Hybrid Architectural Robots: 
Linking Prototypes with Simulations 
Summer Workshop Syllabus

4.S53 Summer 2020 
Instructor: 
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credits: 5G 
W2-5 zoom https://mit.zoom.us/j/96869173047 
weekly Lab/office hours to support development office hour zoom ID 96869173047

Description: The course is an exploration of hybrid Architectural Robots – meaning robotic buildings that are part physical prototype using electronics and sensors and part real time simulations to explore the possibilities of linking human experience with larger scale architectural interactive prototypes in a time where larger scale physical prototypes are not realistic and demands on architecture have developed to enable physical distancing in the health crisis of the pandemic. But it also opens up possibilities to work simultaneously at multiple scales from the tangible interface to holistic building responses and further explore this emerging side of design beyond the formal into the behavioral. The four week course will be a design based exploration of robotic buildings in a time of heightened awareness of human interactions in indoor environments and the possible roles an aware architecture could play in mediating and learning from people’s actions in space. There will be a series of assignments to introduce electronics sensing and actuation and approaches to connect hardware with software geometry based model extensions in grasshopper and processing


Lionel Topp - children playing in marked squares for social distancing

Natalie Roat 
Final project 4.117 SP2020

Jola Idowu 
Final project 4.117 SP2020

Emma Jurczynski 
Final project 4.117 SP2020
Create a partial physical enclosure driven by an agenda of your choice that engages with the human body in space. Develop a parametrically defined form and fabricate a partial human scaled physical prototype of a micro architecture in paper/cardboard using printouts from your digital model to test and document it. What is the role of the object in defining a person’s relationship to space? Define the objects agenda and how your physical form embodies it.
Submit:
1 - A geometric grasshopper model using parameters
2 - A physical prototype of an inhabitable micro architecture (as far as resources allow)
3 - A PDF summary and documentation of the work to present and upload to dropbox

Develop your project conceptually further by replacing one fixed formal feature with an actuated one to create an adaptive physical object in such a way that it has a substantial impact on the character of the enclosure and further empowers its agenda. Experiment with sensing as the trigger for the change. Consider its architectural potential and think of your design more as a character than as a static enclosure.
Submit:
1 - A geometric simulation of actuation - through a parametric model
2 - A physical actuated prototype of an inhabitable micro architecture (as far as resources allow)
3 - A PDF summary and documentation of the work to present and upload to dropbox

Develop your project further moving any more complex or larger design elements into a linked simulated geometric design that corresponds to the physical electronic parts through firefly and arduino. Think carefully about the link between the physical setup (the embodiment) and the simulated part - How do you capture the presence of people with your sensor arrangement? Is it through visual cues, through direct or indirect measures of matter like vibration or changes in the distribution of forces or temperature? Is it a boolean type sensing or a gradient? How do you define the threshold for triggering the actuated state change? How does the sensing range enable the object to include space beyond its physical reach - and how does it affect its physical form? How can you further mediate a response beyond a direct mapping of trigger and response using concepts such as state automata or memory or the state of matter?
Submit:
1 - A linked physical electronic - digital geometric prototype with a control concept
2 - A PDF summary and documentation of the work to present and upload to dropbox

For the final review finalize your overall project and document a person interacting and/or inhabiting your prototype through photos/video using it to tell the story of your designs agenda This final iteration is an embodiment of the agenda from physical form to immaterial sensing into behavior over time.
Submit:
1 - The final physical electronic - digital geometric prototype - documented in its interaction with a person
2 - A PDF summary and documentation of the work to present and upload to dropbox

Schedule draft:
6/10 Intro Embodied Computation - handout assignment 1
Lab Form geometry
6/17 Interactivity - presentation assignment 1 - handout assignment 2
Lab Arduino electronics actuation and sensing
6/23 Prototype - presentation assignment 2 - handout assignment 3
Lab Firefly - linking geometry and electronics - state machines/memory
6/30 Autonomy - Presentation assignment 3 - handout assignment 4
lab programming in processing - data structures
7/7 Final Review Assignment 4 and overall project development
References:


Duffy, Brian R., 2003, “Anthropomorphism and the social robot”, robotics and autonomous systems 42


Fox, Michael, Kemp, Miles, “Interactive Architecture”, 2010, Princeton Architectural Press


Hall, E.T. (Edward Twitchell), 1914-2009 "Beyond culture".


Moniz, A. B., 2013, “Robots and humans as co-workers? The human-centered perspective of work with autonomous systems”; IET Working Papers Series No. WPS03/2013


Learning Objectives:
The course consists of four assignments expanding the concept of embodied computation from matter to behavior. Students should be able to engage with an increasing level of design research through iterative prototypes and move fluidly between different modes and scales of operation. At the core of the course is the Experimentation with different physical and electronic media to develop design prototypes and to reflect critically on its implications for design. Due to the online framework of the course due to COVID19 a hybrid approach is taken combining geometric simulations with partial electronic prototypes.

Completion Requirements:
Completion of each of the assignments, rigor in process and clarity in representation, as well as the overall progress of the semester (including attendance) will be fundamental to completing the course.

Evaluation Criteria and Grading:
The following criteria will be used for the evaluation of student’s work, both in terms of helping their progress and in final grading. (01) Thesis: How clearly is the student articulating the conceptual intentions? (02) Translation of Thesis: How well is the student using their thesis to develop a design response to given problems? (03) Representation Appropriateness: How well matched is their choice of representational means to their intentions? (04) Prototyping Quality: How accomplished are they with drawing, modeling, digital representation, and prototyping? (adjusted for online learning circumstances with prototypes being considered hybrids between simulation and physical prototypes) (05) Oral Presentation Skills: How clearly are they presenting their ideas orally, whether at their desk, in class discussions, or to a more formal jury? (06) Participation in Discussions: How actively and how constructively are they involved in class discussions, both formally and informally? (07) Response to Criticism: How do they effectively take advantage of criticism from instructors, classmates and outside jurors? (08) Auto-Critical Skills: To what extent are they able to critique their own work regularly and effectively? (09) Attendance – attendance to all classes is mandatory, please email beforehand for excused absence.

A: Excellent - Project surpasses expectations in terms of inventiveness, appropriateness, verbal and visual ability, conceptual rigor, craft, and personal development. Student pursues concepts and techniques above and beyond what is discussed in class.

B: Above Average - Project is thorough, well researched, diligently pursued, and successfully completed. Student pursues ideas and suggestions presented in class and puts in effort to resolve required projects. Project is complete on all levels and demonstrates potential for excellence.

C: Average - Project meets the minimum requirements. Suggestions made in class are not pursued with dedication or rigor. Project is incomplete in one or more areas.

D: Poor - Project is incomplete. Basic skills including graphic skills, model-making skills, verbal clarity or logic of presentation are not level-appropriate. Student does not demonstrate the required design skill and knowledge base.

F: Failure - Project is unresolved. Minimum objectives are not met. Performance is not acceptable. This grade will be assigned when you have excessive unexcused absences.

Writing Center
The WCC at MIT (Writing and Communication Center) offers free one-on-one professional advice from communication experts. The WCC is staffed completely by MIT lecturers. All have advanced degrees. All are experienced college classroom teachers of communication. All are all are published scholars and writers. Not counting the WCC’s director’s years (he started the WCC in 1982), the WCC lecturers have a combined 133 years’ worth of teaching here at MIT (ranging from 4 to 24 years). The WCC works with undergraduate, graduate students, post-docs, faculty, staff, alums, and spouses. The WCC helps you strategize about all types of academic and professional writing as well as about all aspects of oral presentations (including practicing classroom presentations & conference talks as well as designing slides). No matter what department or discipline you are in, the WCC helps you think your way more deeply into your topic, helps you see new implications in your data, research, and ideas. The WCC also helps with all English as Second Language issues, from writing and grammar to pronunciation and conversation practice.
The WCC is located in E18-233, 50 Ames Street). To guarantee yourself a time, see the WCC’s page About Appointments where you can then schedule an appointment online.”

Academic Integrity
MIT’s expectations and policies regarding academic integrity should be read carefully and adhered to diligently: http://integrity.mit.edu/.