

Drawing as Thinking for 2.007

Linking Eye and Hand for Better Design

Drawing for 2.007 Design and Manufacturing I
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Pappalardo Lab Hours for Drawing instruction: 4PM: M and W, 1PM: T and R

Introduction

Words are good descriptors. And, CAD programs represent a revolutionary drafting tool. But, drawing and sketching—pencil to paper—is still a first means of developing, problem solving your ideas and designs. The Drawing as Thinking portion of 2.007 is designed to teach freehand drawing skills while fostering the intuition and creativity such skills make available. Students with little or no artistic training will get the chance to effectively output whatever they're able to imagine. A wide range of seeing and drawing exercises will parallel the 2.007 design process to help students move beyond their inhibitions and toward innovative, functional designs.

Philosophy and Objectives (why should I learn how to draw?)

“Until the 1960s, a student in an American engineering school was expected by his or her teachers to use his or her mind’s eye to examine things that engineers had designed—to look at them, listen to them, to walk around them, and thus to develop an intuitive “feel” for the way the material world works (and sometimes doesn’t work)... By the 1980s, engineering curricula had shifted to analytical approaches, so that the visual and other sensual knowledge of the world seemed much less relevant... As faculties dropped drawing and shop practice from their curricula and deemed plant visits unnecessary... working knowledge of the material world disappeared from faculty agendas and therefore from student agendas, and the nonverbal, tacit, intuitive understanding essential to engineering design atrophied.”

--Eugene Ferguson

Primary to the design process is the sketching or drawing of one's ideas. Immediate and without many constraints, drawing/sketching--pencil to paper—is where your inner world of ideas meets an outer world of functionality; a first, creative link between the imagination and the realization of an idea.

“We should talk less and draw more. I personally would like to renounce speech altogether and, like organic nature, communicate everything I have to say in sketches.”

--Johann Wolfgang von Goethe

The drawing portion of 2.007 is intended to augment your design process, as well as provide valuable skills for your future as an engineer/designer. Our work will be to move beyond inhibitions (a physical exercise, drawing is largely a matter of practice and not innate skill), to open possibilities and get you comfortable mark-making as you generate and notate the flow of exciting ideas in raw form.

“What is drawing? How does one learn it? It is working through an invisible iron wall that seems to stand between what one feels and what one can do.”

--Vincent Van Gogh

Drawing, sketching is a deceptively passé skill/process. Before today's CAD programs and advanced prototyping techniques, mechanical drawing, conveying all manner of specifications, was a key component to the 270 design process. Today, mechanical drawing is still very important, but since we have the tools to very precisely model our designs, freehand drawing takes on a different purpose.

This different purpose concerns access to your imagination, and the skills to output that imagination on paper, directly and fluently. The Drawing as Thinking portion of 2.007 is about going deep, tapping the imagination, dreaming up ideas and thinking via the drawing process, as you turn-over ideas in your head and on paper simultaneously. It's about the freedom and quickness to approach problems from new and interesting angles. And, it's about gaining a feel for the medium—both the medium of drawing and the materials, principles of engineering.

“Design is what you do when you don't [yet] know what you are doing, i.e., real design is done during the unstructured, informal, noodling around that occurs before the structured and formal 'design' methods are employed.”

--George Stiny

Seeing--both looking out into the world, and “seeing” in your mind’s eye--is primary to the drawing process. Feeling what you see, or, having a “sense” for good design, as well as the materials and engineering principles you’re working with, is its own form of creative problem-solving. An intuitive sense for the medium is a necessity for drawing. And, such intuition is nurtured by the drawing process. We will practice both.

“Drawing is putting a line (a)round an idea.”

--Henri Matisse

Problem solving in engineering and design is a physical process. Whether or not you’re aware of the fact, you’re very much involved in a process of sensing, feeling, intuiting a design solution in a “muscular” way. This is to say, engineering insight is not just a visual or optical process, but, involves your whole-body history of physically experiencing weight, rigidity/flexibility, torque, acceleration, pressure, forces, etc. Our purpose is to better understand and cultivate this process, and practice it by drawing, which is its own physical exercise. Such skills will complement the more quantitative and precise aspects of the design process.

“One eye sees, the other feels.”

--Paul Klee

To start, we will practice creating mental imagery, turning it over in our mind’s eye and getting it down on paper with a freedom that comes with repetition. We will explore different drawing tools which offer different modalities as the qualities of one’s mark-making such a weight, motion, tonality, organization/composition offer different types of information and different levels of detail for different stages in the design process. You’ll have a chance to explore various media and various techniques. And, with a serious amount of practice, visualizing and drawing your ideas can emerge as one of the most important tools in your engineering toolkit.

“I shut my eyes in order to see”.

--Paul Gauguin

Drawing Labs, will accompany Tuesday and Thursday lectures, and will work directly from the topics discussed. Our effort will be to build proficiency at translating the physics and engineering principles learned into our own visual language—something that will get easier as we work through in-class exercises.

Such exercises are intended stretch your comfort level and test your skills as a group. Individual consultation will be available daily (Monday-Thursday) in the Pappalardo Lab, as noted.

"What you need to invent is an imagination and a pile of junk."
--Thomas Edison

20 Drawing Exercises

Below is a collection of drawing exercises we will mix and match to fit lecture topics

1) Introduction to Drawing as Thinking

Process, Materials, and Getting a Feel for the Medium

We will look at the role of drawing in context (2.007), address different skill levels, go over materials and techniques, and get going on the business of honing our skills.

2) Seeing, Visualizing, and Drawing

How the Mind's Eye and Mark-Making are Inextricably Linked

We'll practice the art of seeing objects, shapes and form, as well as seeing within the mind's eye. We'll then work to turn seeing into drawing on paper via an increasingly skilled hand.

3) Loosening Up

Materials and Techniques to Free-Up the Process

Many of us have some experience drawing diagrams and other small-scale figures. However, different tools and techniques (e.g., graphite and paint-sticks, large-scale and blind contour drawing) offer ways to break old habits, free up talents and expand our practice.

4) Burning the Results

Daring to Fail

Drawing is always an ongoing process. Especially as we work to refine our skills, it's important that our drawings don't become too precious. In other words, one has to be willing to fail, to become unattached to the results, that we can move freely through drawing practice and process. In this simple and unannounced exercise, we will make ceremonial sacrifices.

5) Turning off the Eyes

Seeing With the Hand

Drawing blindfolded is an excellent way to soften your inhibitions and get into a "sculptural" or three-dimensional feel for drawn forms. We will do a series of blind drawing exercises to temper our inner critics and let the hand do what it knows how to do.

6) Drawing Upside-Down

Gymnastics for the Imagination-to-Hand Connection

Turning our objects of study, or drawings themselves, upside-down allows for a fresh perspective and helps us to see shapes and forms more honestly or without preconceived notions.

- 7) Drawing with Both Hands Simultaneously**
Mirror Image Drawing to Open Your Mind and Process
Our hands, arms move with mirror symmetry (think, a symphony conductor), reflecting the bilateral symmetry of the body. In this exercise we will move beyond finger and hand motions to incorporate a more the intelligence of the larger “body system” as it relates to the physicality of drawing.
- 8) Livin’ Large**
Pushing Scale for to Break Old Habits
It’s an entirely different story when a drawing surface is large enough that you have to walk to draw a line. In this exercise we will push scale, large and small, to break open established drawing patterns (e.g., nervous, “tight” or “sketchy” lines) which often have much more to do with habits or inhibitions than a lack of artistic skill.
- 9) Drawing at a Distance**
Stepping Back to Zero-In
Matisse, in his later years, would paint from half way across his studio. To appreciate the genius of his bold forms is to understand the profundity of why he was “stepping back” to “see a greater truth”. In this exercise we will explore body/drawing extensions (e.g., a one-meter long drawing tool) to challenge our neuromuscular control and refocus how we see and steer a drawing in process.
- 10) Point, Line and Plane**
Two-Dimensional Mark-Making; Line and Shape
A mark, a line on the two-dimensional surface of a drawing surface has a world of content. Before we move into rendering three-dimensional forms, with tonality and ground, we will work to better handle the art and power of making marks and lines.
- 11) Negative Space**
The Importance of the Spaces In-Between (Or, What Silence is to Music)
Draw empty space--or what isn’t there--and you’re left with an outline of the object or form you’re studying. Understanding how to see and handle negative space in drawing, is a key to filling out your drawing abilities. In this exercise we will draw the other side, or, what isn’t there, to exercise our seeing and better understand spatial relationships.
- 12) Going 3-D**
Imagining and Rendering In Three-Dimensions
Being able to imagine a square is not so difficult. Being able to turn the square into a cube is a little more challenging. But, can you then roll and turn, walk around, that cube in your mind’s eye? To effectively draw in three-dimensions, you have to be able to visualize in three-dimensions.

Drawing well requires and nurtures “Omnimax” visualization skills. Suffice it to say, we will practice this.

13) Addition and Subtraction

The Basic Arithmetic Behind the Drawing Equation

If you think about it, drawing is a subtractive process; when we make a mark on a piece of paper we greatly subdue the light reflected from the paper with our line. It is this contrast that gives readability, depth and content to our mark-making. In this exercise we will reverse the process and work in terms of erasure to exercise how we perceive and work with this important principle.

14) Figure Ground

Lending Drawn Forms Context

Objects don't typically float in space. While it is valid, even desirable, to render a design in this way, it is important to understand what are called “figure-ground” relationships in drawing. Such relationships lend context to what we are drawing, and help to give body and weight to an object or form. In this exercise we will explore such relationships and move toward understanding and working with tonality.

15) Tonality

The Role of Light

Drawing is a process of modulating the light reflected from a drawing surface with the “dark” line of your pencil or pen. Tonality involves shading and shadow, and pushes the depth—the “lights” and “darks”—of a drawn form. In this exercise we will explore the role of “chiaroscuro” or tonality in drawing to add necessary depth and volume to our work.

16) Putting Things into Motion

How to Draw Energy, Forces, Acceleration, Pressure, Torque, Etc

There are no set rules here. However, if we take our lead from a history drawing, there are inventive and expressive ways to communicate a dimension of time, motion or action in our drawings. In this exercise we will lend “dynamism” to our drawings as we grapple with an elusive fourth-dimension.

17) Part and Whole

Not Getting Lost in the Details

Even when you're drawing a collection of parts--the parts of a single object, or, objects that make up a larger group or system—it is the “whole”, the larger composition that needs to be held in mind if the drawing is to emerge successfully. In this exercise we will practice roughing out the entire composition and then spiral in to lend detail to the final drawing.

18) Getting the Body Involved

How and Why Drawing is an Athletic Event

We tend to think of drawing as an exercise that involves a couple of finger tips, perhaps, the wrist. However, not only is the forearm, upper-arm and shoulder involved, but, the torso and entire body, if one is guiding a drawing tool an appropriate abandon. In this exercise we will do something of a drawing “workout” as we stand to the challenge and mark-make like we would climb a tree.

19) Idea Mapping

How Combined Drawing Skills Can Help You Explore an Idea

Mind-mapping is about visually logging your idea and process. The adage, “a picture is worth a thousand words” speaks the value of such an approach. In this case we will draw many pictures and link them in terms of sequence, relationship and category to better understand what our intuition is saying to the problem solving and design process.

20) Drawing Mechanisms/Machines

Putting It Together and Firing It Up

Drawing an entire mechanism may seem daunting at first. But, not if you consider that the parts form a whole. One can draw a tree much as it grows, starting from the ground, the trunk, and moving upward to treat the branches and leaves. But, a better process is to hold the entire system in mind while we see and render. In this exercise we will move past individual objects to practice drawing entire functioning systems or mechanisms and machines.

References

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Notebooks of the Mind: Explorations of Thinking

Vera John-Steiner, Oxford University Press, New York, 1997

Thinking Like Einstein

Thomas G. West, Prometheus Books, New York, 2004