GSD 6476: – Transformable Design Methods (SCI-6476)

Seminar – Fabrication/Simulation Workshop / 4 Credits
Instructor: Chuck Hoberman
Research Assistant: Joonhaeng Lee
Monday 10:30am – 1:15pm / Gund 522

Introduction

Transformable Design Methods provides a theoretical overview as well as practical methods for designing objects that can change their size, shape and surface. Our goal is to introduce new ways of thinking about design through real-time morphological changes. To do this, we will draw on my practice as a builder of large-scale transformable installations - for public art, sets for live entertainment and kinetic elements in buildings. We will discuss these projects as case studies, as well as those of historic and contemporary practitioners in the field of transformable design.

Classes and Workshops

Class sessions will generally consist of a lecture followed by discussion and review of project assignments. Several workshops will also be offered on software and hardware techniques. All classes are in-person, however, the lecture portion may be offered remotely for up to three sessions.

Within the class students will be introduced to the underlying principles of transformable design. Topics include introduction to mechanisms theory, classification of transformable behaviors (e.g. expansion, morphing, retraction, folding, etc.), design methods to produce behavior types, as well as practical techniques, for construction and automated control. The concepts presented will be reinforced though physical experimentation and software simulations.

Hands-on techniques: A kit of parts, customized for this course, will be provided to all enrolled students. The kit consists of links and connectors to build and activate wide range of different designs. The kit will be used for assignments in the first part of the semester starting with simpler 2D designs followed by more complex 3D assemblies.

As the semester continues, students can extend their fabrication skills using the GSD fab lab to create custom parts from wood, metal & plastic. Assembling these parts with off-the-shelf mechanical connectors allows an extensive range of design possibilities and gives the opportunity to build at larger scales.

Software and Simulation techniques: This course involves use of CAD software to produce simulations and animations of mechanisms, however, no prerequisite software skills are required. Workshops will be offered on Grasshopper/Rhino and Fusion 360. Other platforms such as Solid Works and 3DSMax are also appropriate for the course. Methods taught include:

- Applying parametric methods to different types of transformable structures
- Modeling and simulating transformable mechanics within the software environment
- Analyzing motion and dynamic performance

Course Projects and Assignments

Course assignments will be staged in two parts. For the first part, students will create a series of mechanism studies – both in physical and virtual form. These studies will incorporate the typologies that have been introduced in the lectures. For physical pieces, the kit of parts can be used. For simulations, studies will be CAD models, coding scripts and animations. The intent of these assignments is to reinforce understanding of lecture topics as well as provide a hands-on familiarity with mechanical interaction.

For the second part, students will form groups (2-4 students) to produce a functional project 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 of their design and implementation strategy for the final project. This proposal should include chosen materials, fabrication methods, project 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.

Grades and Groups

Grades are based on the quality of the research, submitted assignments (inclusive of the final group project), and class participation. There is a final review and participation is required for this session.

Preliminary Class Schedule

Date	Topic	in-class activity / workshop	Assignment
1-Sep *(remote)*	Introduction to Transformable Design Principles of kinematics (movable geometry) scissor linkages calculating linkage positions using Rhino https://harvard.zoom.us/j/99978913895?pwd=bzhKYXk3ZmVtdHF2MXdoREpWMDVpQT09	Demo of prototypical linkages Fusion Workshop 1	assemble Fusion model of 4-bar linkage draw scissor linkages in multiple positions
13-Sep *(remote)*	2D mechanisms (1) intro to degrees of freedom joint types https://harvard.zoom.us/j/99135577903?pwd=WDY3VFozc0VvKzlDcEd6RjZucklBdz09	Review assignment #1 Fusion Workshop 2	assemble & animate fusion model of scissor linkage
20-Sep	Principles of mechanical expansion 2D mechanisms (2) Iris structures	Review Assignment #2 Grasshopper Workshop 1	assemble & animate fusion model iris or wheel structure
27-Sep	3D expansion (1) Iris structures + Expanding shapes	Review Assignment #3 Assembly techniques for Kit of Parts -1	assemble Fusion model of 3D linkage
4-Oct	3D expansion (2) Morphing Shapes Final Project Overview	Review Assignment #4 Assembly techniques for Kit of Parts -2	Form Groups prepare preliminary proposals
11-Oct	No Class (Indigenous Peoples Day)		
18-Oct	Principles of transformable origami (1)	Review preliminary proposals Grasshopper Workshop 2	submit final proposals

25-Oct	Adaptive façades Surface Mechanisms	Students present final proposals	Final Project Development
1-Nov	Structural Truss Linkages Deployable shelters	Project update / discussion	Final Project Development
8-Nov	Morphing Shapes (2) Principles of transformable origami (2)	Project update / discussion	Final Project Development
15-Nov	Future challenges + issues Large scale construction Integration with static architecture	Project update / discussion	Final Project Development
22-Nov	Topic / Guest lecture (TBD)	Project update / discussion	Final Project Development
29-Nov	Topic / Guest lecture (TBD)	Project update / discussion	Final Project Development
6-Dec	No Class	(Individual & Group Meetings available)	
13-Dec	Final Review (exact date TBD)		