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Teaching Assistants: Berfin Ataman berfina@mit.edu & Qingyang Xie qyangxie@mit.edu

Schedule: MW 2:00 p.m. - 5:00 p.m. Room 7-434

Units: 3-3-6 HASS-A

Prerequisites: None

Class Overview:

4.021 How to Design introduces fundamental design principles as a way of demystifying design and providing a basic introduction to all aspects of the design process. Through lectures and exercises, students will develop skills of creativity, abstract thinking, representation, iteration, and design development. 4.021 is an introductory class intended for students without a design background, geared towards enabling more effective collaboration with designers, and the ability to apply foundational principles of design to any discipline. Limited to 26; preference to Course 4 and 4B majors/minors, first- and second-year students.

The Design Process:

Each week the class will explore aspects of the design process from context to concepts, drawing, making, iterating, building a narrative and finally presenting. This path exemplifies a traditional design process where a designer starts with an idea and works through testing, expanding, refining, and eventually realizing their idea for review and evaluation. Through weekly topics and assignments, students will develop a variety of design skills relating to each stage of the design path.

Learning Objectives:

The course consists of four exercises exploring various topics through concepts, drawings and physical fabrication. Students should be able to engage with an increasing level of design research through iterative studies and move fluidly between different modes and scales of operation. Conventions of design representation and communication through drawing and modeling will be explored. Students will need to demonstrate basic applications of design skills, understanding of conventions, and an ability to sustain an increasing level of research during the exercises throughout the semester.

Exercise 1: Rule Based Drawing

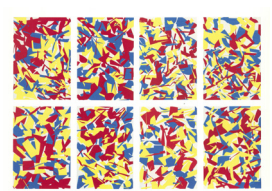
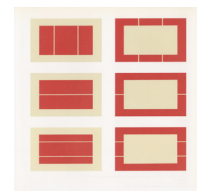
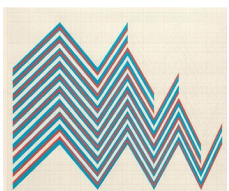
"In conceptual art the idea or the concept is the most important aspect of the work. When an artist uses a conceptual form of art, it means that all of the planning and decisions are made beforehand and the execution is a perfunctory affair. The idea becomes a machine that makes the art...It is usually free from the dependence on the skill of the artist as a craftsman." Sol LeWitt, "Paragraphs on Conceptual Art", Artforum, V/10, Summer 1967,

The first exercise is to develop a drawing that features iteration, a concept essential to design that we will explore in various ways throughout the semester. Iteration = Repetition of an operation. The repeated application of a formula devised to provide a closer approximation to the solution of a given equation so that a series of successively closer approximations may be obtained

Select a drawing tool/tools, and a method/methods for using your tool(s), by developing a series of rules that govern the use of your tool(s). Your rules should be a set of written instructions used to produce a drawing initially authored by you, and subsequently authored by one or more of your classmates.

The intent of this exercise is to allow "a way in" for each of you, regardless of your prior experience in design. This exercise will also begin to establish a common set of graphic and verbal vocabularies that we will use throughout the semester, in a variety of contexts.

Rule Based Drawing should consider how your drawing acts to divide the space of the drawing paper; how various lines, marks, brush strokes or imprints interact with one another; how various parts affect the larger whole; and, how each successive rule interacts with each and all previous rules.



Drawing Requirements:

- A clear concept/intention/thesis about dividing the space of the drawing paper.
- A clear concept/intention/strategy for the use of color in your rules and composition.
- Temporal components of the mechanics (human or other) must be evident.

Example of a Drawing Strategy:

- Start with a geometric primitive (i.e. point, line, plane, curve, etc.), placed at a location of your choice, within the bounds of a sheet of drawing paper and develop rules for transforming your initial primitive (e.g. move, rotation, mirror, scale, deformation, etc.).
- Expand from the starting point to the rest of the drawing area/paper.

Additional Drawing Strategies:

- Use of a secondary tool or template
- Use of a surface or texture place beneath the drawing paper
- A method of physical manipulation: crease, fold, erase, score, etc.
- A system of measurement
- Rules written in such a way as to purposefully cause or encourage anomalies, deformations or randomness
- A strategy of your own device.

Schedule: Process & Iteration

Progress in studio is a process. Work in the classroom and between classes is cumulative. Instructors and Teaching Assistants will review your work during studio providing you with feedback which you will incorporate into a revised or final version of your project for the next class. Iteration is a key condition of effective design. Make, critique, repeat, as many times as possible for best results.

02.03.25 (m)

Presentation: Class Introduction + Exercise 1: *Rule Based Drawing*

Assignment: Study precedents/references and select one or more that you prefer. At our next class, tell us about your precedent author & their work(s). Analyze which rules/procedures are behind the “drawing(s)” you’ve selected and start to develop a series of rules/procedures for your drawing on sketch/trace paper.

02.05.25 (w)

Presentation: Color Theory

Assignment: Make a first draft-drawing based on your rules on a (19” x 24”) sheet of practice paper. Make a second draft-drawing on a second (19”x24”) sheet of practice paper modifying your rules, or keeping the same rules and modifying your implementation of the rules, or using your drawing tool in a different manner.

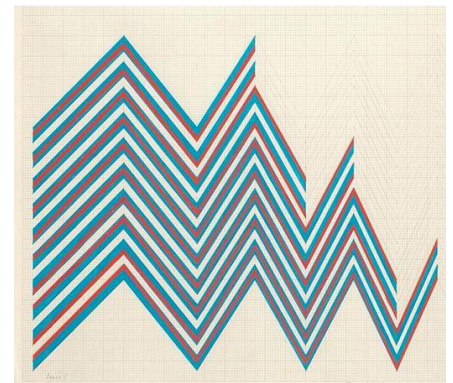
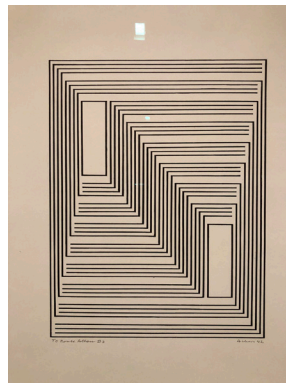
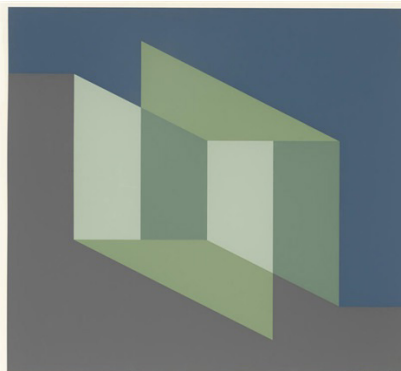
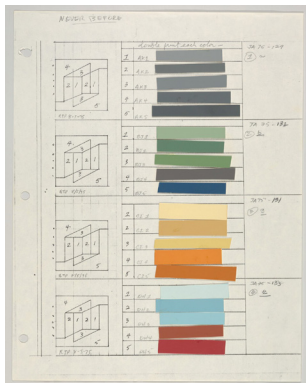
02.10.25 (m)

Presentation: Google Slides Preparation & Use, Time-Lapse Video

Assignment: Type out rules for your selected iteration on an 8 1/2” x 11” piece of paper so that your classmates can successfully draw your rule based drift drawing. Add your rules to your google slides presentation. Make a final iteration of your rule based drawing following your rules and take a time-lapse video with your phone – of you creating your drawing. Add your time lapse video to your google slides presentation.

02.12.25 (w)

Assignment: Follow the rules written by 3 of your classmates, work to contribute towards the creation of 3 of your classmate’s drawings. Assemble your project presentation on Google Slides including images of your 3 classmate produced drawings.



Exercise 2: *Cut & Fold*

“The third approach, centered on the idea of permeability, involves seeking out and responding to the special conditions of the chosen site. In so doing it should prove possible to discover a basis for formal organization, to relate the construction process to the immediate locality, to choose an appropriate scale and relevant dimensions. Such an approach can encompass opposites and allow contradictions, but it permits no apathetic indifference. A dimensional module can be chosen which is small enough to respond to the landscape, yet large enough to coordinate the various interventions. The permeable approach remains open to the influence of local history and geography, their development, and the tendencies they seem to suggest. At best it takes root in such considerations, becoming a natural process, almost biology. Ideally it should be able to absorb and take over quite fearlessly any kind of system, tool or calculation. It can even be open to industrial methods and their autonomous processes, taking these as incidental elements in the mosaic of its subjective scheme.” Lucien Kroll, *An Architecture of Complexity*, MIT Press, Cambridge, Ma., 1987, p. 9

“We must now see our urban society as a dynamic field of interrelated forces. It is a set of mutually independent variables in a rapidly expanding infinite series. Any order introduced within the pattern of forces contributes to a state of dynamic equilibrium - an equilibrium which will change in character as time passes.” Fumihiko Maki, *Investigations in Collective Form*, A Special Publication The School of Architecture Washington University, June 1964

On a sheet of 19" x 24" paper organize, compose, reveal & cut a field of geometric constructions. Your field of geometric constructions should be set up by a structure or set of rules that establishes a relationship between the geometry of your field of lines, the geometric constructions that result from your cuts and folds, and the sheet of paper that your constructions occupy. Make a distinction between the geometry you are drawing to set up the field and the geometry used to define and describe your 3-dimensional field of cuts and folds.

Schedule: Process & Iteration

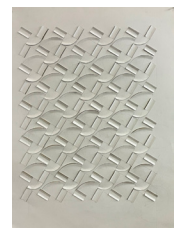
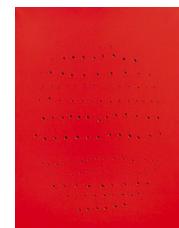
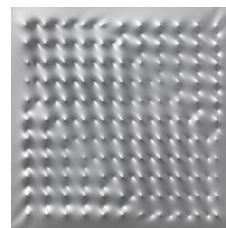
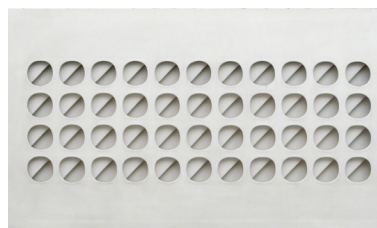
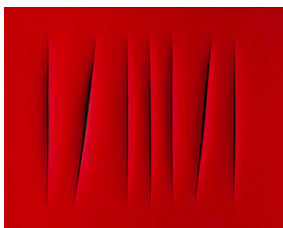
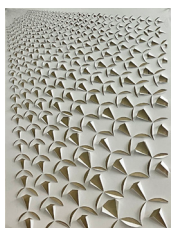
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02.18.25 (T) **Presentation:** Exercise 2 Presentation, 2.5D, Rhino Install & Tutorial (line, arc, circle, rectangle, trim, extend, array, polar array, OSnap), Hand Cutting Demonstration,
Assignment: By hand, draw and use a utility knife to test out potential shapes and patterns you can make through cutting and folding. Once you have established your ‘toolkit’ create a set of rules to describe the process for drawing, cutting, and folding a field of geometric constructions. Using Rhino, draw the lines that represent your cuts and prepare your laser cut file. Remember your file will be cut upside down in order to avoid burn marks. Use Red for cuts and Dashed Cyan lines for folds.

02.19.25 (w) **Presentation:** Introduction to Laser Cutting
Assignment: Using 19" x 24" paper, laser cut & fold a first iteration of your field of geometric constructions.

02.24.25 (M) **Assignment:** During class refine your concept & draw a second iteration of your field of geometric constructions. Between Wednesday’s class and Monday’s class, using a sheet of 19" x 24" paper, laser cut & fold a second iteration of your field of geometric constructions.

02.26.25 (w) **Presentation:** GIF Tutorial, Photography Tutorial
Assignment: Assemble your project presentation on Google Slides including images of your 2 field of geometric constructions iteration rhino drawings, 2 field of geometric constructions cut & fold iterations, and 2 GIFs that show the before & after cutting and folding of your field of geometric constructions.



Exercise 3: *Mis-Drawing Machine* (Design, Fabrication and Use)

The history of drawing and art-making machines stretches back centuries, with artists and inventors creating devices to explore automation, chance, and mechanical aesthetics. There was skepticism on the part of art critics who viewed machine-made art as lacking human intent or soul. There was also a debate about authorship. Over time, there has been a shift in perception. Machine-based art has gained serious critical and academic attention, especially in generative and AI art. Drawing or art making machines were rarely about the automation of art making, they were about playfulness & critique. Many of these machines were created to challenge the boundaries of creativity, question the role of the artist in the art making process, and expand the artists art making toolbox.

Leonardo da Vinci designed mechanical automata, though none were strictly for making art. Leonardo had a fascination with human mechanics & the scientific exploration of vision and proportion. Leonardo's efforts were scientific tools, not artistic methods.

Thomas Skidmore's 18th Century Pantograph was a mechanical device that allowed artists to scale and copy drawings with precise accuracy. The Pantograph was a tool designed to assist artists and engravers in reproducing works with consistency. Ultimately the Pantograph was considered a useful tool rather than an artistic medium.

Jean Tinguely's "Meta-Matics" in the 1950s–1960s built motorized machines that made chaotic, chance-based drawings based on Dada and Surrealist ideas of randomness and anti-art. Critics saw his work as a playful critique of automation, with some dismissing it as a gimmick and others praising its challenge to authorship.

03.03.25 (m) **Presentation:** Exercise 3

03.05.25 (w) **Presentation:** *Design Process*

Assignment: Split into groups of 2 and begin ideating the goals of your drawing machine (concept). Select 3 images from the lecture (or your own reference) to begin talking about the desired effects of your drawing machine. Sketch out how you plan to build your machine so we can talk about your machine during the next class.

03.10.25 (m) **Presentation:** *Rhino Solids (sphere, box, scale, scale1d, rotate, all booleans, trim), 3D Printing Tutorial*

Assignment: Concept statement, Initial paper prototype of the machine, three medium tests for the machine (is it drawing with ink, paint, cuts...?)

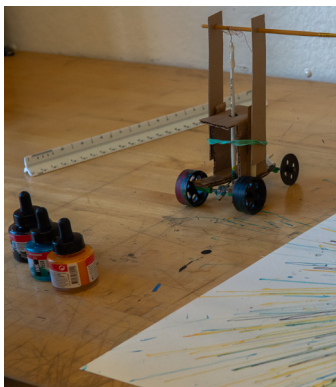
03.12.25 (w) **Assignment:** Initiate fabrication of your Mis-Drawing Machine's final prototype. Use your Mis-Drawing Machine to make a drawing. Refine your Mis-Drawing machine to produce a drawing that most closely aligns w./your concept.

03.17.25 (m) **Assignment:** Update/finalize your concept statement, photograph your Mis-Drawing Machine. Use your Mis-Drawing Machine to make three drawings, make a video/timelapse and/or gif of your machine making a drawing. Add your concept statement, precedent studies, paper prototype Mis-Drawing Machine photographs & drawings, final Mis-Drawing Machine photographs & drawing images, video/timelapse and/or gif of your machine making a drawing, to your Google Slide Presentation.

03.19.25 (w) **Presentation:** *Final Project Student Presentations (Exercises 1, 2, & 3)*

03.24.25 (m) Spring Break (No Homework/Assignment)

03.26.22 (w) Spring Break (No Homework/Assignment)



Exercise 4: Inflatables

Artists and Architects have worked with inflatables at various points throughout the last 100+ years of art and architecture history. Different artists and architects have a variety of ideas or concepts to support their pursuit of inflatables.

Buckminster Fuller – *Cloud Nine* (1960s, unbuilt) “A new era of lightweight, ephemeral structures will allow us to reimagine human habitation.” (Fuller envisioned massive, floating geodesic domes that would remain airborne by heating the air inside.)

Andy Warhol – *Silver Clouds* (1966) “I wanted something that would be just beautiful. Silver was the future, it was spacey—the astronauts wore silver suits.” (Warhol’s floating Mylar balloons challenged traditional sculpture.)

Claes Oldenburg – *Giant Soft Fan* (1966–67) “I like to work with materials that have an element of unpredictability. The softness allows for movement, for breathing almost.” (Oldenburg experimented with soft and inflatable sculptures, rejecting rigid.)

Frei Otto – *Pneumatic Architecture* (1960s–1970s) “We must learn from nature—air structures use the least material to enclose the most space.” (Frei Otto, known for lightweight tensile structures, explored air-inflated architecture for efficiency and sustainability.)

Ant Farm – *Inflatocookbook* (1970s) “Inflatables are about instant architecture, a way of making space without the baggage of traditional buildings.” (This radical collective created DIY inflatable architecture and performances.)

Archigram – *Instant City* (1960s–1970s) “Architecture should be lightweight, flexible, and responsive—like a pop-up city that can emerge anywhere.” (Peter Cook) (This avant-garde group envisioned mobile, inflatable structures that could create temporary urban environments.)

Otto Piene – *Sky Art* (1969–1980s) “I wanted to paint the sky, to create a dynamic experience that goes beyond the gallery.” (Piene used inflatables in environmental art, combining air, light, and movement.)

Tomás Saraceno – *Aerocene* (2015–present) “Can we float without fossil fuels? Can we design a new kind of mobility?” (Saraceno’s air-powered, sustainable inflatables challenge how we think about architecture and movement.)

Jeff Koons – *Balloon Dog* (1994–2000) “I try to capture the idea of expansion, of breath, of optimism.” (Though not a true inflatable, Koons’ metallic sculptures mimic inflatable toys.)

Jimmy Kuehnle – *Wearable Inflatable Performances* “Inflatables let you be ridiculous, oversized, and impossible to ignore.” (Kuehnle creates interactive, wearable inflatables that challenge personal space.)

For our fourth and final exercise we will design an inflatable installation that will alter the experience of our site (TBD) by changing the ways in which space can be occupied and perceived visually, audibly or tactilely. Through your inflatable interventions the site or space can become more: Soft, harsh, cute, shiny, welcoming, disorienting ... (or your desired experiential outcome)

We will kick-off our Inflatables project by visiting our site and analyzing the existing qualities of the space. Where do people enter the space, how are they expected to move through? What are the defining geometries of the space and elements in the space, i.e., columns, windows, steps, and what is their relationship to each other? What are the lighting conditions, natural or artificial? How does air move through our site (does air move through our site)? What kind of colors and textures exist in the space on the floor, ceiling, walls, columns? What are the lines of sight?



Exercise 3: *Inflatables*

Schedule: Process & Iteration

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- 03.31.25** (m) **Presentation:** *Introduction of Assignment, Inflatables*
Assignment: Form into groups of 3, Precedent Study

- 04.02.25** (w) **Presentation:** *Adobe Illustrator Tutorial (.3dm to .ai, artboard size, layers, lineweight, hatch)*
Assignment: Concept statement and initial sketches of your prototypes & vision

- 04.07.25** (m) **Assignment:** Material studies

- 04.09.25** (w) **Assignment:** Material testing including initial inflations

- 04.14.25** (m) **Assignment:** Begin preparations for a mid-project presentation using the provided Google template including: Concept diagram, vector drawing of your 2d sheet & 3d inflatable(s)

- 04.16.25** (w) **Presentation:** *Student Presentations/Mid-Project Review.*
Assignment: On-site half scale or partial prototype tested on-site with feedback from the class

- 04.21.25** (m) No Class Patriots Day

- 04.23.25** (w) **Assignment:** Modify your concept, diagrams, sketches, Rhino drawing, and/or prototype based on the feedback you received during our mid-project review

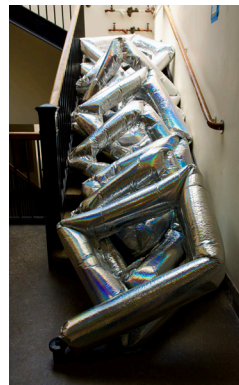
- 04.28.25** (m) **Assignment:** Desk Critiques/Work Day

- 04.30.25** (w) **Assignment:** Desk Critiques/Work Day

- 05.05.25** (m) **Assignment:** Desk Critiques/Work Day

- 05.07.25** (w) **Assignment:** Desk Critiques/Work Day

- 05.12.25** (m) **Set Up/Installation**
Presentation: *Mini slide deck with project title, vignette sequence , concept sentence, analysis diagrams, mock up images, a GIF of the thing inflating and deflating and changing the space.*



Absence Policy

Attendance for the full duration of each class is mandatory. The studio is an exceptional learning environment that requires your physical presence as well as your intellectual presence. You are allowed 3 excused absences for the semester. An excused absence is defined as one that was discussed with & approved by the instructor at least 24 hours prior to the absence, or a family or medical emergency that is confirmed by your physician or a dean in Student Support Services. Absences beyond the three allotted will result in a decrease in your final grade. If you miss six or more studio classes, you will be asked to drop the subject or receive a failing grade.

Evaluation Criteria, Completion Requirements & Grading

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) Concept: How clearly is the student articulating their conceptual intentions? (02) Translation of Concept: How well is the student using their concept to develop a design response to given problems? (03) Representation Appropriateness: How well matched is the student's choice of representational means to their intentions? (04) Representation Quality: How accomplished are students with drawing, modeling, and/or digital representation? To what degree do student's representations convey what they ought to? (05) Oral Presentation Skills: How clearly are students 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 students involved in class discussions, both formally and informally? (07) Response to Criticism: How do students effectively take advantage of criticism from instructors, classmates and outside jurors? (08) Auto-Critical Skills: To what extent are students able to critique their own work regularly and effectively? (09) Attendance – see above.

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 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.

Studio Culture

Work in the studio will build sequentially. Therefore, your commitment to continual development on a daily basis is of paramount importance. It is important that you take advantage of the studio environment. Magnification of your development as a designer is made possible by the collective nature of the class. Group reviews are collective for a reason. Each of you has something to gain from your peers. Since studio is a place for all, it necessitates the careful attention to the needs of everyone in it. Please see your instructors if there are any problems that you are unable to resolve on your own.

Academic Integrity/Honesty

Massachusetts Institute of Technology students are here because of their demonstrated intellectual ability and because of their potential to make a significant contribution to human thought and knowledge. At MIT, students will be given unusual opportunities to do research and undertake scholarship that will advance knowledge in different fields of study. Students will also face many challenges. It is important for MIT students to become familiar with the Institute's policies regarding academic integrity, which is available at Academic Integrity at MIT: A Handbook for Students

Medical

If you are on a Medical Hold due to attesting to potential Covid symptoms, or have tested positive and must isolate, then please contact your instructors so we can make sure you have access to course materials and we can discuss how we address the missed work. In anticipation of students being ill this semester we have already decided that we will provide the following types of academic assistance. You can also contact Student Support Services for additional Assistance <https://studentlife.mit.edu/s3>