Institute of Architecture and Media

Advanced Module 4: GENERATIVE METHODS & DIGITAL FABRICATION

Course number	Name	Art	Hours	Lecturer
161.792	Generative methods and digital fabrication 1	SE	1.5	Hirschberg Dokonal
161.793	Generative methods and digital fabrication 2	SE	1.5	Gosch Hoffmann
161.794	Design project generative methods and digital fabrication	UE	3	Stavric Hoffman Dokonal

General objectives for the students:

Students will apply generative methods for digital fabrication through the use of digital software (Grasshopper/Rhino) and digital tools (Robot arm ABB IR 140 and 3d printer available at TU Graz) in order to understand different computational design strategies and their influence on digital fabrication processes — 200 hours of workload.

1. 50 hours - Different digital fabrication methods and generative design methods will be introduced in order to understand the different phases where these methods can be implemented in a project. Students will **analyze** a series of projects in order to recognise the challenges and problems. They will do a set of analogue experiments with a moldable material - clay. They will develop their own tools and document the fabrication process.

2. 50 hours - Students will be introduced to the kinematics of robot arm ABB IR 140. They will translate their analogue experience into robotic movement and generate G-Code. They will **practice** on the virtual and physical robot arm.

3. 100 hours - Students will **design and develop** an integral “Digital Dishes 4.0” project using generative methods and digital fabrication. In the end, the students will use the robot arm to fabricate their own design in a 1:1 scale.

Phases and topics:

1. **Generative methods and digital fabrication 1**
   - 1.1. Introduction to digital fabrication
   - 1.2. Parametric modelling in Grasshopper
   - 1.3. Design strategies, visual communication and representation
   - 1.4. Transformation of physical into digital information
   - 1.5. Comparative analysis of different strategies for design
2. **Generative methods and digital fabrication 2**
   - 2.1. General understanding of Robot Communication & Control
   - 2.2. Kinematic of robot
   - 2.3. G-Code generation
   - 2.4. Translation of analogue movement into robotic movement
3. **Design project generative methods and digital fabrication**
   - 3.1. Developing ” Digital Dishes 4.0” project
   - 3.2. Development of tools and fabrication strategy
   - 3.3. Fabrication process using robot arm in the scale 1:1

Learning activities:

1. Exercises
2. Practical integral design
3. Workshop

Core bibliography:

1. Bechthold, Martin, Kane, Anthony and King, Nathan. *Ceramic Material Systems: in Architecture and Interior Design*, Berlin, München, Boston: Birkhäuser, 2015. https://doi.org/10.1515/9783038210245
2. Hovestadt, L. Hirschberg, U. and Fritz Oliver (2020), Atlas of Digital Architecture- Terminology, Concepts, Methods, Tools, Examples, Phenomena, Birkhäuser Berlin.
3. Allen, E. and Iano, J. (2008). Fundamentals of building construction: Materials and methods, London, UK: Wiley.
4. Beorkrem C. (2017), Material Strategies in Digital Fabrication: Taylor and Francis.
5. Brownell, B. (2011). Material Strategies: Innovative applications in architecture. New York, USA: Princeton Architectural Press.
6. Cueva, D.G, Pugliese, G, (2020), Advanced 3D Printing with Grasshopper®: Clay and FDM: Kindle Direct Publishing, April 2020.
7. Arturo Tadeschi Algorithms-Aided Design. Parametric strategies using Grasshopper, ISBN: 9788895315300

8. Iwamoto, L. (2013), Digital Fabrications: Architectural and Material Techniques, Princeton Architectural Press,
9. Pottmann, H. et al. (2008). Architectural geometry, Exton, Pennsylvania, USA: Bentley Institute.
10. Yuan, F. P. Menges, A. and Leach, N. (2018), Digital Fabrication: Tongji University Press.

Extended Bibliography:

1. Kolarevic, B. and Klinger, K. (2008). Manufacturing material effects: Rethinking design and making in Architecture. New York, USA: Routledge.
2. Legendre, G. et al. (2011). Mathematics of space. (1st. Ed.). London, UK, Wiley Academy.
3. Sakamoto, T. and Ferré, A. (2008). From control to design Algorithmic Architecture. Barcelona, Spain; New York, USA: Actar.

Electronic resources:

1. Cumulative Index of Computer-Aided Architectural Design (CUMINCAD). Current legislation: http://cumincad.scix.net/cgi-bin/works/Home
2. Grasshopper Prime https://www.modelab.is/grasshopper-primer

Procedures and criteria for student's assessment:

The minimum passing grade for this course is 4 (four), best grade is 1 (one).

Partial Evaluations: 60 %

Final Evaluations: 40 %

CONTENT of MODULE 4:

In this module, we will explore the topic of generative techniques and digital fabrication through a series of designs fabricated on a scale 1:1. We will explore geometrical rules of design and we will implement the rules into parametric models.

At the end of the semester, the successful student will have obtained the skills needed in fabrication, along with an appreciation of the role of parametric modelling in various fabrication processes in real-life. The format of this class will be lecture, practical exercises, discussion and work in groups, as outlined below.

Course Goals:

An essential objective of this course is to make connections between geometry, parametric modelling and fabrication process, particularly those that are relevant to your interests, career goals, or other pursuits. The purpose of the semester project is to encourage the exploration of these connections and to build a design on a scale 1:1.

Attendance Policy:

Attendance is mandatory. If you are absent due to an emergency, you will be responsible for all material covered during that class;

Assignment Schedule/Grading:

Participation in Seminar + Practical exercise	Every Week	15%
Assignment 1	Assigned on 1st week, Tuesday Due 4th week, Friday	10%
Assignment 2	Assigned on 4rd week, Tuesday, Due 8th week, Friday	20%
Final Project	Assigned on 8th week, Tuesday, Due 14th week, Friday	40%
Final Presentation	Tuesday, last week of the semester	15%

Participation:

This course will be highly interactive, with much of the work completed in groups. Your participation grade will be based on your contributions to the group and your participation during whole-class discussions. Needless to say, frequent absences (even for emergencies) will be detrimental to this grade: Your grade for participation will drop one grade for every two absences.

Assignments:

Our assignments are designed to give you the opportunity to show us creativity, and your ability to solve problems and to demonstrate a deep understanding of the reasoning behind what you have learned. Accordingly, the assignments will consist of short-case study analyses and longer design problems requiring deeper analyses and fabrication processes.

Assignments and the final project will be discussed during class. We also expect that you will clear up any questions concerning Assignments and the final project of your own accord.

Assignments 1 and 2 will be completed individually and the final projects will be completed in groups of up to two students. All your assignments will be part of the final booklet and part of your final presentations. A list of possible topics will be presented to you, but you will by no means be restricted to that list. If you have other ideas for your design project, however, you should consult us to make sure that they are appropriate in their content, scope, and depth.

If for any reason the submission is inhibited (such as a problem with the server) on the deadline day, the submission will be postponed and the new deadline will be announced on the course website.

Final project:

The final projects will be completed in groups of two students. It is a complex design project that summarizes your experience for this course. Within a group, two design projects should be developed

and built in a scale 1:1. With your ideas for your final project, you should consult us to make sure that it is appropriate in their content, scope, and depth.

Final presentation:

At the final oral presentation you will present your entire work of this semester. Besides the oral presentation, you should prepare a **booklet** with all your assignments and a final project. You will receive general information regarding the format and requirements for your booklet.

Website:

We will be posting all class-related materials on the website: coming soon. You can access the website using the same password you use to access your TU GRAZ email account. All correspondence should be by email.

Standards for course grades:

1 – EXCELLENT (90-100%)

The student will be able to complete ALL tasks at specified times and dates with excellence and with initiative and adaptability in problem-solving with limited assistance and/or supervision.

2 – GOOD (80-89%)

Student can complete ALL tasks at specified times and dates with good quality and with initiative and adaptability to solving problems with periodic assistance and/or supervision.

3 - AVERAGE (70-79%)

Student can complete ALL tasks with satisfactory quality, but require recurring assistance and/or supervision.

4 - BELOW AVERAGE (60-69%)

Student can complete more than 60% of all tasks satisfactorily, but frequently requires continual assistance and/or supervision to perform the required skills.

5 – FAILURE (0-59%)

Student completes less than 60% of all tasks satisfactorily, and requires continual assistance and/or supervision to perform the required skills.