Paper Machines: TEI 2017 Studio

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Abstract

This studio invites participants to design and build machines with different kinds of paper and craft materials. We will introduce papercrafting using our design tool "FoldMecha", mechanical components, and prototyping methods for physical construction.

Participants interact with sample projects and explore a motion library, then begin the ideation process for their own working machine. During the studio, papercrafting techniques and various craft materials will be provided to further inspire participants creative process.

The goal is to provide hands-on experiences in designing and building machines with paper using design tools and prototyping techniques that we have developed. The studio will culminate in the "show & tell" demo and discussion about bottom up and bricolage design approaches as a means of creative thinking and learning. Outcomes will be showcased at the TEI events.

Keywords

Paper Mechatronics; DIY technology and techniques; bricolage design, exploratory construction.

Schedule

Phase 1: Introduction & Philosophical Framing of Design

Phase 2: Motion Library; Sample Projects Decomposition; FoldMecha demo + warm-up exercise

Phase 3: Brainstorming ideas (in groups)

Phase 4: Tinkering, Concept Selection, & Prototyping

Phase 5: Fabrication

Phase 6: Presentation, Reflection, & Gallery Walk

Detailed proposal description

Conventional CAD tools are well-suited to designing physical embodiments of simple static objects. However, when the device to be designed has mechanical behavior, conventional tools challenge even experienced designers. Despite the reduced burdens of calculation, modeling, and hand skills that current CAD tools provide, designing and building mechanical models still remains demanding. It requires understanding mechanical movements, visualizing relationships between component mechanisms, and accurately predicting the behavior of these mechanical systems.

We developed FoldMecha, a computer-aided design (CAD) system for exploratory construction of mechanical papercraft [1]. Exploratory construction is a springboard for creative learning [3], and FoldMecha supports this type of playful construction. FoldMecha enables users to (a) experiment with and design movements by modifying individual components; (b) download parts to cut and build mechanical prototypes; and (c) apply those prototypes in their own creations. Paper is a flexible, creative medium with different thicknesses, colors, and textures that can be cut, folded, or combined in traditional and whimsical ways with simple craft tools. We choose paper because of its ubiquity and accessibility in design studios and classrooms. Additional layers with electronics, paper circuits, motors, and sensors can extend the existing creative possibilities of paper.

This hands-on studio invites participants to design and build machines with different kinds of paper and craft materials. We will introduce "FoldMecha", then give participants time to engage in physical and digital bricolage, experimentation with movement, and share associated prototyping methods for creative exploration and construction. Our goal is to enable participants to experiment with mechanical movement design using paper and —as Schön poetically puts it—to engage in a "reflective conversation with the materials of a design situation" [4]. During the studio, we will encourage participants to begin with ideation and search for dynamic inspirations in their surrounding environment. Using combined hands-on and simulated modeling, participants conceptualize a movement, then prototype a working machine, advancing to more complicated levels of design and engineering. Video design examples from prior workshops created by school teachers, young adults, and children are shared as examples and inspirations.

This TEI workshop will also engage users in active testing of our design tool and techniques. The feedback gathered will help improve this creative learning activity that is intended to encourage all users to understand basics of mechanical movements by playful, tangible, and exploratory construction, ultimately for creative thinking.

The workshop is open to participants from every discipline. Regardless of experience everyone is invited to work with the materials provided to tinker, work as individuals or in teams, to invent and create a paper machine.

Topics to be covered

1. Bricolage, tinkering, and constructionist approaches to design learning
2. Idea generation and iteration by design and engineering
3. Mechanical engineering automata (mechanical toys)

A positioning in the continuum of practical and theoretical skills

Although we plan to mention some basic theories of learning from tinkering, play, and design, this studio will focus primarily on direct hands-on experiences with software, tools, practical design activities, and explorations that are done with tangible materials. Participants will have better insights into mechanical motions and stronger confidence in working with papercrafts as a creative medium for design.

Learning goals/Discussion objectives

Our primary goal is to provide a hands-on experience on exploratory construction for paper machines as a means of learning mechanical movements. This will lead to valuing bricolage design, an experimental and playful assembling of components, for creative thinking and learning. A secondary goal is to demonstrate the power and utility of paper, cardboard, and papercraft as design prototyping tool.

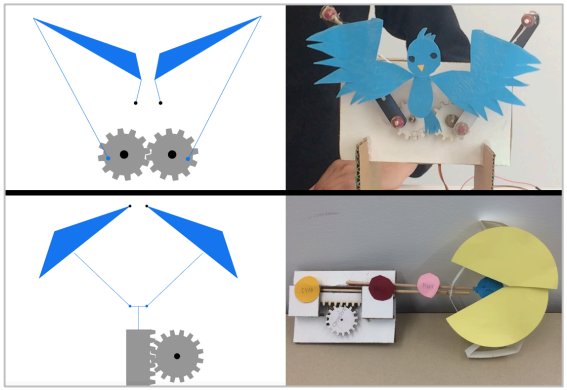

Figure 1. FoldMecha helps users design mechanical movements and construct paper machines: FoldMecha simulation snapshots (left) and paper machines using them as bare-bone structures (right). Both are created by participants in a prior workshop using FoldMecha.

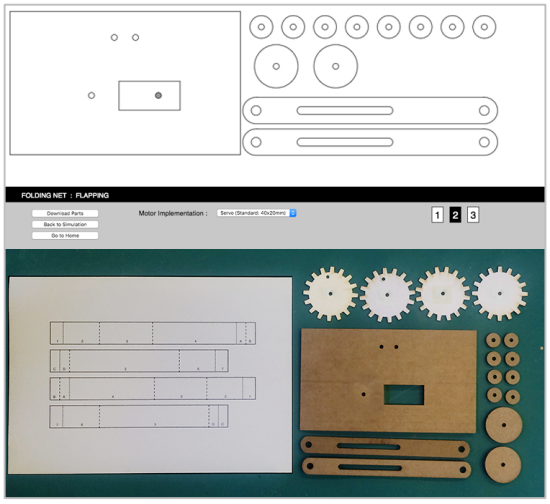

Figure 2. FoldMecha supports users to generate parts for the mechanical movement they designed and customize based on the prototyping plans: FoldMecha screen showing parts to customize and download (top) and printed and cut parts (right).

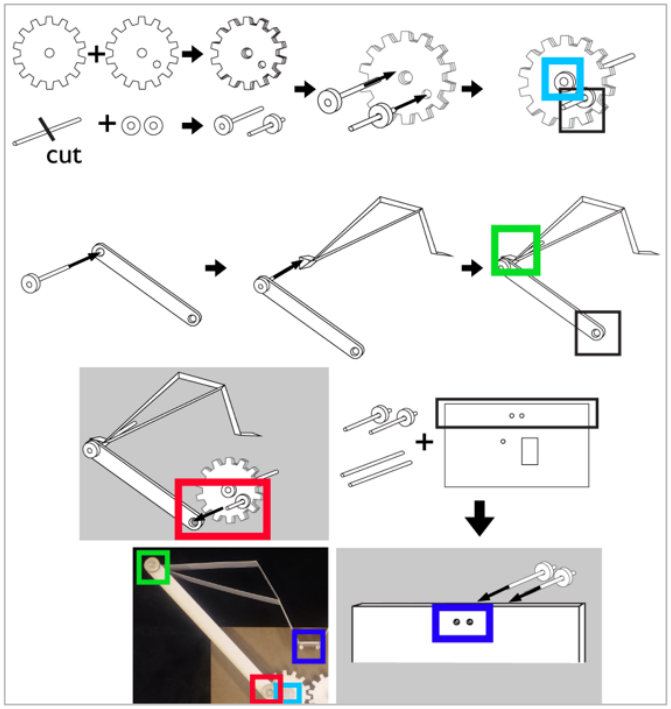

Figure 3. This studio will introduce associate prototyping methods using craft materials with the generated parts. This figure shows how to use lollipop sticks as axles to mount gears and linkages to the stand.

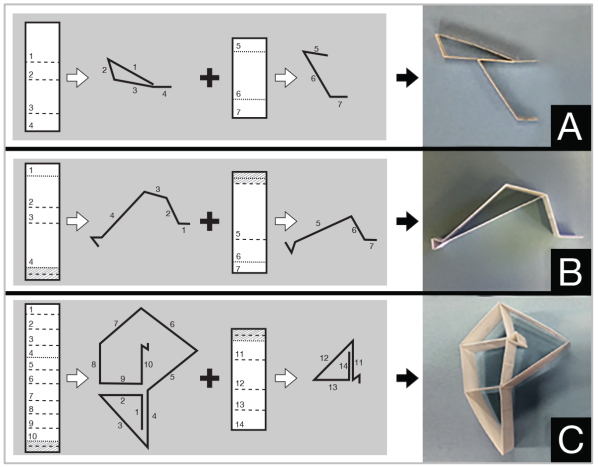

Figure 4. Dashed and dotted lines indicate mountain and valley folds respectively. Folding generates moving joints and unfolded faces become linkages [1,2].

References

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