

# Arch 599 Digital Fabrication – Materials and Methods of Production

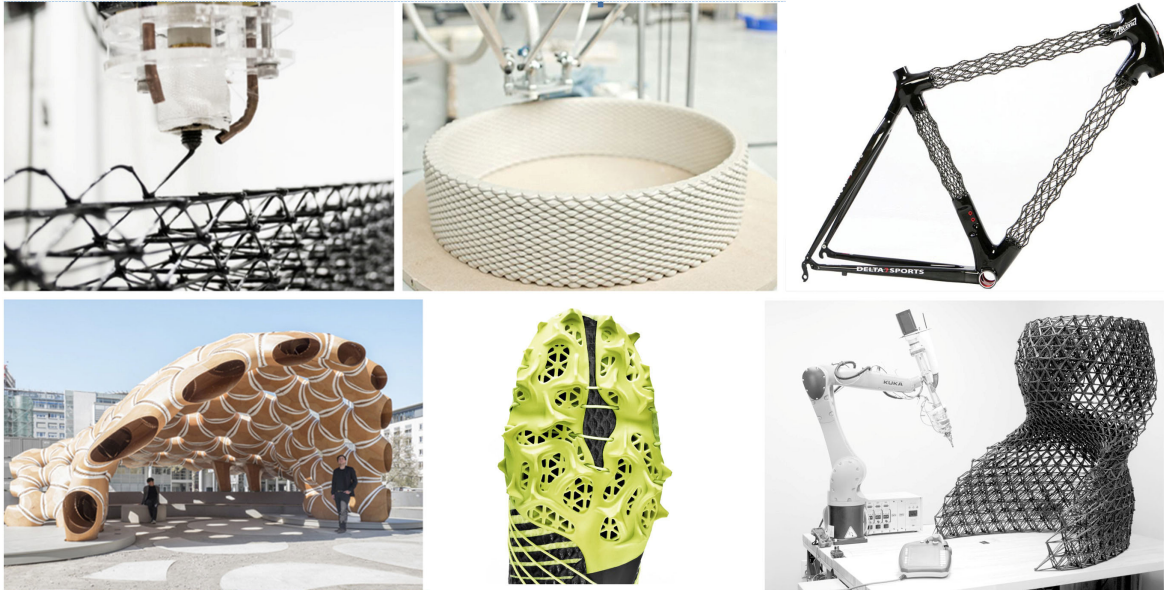
Fall 2019 - Mondays 6:30 p.m. - 9:20 p.m.  
University of Southern California School of Architecture  
Units : 3

Instructor : **Rob Ley**

Email : [ley@rob-ley.com](mailto:ley@rob-ley.com)

[www.rob-ley.com](http://www.rob-ley.com)

ig @rob.ley



(upper left to lower right) – ETH Zurich FDM Lattice, Olivier van Herpt's ceramic printer, Carbon IsoTruss bicycle frame, ICD ITKE Pavilion - Stuttgart University, Nike Hyper-Agility cleats, Branch Technology's robotic FDM

## Course Description

***This course is a broad overview of multiple fabrication 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***  
- 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*  
- 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*  
- *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
                   - 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 Schrickler, *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:

30%	Quality of In-Class research and project presentations)
20%	Mid-Review Presentation of Fabrication Project
30%	Final Review of Fabrication Research Project
20%	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](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://dps.usc.edu)