

Level: U.G.

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Teaching Assistants: Prim Pimpakarn Rattanathumawat (primra@mit.edu) & Lauren Gideonse (gideonse@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 three projects 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 application of design skills, understanding of conventions, and an ability to sustain an increasing level of research in the projects over the semester.

Exercise 1: Vitruvian Volume

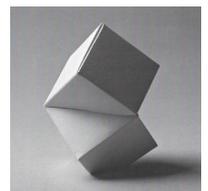
“Haec autem ita fieri debent, ut habeatur ratio firmitas, utilitas, venustatis. (Now these should be so carried out that account is taken of strength, utility, grace.)” Marcus Vitruvius, De architectura, c. 25 B.C., 1.iii.ii

Geometrically draw, cut, & fold a “Vitruvian” volume that is strong, utilitarian & ?

In addition to being strong & utilitarian, your volume should exhibit one of the qualities described in the following list of prompts: agitated, agile, angry, arrogant, beguiling, boisterous, broken, cautious, callous, contrite, diabolical, deliberate, determined, flawed, fine, fat, jumping, jagged, justified, lounging, lost, leaning, morose, maudlin, majestic, notorious, naive, noble, pulsing, pivoting, porous, rapid, radiant, resolute, staggering, suspicious, serene, tentative, tenacious, tussled, violent, venomous, voracious, wicked, wobbly or withered.

Come to class on Wednesday with an Image(s) or precedent(s) that might inspire your design prompt and/or Vitruvian volume and one geometrically constructed, drawn & cut proposal of a volume that makes concrete the abstract concept of your preferred prompt.

On individual sheets of paper provided by faculty/ta’s, use geometric construction to build a contextual relationship between the sheet of paper and the structure that defines and guides the folding of your “Vitruvian” volume.



Exercise 1: Vitruvian Volume (cont.)

Make a distinction between the geometry you are drawing to set up the construction of your “Vitruvian” volume and the “Vitruvian” volume. Use a combination of line weight and cutting to make simultaneously visible your “Vitruvian” volume, its geometry, and the prompt that inspired it.

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.

- 01.31.22** (m) Introduce/Hand Out Assignment & Demonstration: Geometric Construction & Cutting
- 02.02.22** (w) Desk Critiques: Image(s) or precedent(s) that might inspire your design prompt and/or Vitruvian volume. Minimum 1 unique geometrically constructed, drawn, cut, & folded “Vitruvian” volume
- 02.07.22** (m) Desk Critiques: Minimum 1 Revised/New Geometrically Constructed, Drawn, Cut, & Folded “Vitruvian” Volume
- 02.09.22** (w) Pin-Up Final “Vitruvian” Volume Constructed, Drawn, Cut, & Folded
Due: Minimum 3 “Vitruvian” Constructed, Drawn, Cut, & Folded Volumes

Assignment 2: Concept & Context

“Light is a powerful substance. We have a primal connection to it. But, for something so powerful, situations for its felt presence are fragile . . . I like to work with it so that you feel it physically, so you feel the presence of light inhabiting a space.” James Turrell

This assignment explores the steps of (a) building a design concept and (b) framing a context within a design process. Through this assignment, you will develop the conceptual foundation upon which you can design and fabricate a “A Light in Which...”. during the next five weeks, the techniques for 1D - 2D - 3D transformations that you investigated in Assignment 1 will be further explored, refined, and translated using principles for 3D transformations, this time with the function of a “A Light in Which...” fabricated from paper.

You are tasked with developing a concept for your “A Light in Which...,” and framing a context around it. Your concept should be focused on:

- the performance of your “A Light in Which...” with regards to functionality and user experience – i.e. with regards to transparency, translucency, views, optics, movement, or something additional.
- the fabrication techniques with which you’ll achieve the design and performance of your “A Light in Which...”

Your context can be built upon inspiration from outside - existing art, product design, industrial design and architecture, objects, fabrication processes or natural phenomena across various scales. You will be asked to translate your concept and its associated performance into volumetric explorations that focus on implementation and iteration of your initial concept. Having a strong concept, supported by a relevant context, is very important.



Assignment 2: Context & Concept (cont.)

Schedule: process & iteration

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- 02.14.22** (m) 3 concept sketches for your “Light in Which” that relate to the performance and fabrication process for fabricating the modulator from paper. How does it work and how is it made? This can relate to or depart from your drawings – but it should be similarly systematic.
- 02.16.22** (w) Refine your concepts – narrow down to 1 concept and draw it clearly (by hand/sketch) Concepts should be about: 1. The performance of your “Light in Which” in relation to people/views/light etc. and 2. Fabrication process – i.e., how is it made from paper, and how does it work.
- 02.21.22** (t) Introduction to Rhino
Refine your concept & draw your concept diagram in Rhino/Vector 2D.. Start working with paper – fold/shred/weave/etc. Experiment with the paper and start to understand how you can manipulate it to produce certain effects, textures, and performances, and how that can inform your concept and fabrication process.
- 02.22.22** (w) Introduction to Adobe
Use your new fabrication process and experiment with the paper(s)- understand the paper’s formal possibilities. Update your concept and fabrication technique(s) based on what you learn about your paper.
- 02.28.22** (m) Student presentations/mid-project review. Prepare a presentation using the provided template including: Concept diagram, vector drawing of the enclosure, precedents/concept/context and small-scale physical models.
- 03.02.22** (w) Update your concept and fabrication technique/use of paper based on the feedback you received during our mid-project reviews . Update your concept diagram & revise in Adobe.
- 03.07.22** (m) Fabricate you first full-scale experiment with paper.
- 03.09.22** (w) Final Documentation Tutorial/Design Project Photography Tutorial/Presentation
Sketch/diagram describing the fabrication process for your second/final pass at a full-scale paper prototype. Start fabrication. Work on the diagrams/presentation and begin the process of preparing final presentation documentation Concept diagram, vector drawing of your light modulator, precedent studies, context, full-scale physical prototype, photographs, and time-lapse video(s).
- 03.14.22** (m) Desk Critiques
- 03.16.22** (w) Final project presentation. Prepare a presentation using the provided template including: Concept diagram, vector drawing of your light modulator, precedent studies, context, full-scale physical prototype, photographs, and time-lapse video(s).
- 03.21.22** (m) Spring Break
- 03.23.22** (w) Spring Break



Assignment 3: Folding Function

“The visionary starts with a clean sheet of paper, and re-imagines the world. The tweaker inherits things as they are, and has to push and pull them toward some more nearly perfect solution. That is not a lesser task.” Malcolm Gladwell, *The Tweaker*, *The New Yorker*, November 11, 2011

“The danger is that Gladwell’s article will likely be misread in executive suites and boardrooms as confirming the wrong-headed idea that innovation should be cheap, easy and incremental and, no matter what, should not involve any serious invention. That is a recipe for near-term gain and long-term doom and, unfortunately, buttresses the misguided course being taken by more and more companies.” Chunka Mui, *Innovators Beware: The Danger of Viewing Steve Jobs as a ‘Tweaker’*, *Forbes*, November 15, 2011

Folding Function: Does the World Really Need Another Functional Object?

Does the world really need another functional object? How is our process different if we set out to design with a noun in mind vs. a verb, i.e., “I would like to design and fabricate a desk organizer” is very different than “I would like to re-imagine how I interact with the objects in my everyday student dormitory life.”

Vessels for holding and storing were invented thousands of years ago but that hasn’t stopped nearly every generation since from evolving storage from one design to another via an ever changing assortment of materials, tools, and technologies. The history of functional object design is filled with inventors and tweekers. This semester *4.021 How to Design* asks you to choose a path. Would you like to be an inventor or a tweaker? Initially we will study the histories of functional object inventors and tweekers to better understand the various processes used in the past to arrive at an invented or tweaked solution in the present. We will then use our investigations and acquired knowledge to forge our own path and evolve or invent the next generation of functional objects capable of reordering the activities of our everyday lives, improving our everyday lives or perhaps even changing the way we live.

Building upon the skills, techniques, and experiences you acquired working through and completing assignments 1 & 2, assignment 3 will ask you to design and fabricate function using a single sheet of metal of a given dimension, geometrically guided fabrication instructions, and kinetic folding as a technique to transform a plane into a volume with a particular function of your choosing.

Working at full scale with function offers students the opportunity to experience in a single assignment through sketches, physical models, digital models, full-scale mock-ups and completed prototypes, the traditional design sequence of schematic design, design development, presentation drawings, fabrication drawings, fabrication, use, and analysis.

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.

03.28.22 (m) Presentation: *Functional Object Design a History of Invention and Tweaking*
Read Malcolm Gladwell’s article “The Tweaker.”
Identify a design problem or opportunity in your dormitory room, apartment, everyday life that you feel might be an opportunity for tweaking or invention.
Prepare (min. of) 3 sketches and/or diagrams, for next class, describing your proposed tweaks and/or inventions.

03.30.22 (w) Laser Cutting Tutorial + Folding Logic
Refine your concepts – narrow down to 1 concept and draw it clearly (by hand/sketch) Concepts should be about:
1. The function of the proposed object in relation to its context/the design problem its trying to solve/improve
2. Fabrication process – i.e., how is it might be made from a single sheet of paper/metal folded in such a way as to have structural integrity, perform it’s given function, and be graceful.



Assignment 3: Folding Function (cont.)

Schedule: process & iteration (cont.)

- 04.04.22** (m) Draw your concept in Rhino and prepare your drawing for cutting on the laser. Using a piece of the supplied cardboard, make a test cut of your concept.
- 04.06.22** (w) Modify your concept and/or laser cut prototype based on the success (or failure) of your initial full-scale mock-up.
- 04.11.22** (m) Begin preparations for a mid-project presentation using the provided template including: Concept diagram, vector drawing of your 2d sheet & 3d folded functional volume, precedents/concept/context and full scale physical models in cardboard
- 04.13.22** (w) Student presentations/mid-project review. Prepare a presentation using the provided template including: Concept diagram, vector drawing of your 2d sheet & 3d folded functional volume, precedents/concept/context and full scale physical models in cardboard
- 04.18.22** (m) No class Patriots Day
- 04.20.22** (w) Modify your concept, diagrams, sketches, Rhino drawing, and/or laser cut prototype based on the feedback you received during our mid-project review
- 04.25.22** (m) Metal Laser Cutter Tutorial
Desk Critiques
- 04.27.22** (w) Inkjet Vinyl Printer Cutter Tutorial
Desk Critiques & final testing of Rhino file for metal laser cutter using cardboard for mock-up/test
- 05.03.22** (m) Spray Painting Tutorial
Desk Critiques & prepare final preparations of Rhino file for metal laser cutter
- 05.04.22** (w) Metal Laser Cutter
- 05.09.22** (m) Begin/continue preparations for a final-project presentation using the provided template including: Concept diagram, vector drawing of your 2d sheet & 3d folded functional volume, precedents/concept/context and full scale physical models in metal
- TBD** (?) Final project presentation. Prepare a presentation using the provided template including: Concept diagram, vector drawing of your light modulator, precedent studies, context, full-scale physical prototype, photographs, and time-lapse video(s).



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 three excused absences for the semester. An excused absence is defined as one that was discussed with and approved by the professor at least 24 hours prior to the date of 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 below.

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.

Completion requirements

Completion of each of the exercises, 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.

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. All spraying of fixative, spray paint or any other substance should be done inside the shop spray booth.



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.

