48-749 Parametric Modeling with Building Information Models

Fall Semester • 6-12 units • R (CFA 213) • Computer Cluster (TBD)

Instructor: Ramesh Krishnamurti • ramesh@cmu.edu

Co-Instructor: Tajin Biswas • tbiswas@andrew.cmu.edu
Co-Instructor: Tsung-hsien Wang • tsunghsw@andrew.cmu.edu

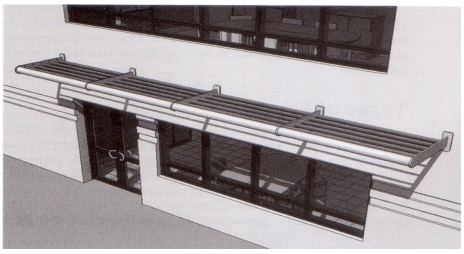
Course website: http://www.andrew.cmu.edu/~ramesh/teaching/course/48-749/

Syllabus

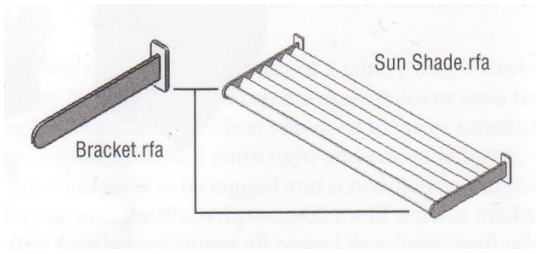
Motivation

The advent of Building Information Modeling (BIM) has changed the landscape of Architecture, Engineering and Construction (AEC) practice around the world. Models can now be sent directly to fabrication machines, energy analysis can be done at the outset of design, and construction costs are becoming increasingly predictable. In practice, architects and designers are showing an increasing interest in being able to compute and to fabricate forms and components that are required for buildings to come into existence.

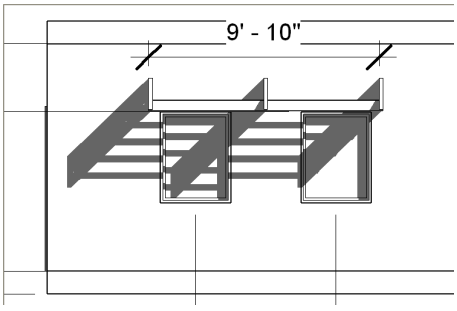
Contemporary approaches to using BIM tools such as Revit, offer a parametric 3D model which can be used to generate information for quantity take–offs, solar studies, day-lighting simulation, fabrication possibilities early in the design process. With more parametric control over designed components designers can explore variations, analyze design artifacts and be more efficient. However, to construct parametric components responding to designer needs computationally, poses challenges for the architecture designer, particularly to those with little formal training, and more so, when required to tackle evolving issues between complex problems within the AEC domain.



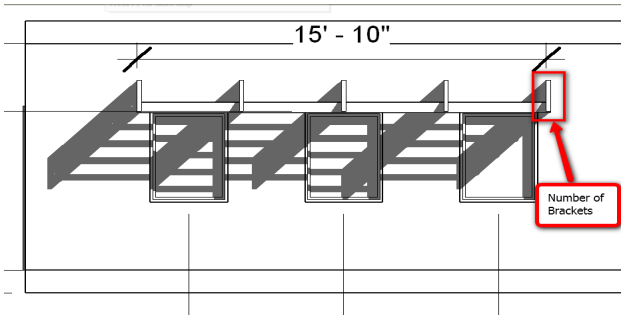
Sun shade in model



Sun shade created with nested family



A parametric sunshade



A sunshade parametrically defined with constraints and formula

This emerging need has compelled a better understanding of concepts that support building information modeling, to develop new (computational) schemes that can intelligently or ably assist designers in managing information and propagating designs.

Course Description

This is an introductory course to BIM, both in theory and practice, via parametric modeling. The course is offered either as a half-semester assignment-based mini course (without prerequisites) or extended to a full semester course with a project component (for those students who meet the necessary requirement at mid-semester. In addition, some programming experience (Visual Basic or C#) would be beneficial. Overall, the course will introduce:

- *Fundamental concepts of building information modeling*

The emphasis in the lectures will be on the concepts of building information modeling, capabilities of current BIM tools and their applicability in the AEC domain. Students will be introduced to parametric architectural modeling to create and experiment with projects. (Examples that we have worked with such as, lighting variations following sun path, water use, quantity schedules and costs, sustainable building evaluation, fabrication etc. will be illustrated)

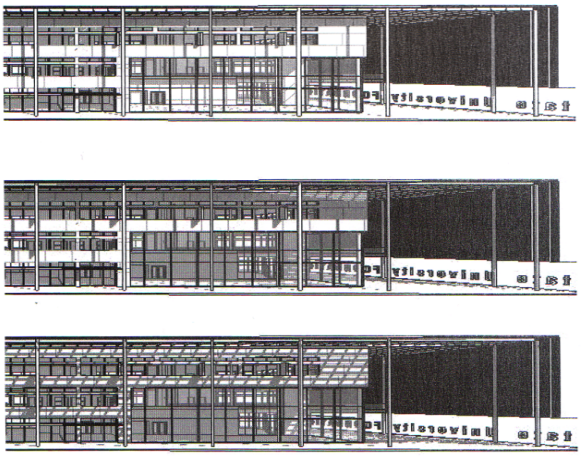
- *Parametric modeling techniques and tools*

Tools that are available to model design parametrically will be introduced in this class to illustrate the construction of geometrical relationships among complex shapes. The lectures here will focus on hands-on techniques that can be applied to the design process, to extend the efficiency and productivity of work during the process. **For practical reasons, the course will use Autodesk Revit 2010/2011 and .NET framework**.

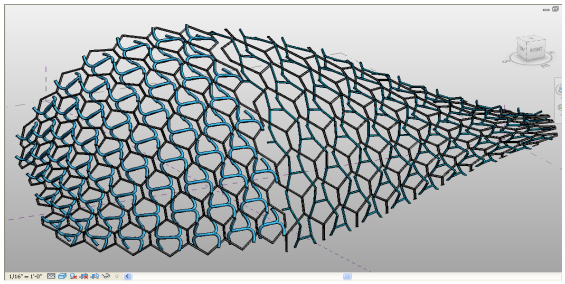
Course Topics

The topics covered in this course are:

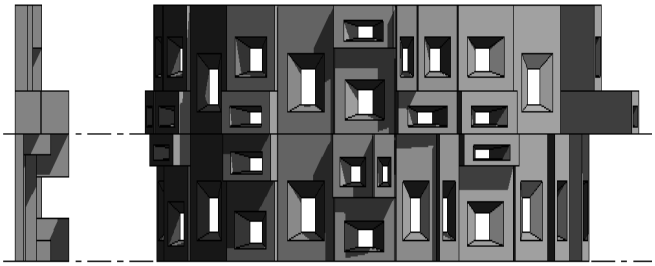
- Building Information Modeling
- Modeling Parametric Families
- Encoding Design Rules
- Evaluating Preliminary Design
- Some Applications:
  - Embodied Carbon Calculation
  - Water Use
  - Fabrication



Sun studies throughout the year



Customized Revit Family: Pattern based panel



Parametric Façade with pattern based panel

Course Objective

This course is to prepare students for modeling architectural geometry through development of BIM and parametric schemes for architecture applications.

For students with having no programming background, this course is primarily a half-semester mini course (6 units), which supplies the basis of understanding parametric geometric construction mechanisms. For all students, the full semester course (9-12 units) is regarded as the venue for pursuing individual projects related to advanced geometric constructions with parametric and/or algorithmic computation. The second-half semester might involve writing programming scripts to automate the generative process.

Course Credit: 6, 9 or 12 units

Irrespective of how students are initially registered for this course:

- All students will be *initially evaluated* for a half-semester course (worth 6 units). Students who score at least C+ at mid-semester may proceed to the full semester course for credit.
- The project and any accompanying preparatory assignments will be worth an additional 3 units. The course project will be defined, by mutual agreement of each student and the instructors, after mid-semester.
- Students may add to their skill and degree of difficulty by completing a Revit-based advanced parametric modeling/BIM assignment for an additional 3 units. This is required of all Computational Design students.

Readings and Reference

- Aubin, Paul F. Mastering Autodesk Revit Building, 2006, Thomson Delmar Learning
- Demchak G., Dzambazova, T., and Krygiel E.:2010, Mastering Revit Architecture 2010, John Wiley

Course Requirements

- Modeling Assignments (6 units)
- Project (+ preparatory assignments) (3 units)
- A Revit based advanced parametric modeling assignment (3 units)

Grading

A	90-100	Excellent
B	80-90	Good
C	70-80	Fair
Else		Why are you in this class?

Course Schedule: First mini

Date	Lecture and topic	Assignment
Week 1 08/26	**Introduction to building information modeling** *Introduction to Revit Architecture 2010/2011*	
Week 2 09/02	**BIM capabilities** *Construction of a simple project*	**MA 1**
Week 3 09/09	**BIM in the AECM domain** *Revit (Lighting Studies, Recycled content calculation)*	**MA 1 due/MA 2**
Week 4 09/16	**Type of families** *Revit Modeling 3d Families I*	
Week 5 09/23	**Categories and Parameters** *Revit Modeling 3d Families II*	**MA 2 due/MA 3**
Week 6 09/30	**Encoding Design Rules** *Revit Modeling 3d Families III*	
Week 7 10/07	**Prototyping** *Revit Modeling 3d Families IV*	**MA 3 due**

***** 10/14-16 Graduate Mini-1 Exam days (No Class)

Course Schedule: Second mini

Date	Class	Assignment
Week 8 10/21	**Introduction to .NET SDK** *Introduction to .NET SDK and C#*	**Project**
Week 9 10/28	**Introduction to Database** *Database and SQL*	
Week 10 11/04	**Databases used to automating modeling process** *Databases I and II*	**Project proposal**
Week 11 11/11	**Databases used to automating modeling process** *Databases III and IV*	
Week 12 11/18	**Example project: LEED credit evaluation using databases** *Databases I-IV*	**Project Preliminary**
Week 13 11/24-26	**Thanksgiving Holiday (NO CLASS)**	
Week 14 12/02	**Project assistance**	
Week 15 12/09	**Review** **Final Presentation**	**Projects due**