

A4824: Transformable Design Methods

Tech Elective

Instructor: Matthew Davis

Thursdays 11:00am-1pm

408 Avery

Syllabus

Architects have long imagined a built environment that is fundamentally dynamic. Portable buildings, retractable coverings, kinetic facades, and spaces that morph: these transformable structures have become part of the lexicon of architectural possibilities. Despite persistent interest, examples of truly dynamic buildings are few and architectural design remains focused on the development of objects that are essentially static. How can we understand *transformation* itself as a design parameter that can be shaped, crafted, and optimized?

Classes and Workshops

This course will provide a theoretical overview and practical methods for designing objects that can change their size, shape, and surface. Our goal is to introduce new ways of thinking about design by developing structures that demonstrate real time changes of morphology. Within the class, we will build up a systematic methodology for the creation and development of transformable mechanisms. Our starting point will draw purely on geometric tools, then move onto the basics of kinematic analysis & synthesis, ultimately leading towards a parametric approach that joins form and movement through an integrated design process.

Specific topics will include: self-actuated form-creation through origami and other means, design of transformable structures that change size and shape, the development of design tools that enable the creation of transformable objects, and strategies for physical interaction and automated control. Lectures will provide an overview of particular design methods associated with each topic, and there will be weekly assignments surrounding the fabrication and demonstration of transformable mechanisms.

Projects and Assignments

The course will have a significant workshop component based on semester-long group projects that address the design and fabrication of one or more physical pieces demonstrating physical transformation or the development of interactive software that aids in the design of transformable structures. Projects can be tailored to meet specific interests of each group and may range for full-scale operable architectural sections to scale-models that focus on broader architectural context.

Course assignments will be stages in 2 parts. For the first part, students will create a series of mechanism studies. These studies will incorporate the typologies that have been introduced in the lectures and will take the form of CAD models and animations, as well as prototypical mechanisms. The intent of these assignments is to reinforce understanding of lecture topics as well as provide hands-on familiarity with mechanical interaction.

For the second part, students will form groups to produce a prototypical piece demonstrating physical transformation, groups may choose the project emphasis according to their particular interests. Projects may range from full-scale operable architectural sections to scale-models that focus on broader architectural context. This project offers the opportunity for creative engagement and original thinking about new possibilities for transformable architecture.

Initially, each group will be expected to write and present a short proposal outlining the conceptual framework and a concise narrative to their design and implementation strategy for the final project. This proposal should include chosen materials, fabrication methods, projects timeline, and overall objectives. Strategies for physical actuation whether through manual interaction or controlled motorization, should also be included. Final presentation of the prototype/installation should be supported by substantial process documentation such as animations, video, and photographs. In addition to the final prototype and documentation, each student will be asked to write a short journal-style research paper that merges the initial proposal, project development, and knowledge gained during production of the final piece.

Methods, Tools, Resources

This course involves the use of CAD software to produce simulations and animations of mechanisms. While there is no specific requirement for the students' familiarity with any single CAD package, it is expected that students will utilize one or more programs such as Solidworks, 3DSMax, Rhino, Grasshopper, Digital Project and others during the course and the workshop.

Additionally, fabrication of assigned prototypes and projects will require the use of fabrication facilities and students are expected to participate in all lab introductions and the required safety orientations as directed by the fabrication lab staff. Materials for prototypes and projects are typically the student's responsibility.

Office hours outside of class will be made through arrangement between the instructor and individual student or groups.

Grades and Groups

The final project will involve groups of 2-3 students. Grades will be assigned on individual performance based on the quality of the research, submitted assignments, final documentation and on class participation. There is a final review and participation is required for this session.

Tentative Schedule

The following schedule is for the purposes of creating a general outline of course scope and pace and is subject to change at the instructor's discretion. Students should expect weekly deliverables.

| Date: | Class Lecture | Workshop | Task |
|--------------|---|-------------------------------|---|
| 7-Sep | Intro to Transformable Design | | Assignment #1 Given |
| 14-Sep | Mechanisms and the geometry of movement | Review Assignment #1 | Assignment #2 Given |
| 21-Sep | Two Dimensional expanding structures | Review Assignment #2 | Assignment #3 Given |
| 28-Sept | Iris Structures | Review Assignment #3 | Assignment #4 Given Final Project Overview |
| 5-Oct | Three Dimensional Expanding Structures | Review Assignment #4 | Form Groups/Prepare Preliminary Proposal |
| 12-Oct | Surface Mechanisms 1 | Review Preliminary Proposals | Develop Preliminary Prototypes |
| 19-Oct | Deployable Architecture | Review Preliminary Prototypes | Submit Final Proposal |
| 26-Oct | Surface Mechanisms 2 + Origami | Review Final Proposal | |
| 2-Nov | Special Topics in Transformable Design | Projects update/discussion | |
| 9-Nov | Morphing Shapes | Projects update/discussion | |
| 16-Nov | Individual Group Meetings | Projects update/discussion | |
| 23-Nov | Thanksgiving Break | | |
| 30-Nov | Individual Group Meetings | Projects update/discussion | |
| | Final Review (Date TBD) | | Final Project Due |