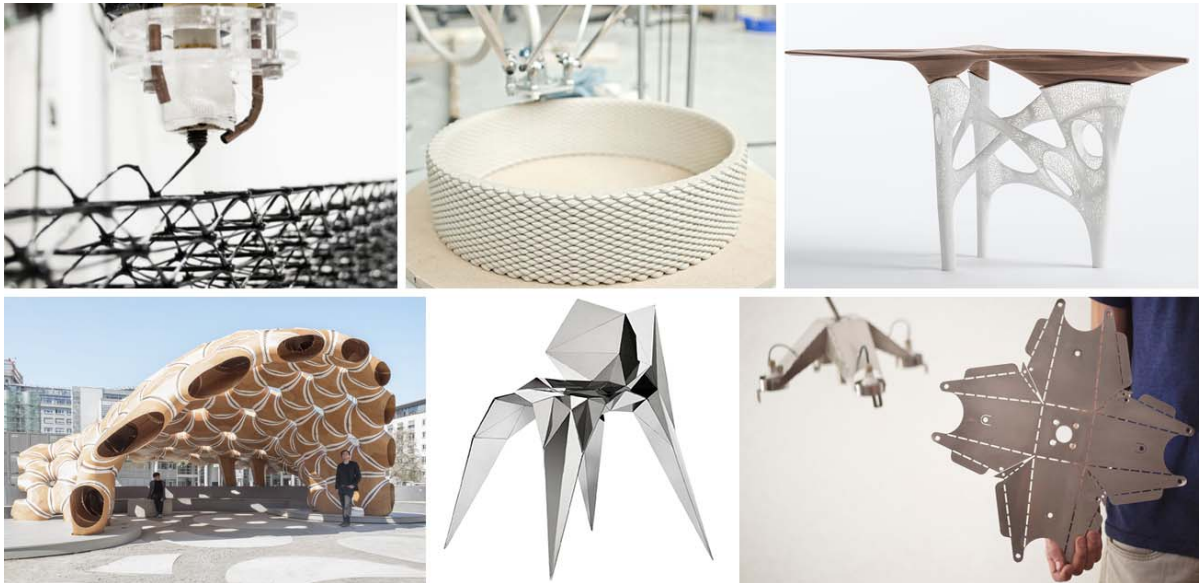


University of Southern California School of Architecture

Units : 2

Instructor : Rob Ley

Email : ley@rob-ley.com



(Upper left to lower right) - ETH Zurich FDM Lattice, Olivier van Herpt's ceramic printer, Alek SA Studio table, ICD ITKE Pavilion - Stuttgart University, Break-formed chair by Zhoujie Zhang, Michael O'Brien's folded metal surgical lamp

Course Description

As software and hardware continues to develop and become increasingly capable of sophisticated operations and processes, computational 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 seen not as a mere end-result of architectural design. Rather, the awareness of material performance and the feedback offered through design-by-making empowers designers to push architectural pedagogies further and further.

CNC based hardware and software including milling, assembly, 3-D printing, laser cutting and the use of robots of various kinds in the construction industry are becoming both more sophisticated and progressively less expensive. These new technologies have introduced a greater degree of control and precision in the construction process, and have opened up a range of new methods of fabrication. Furthermore, having command over the means of fabrication and production offers a renewed level of control (and exploration) for the contemporary architect.

This course will be a combination of lecture and lab. Lectures will cover three primary categories of industrial process (Additive, Subtractive, and Transformative). In addition to the lectures, students will work together in groups of 2 to further investigate these topics through the development of a semester long fabrication project. This project will be small in scale and will allow students to apply the processes and techniques covered in lectures in a manner that encourages creativity and precision.

Learning Objectives

This course provides an introduction to a range of new fabrication techniques and technologies that will encourage students to rethink the nature of architectural fabrication and representation. The subject matter in this course anticipates that students already have a working knowledge of the major material groups within architectural design and construction (Wood, Metals, Concrete, Masonry, Glass, Plastics, and Composites). Over the course of the semester, we will look closely at how these materials are being utilized and advanced in fields outside of architecture, and will also learn the methods and processes that are used in their fabrication.

Each student will be required to make two submissions. The initial submission will be based on case studies in material technologies, followed by a final submission based on a small group project. Each student will adopt a technology and present an analytical project based in a critical engagement with the technology as a pro-active design tool. The result will be both physical production and textual documentation.

Course Schedule

* All lectures include case studies of relevant projects and applications

- Week 01**
- **Materials and Properties**
 - *Course Introduction*
 - *Lecture 1 - **Metals and Ceramics - Case Studies and Applications***
 - Steel, Aluminum, Alloys
 - Ceramic Hybrids
 - Production and Fabrication Standards
 - *Reading* : John Fernandez, Material Architecture
- Week 02**
- **Materials and Properties**
 - *Lecture 2 - **Wood and Fibrous Materials - Case Studies and Applications***
 - Laminated wood products
 - Veneers
 - Steam bent members
 - *Reading* : Benjamin Aranda/ Chris Lasch, Tooling Pamphlet Architecture 27, 2006
- Week 03**
- **Materials and Properties**
 - *Lecture 3 - **Plastics & Composites***
 - Polymers
 - Thermoplastics
 - Composite Matrixes (Fiberglass, Carbon Fiber, Kevlar)
 - Honeycomb materials
 - *Student Fab Project Work Session* : Introduction to projects
 - *Reading* : Ruairi Glynn/Bob Sheil, Fabricate: Making Digital Architecture, 2013
- Week 04**
- **Additive, Subtractive, and Transformative Fabrication Processes Overview**
 - *Lecture 4 - **Guest Lecturer - Peter Carlson of Carlson Arts***
 - *Student Fab Project Work Session* : **Assignment** of project proposals
- Week 05**
- **Subtractive Fabrication Processes**
 - *Lecture 5 - 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 06** - **Additive Fabrication Processes**
 - *Lecture 6* - Additive Fabrication Processes Case Studies
 - Fused Deposition Processes
 - Injection Molding, Roto-Molding
 - Casting Technologies
 - 3D Printing (SLA, SLS, FDM)
 - *Student Fab Project Work Session* : Assign final projects & groups
- Week 07** - **Transformative Fabrication Processes**
 - *Lecture 7* - Transformative Fabrication Processes Case Studies
 - Bending (Sheet metal forming)
 - Forming (Vacu-forming, Hydro-forming)
 - *Student Fab Project Work Session* : Review projects progress
- Week 08** - **Subtractive Fabrication Processes**
 - *Lecture 8* - 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 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
 - 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**

Recommended Readings

Branko Kolarevic and Kevin Klinger, *Manufacturing Material Effects: Rethinking Design and Making in Architecture*, 2014

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

Benjamin Aranda/ Chris Lasch, Tooling Pamphlet Architecture 27, 2006

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

Branko Kolarevic, Architecture in the Digital Age: Design and Manufacturing, London: Taylor & Francis, 2005

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

Bob Shiel, Ruairi Glynn, Fabricate: Making Digital Architecture, Toronto: Riverside Architectural Press, 2011

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:

- 15% Class Participation
- 20% Mid-Review Presentation of Fabrication Project
- 40% Final Review of Fabrication Research Project
- 25% Project Documentation (Booklet)

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” policy.usc.edu/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>.

Support Systems:

Student Counseling Services (SCS) – (213) 740-7711 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

National Suicide Prevention Lifeline – 1 (800) 273-8255

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. engemannshc.usc.edu/rsvp

Sexual Assault Resource Center

For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: sarc.usc.edu

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086

Works with faculty, staff, visitors, applicants, and students around issues of protected class. equity.usc.edu

Bias Assessment Response and Support

Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. studentaffairs.usc.edu/bias-assessment-response-support

The Office of Disability Services and Programs

Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

Student Support and Advocacy – (213) 821-4710

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. studentaffairs.usc.edu/ssa

Diversity at USC

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. diversity.usc.edu

USC Emergency Information

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime. Provides overall safety to USC community. dps.usc.edu