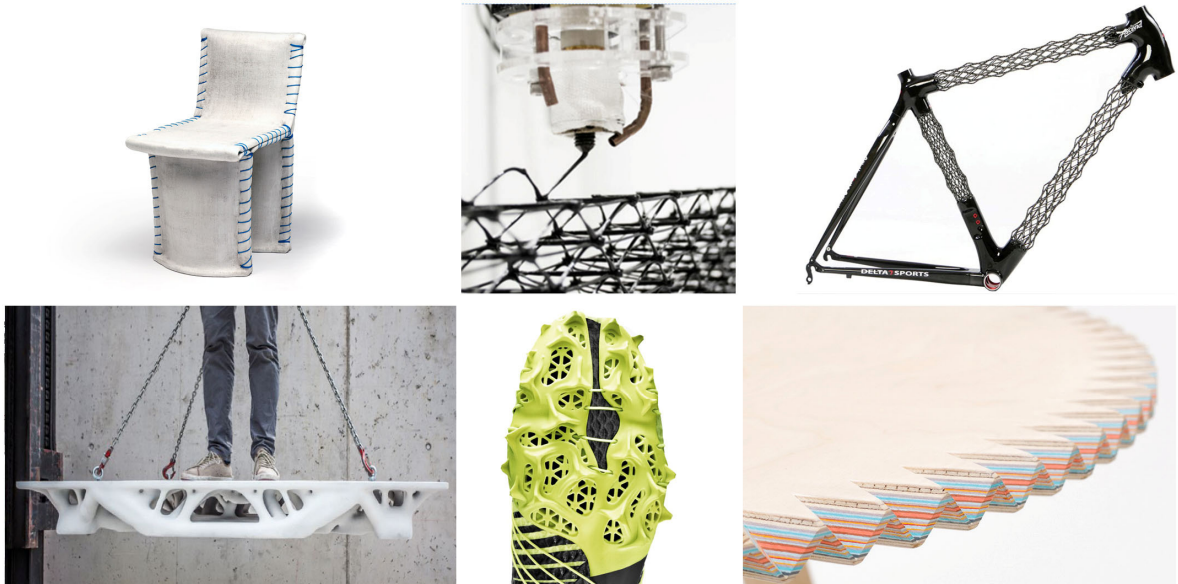
Fall 2020 - Tuesdays 1:00 p.m. - 3:50 p.m.
University of Southern California School of Architecture
Units : 3

Instructor : **Rob Ley**

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(upper left to lower right) – Stitched concrete chair by Florian Schmid, ETH Zurich FDM Lattice, Carbon IsoTruss bicycle frame, ETH Zurich 3D Printed "Stay in Place Formwork", Nike Hyper-Agility cleats, Breaking Surface Table by Sophie Hardy

Course Description

This course is an overview of multiple fabrication, manufacturing, and construction techniques used in the production of architecture, furniture, and industrial design.

As software and hardware continues to develop and become increasingly capable of sophisticated operations and processes, design has evolved beyond the initial exploration of complex formal expression and has expanded into multiple philosophies within architecture. One such philosophy involves the relationship between materiality, formation, and design. Within this vein, material studies and fabrication processes are understood not merely as end-results of an architectural design. Rather, the awareness of material performance offered through design-by-making leads the design process itself, creating a constructive feedback loop.

This course will be a combination of lecture and lab. Lectures will cover three primary categories of industrial process (**Additive, Subtractive, and Transformative**) along with materials research (**Plastics, Composites, Wood, and Metals**). We will engage a series of discovery-based, hands-on workshops where students will begin small scale material and fabrication prototypes, utilizing various digital fabrication technologies (CNC milling, 3D printing, Laser Cutting, etc). In the second half of the course, students will further develop their initial material based discoveries into refined, small-scale projects that exhibit a high degree of material awareness and craft.

This course will study examples taken from various architecture-adjacent fields of as a means of broadening our sources of inspiration. Industries such as automotive, aeronautical, and garment design (to name a few) have consistently been at the forefront of performance driven design and we will look for opportunities to glean such newfound techniques into our architectural lexicon.

Past experience working with materials or fabrication techniques is not a prerequisite for the class. The subject matter in this course will begin at an introductory level, and will then accelerate quickly as the semester continues.

Course Schedule

* All lectures include case studies of relevant projects and applications

- Week 01**
- **Materials and Properties**
 - *Lecture 1 - **Plastics & Composites***
 - Polymers
 - Thermoplastics
 - Composite Matrixes (Fiberglass, Carbon Fiber, Kevlar)
 - Honeycomb materials
 - *Student Fab Project Work Session* : **Students to begin Thermoforming studies**
- Week 02**
- **Materials and Properties**
 - *Lecture 2 - **Wood and Fibrous Materials - Case Studies and Applications***
 - **Required Reading**: Benjamin Aranda/ Chris Lasch, *Tooling Pamphlet Architecture 27*, 2006
 - Laminated wood products
 - Veneers
 - Steam bent members
 - *Student Fab Project Work Session* : **Students to begin Ply-Lamination studies**
- Week 03**
- **Materials and Properties**
 - *Course Introduction*
 - *Lecture 3 - **Metals and Ceramics - Case Studies and Applications***
 - Steel, Aluminum, Alloys
 - Ceramic Hybrids
 - Production and Fabrication Standards
 - *Student Fab Project Work Session* : **Students to begin Metal bending studies**
- Week 04**
- *Lecture 4 - **Guest Lecturer - Peter Carlson of Carlson Arts***
 - *Student Fab Project Work Session* : **Students to present first 3 Material Studies to class**
- Week 05**
- **Additive Fabrication Processes**
 - *Lecture 5 - Additive Fabrication Processes Case Studies*
 - **Required Reading**: Branko Kolarevic and Kevin Klingler, *Manufacturing Material Effects: Rethinking Design and Making in Architecture*, 2014
 - Fused Deposition Processes
 - Injection Molding, Roto-Molding
 - Casting Technologies
 - 3D Printing (SLA, SLS, FDM)
 - *Student Fab Project Work Session* : Assign final projects & groups
- Week 06**
- **Subtractive Fabrication Processes**
 - *Lecture 6 - Subtractive Fabrication Processes Case Studies*
 - Laser Cutting [vaporization cutting and industrial manufacturing]
 - Water Jet Processes
 - CNC 3, 5, & 7 Axis Milling, Cutting, Planing, Drilling
 - *Student Fab Project Work Session* : Review project prototypes
- Week 07**
- **Transformative Fabrication Processes**
 - *Lecture 7 - Transformative Fabrication Processes Case Studies*
 - **Required Reading**: Branko Kolarevic, *Architecture in the Digital Age: Design and Manufacturing*, London: Taylor & Francis, 2005

- *Student Fab Project Work Session* : Instructor to review projects progress

- Week 08** - **Mass Production Manufacturing Processes**
- *Lecture 8* - Methods of Factory-Based production
- *Student Fab Project Work Session* : Review project prototypes
- Week 09** - **Lab Session in Workshop**
- Review project progress
- Week 10** - **Mid- Review Presentation of Student Fabrication Projects**
- Week 11** - **Lab Session in Workshop**
- Review project progress
- Week 12** - **Exotic and Experimental Fabrication Processes**
- *Lecture 9* - Exotic/Experimental Fabrication Processes Case Studies
- **Required Reading:** Bob Shiel, Ruairi Glynn, *Fabricate: Making Digital Architecture*,
Toronto:
Riverside Architectural Press, 2011
- Biological Growth Formation
 - Crystal Structure Formation
 - Explosion Forming
 - Muscle Wire and Self-Assembling Structures
- *Student Fab Project Work Session* : Review project prototypes
- Week 13** - **Lab Session in Workshop**
- *Documentation Draft for Review*
- Week 14** - **Lab Session in Workshop**
- Review project progress
- Week 15** - **Final Presentation of Projects & Documentation**
- Finals** - **See University Schedule**
- **FINAL DOCUMENTATION BOOK DUE (20% of GRADE)**
 - o **Part 1: Introduction**
 - o **Part 2: Critical Assessment of Process**
 - o **Part 3: Final Project Documentation**

Additional Recommended Readings:

Digital Fabrication, Paul Andersen, David Salomon, Sanford Kwinter, David Carson, Architecture of Patterns, W. W. Norton & Co, 2010

Cecil Balmond, Informal, 2002

Emergent Design Group, Morphogenetic Design Strategies AD, 2004

Heino Engel, Structure Systems, 1997

Lisa Iwamoto, Digital Fabrications: Architectural and Material Techniques, Princeton: Princeton Architectural Press, 2009

Farshid Moussavi, Daniel Lopez, Garrick Ambrose, Ben Fortunato, Ryan R. Ludwig and Ahmadreza Schricker, *The Function of Form*

Rivka Oxman and Robert Oxman, *The New Structuralism: Design, Engineering and Architectural Technologies*

Lars Spuybroek, *NOX: Machining Architecture*, London: Thames and Hudson, 2004

Michael Weinstock, Michael Hensel, Achim Menges (eds.), *Emergence: Morphogenetic Design Strategies*, AD, Vol 74, No. 3, May/June 2004

Gail Peter Borden and Michael Meredith, *Matter: Material Processes in Architectural Production*

Gail Peter Borden, *Material Precedent: The Typology of Modern Tectonics*

Blaine Brownell, *Transmaterial 1/2/3*

GRADING

Grading will be determined from the following distribution:

- 30% Quality of in-class research & reading discussions
- 20% Mid-Review Presentation of Fabrication Project
- 30% Final Review of Fabrication Research Project
- 20% Project Documentation (booklet – Due on Date of Final)

Course Requirements

The basic requirements for any course revolve around active participation. This means that each student is expected to attend class meetings attentively, come prepared to participate fully in class discussions, and complete the assignments on time and according to directions.

Attending classes is a basic responsibility of every USC student who is enrolled in courses at the School of Architecture. The School of Architecture's general absence policy is to allow a student to miss the equivalent of one week of class sessions, without directly affecting the student's grade and ability to complete the course (this is for excused absences for any confirmed personal illness/family emergency/religious observance or for any unexcused absences). For each absence over that allowed number, the student's letter grade can be lowered up to one full letter grade.

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" <https://policy.usc.edu/student/scampus/part-b>. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Discrimination, sexual assault, intimate partner violence, stalking, and harassment are prohibited by the university. You are encouraged to report all incidents to the Office of Equity and Diversity/Title IX Office <http://equity.usc.edu> and/or to the Department of Public Safety <http://dps.usc.edu>. This is important for the health and safety of the whole USC community.

Faculty and staff must report any information regarding an incident to the Title IX Coordinator who will provide outreach and information to the affected party. The sexual assault resource center webpage <http://sarc.usc.edu> fully describes reporting options. Relationship and Sexual Violence Services <https://engemannshc.usc.edu/rsvp> provides 24/7 confidential support.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the American Language Institute <http://ali.usc.edu>, which sponsors courses and workshops specifically for international graduate students. The Office of Disability Services and Programs <http://dsp.usc.edu> provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, USC Emergency Information <http://emergency.usc.edu> will provide safety and other updates, including ways in which instruction will be continued by means of Blackboard, teleconferencing, and other technology.