

# ENGINEERING SKETCHING, GESTURE DRAWING AND 'HOW-TO' VIDEOS TO IMPROVE VISUALIZATION

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## **ABSTRACT**

Engineering drawing, or engineering sketching, as it is known in our course, functions as a tool for creativity, design, and analysis rather than strictly for technical representation. This component is taught by an artist-in-residence and is worth one-third of the course grade. The technical drawing components (orthographic, isometric, etc.) are developed as supporting elements to the evolution of ideas rather than as an end in themselves. Students are taught how to convey ideas quickly by sketching on paper quickly and correctly. As a design tool, engineering sketching is being used to visualize engineering concepts such as movement, forces, and stresses. During the latter part of the course students are asked to use their newfound drawing abilities to explore projects ranging from biomimetics, inclusive design, design for development to the history of design, and design styles. The students are shown how to construct these drawings during 'live' drawing sessions. The students are taken through the steps required for drawing complex objects (ranging from hand-tools to an IC engine). The start of each drawing lecture simulates gesture drawing commonly seen in Fine Arts: students are shown slides of objects for roughly one minute and are asked to translate these objects into isometric sketches. Also, a series of videos are being developed to reach all 750 first year students – making drawing 'help' available in the middle of the night when most students are finishing their work. The videos were made available on our website this past February and will in future be formatted to be available for portable players. This paper describes the sketching process; the changes that have been made over the previous five years and the new components introduced this year. It will also include examples of student work.

*Keywords: Engineering sketching, visualization, gesture drawing, drawing videos*

## 1 INTRODUCTION

Training in engineering drawing has been traditionally focused on learning technical drawing or drafting skills in isolation from analytical and design skills. Since the introduction of computer assisted drawing in the 1970's, the drawing and drafting abilities of engineering students have declined in the same way that their design skills have declined [1]. Engineering 251/253 (a first year design and communication course), as taught at The Schulich School of Engineering at The University of Calgary, has developed a visual literacy component that combines pedagogy and methods from

Engineering, Environmental Design, and Fine Art. The underlying approach is to involve the students in the performance of drawing as a means for developing the mind/hand/eye coordination necessary for achieving a high level of visual literacy [Fig. 1].

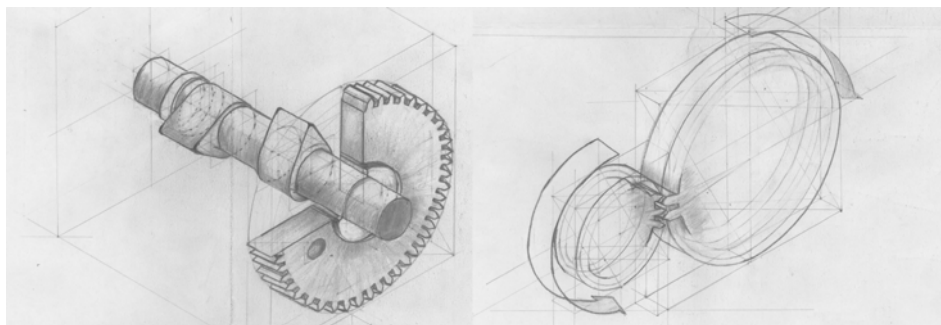


Figure 1 Student drawing: Isometric camshaft with gear ratio

This paper describes the sketching process; why we still draw by hand; the changes that have been made over the past five years and the new components introduced this year. Gesture drawing and drawing videos are two of these new components.

## 2 ENGINEERING SKETCHING

### 2.1 Primi pensieri (first thoughts): “I can’t draw, I don’t want to, I don’t have to – sketching, so what![2]”

Most students entering their first year in the Engineering faculty do not expect to be drawing with pencil and paper. They have convinced themselves that they do not draw, cannot draw, and will not draw in their future career. Instead, they expect to be given a software program that will do everything for them: idea generation, visualization, and construction.

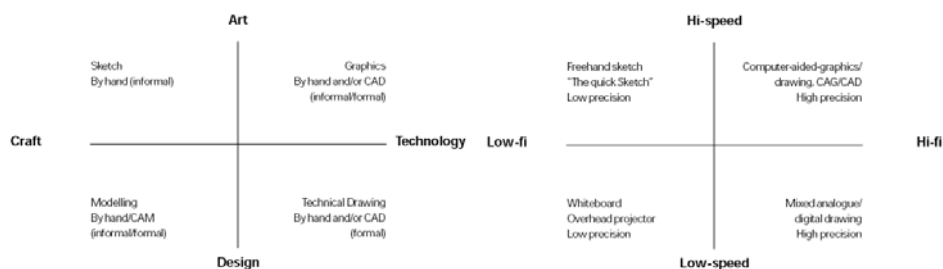


Figure 2 Placing sketching and the speed of sketching

The danger of starting with a software program in first year design engineering is that it becomes a part of ‘the jumping to solutions’ culture. Novice designers need to explore the design problem/need thoroughly before jumping to a ‘brilliant’ solution. The use of software may in fact encourage the students to “go straight into their finished work without going through the critical and creative thought period[3].” The emphasis of the drawing component is on visualization, which will enable the students to use 3-D modelling software with more efficiency. If a student can ‘see’ the object in advance, the software can be exploited to a much greater extend; the student will bring his or her

own creativity, not being limited to the creativity of the programmer. As Ferguson notes in *Engineering and the Mind's Eye*: “if designers use commercial computer programs... they turn over all the small and tiny decisions to the programmer, who is more likely to be an ‘engineering scientist’ than an experienced designer”[3].

Our students work on four-person design teams for eight months, during which they change design partners five or six times. They spend the majority of their time designing solutions to real world problems (Engineers without Borders, Inclusive Design, Solar Decathlon, etc.). Sketching is seen as a form of visual communication on a team and the students are expected to sketch their ideas during team meetings. Figure 2 places the sketching activity in an Art/Craft quadrant as an informal activity. Students in our course move clockwise through three stages of this figure: sketch, graphics and technical drawing (all by hand). They perceive drawing by hand mostly as an artistic and craft-type activity – the current digital culture puts sketching in a lo-fi, tenuous, and slightly old-fashioned position.

By the end of each year however the vast majority of students are able to produce drawings of ‘good’ to ‘very good’ quality. Students show improved visualization and sketching skills, and an appreciation for the role of drawing in the design process.

## 2.2 How we start

We begin by introducing the students to basic concepts and historical facts in lecture. They are shown the link between Chinese perspective and oblique drawing; how the introduction of cavalier oblique by Jesuits returned from China seemed ideal for accurate drawings of fortifications in the 17th century; how William Farish put the final touches on the method of isometric projection for ever-expanding assembly shops of the Industrial Revolution.

All major projections are shown in their first drawing lecture and quick sketches of each projection are demonstrated (The students are required to have drawn replicas in their logbooks by the end of class). Students are also shown the two major groupings of paraline- and perspective-based projections: systems representing what we know and what we see. By the end of the lecture they will be familiar with the relationship between orthographic and isometric, various types of oblique projection, and the ability to take true measurements from some of these types of drawings. The students are shown the separate, artistic development in the Italian Renaissance of one-, two- and three-point perspective; a system designed to replicate what we see. These concepts are then translated into drawings during the subsequent lectures. Throughout this two-semester course, 750 students are expected to complete a total of 11 drawings and projects individually, and one project within a group of four. The drawing assignments are introduced every two weeks, and students have one week to work on a good copy based on concepts that were drawn and discussed in class. By having all 750 students drawing along with the instructor, they quickly discover that they might, after all, be able to draw. The instructor guides the students through the basic construction of a particular drawing (be it oblique, isometric, orthographic, or perspective) using a document camera.

The students are shown both reductive and additive methods of construction.

1. The reductive method starts with an outer envelope and removes volumes. Students construct basic drawings by looking for cross sections, basic shapes, and anchor points (to work with when it comes to the more free and fluid areas in the drawing).

2. The additive construction method is shown when the students have to produce more complex accumulations of shapes: exploded diagrams or multiple part drawings.

### 3 GESTURE DRAWING WITH 750 STUDENTS

#### 3.1 Gesture drawing in art

If drawing is ‘learning by doing’ and ‘learning by making’, gesture drawing has been described as ‘learning by being’. When creating a gesture drawing, according to Kimon Nicolaides in *The Natural Way to Draw*, ‘you should draw, not what the thing looks like, but what it is doing. You need to “sense” the thing that you are drawing. Is it fluid and soft, or spiky and hard? Is it coiled like a spring, or off-centre and asymmetric, or is it solid and balanced [4]?’ The ‘sense of the thing’ or form of an animate or inanimate object is a consequence of being (a)symmetric and/or (un)balanced, basically a consequence of force [Fig. 3]. We can perceive these forces when we see, for example, a dancer jump across a stage or a bridge across a gorge. One might use the word ‘leap’ to describe the manner in which the dancer jumps and the manner in which the bridge spans from one side to the other. Gesture drawing gives form to such an insight. It relies on ‘empathetic sensation: a capacity to share the physical sensation of another person or of an inanimate thing [5].’

<b>SELECT</b> Elements of drawing:	<b>COMBINE</b> Combinations of elements produce:	<b>COMMUNICATE</b> Combinations stand for physical and emotional experiences of the world:
point line shape (2D) texture tone colour plane	contrast proportion scale pattern rhythm	spatial depth force direction movement volume, mass, weight balance symmetry structure form (3D) surface properties observer's position(s) /mood, attitude

Figure 3 Drawing to perceive and communicate engineering concepts [6]

#### 3.2 Gesture drawing in a large engineering design class

One of the changes made this year is the introduction of a ten-minute gesture drawing session. This session is similar to model gesture drawing classes in the fine arts. In Fine Arts, to get students to ‘warm up’ and be less self-conscious about their mark making, a model will do a series of short poses for 30 to 60 minutes. Students attempt to get the rough shape and feel of the model on paper within this time period.

The majority of students in the engineering school are sequential learners who are quite precise and thorough. While these are necessary qualities for an engineer, they tend to hamper students’ ability to ‘go with the flow’ and to be less self-conscious in a drawing setting. The gesture drawing sessions in our course are slide shows where basic and more complex shapes are shown in rapid succession [Fig. 4].

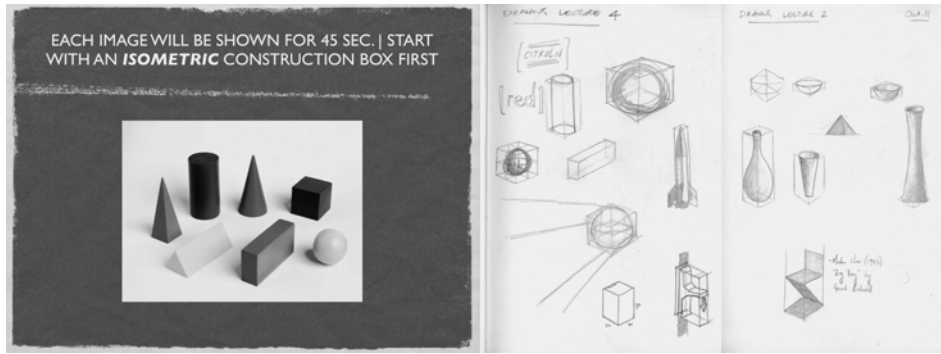


Figure 4 Example gesture drawing slide and student 45 second gesture drawings

The computer, not the instructor, ‘times’ the slides (which to the students is somehow more acceptable). Students have to translate perspective photographs into isometric drawings [Fig. 4]. The translation of the perspective images is encouraged at this stage. It allows students who are not visually literate to ‘sequentially’ go through the building of an object. The translation phase allows students to place the objects inside a 3-dimensional grid that centres the objects and allows for ‘logical’ construction. Students can ask themselves: ‘Where do the edges of the object meet the construction box? Is the centre of the object in the centre of the envelope? Are the parallel edges of the object parallel in the sketch?’ The short time periods during which these images are shown, forces the students to think and draw rather than decide whether they like their drawing or not. The most important aspect of this exercise is speed of drawing and being less self-consciousness.

#### 4 ON-LINE DRAWING VIDEOS

With the help of our *Teaching and Learning Centre* and our *Students’ Union Teaching Innovation Fund* a set of videos is being developed to reach all 750 students [Fig. 4]. Many students need to see the drawing process more than once. They are introduced to drawing assignments in lecture where the instructor draws a particular projection or problem with the students. These practice sessions usually last 10 to 15 minutes.

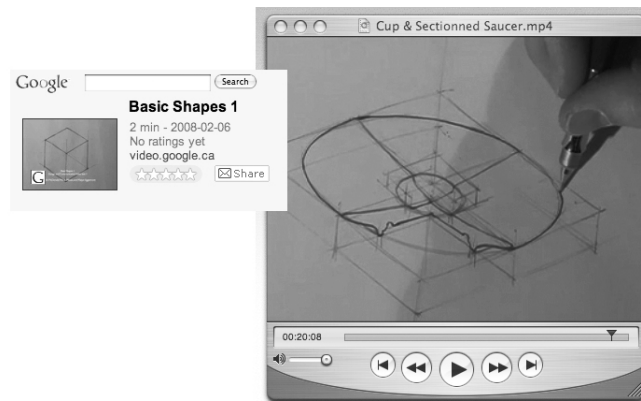


Figure 5 Student access to drawing video test and drawing video detail

The drawing videos (previously on Google video, now on our class website) allow students to access a similar session at any time. Many students would ask for extra help during the instructor office hours, but many were either too busy or too intimidated ('I can't draw anyways'). The videos are a way to reach all students at any time of the day when they need drawing help. Possibly these videos could speed up the complexity of the drawing assignments in future as access means drawing help and opportunities for guided practice.

## 5 CONCLUSION

Each year during our two-semester course, roughly 7,000 drawings are produced. The drawing component of Engg 251/253 has been called the renaissance component of the course. Our goal is to involve the students in the performance of drawing through demonstrations, gesture drawings, and accessing drawing videos as a means for developing the mind/hand/eye coordination necessary for achieving a high level of visual literacy. The students are taught first and foremost to 'see' again. As Teilhard De Chardin said: 'The whole of life lies in the verb "seeing".'

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