

## Arch 3590 | Fall 2019

### Parametric Computation, Materials and Fabrication

Wed: 8:30am - 10:35pm V-834B | Fri: 8:30am - 10:35pm V-833  
Prof. Yevgeniy Koramblyum (ykoramblyum@citytech.cuny.edu)  
Prof. Ravi Raj (rraj@citytech.cuny.edu)  
CLT: TBD

Department of Architectural Technology  
New York City College of Technology  
City University of New York  
300 Jay Street, Brooklyn, NY 11201

#### COURSE SYLLABUS

**ARCH 3690:** Parametric Computation, Materials and Fabrication  
1 classroom hour, 4 lab/studio hours, 3 credits

**PREREQUISITES:** ARCH 1191 Visual Studies I  
ARCH 1291 Visual Studies II

#### COURSE DESCRIPTION:

This course is an introduction to parametric computational design and digital fabrication. Grasshopper, a Rhino plug-in, will be used as a primary digital modeling tool. Students will learn how to use the tool, how to work with algorithms, and how to utilize them for architectural design projects. The course will also explore qualities of basic materials such as paper, wood, concrete, and plastics in the context of computational design and digital fabrication thinking and techniques.

Students will be challenged to design and fabricate three small projects: a paper lamp, a CNC milling, a pavilion/furniture project. Students will create their own geometry creation algorithms in Grasshopper and prepare 3D models for the fabrication of physical models of each project. The projects will provide students with opportunities to explore and learn the concept and techniques of parametric rule-based design, digital fabrication tools, assembly of fabricated parts.

#### REQUIRED MATERIALS:

Google Drive account and Flash Drive (recommended 8GB or more), Bristol Paper 19"x24" Pad (Any Art Store: Blick), 2" Insulation Foam Half a Sheet Minimum (Provided), Corrugated Cardboard (Any Art Store/Street/Home Depot)

#### REQUIRED TEXT:

Course Readings to be available in PDF via Google Drive.

#### RECOMMENDED TEXTS:

Abruzzo, Emily et al. *Models*. 2008, New York, NY: 306090 Press.  
Aranda, Benjamin and Christopher Lasch. *Tooling*. 2005, New York: Princeton Architectural Press.  
Garcia, Mark (ed.), *The Patterns of Architecture: Architectural Design*. 2009, London: Wiley.  
Gramazio, Fabio and Matthias Kohler, *Digital Materiality in Architecture*, 2008, Basel: Lars Mueller.  
Guidot, Raymond (ed.), *Industrial Design Techniques and Materials*. 2006, London: Flammarion.  
Kolarevic, Branko. *Architecture in the Digital Age: Design and Manufacturing*. 2005: New York: Taylor & Francis.  
Lally, Sean, *Energies: New Material Boundaries: Architectural Design*. 2009, London: Wiley.  
Meredith, Michael. *From Control to Design: Parametric/Algorithmic Architecture*, 2008, New York, NY: Actar Publishing.

#### ATTENDANCE POLICY:

No absences accounting for more than 10% of class time are permitted during the semester. For purposes of record, two lateness's are considered as one absence. Exceeding this limit will expose the student to failing at the discretion of the instructor.

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### COURSE STRUCTURE

This course will be offered as a lecture/lab format with readings/lectures as well as hands on tutorials that introduce computational concepts, techniques and methods needed for completion of projects for approximately the first third of the semester. After this, the course will focus increasingly on digital fabrication processes and assembly. Students will produce a series of three fabrication projects with the tools and techniques covered in the course that communicate ideas and incorporate data of increasing complexity.

### GRADING

Project 01 – Paper Light Sculpture Final Model:	20% of total grade
Project 02 – Foam Surface final model:	20% of total grade
Project 03 – Final Group Project:	20% of total grade
Assignments – Weekly/Bi-Weekly:	10% of total grade
Readings / Research Project:	10% of total grade
Final Presentation Drawings + Models:	10% of total grade
Class Participation + Attendance:	10% of total grade

- A = 95% completion of assignments, drawings and attendance
- A- = 90% completion of assignments, drawings and attendance
- B+ = 80-85% completion of assignments, drawings and attendance
- B- = 75-80% completion of assignments, drawings and attendance
- C+ = 70-75% completion of assignments, drawings and attendance
- C = 65-70% completion of assignments, drawings and attendance
- C- = 60-65% completion of assignments, drawings and attendance
- D = < 60% completion of assignments, drawings and attendance
- F = < 50% completion of assignments, drawings and attendance

### LEARNING OBJECTIVES:

Upon completion of the course, students should be able to:

1. Illustrate an ability to apply an understanding of parametric processes.
2. Illustrate an ability to apply an understanding of materials properties to their design work.
3. Demonstrate an understanding of the distinction between parametric and traditional digital design methodologies.
4. Demonstrate proficiency in best practices for 3D modeling for laser cutter operation through surface flattening/building and contouring, and in operating laser cutters.
5. Demonstrate knowledge to create profiling, drilling, and surface modeling drawings for use with a CNC mill. Show applied understanding of mill software interfaces (i.e. RhinoCAM and MadCAM).
6. Demonstrate knowledge of CNC and laser cutter mill operation: (i.e. safety procedures, tool selection, job setup, step-over calculation, and spindle speeds).
7. Demonstrate an understanding of the differences between different fabrication processes, such as rapid prototyping and final fabrication, additive and subtractive fabrication processes, etc.

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#### ASSESSMENT

Through computer based and fabrication projects, and oral presentations, students will demonstrate their ability to:

1. Utilize material properties knowledge in producing fabrication projects.
2. Produce digital parametric modeling projects of medium complexity.
3. Produce fabrication projects that utilize fundamental skills involving key set up, workflow, and assembly techniques, as well as best safety practices.
4. Explain the differences between traditional and parametric design.

#### ACADEMIC INTEGRITY:

Students and all others who work with information, ideas, texts, images, music, inventions and other intellectual property owe their audience and sources accuracy and honesty in using, crediting and citation of sources. As a community of intellectual and professional workers, the college recognizes its responsibility for providing instruction in information literacy and academic integrity, offering models of good practice, and responding vigilantly and appropriately to infractions of academic integrity. Accordingly, academic dishonesty is prohibited in The City University of New York and is punishable by penalties, including failing grades, suspension and expulsion.

#### FILE SUBMISSION AND NAMING CONVENTIONS

All digital files should be submitted in PDF formats, and named according to the following system (naming convention will also be on the submittal form):

**LastName\_Project#\_Part#\_File# (if submitting more than 1 file)**

**Example: Smith\_Project1\_Part2\_1.pdf**

Homework submittal are similar:

**LastName\_DueDate\_File# (if submitting more than 1 file)**

You will have received an invitation to join the course Google Drive folder where we will post our lectures, class files, and readings. To submit homework and projects use the links to the forms below. You will be prompted to upload your PDF. On the final week, a single PDF document archiving all assignments and progress in this course will **ALSO** be submitted!

[LINK FOR SUBMITTED PROJECTS AND THEIR PARTS](#)

[LINK FOR SUBMITTING GRASSHOPPER PRACTICE ASSIGNMENTS](#)

[LINK FOR SUBMITTING READING RESPONSES](#)

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#### CLASS TIME

It is crucial to learning to be present and alert. The nature of the work and the amount of ground we will cover places the responsibility on the student to contribute to maintaining the momentum of the course.

Checking e-mail, instant messaging, web browsing, having cell phones on, and inactivity in class will also result in expulsion for the day and even an absence.

No work will be accepted late, except under exceptional circumstances, which should be communicated to the professor in advance of the due date. If assignments are submitted after the deadline, they will be penalized one-half letter grade for every class the work is late. Work that is not submitted within three classes will earn a failing grade.

On the first day of class each student should exchange their email address and phone number with at least two other students. If absent, it is the student's responsibility to contact another member of the class or to see the instructor to find out what was assigned for the following class.

#### CAD LAB Rules/Policies

1. **No eating or drinking in computer labs**
2. **Only registered students may be in the computer lab during class**
3. **Students must work on class assignments during class time**
4. **Open Lab hours are posted on the door to the computer lab**
5. **Open your drawings from the software program, not from the file**
6. **Work from the hard drive, not from a USB (flash) drive**
7. **Copy the folder with your work from your flash drive to the hard drive when you begin (include materials and maps and any attached material, as well as your drawing). Copy it back to the cloud/flash drive when you finish.**

#### RHINO AND GRASSHOPPER

Remember, Grasshopper information is not saved within the Rhino file and vice versa, therefore you should always be saving both a Rhino file and a Grasshopper file when working on an assignment. You can also "Internalize data" in your parameters.

You should, as much as is possible, limit your work to the following software versions:

Rhino 6.0 64bit (Version 5.0 will work for most of the concepts we will cover but will not be able to open files we do in class.)

Grasshopper 1.0 (Already integrated into Rhino 6)

If you choose to work in other versions it is at your own risk - so make sure you know how to translate the files and if you are at risk of losing data. Grasshopper no longer works in Rhino 4, and the Rhino 5 WIP, Beta, and Evaluation versions have all expired.

You can download Rhino 6 for free with 25 saves at:

<https://www.rhino3d.com/download/rhino-for-windows/6/evaluation>

Students can purchase their own full copy of Rhino at Novedge.com.

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### FILE BACKUP AND INCREMENTAL SAVING

Each student is expected to have at least one thumb drive for backing up work done locally in the labs. Never leave your work on a local lab machine as these files are regularly deleted. In addition to the thumb drive it's wise to have additional backup options, both physical (thumb drives, external hard drives, home computers) and cloud-based (Dropbox, Box, SkyDrive, Google Drive, etc.).

It's also important to save your files often and to use the File > Incremental Save... option in Rhino. This will save your file as a new version of the file rather than overwriting the file as a typical Save command would. The Rhino incremental save will append your file name with a three-digit integer which counts up each time you save (001, 002, 003, etc.). A good working method is to incrementally save your file each time you make a substantial change to the geometry - this way you can always return to a previous version if you lose data or your file corrupts.

### COURSE RESOURCES

- There is an Arch Tech department library in V818 with a number of interesting texts on the topics of digital fabrication and advanced architectural computation. Ask the front desk for assistance obtaining books.
- We have a full digital media assistance site with descriptions and instructions for fabrication equipment, workshop notices, software tutorials, and more at <http://www.nycctfab.com/>.
- While in the past we've used paper signup sheets, we will now be implementing online laser cutter scheduling at
- Most (if not all!) lectures will be recorded and posted to the course Vimeo site at <http://vimeo.com/nycctfab>. For videos specific to 3590, select "Channels" in the right-side menu and select the ARCH3590 channel.
- Sample Grasshopper definitions and explanations will be posted to my Grasshopper blog at <http://www.grasshopper3d.com/profiles/blogs/arch-3590-introduction-to-computation-and-fabrication-spring-2013>
- Codecademy (<http://www.codecademy.com/>) is an incredible site for beginners to interactively learn code online and they've recently added Python - which is a language that we'll be using in the course. Brian has created a Codecademy group for exploring Python - if you're interested in joining/registering for the site here [http://www.codecademy.com/register/sign\\_up](http://www.codecademy.com/register/sign_up) and then email me your Codecademy username so I can invite you to the group.
- Professor Downey's site <http://www.designalyze.com/> has video tutorials and sample file downloads that correspond with class assignments in Rhino, Grasshopper, and Python as well as more advanced videos that build off of concepts learned in class.
- <http://www.grasshopper3d.com/> : Please visit the forum. Using the forum is crucial to answering questions that you will have. Most questions also have definitions posted! The forum is also a great resource for inspiration and learning all the great things you can do with grasshopper!
- <http://www.food4rhino.com/>: All plugins for rhino and grasshopper can be downloaded here. Some of the most useful plugins for me (in order of usefulness). They may or may not already be installed in your machine.
  - **Lunchbox**: Great tools for grids, paneling, and platonic solids. Etc
  - **Weavebird**: Tools for mesh manipulation and smoothing
  - **Human**: Enhanced display tools. (line weights, linetypes, texture mapping, etc.)
  - **Fabtools**: Tools for fabrication
  - **Kangaroo**: Amazing Live Physics engine for interactive simulation, form-finding, optimization and constraint solving!!!!
  - **GHPython**: Use python within grasshopper! Call some commands that are in Rhino3D but not in GH
  - **Galapagos**: Evolutionary solver, and optimization
  - **Hoopsnake**: Create recursive geometries such as trees, nautilus, fractals. etc.

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- **Cacoon:** Creating of complex mesh using metaballs or “marching cubes”
- **Millipede:** Structural and finite element analysis, and topological optimization based on analysis