Arc 596 Seminar
Instructor: Axel Kilian
Spring 2017

ARC596 Design Seminar
Embodied Computation

Introduction

Embodied Computation stands for an approach to design which treats the physical and the computational aspect of the construct as one and that extends the process of design into the lifetime of the built artefact through the combination of the physical design of the construct and the continuous updates of the software part.

At the core of architecture is the physical construct, its form, scale and materiality as it relates to the humans that inhabit it. We will explore the concept of embodied computation as it relates to architectural body and the changes that computation can bring to it. In comparison to the more established anthropomorphic robotics approach, the architectural body is much larger in scale and surrounds us. This is in contrast to the anthropomorphic object to object interaction so ingrained in human computer interaction. We will explore computational principles that steer formal processes, that become embedded in physical form through sensing feedback and control, or through acting upon the world as a computational social construct.

The seminar is focused on a prototype development and subsequent experimentation with the prototype to explore concepts of embodied computation and how it relates to human occupation. The seminar is structured into a series of design responses to concepts such as the model. Hands on work in computational design such as developing code in processing, parametric design, and physical prototypes are introduced and supported.

The emphasis is on learning new methods of developing design, and a strong motivation to tackle new knowledge and work in an experimental design setting is expected. Besides the development of the computational design a final report/paper is required to document, reflect and summarize the work. Ideally this paper is the basis for a submission for publication to a conference in the field of computation such as acadia, ecaade, caadfutures, or similar emerging ones.

Define a design experiment

Develop a design experiment as your semester project. Create a design speculation centered on a hypothesis linked to embodiment of a computational construct in physical form and its relationship to its human inhabitants. How does the construct communicate and/or react, what form of communication does it use, light sound motion or form? How are sensors distributed throughout the physical construct what do they see or hear? How does the architectural construct respond or shape the interaction with its human coun-

Space modulating installation -studio project by Francois Sabourin - Studio 505B project FALL 2016 taught by Axel Kilian and Ji Shi (AI)

Rope Bridge built by drones, joint PhD research project by Federico Augugliaro, Ammar Mirjan, in the research groups of Fabio Gramazio, Matthias Kohler, and Raffaello D'Andrea, 2016

Bouyant Extrusion, Rob Arch workshop 14, Ryan Johns, Nick Foley, Axel Kilian.

Physical analog computing and assembly of a tower form - complexity as enabling principle - Konrad Zuse - Helixtower 1992 - restored and demonstrated by Nora Eibisch.

terparts, what time frame does it follow, second, minutes, days, or years?

Model

Develop a computational model for your design experiment that links the design ideas with key parameters and the design context. "Model" stands here for an abstract conceptual set of dependencies that are embodied in an algorithmic, parametric construct, and material construct.

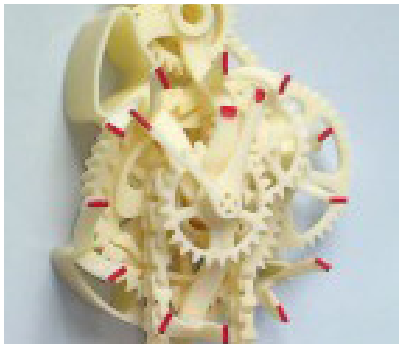
Shaping liquid test, Axel Kilian, Ryan Johns 2014

Embodied Computation Prototype

Develop an embodiment of your design experiment bridging physical and computational realm, carefully considering its generation and materialization and its link to humans and its scale of occupation. Integrate the computational as a continuum between idea and deployed construct. Determine criteria on which to evaluate your prototype and integrate any findings into your design. Depending on the scale of your prototype consider developing a "selective" prototype, that keeps key components and relationships of a full scale prototype but configures them into a prototypal scale.

Experiment

Use your prototype to play through different usage scenarios and document the results. Evaluate your construct based on your set criteria and make adjustments as necessary



3d printed mechanical clock Peter Schmitt, 2008, Media Lab

Final Report

The final report has to be a technical and conceptual report modeled after short research papers, reporting on your findings in a way that allows others to understand and possibly retrace your steps.

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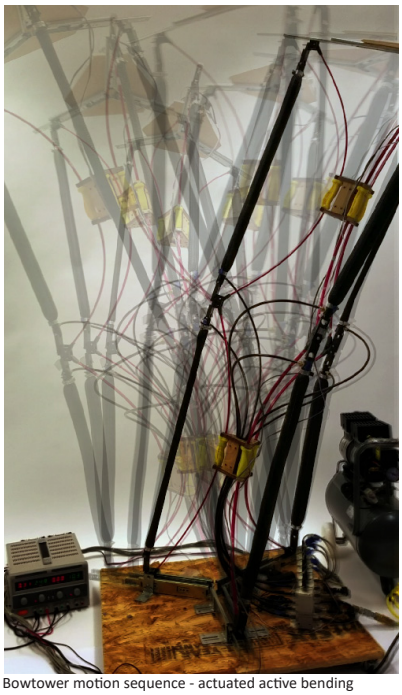

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Helmut Pottmann., Andreas Asperl., Michael Hofer, Axel Kilian, "Architectural Geometry", Bentley Institute Press, 2007

Conference proceedings:
Rob | Arch 2012 conference proceedings, Sigrid Brell-Cokcan, Braumann, Johannes.

Rob | Arch 2014 conference proceedings, Wes McGee, Monica Ponce de Leon

Fabricate 2014 - conference proceedings - Fabio Gramazio, Matthias Kohler, Silke Langenberg

Michael Fox, Miles Kemp, "Interactive Architecture"

Valentino Braitenberg, "Vehicles, Experiments in synthetic Psychology",

IJAC - Architectural Robotics: Catalyzing New Design Opportunities. Guest editors: Michael Fox, Aaron Sprecher, Doug Noble, Mike Christenson, Anton Harfmann, Aaron Temkin, Nancy Cheng
http://multi-science.atypon.com/toc/ijac/10/3

António Brandão Moniz, Robots and humans as co-workers? The human-centered perspective of work with autonomous systems

Radhika Nagpal, Programmable Self-Assembly Using Biologi¬cally-Inspired Multiagent Control, AAMA, 02, Bologna Italy

Nick Bostrom, "THE ETHICS OF ARTIFICIAL INTELLIGENCE ", Cambridge Handbook of Artificial Intelligence, eds. William Ramsey and Keith Frankish (Cambridge University Press, 2011)

Philip DeCamp, George Shaw, Rony Kubat, Deb Roy, "An Immersive System for Browsing and Visualizing Surveillance Video", Proceed-

ings of ACM Multimedia 2010. Florence, Ital.

Schedule (draft): Friday 1.30-4.20 class and Tuesdays 7.30-9.30 lab

Design Experiment definition

Week 1

Tuesday:Feb 7 (one time) Introduction – "Embodiment Computation" assignment ONE – design experiment

Lab: Feb 14 Sketching in code - hands on lab processing

Model

Week 2

Friday: Feb 17 Models of design - Presentation assignment ONE – handout assignment TWO - "Model"

Lab: Feb 21 Embodiment in electronics -Arduino hands on lab

Week 3

Friday Feb 24 Fabrication and geometry - update, discussion of "Model" assignment

Lab: Feb 28 Prototyping, fabrication, design geometries, parametric design

Embodied Computation Prototype

Week 4

Friday: Mar 3 Presentation "model" assignment– handout "Embodied Computation Prototype"

Lab: Mar 7 algorithmic constructs, control flows

Week 5

Friday Mar 10 Lecture geometry - update, discussion "Embodied Computation Prototype" assignment

Lab: Mar 14 Hands on help with Embodied Computation Prototype

Week 6 - Midterm
Presentation "Embodied Computation Prototype"

Friday Mar 17 Presentation assignment "Embodied Computation Prototype" – handout assignment "Experiment"

Spring Break (March 12-20)

Experiment

Week 7

Lab Mar 28

Friday Mar 31 Search space, design space, design metric - update, discussion "Experiment" assignment

Lab Apr 4 Programming and modelling topics – based on students' projects

Week 8

Friday Apr 7 Artificial Intelligence lecture - update Presentations on "Experiment" assignment

Lab Apr 11 Programming and modelling topics – based on student's projects

Week 9

Friday Apr 14 Material computation - update on "Experiment" assignment

Lab Apr 18 Programming modelling topics – based on student's projects

Week 10

Friday Apr 21 Final presentation "Experiment" – handout final paper assignment

Lab Apr 25 Hands on help final project – based on student's projects

Week 11

Friday Apr 28 Outlook – embodied computation – robotics

Lab May 2 Hands on help final project – topics based on student's projects

Week 12

Friday May 5 Final Project Presentation in class and first draft of final paper due.

Final Paper due May 18th