Course Syllabus

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Advanced Models in Architectural Simulation
Prof. Mark Collins & Toru Hasegawa
Columbia GSAPP
ArchA4707
Architecture Technologies Elective

Course Introduction

This seminar introduces a powerful set of models to simulate, predict and even improve architectural design. We look at models that reduce systems to their critical relationships to capture the underlying system's productivity. Pulled from the worlds of material computing, biomimetics, computational geometry and data science, these simulation-based models are well documented and highly applicable to architectural design. This is a class for those that think the computer can do more than render.

Course Content, Structure and Goals

Specific models introduced in the seminar include: Physics-Based Modeling (Tensile and Fabric Modeling), Soap Films (Minimization), Soft-Kill Structural Optimization (Solid Thinking Inspire), Ant-Colony Optimization (Sasaki), Neural Networks (DeepDream) among others.

Models will be introduced through explanation, presentations, demos and tech literature. Workshops with a subset of the models introduced will give students a hands-on experience with deploying architectural simulation in design. We will use Rhino Grasshopper as a primary staging area, but will also be utilizing some course-specific code and plugins to explore a few models in-depth.

Students learn simulation tools and techniques for driving architectural design in a hands-on environment. Alongside this we will hear from the inventors of these models themselves through a study of the supporting technical literature. Disseminating these important techniques before students go to either job or independent study is a primary goal - setting students up to be innovators in their next setting by empowering them with systems-based approaches to design.

Seminar Project and Assessment

Each student will be asked to deploy one of the introduced simulation-based models in the design or optimization of a series of design candidates. Models should do actual work, in this context defined as generating or re-shaping input surfaces and parameters into intent-driven outcomes. The project will be to not only demonstrate a method but to quantify its performance through a technical presentation.

Students will use the class workshops to develop their own technical presentation and short paper, which cites and builds upon the original inventor's work. It should be visually illustrated with idealized input and outputs, actual inputs and outputs, as well as diagrams of how the model operates to yield one from the other. The project will be supported with the workshops and with individual assistance, troubleshooting and feedback from the professors. The class is limited to 14 students. Students may collaborate on a paper, but groups are limited to two students.

Course Readings (provided)

Structural Design through Ant Colony Optimization, Sasaki
Creative Evolutionary Systems, Bentley
An Evolutionary Architecture, Frazer
Computing Machinery and Intelligence, Turing
Genetic Algorithms, Holland
Computer aided Architectural Design, Mitchell
Cell Packing Structures, Evolute
Evolving 3D Morphology and Behavior by Competition, Sims
Generative and Evolutionary Techniques for Building Envelope Design, Frazer
Going Deeper with Convolutions, Google Deep Dream
Particle-Spring Systems for structural form-finding, Killian
Cellular Automata, Wolfram
Computational Models of Space, Isovists and Isovist Fields

Course Requirements

This is an advanced architectural technologies elective. Students are expected to have experience in 3D modeling, preferably in Rhino. Students without Rhino Grasshopper experience will be asked to do additional instruction and tutorials. MARCH candidates should have completed AT I/II.

Course Summary:

Date	Details