SECTION 6:

ABRIDGED COURSE SYLLABI
CARNEGIE MELLON UNIVERSITY 2007 - 2011
(reverse chronological order)

dFAB 48-531 / 2010

Fabricating Customization – Robotic Fabrication

Carnegie Mellon University

Course Information

Instructor:	Jeremy Ficca	jficca@cmu.edu
Schedule:	T/TH	12:00PM – 1:30PM
Location:	dFAB	
	Office hours:	Monday 9:00-11:00AM MMCH 201 (please schedule appointment via email)

Introduction

Ongoing advancements in digital fabrication are facilitating the realization of architectural speculations invested in geometric complexity, material performance and emergent tectonics. Here, the "physical" is infused with characteristics of its "digital" origins, resulting in novel methods of construction and alternative conceptions of tectonics. The schism of the previous decade between digital design and realization is giving way to an ever-increasing collection of architecture reliant upon the most advanced methods of digital design, yet firmly residing in the physical realm. Furthermore, the allure of one-off customization (mass customization) offered through the use of digital fabrication tools is calling into question the long-standing reliance upon systems of mass production and standardized building components. The convergent impact of these interrelated streams is radically transforming the discourse and practice of architecture while ushering in a phase of architectural investigation and production that relishes in the complexity afforded through the use of sophisticated software and hardware tools.

While industrial robotic equipment have been deployed in various capacities for nearly the past 40 years, the utilization of automated equipment for the fabrication and assembly of buildings has a limited history. The significant investments by Japanese construction companies in the 1980's in automated construction were largely deemed a failure due to the associated cost and complexity. Recently, a renewed interest in the robotic fabrication of architecture has emerged. This has been fueled in part by advancements in digital modeling and simulation that have fostered connections between design and fabrication and the promise to translate design data into robot instructional code. Fundamental to the use of industrial robotic equipment is the inherent task flexibility. The industrial robot, like the human arm and hand, is defined as a tool by that which it holds. As a result, one robot can "do" multiple things and "work" with various materials.

This course explores emerging themes of "digital tectonics" and "digital materiality" afforded through semi-automated robotic fabrication and assembly. Through a series of design and fabrication investigations student groups will develop a comprehensive understanding of the robotic fabrication workflow relating to subtractive and additive digital design processes. The 7-axis robotic work cell will serve as the principle instruments of the exploration. In an effort to leverage the equipment available, particular focus will be directed to a critical understanding of the distinctions between traditional digital fabrication and robotic fabrication.

Research Focus

This course is conducted as an advanced research seminar in which design, prototyping and fabrication are interrelated and complimentary endeavors. It provides you an opportunity to engage in prescient research into emerging methods of robotic fabrication. The various course projects fit within the overarching course theme and serve as an opportunity to explore new territory while building upon the research from previous semesters.

Course Theme

The wall and facade will serve as the focus for fabrication projects during the course of the semester. The space making and structural capacity of the surface will be explored at multiple scales. Particular attention will be placed on geometric transformability afforded through the use of the robot. Subtractive (i.e. milling) and additive (i.e. bending) fabrication will serve as the course process focus and allow concurrent paths of investigation. This theme builds upon last years project focus on the architectural screen.

Materiality

Robust digital fabrication tools such as the industrial robot provide an opportunity to engage and exploit materials. The design projects of this course seek to utilize digital fabrication workflows as a means to utilize and express inherent material characteristics. As such, materials will not serve as a proxy for those that are more expensive or "resistant". Rather they will be addressed in light of what they offer. This subtle, yet significant distinction will allow a more meaningful engagement of materiality.

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Course Objectives

Provide an applied overview of industrial robotic fabrication processes.
Provide a contemporary overview of the relationships between technology, production and design.
Utilize robotic fabrication workflows to develop novel methods of component creation and material assembly.
Utilize digital design and fabrication workflows to develop a geometric logic that is capable of transformation in response to specific site / program conditions.

Students enrolled in this course will:

1: apply various digital fabrication tools in the context of design problems to transform standard materials
2: understand and apply basic concepts of digital fabrication and digital workflows
3: develop and fabricate a component system to express the potential of the equipment at hand

Topics covered in class:

Digitally driven fabrication
Robotic Fabrication
Digital materiality
Mechanized craft
Digital Tectonics
Architectural components

Working Method

Given the nature and demands of the course, students will work in small groups for the first half of the semester and as one group for the final project. Students must be willing and eager to collaborate. Do not enroll in this class if you do not want to work collaboratively. Each student in a given group should become the resident expert of a particular facet of the process. This will enable the groups to achieve a greater level of output in less time.

Technical proficiency and critical engagement of the processes will occur through a structured sequence of fabrication projects that build upon the course theme. As an advanced digital fabrication course, students must be proficient with CNC routing and high fidelity digital modeling.

Projects

1. Fabrication Projects:
The first half of the semester consists of 4 brief, yet immersive fabrication projects that provide a targeted overview of the subtractive and additive robotic workflow available within the School of Architecture. While targeted fabrication process workshops will occur at the onset of each project, students must plan on scheduling time outside of class to meet with Zach Ali to further their understanding of the required skills.

2. Culminating Installation Project:
Immediately following fall break, students will form into one 12-person group to develop and fabricate a 1:1 digital fabrication project to be sited on campus. Given the time constraints, everyone must utilize resources strategically. The installation is intended to build upon the previous work of the semester and highlight the utilization of the equipment. Students are expected to create an installation of the highest level of craft that communicates the processes utilized. A final project presentation/review will occur at the end of the semester. Guest critics will be invited.

Material Support:
Course materials are financially supported in part through course funding. You should expect to contribute $100 in addition to this allocation.

Course Organization

Discussions and Presentations:
This is an advanced level seminar and relies upon group discourse. All students are expected to contribute to weekly discussions about readings, assignments and research areas.

Fabrication Projects:
See description within Projects

Final Installation Project:
See description within Projects

Equipment and Process workshops:

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Digital Tectonics – Robotic Fabrication

Carnegie Mellon University

Course Information

Instructor:	Jeremy Ficca	jficca@cmu.edu
	Zach Ali	pzali@andrew.cmu.edu
Schedule:	T/TH	9:00AM – 10:20AM
Location:	MM 102 and dFAB (see schedule)	
	Office hours:	Monday 9:00-11:00AM MMCH 201 (please schedule appointment via email)

Introduction

This course explores the tectonic and organizational opportunities afforded through automated fabrication and assembly, specifically robotic fabrication. Given the process / task flexibility inherent with robotics, particular attention will be paid to a range of processes and scales. Through a series of design and fabrication investigations student groups will develop a comprehensive understanding of the robotic fabrication workflow relating to subtractive digital design processes. The recently acquired 7 axis robotic milling machine will serve as the principle instruments of the exploration. In an effort to leverage the equipment available, particular focus will be directed to a critical understanding of the distinctions between traditional digital fabrication and robotic fabrication. Technical proficiency and critical engagement of the processes will occur through a structured sequence of fabrication projects that build upon the course theme. As an advanced digital fabrication course, students must be proficient with CNC routing and high fidelity digital modeling.

Course Theme

The architectural screen will serve as the focus for fabrication projects during the course of the semester. The mediating capacity of the thickened surface will be explored at multiple scales. Particular attention will be placed on the transformative potential of the material across its section.

Course Objectives

Provide an applied overview of industrial robotic fabrication processes.

Provide a contemporary overview of the relationships between technology, production and design.

Utilize subtractive robot fabrication to create physical components.

Students enrolled in this course will:

1: apply various digital fabrication tools in the context of design problems to transform standard materials

2: understand and apply basic concepts of digital fabrication and digital workflows

3: develop and fabricate a component system to express the potential of the equipment at hand

Topics covered in class:

- Digitally driven fabrication
- Digital materiality
- Mechanized craft
- Digital Tectonics
- Architectural components

Working Method

Given the nature and demands of the course, students will work in small groups for the first half of the semester and as one group for the final project. Students must be willing and eager to collaborate. Do not enroll in this class if you do not want to work collaboratively. Each student in a given group should become the resident expert of a particular facet of the process. This will enable the groups to achieve a greater level of output in less time.

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Projects

1. Fabrication Projects:
The first half of the semester consists of 4 brief, yet immersive fabrication projects that provide a targeted overview of the subtractive robotic workflow available within the School of Architecture. While targeted fabrication process workshops will occur at the onset of each project, students must plan on scheduling time outside of class to meet with Zach Ali to further their understanding of the required skills.

2. Culminating Installation Project:
Immediately following fall break, students will form into one 12-person group to develop and fabricate a 1:1 digital fabrication project to be sited on campus. Given the time constraints, everyone must utilize resources strategically. The installation is intended to build upon the previous work of the semester and highlight the utilization of the equipment. Students are expected to create an installation of the highest level of craft that communicates the processes utilized. A final project presentation/review will occur at the end of the semester. Guest critics will be invited.

Cost:
Course materials are financially supported through the generosity of the Enkeboll Foundation.

Course Organization

Discussions and Presentations:
This is an advanced level seminar and relies upon group discourse. All students are expected to contribute to weekly discussions about the design projects and research areas.

Fabrication Projects:
See description within Projects

Final Installation Project:
See description within Projects

Equipment and Process workshops:
In-class workshops will run in concert with the group fabrication projects for the first half of the semester. Students will develop a working understanding of subtractive robotic processes.

Operating Procedures

Attendance
Attendance and on time arrival is critical. Please make note of the CFA and dFAB class meeting locations as indicated in the course schedule.

Distractions
Use of Cell Phones, Pagers and all other communication devices is prohibited during class time.

Assignment completion
All assignments are due at the start of class as indicated on the course schedule. Late assignments will receive a grade of 0.

Religious Holidays, Sickness or Other Emergencies
Please contact me if you must miss studio for sickness or other another emergency. This will enable us to discuss the duration of missed classes and plan as best to prevent the student from falling behind. If I am not contacted I will assume that you are intentionally missing studio.

Disabilities
Students with disabilities should contact me to schedule a meeting so we can discuss academic accommodations. Please be prepared to provide the university accommodation letter.

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Fabricating Customization

Carnegie Mellon University

Course Information

Instructor:	Jeremy Ficca	jficca@cmu.edu
	Zach Ali	pzali@andrew.cmu.edu
Schedule:	T/TH	12:00PM – 1:20PM
Location:	CFA 212 and dFAB (see schedule)	
	Office hours:	Monday 9:00-11:00AM MMCH 201 (please schedule appointment via email)

Introduction

This course serves as an introduction to the expanding impact of digital fabrication upon the design and practice of architecture. Readings and lectures provide a historic and contemporary context for individual and group digital fabrication design projects. Particular focus is directed to contemporary relationships of design, customization and technology as they relate to the evolution of production and standards from a system of mass production to nimble systems of mass customization. A critical study of design investigations surrounding the Second World War to the present will serve as a frame of reference for design investigations that seek to leverage cutting edge technology for the realization of novel design solutions.

This course operates within the premise that architecture is undergoing a paradigm shift, driven in part by the convergent impact of technological advancement, a call for increased accountability and relevancy and greater complexity and integration. Workflows relating to processes of digital fabrication act as a significant component to this equation. Furthermore recent focus on materiality, digital tectonics and machine craft offer compelling links between virtual information and physical artifact.

The discourse will enable students to critically apply a foundational understanding of methods of digital fabrication to increasingly complex design projects. These methods of material processing will distinctly transform everyday materials in a manor that seeks to move beyond formal novelty to meaningful architectural impact.

Course Objectives

Provide an applied overview of various methods of digital fabrication.

Provide a contemporary overview of the relationships between technology, production and design.

Students enrolled in this course will:

1: apply various digital fabrication tools in the context of design problems to transform standard materials

2: understand and apply basic concepts of digital fabrication and digital workflows

3: understand the evolving role of mechanized production relating to architecture

4: develop and fabricate customizable component systems

Topics covered in class:

Mass production / Mass customization
Digitally driven fabrication
Digital materiality
Mechanized craft
Prefabrication
Versioning
Architectural components

Working Method

Given the nature and demands of the course, students will work independently and in small groups throughout the semester. Students must be willing and eager to collaborate. Do not enroll in this class if you do not want to work collaboratively.

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Projects

1. Fabrication Projects:
The first half of the semester consists of 6 brief, yet immersive fabrication projects that provide a general overview of the equipment and workflow available within the School of Architecture. While targeted fabrication process workshops will occur at the onset of each project, students should plan on scheduling time outside of class to meet with Zach Ali and the dFAB monitors to further their understanding of the required skills.

2. Case Study:
Each reading group will choose a unique contemporary architectural practice as a case study into the impact of contemporary design and fabrication processes upon the practice of architecture. Thorough research of projects from the chosen practice will result in 20-25 minute presentations at select dates during the semester as indicated in the syllabus. Groups are strongly encouraged to contact and interview their respective practices regarding their area of investigation. An emailed list of thoughtful questions is a viable method in light of the time demands placed upon practicing architects.

3. Installation Projects:
Immediately following fall break, students will form into groups of four to develop and fabricate a 1:1 digital fabrication project to be sited on campus at a location of the groups choosing. Given the relative budgetary and time constraints, groups must utilize resources strategically. Installations are required to thoughtfully engage existing context in a manor that expands, rather than distracts from current use. Each group will work with a primary material and process and are expected to create installations of the highest level of craft that communicate the processes utilized. A final project presentation/review will occur at the end of the semester. Guest critics will be invited.

Cost:
Each student will be expected to contribute $150 to the budget of each group. This will be used to purchase materials.

Course Organization

Lectures and Discussion:
This is an advanced level seminar and relies upon group discourse. All students are expected to contribute to weekly discussions about the readings, presentations and research areas. Students will be assigned to reading / research groups. Each reading group is expected to prepare a series of questions and lead a group discussion as indicated in the course schedule.

Readings:
Weekly readings can be found as pdfs on the course website and on reserve at the library. Historical and contemporary texts will be covered.

Fabrication Projects:
See description within Projects

Case Study:
See description within Projects

Suggested Practices:

Marble Fairbanks
Gramazio & Kohler
ARO – Architecture Research Office
Iwamotto Scott Architecture
William Massie Architects
ShoP – Sharples Holden Pasquarelli
Barkow Leibinger
PLY Architects
Kiernan Timberlake

Installation Projects:
See description within Projects

Equipment and Process workshops:
In-class workshops will run in concert with the individual fabrication projects for the first half of the semester. Students will develop a working understanding of basic digital fabrication workflows relating to multi-axis CNC routing, laser cutting, vacuum forming and 3d printing.