Course title: Science and Technology Workshop - Computational Design Theory and Application
Course code: ARCH 3102 BRGE
Programs offering course: Global Architecture and Design
Language of instruction: English
U.S. semester credits: 3.00
Contact hours: 45.00
Term: Spring Block II 2020

Course Description

In this science and technology workshop, students will learn computational design theory and application. Students will learn about core concepts of generative design and the application of calculus using two advanced digital design software programs: Rhinoceros and Grasshopper. Designers increasingly need to create reactive and flexible environments which are efficient and adaptive at the same time and capable to integrate diverse and competing requirements. Computational design tools, especially when paired with environmental data sources, allow for the creation of generative design models. As such, they provide performative design solutions to meet the complexity of multi-factorial demands and diverse environments of the present—and often reach out into the future as an enabler and catalyst. Rather than masterful command of specific tools, this course investigates the intersection of technologies and benefits of platforms. The instructional goal of the course is therefore to exhibit judgement in utilizing media for purpose, rather than rely purely on calculus.

Learning Objectives

By completing this course, students will:

- Employ NURBS Modeling and parametric/scripting tools in the design and simulation process.
- Explore critical ideas about a multi-systemic approach to design in an existing climatic and urban context.
- Document and optimize their designs for execution using the most suitable strategy for production.
- Assess data gained from various analysis tools or external datasets.
- Assemble and apply data sets to drive the generation of form and to develop behavioral morphological form families.
- Organize and prepare digital files required for CNC aided manufacturing or 3D printing.
- Develop and apply generative design methodologies to design in a more efficient and sustainable manner.

Course Prerequisites

This course is intended for students studying the built environment and offered as part of the Global Architecture + Design program—and open to selected students from the Open Campus Block program, based on the review by and approval of the Global Architecture + Design Program Coordinator. Interested students from the Open Campus Block program must have prior 3D digital modeling experience. This may be a previous course in 3D digital modeling or a design studio where 3D digital modeling was used.

Methods of Instruction

In-class slide lectures and desk critiques of project development; hands-on software training. Software includes the free-form 3d modeling tool Rhinoceros3d and the parametric scripting environment Grasshopper3d.

NOTE: The workshop is structured in a series of exercises. Time and duration of the exercises will be dependent on the level of digital modeling skills of participants.

Assessment and Final Grade

1. Workshop Progress 20%
2. Homework Assignments 20%
3. Transfer & Application, Part 1 20%
Course Requirements

Workshop Progress

Students follow the workshop instructor during hands-on training sessions. It's important that students pay close attention to complete the in-class task. In the workshop students will learn various methods and techniques to develop tailor-made geometrical systems that are correlating to form a complex multi-systemic approach to design which integrates the various aspects of the contemporary city (fabric modulation, street systems, open spaces, functionality, tectonic articulation, performance, lifecycle, etc.).

Homework Assignments

Weekly homework assignments reinforce the in-class training.

Transfer & Application, Part 1

Transfer & Application, Part 2

A term assignment demonstrates that students can transfer and apply their new skills to solve a design challenge.

Participation

Participation is valued as meaningful contribution in the digital and tangible classroom, utilizing the resources and materials presented to students as part of the course. Meaningful contribution requires students to be prepared in advance of each class session and to have regular attendance. Students must clearly demonstrate they have engaged with the materials as directed, for example, through classroom discussions, online discussion boards, peer-to-peer feedback (after presentations), interaction with guest speakers, and attentiveness on co-curricular and outside-of-classroom activities.

Attendance

Regular class attendance is required throughout the program, and all absences will result in a lower participation grade for any affected CIEE course. Due to the intensive schedules for Open Campus and Short Term programs, absences that constitute more than 10% of the total course will result in a written warning.

Students who transfer from one CIEE class to another during the add/drop period will not be considered absent from the first session(s) of their new class, provided they were marked present for the first session(s) of their original class. Otherwise, the absence(s) from the original class carry over to the new class and count against the grade in that class.

For CIEE classes, excessively tardy (over 15 minutes late) students must be marked absent.

Attendance policies also apply to any required co-curricular class excursion or event, as well as to any required field placement. Students may not miss placement/work hours at an internship or service learning site unless approved in advance by the Academic Director and placement supervisor. All students must complete all of the requisite 100 minimum work hours on site at the internship or service learning placement to be eligible for academic credit.

Students who miss class for personal travel, including unforeseen delays that arise as a result of personal travel, will be marked as absent. No make-up or re-sit opportunity will be provided.

Attendance policies also apply to any required class excursion, with the exception that some class excursions cannot accommodate any tardiness, and students risk being marked as absent if they fail to be present at the appointed time.

Absences for classes will lead to the following penalties:
N.B. Course schedule is subject to change due to study tours, excursions, and local holidays. Final schedules will be included in the final syllabus provided to students on site.

**Weekly Schedule**

**Week 1**

**Class: 1.1**

**Topics:**
- Introduction to Rhinoceros
- User Interface
- Solids, Nurbs and Meshes
- Commands
- Curves and Curve tools
- Nurbs Surfaces
- History and simple parametric models

**Reading:**


**Class: 1.2**

**Topics:**
- Advanced Modeling Strategies
- Complex surfaces
- Editing surfaces
- Analyzing surfaces

**Reading:**


**Week 2**

**Class: 2.1**

**Percentage of Total Course Hours Missed** | **Minimum Penalty**
---|---
Up to 10% | Participation graded as per class requirements
10 – 20% | Participation graded as per class requirements, 3% grade penalty & written warning
More than 20% | Automatic course failure, and possible expulsion
Topics:
- Documentation & manufacturing
- Drafting tools
- Layouts
- Generating 2D Drawings
- Print and Exports
- Preparing and exporting files for milling and 3d printing

Reading:


**Evaluation of workshop progress in the course to date**

Class: 2.2

Topics:
- Introduction to Grasshopper
- Introduction to scripting
- User Interface
- Introductory examples

Reading:


Due date for submission of weekly homework

**Week 3**

Class: 3.1

Topics:
- Surface Tesselations
- Introduction to Tesselation
- Tesselations in grasshopper
- Tesselations using paneling tools
- Surface Population

Reading:


**Due date for submission of transfer and application, part 1**

Class: 3.2

Topics:
- Component Design
- Introduction
- Component Design
- Attractor as Driver
- Data as Driver
- Morphological Studies

Reading:

Week 4

Class: 4.1

Topics:
- Performance Optimization
- Introduction
- Environmental Performance
- Structural Performance

Reading:


Evaluation of workshop progress in the course to date

Class: 4.2

Topics:
- Growth
- Introduction
- Zoning and growth
- Behavioral growth models: Loops and conditions

Reading:


Due date for submission of weekly homework

Week 5

Class: 5.1

Individual Project Support. The instructor will guide students on how to specially apply Rhino and Grasshopper to meet their project goals.

Reading:


Class: 5.2

Individual Project Support Continues

In this session, the focus will be on digital fabrication and students will learn how to develop their geometries for 3D printing and Milling in the Fab Lab.

Week 6

Class: 6.1

Final steps to finish transfer and application process

Reading:

*AD – Architectural Design*. (Special Issue: City Catalyst: Architecture in the Age of Extreme Urbanisation), 82, no. 5, 2012.

Class: 6.2

Presentation of the results of transfer and application
Course Materials

Readings

AD – Architectural Design (Special Issue: Digital Cities), 79, no. 4, 2009.

__________. (Special Issue: Typological Urbanism: Projective Cities), 81, no. 1, 2011.

__________. (Special Issue: City Catalyst: Architecture in the Age of Extreme Urbanisation), 82, no. 5, 2012.

__________. (Special Issue: System City: Infrastructure and the Spaces of Flows), 83, no. 4, 2013.

__________. (Special Issue: Mass Customized Cities), 85, no. 6, 2015.


Online Resources

Grasshopper Tutorials: http://www.grasshopper3d.com/page/tutorials-1

Python for Grasshopper: http://www.food4rhino.com/

Media Resources

Software Requirements

- Rhino 5 64-bit on Windows or using Bootcamp on Mac OS (do *not* use native version on Mac), with latest version of Grasshopper.
- Python for Grasshopper (available through the “Online References” below).