AC 2009-290: THIS IS NOT TIMES NEW ROMAN: ENGINEERING DESIGN LESSONS VIA TYPEFACE DESIGN

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This is not Times New Roman:
Engineering design lessons via typeface design

Abstract

Our first year engineering communications and design course has a visualization component that teaches students 2D and 3D engineering sketching. This year as part of the 2D sketching component students were asked to analyze different fonts (Fig. 1) and to design their own font using an online font design program called FontStruct (fontstruct.fontshop.com/). Students will be able to download their newly designed font to their computers and use it in their word processing software.

There are parallels between typeface design and engineering design:

- Building up internally consistent complex mechanisms/artifacts from a basic element
- Off-the-shelf parts or techniques
- Basic functionality requirements
- The effects of subtlety on the overall effectiveness of the design

This paper discusses what engineering design can learn from typeface design, how lessons can be applied and what effects we can expect to see. Examples of student work will be provided in the final paper.

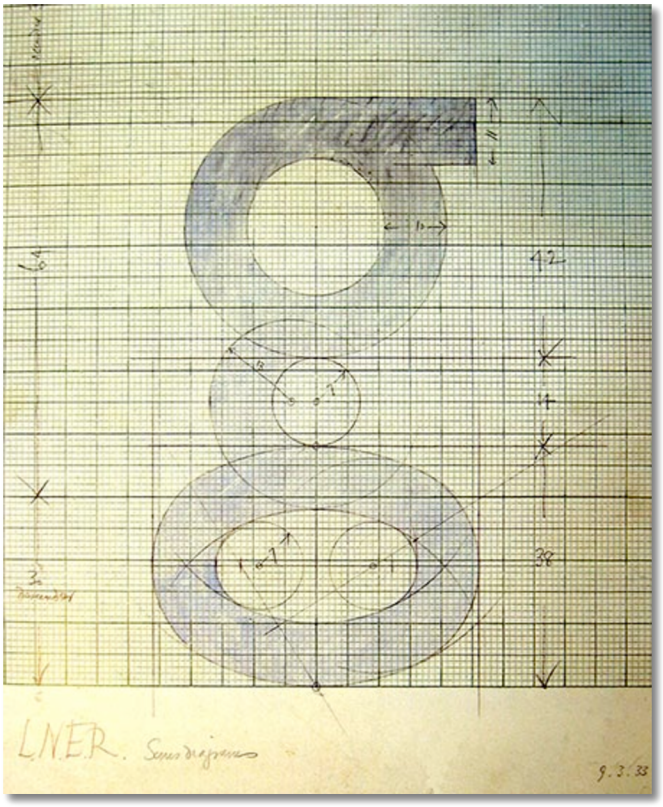

Figure 1: Geometric construction for the Gill Sans font designed by Eric Gill in 1933[1]

Introduction

Typeface design is a new component in our course and a variation on the theme of the engineering lettering components students used to learn. Many aspects of typeface design can be found in the basics of lettering. C. Leslie Martin's book *Design Graphics* discusses the following characteristics of good lettering and lettering procedure:

- Attractive lettering: "It is essential that each letter be beautiful… Each letter must be coordinated with all the other letters of the alphabet."
- Proportions and correct spacing of letters: "…place the letters to produce the most pleasing optical effect…space the letters so as to make them appear to be the same average distance apart."

- Serifs: "When serifs are used, they should be used throughout the alphabet on all letters wherever they can be used appropriately."
- The shapes of letter: "…it is usually best to keep the same general characteristics of letters in so far as possible throughout the entire alphabet…This system gives harmony of form and proportions throughout all the lettering."[2]

Figure 2: Example of engineering lettering.

We started the typeface design project by having students look at standard fonts (Helvetica, Arial, Verdana, Times New Roman, Georgia, etc.). Students were asked to look for patterns in each font, design characteristics and differences between sets of fonts (Figs. 3 and 4).

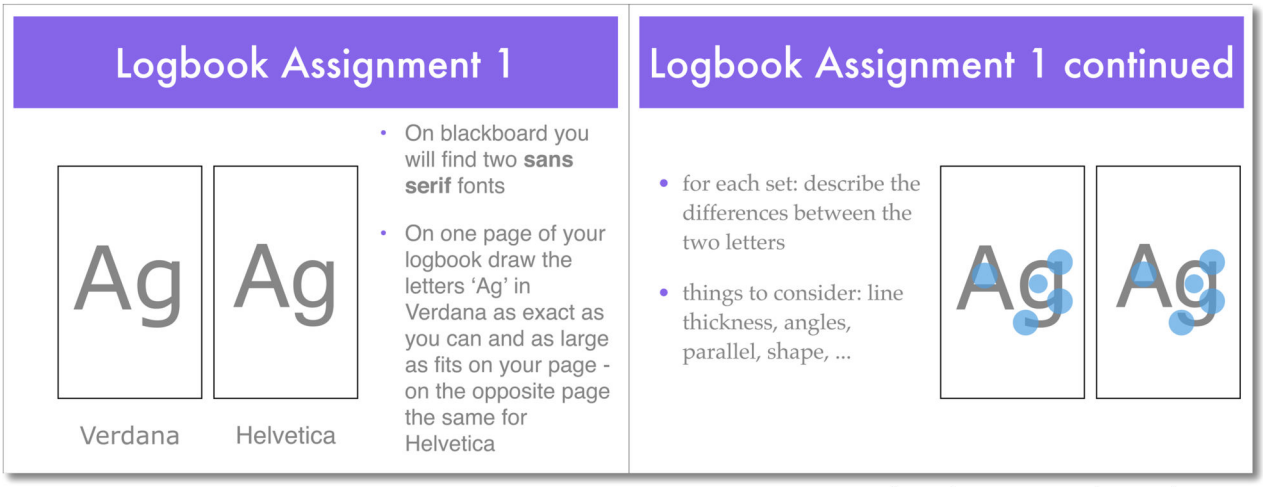

Figure 3: Font comparison assignment.

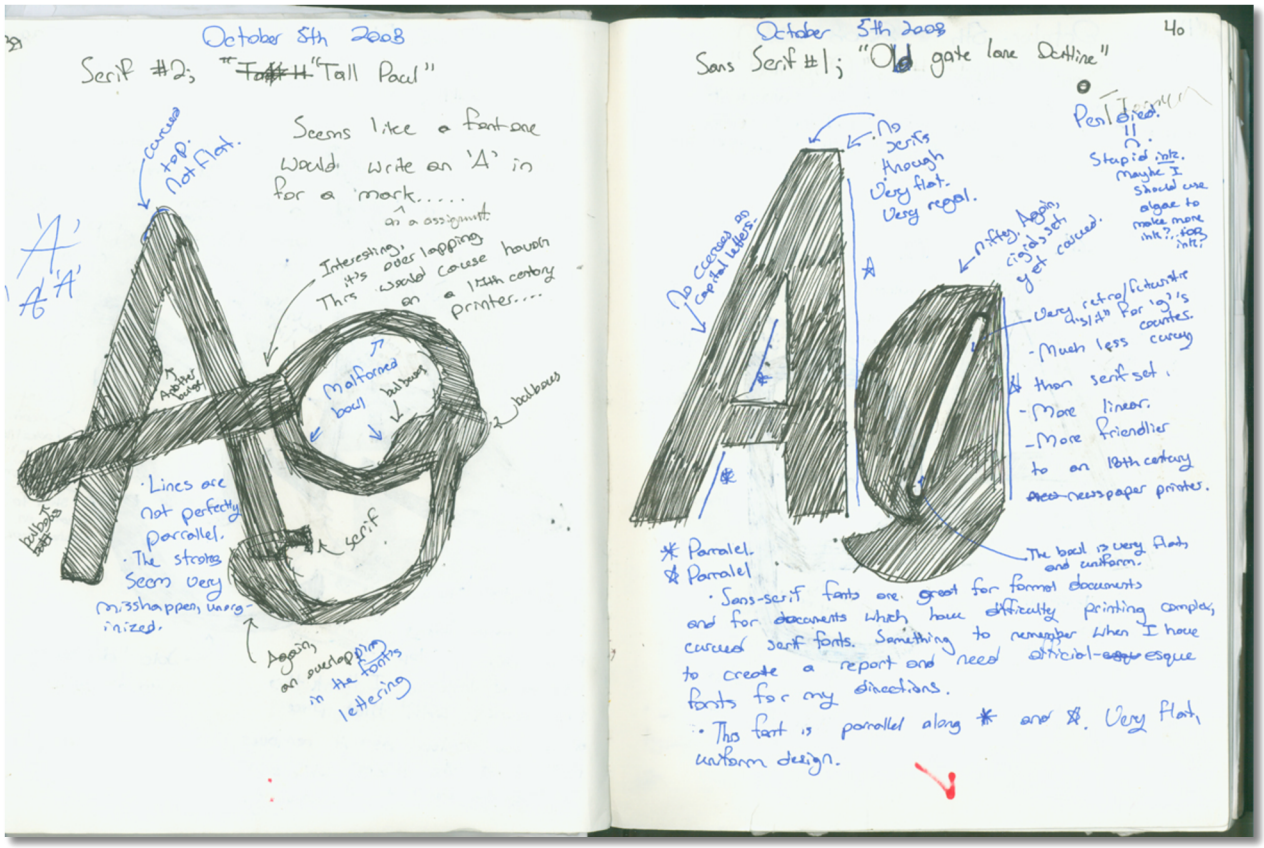

Figure 4: Student logbook entry for font assignment.

2D Design

Cohesive two-dimensional forms (possessing the dimensions of height and width) can be achieved by organizing a number of visual elements. These elements are rhythm, repetition, variety, balance, proportion, dominance, movement and economy. These elements result in unity and this unity is commonly known as the composition or the design. It is up to the designer to create the right balance of these elements and in the case of font design all elements are important[3]. Figure 5 shows the font Futura, designed in 1927, which is based on geometric shapes and followed the design style of the Bauhaus movement. Futura was the font used on the commemorative plaque left on Earth's moon in July 1969 (Fig. 6).[4]

Figure 5: Design of the font Futura

Figure 6: Futura on the moon.

Font Design

Font designs tend to be categorized by the historical period they are from (or reviving). There are many ways of defining the categories, but most follow the same general trend of eight categories as listed by Robert Bringhurst [5]:

1. Renaissance (15th and 16th centuries): saw the introduction of typefaces that (largely) attempted to replicate scribal lettering that they replaced in the first printed books. Many of these first typefaces are still held up by many designers as the optimum in readability and elegance (Fig. 7).

Figure 7: Bembo

2. Baroque (17th century): still in the scribal tradition (i.e., pen-based shapes), but with the introduction of geometric features such as tear-dropped terminals difficult to make with a pen (Fig. 8).

Figure 8: Caslon

3. Neoclassical (18th century): moving away from the scribal tradition, with the introduction of many rationalist geometric details Fig. 9).

Figure 9: Romain

4. Romantic: high contrast between strokes within the letterforms, geometric construction throughout, but referring to historical proportions and layouts (Fig. 10).

Figure 10: Walbaum

5. Realist (19th and early 20th centuries): scribal traditions are essentially absent. The emphasis is on geometry and machine-like precision (Fig. 11).

Figure 11: Akzidenz Grotesk

6. Geometric modernist (20th century): pure geometric design, but with much effort in adding subtle detailing to increase readability (Fig. 12).

Figure 12: Renner / Futura

7. Neohumanist (20th century): a modernist re-interpretation of the Renaissance types (Fig. 13).

Figure 13: Palatino

8. Postmodernist (late 20th and early 21st centuries): often parodies of historical models, or pastiches of styles and the influences of the current technologies (Figs 14-16).

Figure 14: Aspect

Figure 15: Scala Sans Italic

Figure 16: Bree

Current trends in Font Design

The current trend in type design is a postmodern mixing of the geometric modernist with the humanist scribal tradition. Modernist sans serifs such as Helvetica (realist) and Futura (geometric) have been "humanized" to produce (postmodern) humanist sans serifs such as Scala Sans, Bree, and Aspect. Note that, while the last three typefaces are definitely geometric, the shapes of the glyphs reference the movements that a scribe would have made as he moved the pen across the page. Recent advances in font formats, especially the Unicode-based "opentype", have largely enabled typefaces to a certain amount of intrinsic adaptability – rule-sets within the font data file itself allow glyphs (or letters in the typeface) to change in relation to the surrounding glyphs. This allows the typeface to simulate the decision-making process of the scribal tradition – for example, figure 17 shows the various automatic adjustments made to a phrase (note the differences between various glyphs of *i* [4 versions], *f* [2 versions], *l* [3 versions], *t* [3 versions], *e* [2 versions], and *s* [2 versions]). While the increase in readability is questionable, the imitation of hand-written text is reasonably good.

Figure 17: Cezanne Pro typeface

What can Engineering learn from Font Design (+ *vice versa*)?

Both engineering design and type design are rooted in draftsmanship and both emphasize current technologies. There are other parallels:

Engineering design		*Type Design*
Components		Glyphs
Assemblies	*versus*	Typefaces
Systems		Books / libraries
Functionality		Readability
Rule-based design		Rule-based design

a. Things engineering can learn from type design

As with machine design, a complete, readable typeface is an "artifact" built up of many interconnecting subcomponents. While book typeface designers are aware of the current trends and what may sell well, readability is key:

1. Typeface designers approach their projects rooted in both the history and current trends of their industry.
2. In type design one usually starts with the concept as shown by a few glyphs of the alphabet (some start with *h a m b u r g e r s*) from these the other glyphs are filled in piece-wise based on decisions made while designing the existing glyphs. While each glyph requires new decisions, the general style has been already defined. This approach tends to reliably produce unified typefaces where no one glyph appears "out of place".
3. They make extensive use of grids (which, currently, are part of the typeface data formats themselves) and proportions, . . .
4. but understand that there is only a subtle difference between a successful typeface and one destined to failure.
5. Typefaces for books are designed with the universal reader in mind: readability is based on letter-shape, word-shape, and negative spaces. This requires . . .
6. constant testing for readability or overall impression.

b. Things type can learn from engineering

Engineering designers tend to approach problems methodically and with a singleness of purpose:

1. Engineers tend to design to available standards, ensuring safety, interchangeability, and predictable failure modes.
2. Engineers tend to thoroughness: every facet of the designed artifact is explored, tested, and redesigned until the optimum is found. Many generations of designed objects may be manufactured during this process.

It seems reasonable to assume that lessons could be transferred from one realm to the other. The experience with the font component of the course thus far indicates that engineering students, being as methodical as they are, could become quite adept at typeface design. Lessons learned from this exercise will hopefully translate into more consistent and stylistically more coherent engineering design.

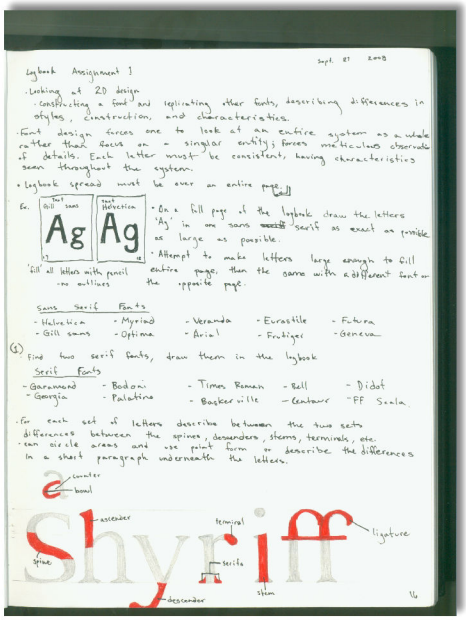

Figure 18: Font design elements in student logbook.

The Student Project

a. FontStruct

FontStruct is an online font generator. Students were asked to sign up with a name and password. Upon entering the site he or she can create a full font: upper case, lower case, numbers and punctuation. Once the entire font has been created students can save and download their 'font' folder. This folder can be inserted into a computer font library. Word processing

software can then recognize the font the student has created and Word documents can be typed using this designed font. Students were asked to start their font design with the word 'hamburger'. As seen in figure 5, 'hamburger' can subsequently generate the remainder of the font.

FontStruct when first opened shows a grid and a tool palette. Students can pick from a variety of

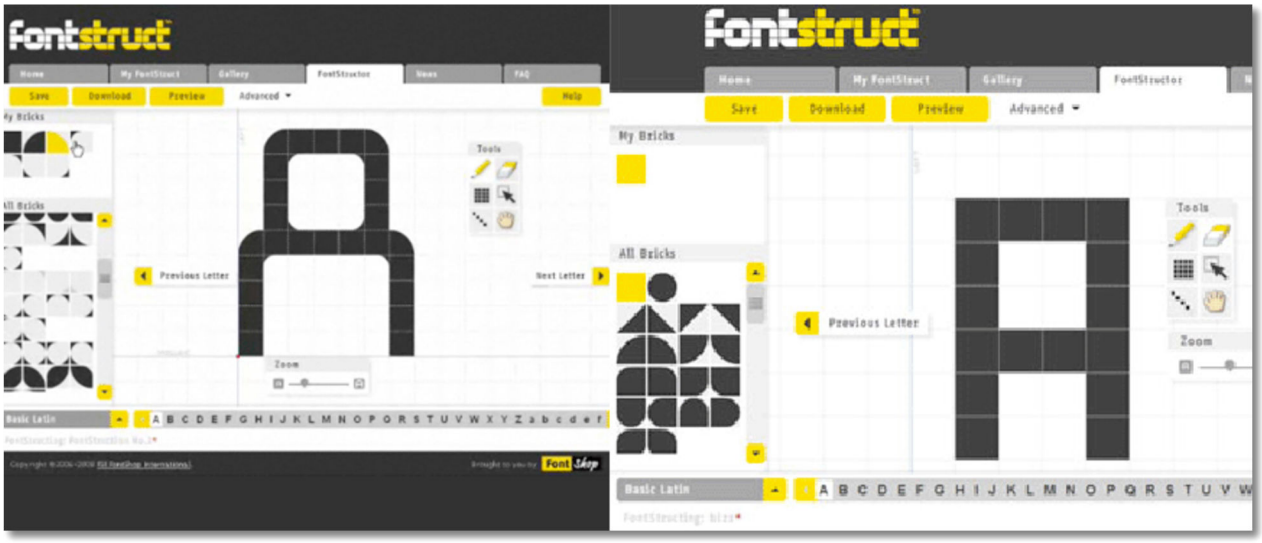

Figure 19: FontStruct grid and palette.

pixel shapes and start 'dragging and dropping' to create letters. Students were asked to pay attention to consistency within the design: serif or sans serif, thickness, line weights, angles, curves, ascenders and descenders (Fig. 18). Due to the multicultural nature of our classroom, the assignment also included the design of other alphabets. Figure 19 shows some very basic designs using the FontStruct design palettes. The toolbar at the bottom of the page shows which letter of the alphabet you are designing and whether you are designing upper or lower case. This bar also shows which alphabet you are designing - in this case 'basic Latin'. FontStruct also has a setting for the Arabic alphabet.

b. 740 Students using FontStruct

One of the challenges of a design and communications course for 740 students is its' sheer size. In the case of FontStruct the problems have been minor. A few students had difficulties in downloading their font folder and installing it in their computer font library. A screenshot of their font design solved this issue temporarily. All students should be able to type using their very own font by the end of the second semester.

c. Student Design Examples (Western and other alphabets) and Analysis

FontStruct at first sight seems like a crude design tool. The letters 'A' shown in figure 19 are very basic. However even when letters are

Figure 20: Student FontStruct design.

basic it is a challenge to create a consistent design style throughout the entire alphabet. The ultimate goal of this assignment is to get students to pay attention to details and to start to see design consistency in a system (Fig. 20).
Rhythm, repetition, variety, and proportion of design elements are important to learn and difficult to see. This assignment will help students to keep track of these elements by showing them a design system that is quite complex and subtle while keeping the design tool as simple as possible.
Figure 21 shows three student designs at the end of the first term. The examples reflect the multicultural nature of the students and the variety possible with the FontStruct program. For the second term they will have to finish their full font. Examples of these will be shown in the paper presentation.

Figure 21: Student FontStruct designs.

Conclusion

While the student FontStruct designs lacked the polish and techniques that we would expect from a trained typeface designer, there are signs that the design requirements are being understood and that the students were using some aspects of typeface design:

- That the aesthetic defined by the first glyphs was used to design each subsequent glyph in the typeface.
- That subtle differences have a large effect on the overall functionality of their typefaces.
- That, while they did not have enough knowledge to reference typeface design history, the students were able to reference their own history – for example, their familial backgrounds and life experiences.

Typeface design is a form of 2D design that has many parallels with the basics of engineering design. In the search for new ways to introduce first year engineering students to the many levels of design, typeface design was seen as the best vehicle to discuss design subtlety, repetition, rhythm, variety and harmony of form.

Bibliography

1. Die Hundert Besten Schriften aller Zeiten, <http://www.100besteschriften.de/9_Gill+Sans+[Update].html>, (current November, 2008).
2. Martin, C.L. (1969) *Design Graphics* (4 Ed.). The Macmillan Company, Toronto, pp. 26 – 31.
3. Ocvirk, O., Stinson, R., Wigg, P., Bone, R., Cayton, D. (1998) *Art Fundamentals: Theory and Practice* (9 Ed.). McGrawHill, New York.
4. Futura, <http://en.wikipedia.org/wiki/Futura_(typeface)>, (current Jan. 29, 2009).
5. Bringhurst, R. *The Elements of Typographic Style*. Hartley & Marks, Vancouver, 2001, pp 12-15.