ARCH 212 | Digital Fabrication

LivMatS Pavillion | University of Stuttgart Institute for Computational Design and Construction, Freiburg, Germany, 2021.

Schedule

Tuesdays 2:00pm – 4:50pm EST

Location

ARC 1101

Instructors

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Teaching Assistants

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Territorial Acknowledgment

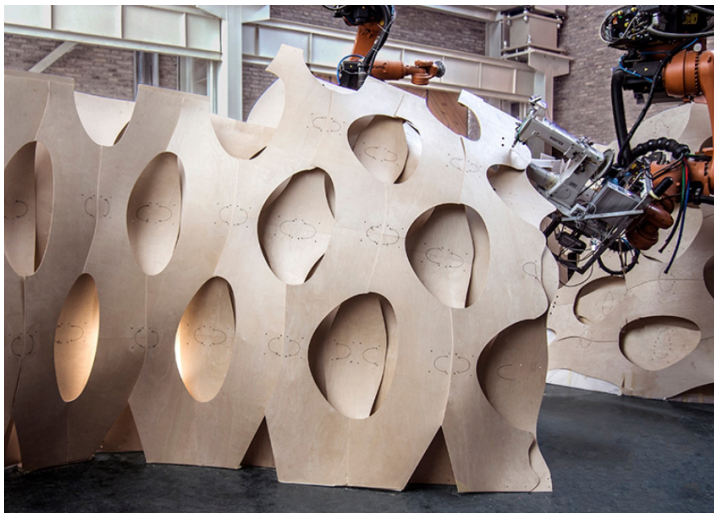
We acknowledge that the School of Architecture is located on the traditional territory of the Neutral, Anishinaabeg and Haudenosaunee peoples. The University is situated on the Haldimand Tract, the land promised to the Six Nations that includes 10 kilometres on each side of the Grand River. (see references here: https://uwaterloo.ca/engineering/about/territorial-acknowledgment)

Course Description

ARCH 212 examines the potential of digital tools to drive design-to-production workflows in the practice of architecture. Building on CAD and CAM skills acquired in ARCH 113, ARCH 212 introduces students to parametric modelling and fabrication techniques in order to develop architectural ideas and become fluid in digital design methodologies. The course examines how digital tools can enrich the practice of architecture by creating direct links between conceptualization and production.

We will begin the term by looking at case studies that utilize digital design in building construction. These case studies will support the development of students' parametric modelling skills and enable discussions around the role of computational tools in the field of architecture. Students will then have an opportunity to implement these skills in conjunction with additive and subtractive manufacturing techniques. The final term project will move students through a sequence of digital design exercises where three fabrication technologies will be utilized as tools for design research: 3D printing, CNC milling, and laser cutting. In ARCH 212, these fabrication tools will be used to establish design frameworks that support the development of digital craft. Digital craft is the careful integration of material behaviour and digital design processes through computational design thinking. Digital craft is made possible when users understand how machines communicate. As architects, this understanding enables more precise exchanges with technology that enrich our design processes and allow us to develop new form and spatial languages.

> *"In order to be able to talk again about craftsmanship in relation to materiality in architecture a connection needs to be established between the digital world and the actual material world. This is happening - or can happen - through digital fabrication. Architects today have direct access to the machines that are able to translate a digital model into an actual object. They have access to the machines and the software that control them. Learning how to use them is part of their academic education. Therefore they reconnect themselves with the material aspect in a direct way. Only that now this connection is mediated through protocols. That is, through the framework that allows the computer to communicate with the machine and therefore the framework that allows the translation from a digital, virtual object to a physical one... The real challenge for architecture in this case is to try to harness those protocols and instead of following the preset standards to try and invent new ways of operating the machines. Otherwise the machines remain out of the control of the architect and they become just tools that functions in a manner that in most cases the designer does not understand and, most importantly, does not control."*
>
> – Dimitris Gourdoukis in *Digital Craftsmanship: From the Arts and Craft to Digital Fabrication*



Sewn Timber Shell | University of Stuttgart Institute for Computational Design and Construction, Freiburg, Germany, 2017.

Course Goals and Learning Outcomes

The following is a list of expected learning outcomes for ARCH 212. To obtain a passing grade in the course, students must demonstrate an understanding of these concepts and an ability to apply these skill sets in course deliverables:

- Build familiarity and dexterity with digital design tools and fabrication methods including Grasshopper for Rhino, 3D printing, CNC milling, and laser cutting.
- Build adeptness and critical intuition for digital workflows. This means determining what are the most appropriate methods of digital craft and how to use them.
- A basic understanding and demonstrated application of parametric/associative design.
- Utilize digital fabrication as a method of inquiry to support design processes.
- Establish healthy habits for successful digital workflows and collaboration including time management and digital file organization..
- Gather and evaluate architectural precedents to build digital design literacy.

Structure

The course structure will be split between four sections:

Lectures – Will focus on examining digital fabrication methodologies as well as their applications and efficacy across different contexts.

Tutorials – Will focus on digital skill acquisition. These tutorials will explain the fundamental tools required to complete the course work. However, it is expected that you utilize digital fabrication as a mode of inquiry to advance your skill set beyond this training. Tutorials will set up the framework for completing course deliverables.

Work sessions – Will provide in-class time to work through design problems with instructors and teaching assistants. Additional office hours will be provided by the teaching assistants outside of class time. Sign-ups will be facilitated around deadlines as needed.

Fabrication time – Will be provided to utilize the equipment in the workshop and Mlab. Fabrication time will be facilitated by the teaching assistants and fabrication lab staff, Heinz Koller and Michael Syms. Students will be required to book fabrication time and prepare files in advance of utilizing the equipment. Note that all course work must be completed within the available time slots.

Resources

There are no required textbooks for this course. Students are strongly encouraged to reference publications and digital media as a way of developing design literacy. Short supplemental readings will be provided at key points during the course.

Hardware requirements:

- Working laptop and mouse.
- External hard drive for regular file back-ups.

Software requirements:

- Rhinoceros 7
- Grasshopper for Rhinoceros 7

Material requirements:

- Sheet material for laser cutting (refer to laser cutting safety tutorial for appropriate materials).
- Spool of 1.75 PLA filament for 3D printing.
- Block of high density foam for CNC milling (minimum dimensions, 180mm x 180mm x 60mm).

***Note:** RhinoCam and Simplify 3D will also be required to complete select course deliverables. However, students are not required to purchase this software, it will be available for use on computers at the School of Architecture fabrication labs.

Course Requirements & Assessment

Students must complete all exercises and obtain a passing average to receive credit for this course. Course assessment will be broken up into three sets of deliverables:

Labs (L01, L02, L03) – *15% of total grade*

- 3 labs @5% each.
- Submitted independently.

Case Study – *25% of total grade*

- Submitted in groups.

Assignments (A01, A02, A03) – *60% of total grade*

- 3 assignments @20% each.
- Submitted in groups.

In addition to the criteria provided as part of each assignment outline, all submission will be evaluated on:

- Completion of deliverables.
- Craft, clarity and precision of the work.
- Demonstrated understanding of digital skills acquired during tutorials.
- Consideration of design methodologies and themes discussed during lectures.
- Breadth of exploration and development.

Course Delivery Platforms and Communication

The following platforms will be used to deliver, organize, and share course content:

- **LEARN –** Work submission, grade recording, and release.
- **Teams –** Course documents and recorded lectures.
- **Email –** Official communications including communications outside of class hours.

Response times for communication outside class time with the teaching team will be up to 24 hours, Monday to Friday 9AM-5PM EST. Please use **email only** to communicate with the teaching team outside of class hours. When asking the teaching team for digital support, please follow these protocols:

- Include files in question.
- List the steps you have already taken in problem-solving.
- Include images and notes of what you are trying to achieve.

Covid-19 Special Statement

Given the continuously evolving situation around COVID-19, students are to refer to the University of Waterloo's developing information resource page (https://uwaterloo.ca/coronavirus/) for up-to-date information on academic updates, health services, important dates, co-op, accommodation rules and other university level responses to COVID-19.

Notice of Recording

Technical tutorials in ARCH 212 will be recorded for students to reference during completion of course deliverables. The course's official Notice of Recording document will be found on the course's LEARN site. This document outlines shared responsibilities for instructors and students around issues of privacy and security. Each student is responsible for reviewing this document.

Fair Contingencies for Emergency Remote Teaching

To provide contingency for unforeseen circumstances, the instructor reserves the right to modify course topics and/or assessments and/or weight and/or deadlines with due and fair notice to students. In the event of such challenges, the instructor will work with the Department/Faculty to find reasonable and fair solutions that respect rights and workloads of students, staff, and faculty.

Late Work

Course deliverables that are handed in late will receive an initial penalty of 5% if submitted within one hour of the deadline. An additional 5% penalty will be applied to course deliverables submitted within the subsequent 23-hour period. This means that all late course deliverables submitted more than 1 hour after the deadline will receive an automatic 10% deduction. Course deliverables handed in 24 hours beyond the deadline will receive 0%.

ARCH 212 relies on digital tools to complete all course deliverables. Students are expected to work diligently to ensure all assignments are submitted on time. Digital fluency, including file and software maintenance, are critical to both your academic success as well as your professional development. Computer crashes, corrupt files or forgetting to save or back-up will not be acceptable excuses for late submissions.

Only in the case of a justified medical or personal reason will these penalties be waived, and only if these have been officially submitted to the Undergraduate Student Services Coordinator and accepted by the Undergraduate Office.

Students seeking accommodations due to COVID-19, are to follow Covid-19-related accommodations as outlined by the university here: (https://uwaterloo.ca/coronavirus/academic-information#accommodations).

Passing Grades

The standard minimum passing grade in each ARCH course is 50% with the following exceptions: the minimum passing grade is 60% for all studio courses (ARCH 192, ARCH 193, ARCH 292, ARCH 293, ARCH 392, ARCH 393, ARCH 492, and ARCH 493). Grades below the specified passing grade result in a course failure.

CACB Student Performance Criteria

The BAS/MArch program enables students to achieve the accreditation standards set by the Canadian Architectural Certification Board as described here. This course addresses the CACB criteria and standards that are noted on the Accreditation page of the School of Architecture website.

Mental Health Support

All of us need a support system. We encourage you to seek out mental health supports when they are needed. Please reach out to Campus Wellness (https://uwaterloo.ca/campus-wellness/) and Counselling Services (https://uwaterloo.ca/campus-wellness/counselling-services).

We understand that these circumstances can be troubling, and you may need to speak with someone for emotional support. Good2Talk (https://good2talk.ca/) is a post-secondary student helpline based in Ontario, Canada that is available to all students.

Equity Diversity and Inclusion Commitment

The School of Architecture is committed to foster and support equity, diversity and inclusion. If you experience discrimination, micro-aggression, or other forms of racism, sexism, discrimination against 2SLGBTQ+, or disability, there are several pathways available for addressing this:

A) If you feel comfortable bringing this up directly with the faculty, staff or student who has said or done something offensive, we invite you, or a friend, to speak directly with this person. People make mistakes and dealing them directly in the present may be the most effective means of addressing the issue.

B) You can reach out to either the Undergraduate office, Graduate office, or Director (Maya Przybylski). If you contact any of these people in confidence, they are bound to preserve your anonymity and follow up on your report.

C) You can choose to report centrally to the Equity Office. The Equity Office can be reached by emailing equity@uwaterloo.ca. More information on the functions and services of the equity office can be found here: https://uwaterloo.ca/human-rights-equity-inclusion/about/equity-office.

D) Racial Advocacy for Inclusion, Solidarity and Equity (RAISE) is a student-led Waterloo Undergraduate Student Association (UWSA) service launching in the Winter 2019 term. RAISE serves to address racism and xenophobia on the University of Waterloo campus with initiatives reflective of RAISE's three pillars of Education and Advocacy, Peer-to-Peer Support, and Community Building. The initiatives include but are not limited to: formal means to report and confront racism, accessible and considerate peer-support, and organization of social events to cultivate both an uplifting and united community. You can report an incident using their online form.

Academic Integrity, Grievance, Discipline, Appeals, and Note for Students with Disabilities

Academic integrity – In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check the Office of Academic Integrity for more information.]

Grievance – A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline – A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions. [Check the Office of Academic Integrity for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance

from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

Appeals – A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals.

Note for students with disabilities – AccessAbility Services, located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

Turnitin.com – Text matching software (Turnitin®) may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course. It is the responsibility of the student to notify the instructor if they, in the first week of term or at the time assignment details are provided, wish to submit the alternate assignment.

Topics and Schedule

Week	Date	Lecture/Topics	Deliverable Assigned	Deliverable Due
01	September 13	Course Introduction + Technical Tutorial 1	L01	
02	September 20	Parametric Design Lecture + Technical Tutorial 2	Case Study, L02	L01
03	September 27	Additive Manufacturing Lecture + Fabrication Tutorial 1		L02
04	October 4	Subtractive Manufacturing Lecture + Fabrication Tutorial 2	A01, A02, A03	Case Study
Reading Week (October 10-16) – No Class				
05	October 18	Fabrication Tutorial 3 + Technical Tutorial 3	L03	
06	October 25	Post-Processing Lecture		L03
07	November 1	Worksession		
08	November 8	Worksession		A01
09	November 15	Worksession		
10	November 22	Worksession		A02
11	November 29	Advanced 3DP Lecture		
12	December 6	**Last day of Classes** – Worksession		A03

**note: course content and lab assignments are subject to change*