# 4.117/8 Creative Computation

## Syllabus

Spring 2022


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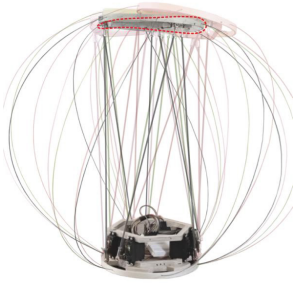
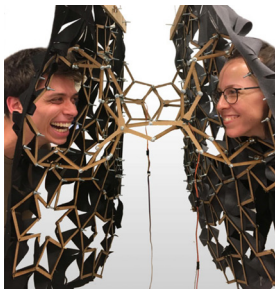
credits: (3-0-6)G (3-0-9)UG

W2-5 room 3-442 - Zoom Meeting ID: https://mit.zoom.us/j/93583849217

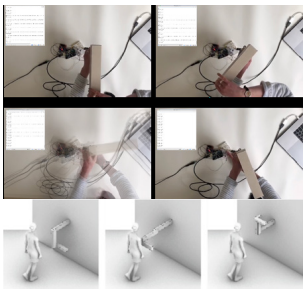
office hours per signup sheet



Choreographed Evasion
Natalie Pearl Spring 2020



A socially connecting wall
Molly Mason 4.s13 Spring 2019



Actuation of Timber Blocks for spatial gestures Emma Jurczynski Spring 2020

Description: The relationship of shaped material artifacts and people is changing with the ubiquity of computation. Mechanical solutions relying on analog computation are increasingly replaced with algorithmic feedback and control systems and even learned control strategies. This shift of parts of design to the intangible makes it harder to spot bias and easier to scale up deployment with little scrutiny and have far reaching consequences. But the effects are not equally distributed with for instance bias in AI, as discussed in "Gender shades" (Buolamwini 2017), affecting women and BIPOC disproportionally contributing to systemic racism. But also purely material based design embodies agendas through form. In the shift to the intangible, single-purpose built artifacts disappear and are incorporated into apps displayed on generic touchscreen devices. To counter that in architecture we focus on developing designs that reclaim the physical-digital hybrids as embodied computation critically and expand it into architecture. We revisit the potential of the spatial relations that computational-physical hybrids can develop with people at the architectural scale. Edward T. Hall (Hall 1969) introduced the term Proxemics to describe the effect of human use of space. Ray Birdwhistell (Birdwhistell 1970) created the term Kinesics (body language meaning the nonverbal communication of the body and the face). The hypothesis is that with a shifted focus in the design of artifacts from form to behavior through computation, the human-architecture relationship can be redefined and architects empowered as critical designers of spatial relationships. How do we develop non-verbal forms of architectural articulation to embrace emerging autonomy at an architectural scale? How can we develop alternatives to formal primitivism and superficial anti-tech motions in design by exploring an expanded conceptual design canon rather than getting stuck in stylistic camouflage? It is crucial to build computational fluency in design to create awareness of bias built into both physical and computational control and develop critical alternatives through design from within architecture and through a diverse set of authors driven by their own concerns, agendas and sensibilities.

Grading:
Participation 10%
Assignment 1 20%
Assignment 2 20%
Assignment 3 20%
Assignment 4 20%
Paper report 10%

Assignment summaries

A sequence of assignments structures the development of a prototype that is an exploration of the human interaction with computational artifacts and their extension from material form to behavioral entities.

Assignment 1A + B

(A) Fabricate a physical object at 1:1 scale that engages with the human body in space driven by an agenda of your choice. Document your spatial interaction with the object.
(B) Translate your physical object into a parametrically defined geometry in Grasshopper. What is your parametric approach, what of your agenda can geometry capture? How do you capture the object-person relationship in space parametrically?
Discuss how the object's agenda is embodied in your physical object's form.

Assignment 2

As an extension to your initial embodied form, substitute at least one formal feature of your object with an actuated one using the arduino platform and a form of actuation. Reflect on how actuated variability has an impact on the character of the piece. Does flexibility expand its agenda? Does change make it more arbitrary? Does a person engage differently with your object? Consider the architectural potential of your actuated object. Think of it as an entity with character not as a component. It must be a singular standalone installation, conceptually complete as built somewhat like a micro architecture. How does it actuate, where does it derive its energy from, how do you setup and exploit the singular degree of freedom for change?

Assignment 3

Develop your project further with the addition of sensing and its careful integration into the physical setup of your construct – how do you capture the presence and action of people? 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 continium? How do you define the threshold for change? How does the sensing range enable the object to include space beyond its physical reach - and how does it affect its physical form?

Assignment 4

For the final assignment, link your physical prototype through firefly/processing to an interactive grasshopper or processing geometry that extends it in scale and/or conceptually. Add a layer of autonomy through simple decision making based on sensor readings and memory. The goal is to extend your object's formal agenda through behavior into time.

Final Paper

Final technical paper write up of the overall project development.

Schedule draft:

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|---|---|
| 2/2 | Intro computation - lab form geometry - handout assignment 1 |
| 2/9 | Presentation assignment 1A - lab grasshopper |
| 2/16 | Intro Interactivity - Presentation assignment 1B – handout assignment 2 |
| 2/23 | Proposal presentation assignment 2 - Lab Arduino electronics |
| 3/2 | Update presentation assignment 2 - Lab actuation |
| 3/4 | Add Date |
| 3/9 | Final Presentation assignment 2 – handout assignment 3 |
| 3/16 | Proposal presentation assignment 3 – Lab sensing |
| 3/23 | Spring Break |
| 3/30 | Update presentation assignment 3 – Lab networking |
| 4/6 | Final Presentation assignment 3 – Handout assignment 4 |
| 4/13 | Proposal presentation assignment 4 – Lab Firefly - linking geometry-electronics |
| 4/19 | Drop Date |
| 4/20 | Lab state machines/memory data structures/processing |
| 4/27 | Update presentation assignment 4 - Lab Larger scale prototypes-simulation |
| 5/4 | Lab Technical paper writing |
| 5/11 | no class meetings allowed for MArchs |
| 5/13-18 | Final Review Assignment 4 + Final Paper - date scheduled by registrar in final exam week |

References:


A. Bajcsy, D. Losey, M. O'Malley, and A.D. Dragan. Learning Robot Objectives from Physical Human Interaction. Conference on Robot Learning (CoRL), 2017

Bier, Henriette., 2014, "Robotic Building(s)", Next Generation Building 1 (2014) 83–92 83, DOI: 10.7564/14-NGBJ8

Bier, Henriette, 2011. "Robotic environments", In Proceedings of the 28th international symposium on automation and robotics in construction, 863–868

Birdwhistell, Ray L., 1918-1994. Kinesics and context;essays on body motion communication Philadelphia, University of Pennsylvania Press [1970

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

Braitenberg, V. (1984). Vehicles: Experiments in synthetic psychology. Cambridge, MA: MIT Press

Brooks, Rodney. A.,(1991) "Intelligence without representation", Artificial Intelligence 47, 139–159

Buolamwini, Joy Adowaa (2017). Gender shades : intersectional phenotypic and demographic evaluation of face datasets and gender classifiers

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

Dunne, Anthony, Raby, Fiona, Speculative Everything: Design, Fiction, and Social Dreaming, 2013

Dunne, Anthony, Raby, Fiona, Dunne & Raby Robot 1 from the Technological Dreams Series: no 1, Robots project (Model) 2007

Eng, K., Mintz, M., Verschure, P. F M J, 2005, "Collective Human Behavior in Interactive Spaces", International Conference on Robotics and Automation.

Eng, K., Klein, D., Baebler, A., Bernardet, U., Blanchard, M., Costa, M., Delbrueck T., Douglas R., J., Hepp, K., Manzolli, J., Mintz M., Roth, F., Rutishauser, U., Wassermann, K., Whatley, A.M., Wittmann, A., Wyss, R., Verschure, P., F.M.J., 2003, "Design for a brain revisited: The Neuromorphic Design and Functionality of the interactive space 'Ada'", Reviews in the Neurosciences, 14, 145-180.

Fox, Michael, Kemp, Miles, "Interactive Architecture", 2010, Princeton Architectural Press

Gajamohan, Mohanarajah. Merz, Michael. Thommen, Igor. D'Andrea, Raffaello. (2012). "The Cubli: A Cube that can Jump Up and Balance", 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems October 7-12, 2012. Vilamoura, Algarve, Portugal.

Green, Keith Evan and Gross, Mark, 2012, "Architectural Robotics, Inevitably", Interactions Magazine xix,1 January February.

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

Hall, Edward T. (Edward Twitchell), 1914-2009. The silent language. Garden City, N.Y., Doubleday, 1959.

Hall, Mildred Reed., Hall, Edward T. "The fourth dimension in architecture : the impact of building on man's behavior : Eero Saarinen's administrative center for Deere & Company, Moline, Illinois "

Joo, H., Simon, T., Li, X., Liu, H., Tan, L., Gui, L., Banerjee, S., Godisart, T., Nabbe, B., Matthew, I., Kanade, T., Nobuhara, S., and Sheikh, Y., (2015), "Panoptic Studio: A Massively Multiview System for Social Interaction Capture", 2015 ICCV.

Kantayya, Shalini (director), (2020), "CODED BIAS: A DOCUMENTARY", about poet and computer scientist Joy Buolamwini and how she uncovers racial and gender bias in AI systems

Mindell, D., (2015), "Our Robots, Ourselves – Robots and the Myths of Autonomy", Viking.

Nagpal,Radhika, (2002), Programmable Self-Assembly Using Biologically-Inspired Multi agent Control, AAMA, 02, Bologna Italy

Pallasmaa, Juhani. The eyes of the skin: architecture and the senses. John Wiley & Sons, 2012.

Pottmann, H., Asperl, A., Hofer, M., Kilian, A., Architectural Geometry, Bentley Institute Press, 2007

Turing, Alan , (1950 ), "COMPUTING MACHINERY AND INTELLIGENCE, "Can machines think", Computing Machinery and Intelligence. Mind 49: 433-460.

Grasshopper3d.com arduino.cc http://www.fireflyexperiments.com/ https://www.food4rhino.com/ rhino3d.com processing.org http://kangaroo3d.com/

Backup Plans in terms of learning continuity regrading Covid
We will make an effort to record all course sessions via zoom both for future reference and for anyone who maybe out in isolation or sick at any time. We will also support isolating students as good as we can to help them keep up with the course material. If the instructor has to isolate we will shift the course to remote via the posted zoom room and use the established digital tools slack and dropbox to continue teaching and collaborating. Everything else will happen in person as it stands now.

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. A technical final paper is expected in documenting the final outcome and semester progress.

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:
All students are expected to attend all synchronous classes and participate in presentation updates, final presentations and discussion of presented work. If attending the synchronous class is not possible please contact the instructor beforehand to arrange an alternative. Regular attendance of synchronous weekly sessions is crucial for design development and live project discussions.
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? (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.

Diversity
MIT values an inclusive environment. I hope to foster a sense of community in this classroom and consider this classroom to be a place where you will be treated with respect. I welcome individuals of all backgrounds, beliefs, ethnicities, national origins, gender identities, sexual orientations, religious and political affiliations – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class. If this standard is not being upheld, please feel free to speak with me.

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."

Mental Health

As a student, you may experience a range of challenges that can interfere with learning, such as strained relationships, increased anxiety, substance use, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may impact your ability to attend class, concentrate, complete work, take an exam, or participate in daily activities.

Undergraduates: Please discuss this with Student Support Services (S3). You may consult with Student Support Services in 5-104 or at (617) 253-4861.

Graduate Students: Please reach out to the deans for personal support in the Office of Graduate Education. For urgent or after-hours concerns, please contact MIT Police

Academic integrity

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

From the Office of Student Citizenship, W20-507, (617) 258-8423

In this course, I will hold you to the high standard of academic integrity expected of all students at the Institute. I do this for two reasons. First, it is essential to the learning process that you are the one doing the work. Failing to do the work yourself will result in a lesser understanding of the content, and therefore a less meaningful education for you. Second, it is important that there be a level playing field for all students in this course and at the Institute so that the rigor and integrity of the Institute's educational program are maintained.

Please review the Academic Integrity policy and related resources (e.g., working under pressure; how to paraphrase, summarize, and quote; etc.) and contact me if you have any questions about appropriate citation methods, the degree of collaboration that is permitted, or anything else related to the Academic Integrity of this course..