

Arch 497: Digital Design and Fabrication

Syllabus: Spring 2006

Instructors: Thomas J McLeish mcleish@iit.edu

Chris Palmer

Course Time: Wednesday, 6:25-9:05

Course Location: SH-236

Course Description: This course explores the design and fabrication of architectural components in contemporary practice. We will investigate through the design and prototyping of a custom architectural component [schedule subject to change]:

1. Survey of CAD/CAM use in architectural practice and component manufacturing.
 - a. Gehry Technologies
 - b. Zahner Metals
 - c. Ove Arup + Bentley: Microstation
 - d. Parametric modeling
2. Behavioral models of building structures using Structural analysis tools
 - a. Survey of existing structural modeling tools.
 - i. Bentley Structural
 - ii. Gehry Technologies
 - iii. Dr. Frames
 - b. Analysis of building structure using Dr. Frame tools.
 - c. Presentation of structural systems by Structural Engineer.
3. Use of CAD tools to model building components for production.
 - a. 3D Studio MAX
 - b. Rhino 3D
4. Use of CAD tools to analyse structural properties of components
 - a. ANSYS
 - b. Autodesk Inventor
5. Material properties and related fabrication constraints
 - a. Casting: Shrinkage, formwork, cost
 - b. Milling: toolpaths, lathes, mills, waterjet, laser cutter
 - c. Metals
 - i. Steel
 - ii. Aluminum
 - d. Wood
 - e. Plastic
 - f. Ceramics
 - g. Glass
6. Current fabrication processes
 - a. Site visit to custom metals fabrication: Western Fabricating
 - b. Architectural firm fabricating custom parts integral to its practice: DMAC Architects, Jordan Moser Associates
 - c. Metals casting firm...
7. Use of IIT owned CNC tools to fabricate architectural components
 - a. Milling machines
 - b. Lathe
 - c. Laser cutter
8. Rapid prototyping
 - a. Stereolithography
 - b. 3D printing: Stratasys
 - c. Water jet
 - d. Laser cutter

Arch 497: Digital Design and Fabrication

Students should be comfortable navigating a 3D digital environment and have some experience with 3D modeling.

Students will be required to write a research paper on a relevant topic, fabricate design studies of an architectural component, and produce a full-scale working prototype of a final design solution.

Course Objectives:

The primary objective for this course is to expose students to new technologies used in architectural practice and component design and fabrication - such that they can include them within their architectural palette and have a meaningful dialogue with those construction team members who specialize in these trades. Students successfully completing this course will demonstrate the following:

- An understanding of the broader implications of digital design and fabrication on architectural practice.
- An understanding of a variety of architectural materials and their use in digital fabrication.
- The ability to use 3D modeling tools to design, analyze, and fabricate an architectural component.
- The ability to prepare and transfer data between various modeling and fabrication tools.

Course Format:

Each class period will be divided into three parts: open discussion, lecture/tutorial, and open lab time. By the end of this course students will have made contact with Rhino 3D, 3D Studio MAX, MADCAM, AutoDesk Inventor 10, CNC Milling tools, Laser Cutter Prototyping, and more.

Suggested Texts:

Appropriate text excerpts will be provided as necessary. This will include white papers on fabrication process, research papers on use of new fabrication techniques in practice, and user guides for hardware and software used in the course. It is essential that the student with little or no CAD experience be willing to put additional time outside of class as the techniques covered will be new and will require the student to practice to become facile.

Student Evaluation:

The following areas will be considered when determining final grades:

- **Assignments – 50%**
 - Several assignments will be given during the course. These will range from draft paper topics to submission of digital models to preliminary design prototypes for final project.
- **Research Paper – 20%**
 - Topics in advanced digital fabrication.
- **Final Project – 30%**
 - Final working prototype.
- **Conditionals**
 - Attendance in the course is mandatory. A second unexcused absence will result in a lower lettered grade. A third unexcused absence will result in a failing grade.
 - Participation in class discussion and group work will also be factored into student evaluation.

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Course Outline [subject to change]:

Week 1: Introduction

- Introduction to the course
 - Overview of the syllabus, course outline and student evaluations.
 - Introduction to hardware, network and software.
- Overview of CAD/CAM use in practice.

Week 2:

- Introduction to Dr. Frames / behavioral analysis
- Architectural Components: the big picture

Week 3:

- Architectural Components: the detail / Component analysis
- Review of 3D Studio/Rhino

Week 4:

- Site visit: architect
- Interview with Robert Aish: Bentley

Week 5:

- Site visit: fabricator
- Interview with Zahner Metals

Week 6:

- Use of laser cutter
- Material properties

Week 7:

- Introduction to Inventor + Stress Analysis [ANSYS]

Week 8:

- Review of digital fabrication in practice.
- Vacuum forming

Week 9:

- Submission of research paper
- Preliminary design studies prototypes

Week 10:

- Preliminary design studies prototypes
- Use of CNC mill

Week 11:

- Preliminary design studies review

Week 12:

- Preliminary design studies review

Week 13:

- Student presentations of final project
 - Documentation + Analysis + Suggested fabrication methodologies
- Final working prototype
- Preparation of final project as website.

Week 14: Review week

- Submission of final project as website.