

A Constructed Dürer Alphabet

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Abstract

The author used METAFONT to implement the design of a Roman uppercase alphabet by Albrecht Dürer. Although Dürer intended only a Roman alphabet, an attempt was made to create METAFONT programs to generate related fonts in a bold, sans serif, typewriter-like, slanted, and casual style. (The last of these is a style inspired by informal Roman letterforms designed by Sumner Stone and Neenie Billawala.)

Introduction

In the year 1525, the German artist Albrecht Dürer published a work on art techniques which included his specifications for an uppercase Roman alphabet. Dürer was one of a series of artists who, fascinated by the beauty of Roman capitals especially as they appeared on antique Roman monuments, sought to generate recipes for their construction. The recipes would only involve circular arcs and straight line segments. Knuth [1979] lists many of these efforts, and they have continued right till the present day (see Goines [1982]).

Published accounts of these alphabetic constructions reveal that, for the most part, these alphabets are dreary and lifeless. Dürer's alphabet is an exception, and there are two reasons for that.

1. Dürer was far superior an artist to any of these others, and
2. Dürer cheated. Many of his letters require curves other than circular arcs, and some other little flourishes and touches that add zest to the plates that accompanied his work are not specified at all in the printed description.

Nevertheless, I thought it would be an interesting project to use METAFONT to create the uppercase font for use by T_EX and other typesetting systems. The purpose of this presentation is to describe this project.

Dürer's Design Scheme

Dürer imagined each letter as inhabiting the inside of a square. Fractions of each side determine the linear dimensions of each letter. Let the length of each side be s . Then for example, all thick stems of letters (such as the verticals in I and H or the

thickest parts of the curves in S) are to be one-tenth of s , and all thin stems (such as the horizontal cross stroke in H) are to be one-third as broad as the thick stroke. All seriffed corners are constructed the same way, out of broad strokes and filled-in quarter-circles.

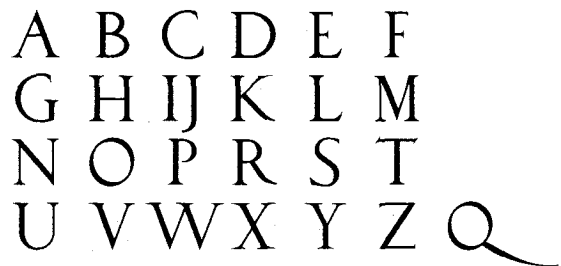


Figure 1: Dürer's uppercase Roman alphabet.

METAFONT proved adept at creating these letters, and at smoothing over those portions of the curve which are not strictly circular or straight. After all, one basic design goal of the METAFONT system is to create pleasing curves. However, when METAFONT was constrained to use circular arcs as much as possible, it took more time than usual to create each letter. Figure 1 displays this font.

It's helpful to examine the construction of one of the letters, such as the capital D, to see how Dürer's design scheme works (see Figure 2). Begin by laying out a square of side s . Next, mark two serifs at the upper and lower left corners. The serifs are framed by quarter-circles whose radius is $T = s/10$. Abutting the serifs, draw the vertical stem, whose thickness is also T .

Two short horizontal bars will connect the stem to the curved bowl. These bars are each of thickness $t = T/3$ and of length $(1/2 - 2/10)s$. The outermost outline of the curved lobe will be a

semi-circle whose radius is $s/2$. The thickest part of the lobe will be of thickness T , and will connect the upper and lower thin bars. This inner arc will have diameter $s - 2t$ and radius half that. The center for this circle will be at the point with coordinates $(1/2s - (T - t), s/2)$; the origin of this coordinate system is at the lower left corner of the bounding box. Round the lower inner corner by adding a serif-like quarter-circle, and, finally, fill in the entire outline. (In METAFONT, the construction technique is easier to implement than it is to describe.)

In the same way, Dürer presents descriptions for 22 other letters. (His account omits the J, U, and W.) Competent modern translations of Dürer's letter programs together with the illustrative plates are listed in the bibliography.

Generalizing the Design

Dürer's alphabet turns out to be surprisingly handsome, and great fun to implement with METAFONT. (See Figure 1 for specimen letters.) As I entered the terminal phases of this project, I was struck by one inadequacy. Although the alphabet, which I call Computer Dürer Roman (CDR), was a METAFONT font, it was not a true meta-font, because there were few parameters to vary. With properly designed meta-fonts, such as the Computer Modern or Pandora families, it's possible to twirl and twist software "knobs" to generate whole families of different (but compatible) fonts.

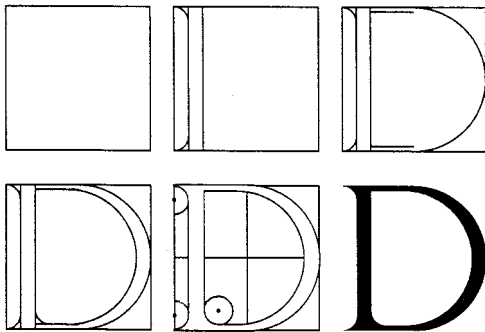


Figure 2: Dürer's construction of the letter D. In the penultimate frame, the D appears surrounded by the "scaffolding" as it appears in Dürer's plates.

In my opinion Dürer's design specifications themselves left little room for adjustment. In Figure 3, for example, we see Dürer's H together with several variants obtained by varying the radius of the serif quarter-circle, which is also the thickness of the vertical stems. There does not seem to be much room for parameterization in this design scheme, and varying the serif radius leads to designs

which aren't particularly pleasing. The bottle-neck to the metamorphosis to a true meta-font seems to be Dürer's construction of serifs, tied as they are to quarter-circles.

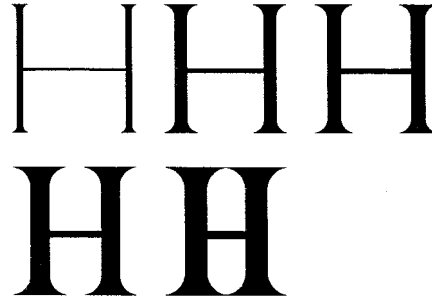


Figure 3: Varying the serif radius and stem thickness for the letter H. The second letter shows the H as Dürer wanted it. The third letter shows an H where the stem thickness is one-ninth the side, a fraction given by other letter designers contemporary with Dürer.

The key to successful parameterization of the Dürer font lies in rethinking the arcs that constitute the serifs and bowls. For example, it is possible to design a "circular," Dürer-like serif in the following way, motivated by techniques used both by Don Knuth and Neenie Billwala in their METAFONT constructions.

For this demonstration and discussion, imagine that we want a serif in the top left position of a stem, such as the upper serif of a D. Draw a pair of horizontal upper bars separated by a distance d ; this is the *slab*. In CDR, this value is $d = 0$, so the pair of slab strokes collapses into the single horizontal stroke we see in Dürer's serifs. Draw also the vertical bar that frames the serif; this is the *bracket*. Call the point where the slab and the bracket intersect the *corner point*.

Now construct an auxiliary point which lies midway between the endpoints of the slab and bracket. Hypothesize the existence of a *darkness* parameter whose meaning will shortly be explained. It will be a number between 0 and 1.

Create the curved serif path as one which starts at the end of the horizontal member, proceeds right, passes through a point which is *darkness* of the way between the auxiliary point and the corner point, and ends up travelling down at the end of the vertical member. Finally, connect the ends of the slab strokes by a smooth curve.

Now we have a serif whose exact appearance depends on four parameters:

1. d , the thickness of the slab

2. the length of the slab
3. the length of the bracket
4. the value of the *darkness* parameter

See Figure 4 for a diagram of a generalized Dürer serif.

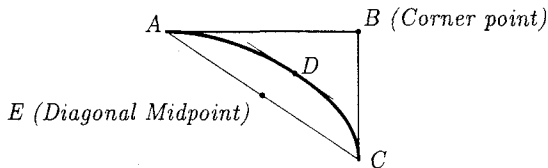


Figure 4: One way to draw the arc of a serif. The line at point *D* is parallel to the line connecting *A* and *C*. The heavy line traces the outline of the serif.

When $d = 0$, when the vertical and horizontal serif strokes are both equal to $s/10$, and when *darkness* = $1 - \sqrt{2}/2 \approx 0.29$, the serif that METAFONT draws is visually indistinguishable from a Dürer quarter-circle serif (although the equation of the curve that METAFONT draws is *not* that of a circle). Under this interpretation of a Dürer serif, it now becomes possible to hope that meta-descriptions of letters are possible that will reproduce Dürer's letters for one value of the parameters, and generate a series of related fonts for other values of the parameters (see Figure 5).

In order to exploit this insight, all the programs were redone in order to incorporate "the METAFONT way" in a better fashion. Figure 6 displays examples of non-Roman Computer Dürer fonts, specifically a boldface, slanted, sans serif, a monospaced typewriter-like font, and a *casual* font (together with CDR for purposes of comparison). The casual font was inspired by a family of fonts created by Sumner Stone of Adobe Systems and by some of the variant Pandora letterforms designed by Neenie Billawala [1989]. Stone's fonts are METAFONT-like in that a whole family of fonts was designed to be visually compatible; specimens will be found in recent issues of the Adobe Type Catalog, *Font & Function*. His Stone Informal fonts attempt to provide a font with an obvious connection to a formal Roman font, but which by looser joins of straight strokes, a more flowing sinuosity of the curves, and occasional omission of a serif communicates an informal, casual bearing.

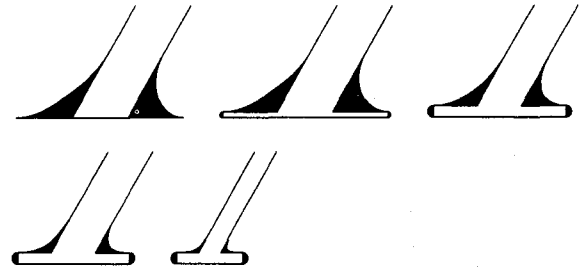


Figure 5: Examples of meta-serifs. The initial serif is that of Dürer.

Design Limitations

In my creation of a meta-design, I tried to restrict myself to the macros Knuth created for his Computer Modern types. There were several reasons for this.

1. I hoped to reduce the time for design by using these available tools. Creation of a set of robust METAFONT macros is far from trivial.
2. I felt I would learn more about type anatomy by trying to fit CDR into a CMR mold.
3. In any full-scale font design scheme, a close following of Knuth's macros may make it easy to adapt all the math fonts for the new family. Although that was not a concern here, I thought it best to cultivate this style.
4. With luck, I would be able to adapt existing members from the Computer Modern family for characters not designed by Dürer (see below).

I was not successful in this endeavor. METAFONT type design macros are not valid for any but a single family of type fonts. However, I was able to adapt pre-existing CM macros for many of the tasks I needed.

A More Useful Font?

A major disappointment in this project arose because of the limited uses of this font. Not only are there no lowercase letters, no punctuation marks, and no numerals (Dürer created no designs for them), but the uppercase alphabet is not even complete. It lacks the J, U, and W, which did not exist in those days. I was able to jury-rig a U applying the existing principals of this font, a W from two V's, and a purely ad hoc design for the J, but these letters suffer in comparison with their mates.

In an attempt to render this font more useful, I generated some CMR10 fonts with special values of the parameters and also some minor tinkering with the program files. Therefore, these fonts

are no longer members of the Computer Modern family. I replaced as many of Knuth's values in the file `CMR10.MF` by Dürer-like values to see if the resulting font was in any way compatible with the cap fonts `CDR10`. For example, I identified the side s of the square with METAFONT's `cap_height` parameter, and let `thick_stem` be `.1cap_height`. Minor adjustments to letter programs were needed to eliminate some visual clashes between Computer Modern fonts and the Dürer font. A sample of typesetting mixing the Dürer caps with the modified Computer Modern font appears in Figure 7 shown at a 10-point, magstep 3, size. For comparison, the same paragraph is shown in the corresponding Computer Modern font. It looks nicer than I expected, but the results should not be taken too seriously.

DUERER A I P U
 DUERER A I P U
 DUERER A I P U
 DUERER A I P U
 DUERER A I P U
 DUERER A I P U

Figure 6: Members of the Computer Dürer family of fonts: bold, slant, sans serif, monospaced typewriter, and casual.

An additional lesson I learned from this project is that type design is a difficult craft in its own right, and while it is feasible to assign the task of rendering an existing font in METAFONT to someone like myself, it is *not* feasible to ask this person to design type.

ACKNOWLEDGMENTS. I am grateful for the financial support of the Research Foundation of the City University of New York, grant number 669243, for this project. I thank Barbara Beeton, David Ness, and Hermann Zapf for several helpful comments.

Bibliography

Billawala, Neenie. *Metamarks: Preliminary studies for a Pandora's Box of shapes*. Stanford, CA: Computer Science Department, Stanford University (report STAN-CS-89-1256), 1989. (Copies

obtainable from the T_EX Users Group, P. O. Box 9506, Providence, RI 02940-9506 USA.)
 Dürer, Albrecht. *The Painter's Manual*. Trans. Walter L. Strauss. New York: Abaris Books, Inc., 1977.
 Dürer, Albrecht. *Of the Just Shaping of Letters*. Trans. R. T. Nichol from the Latin text of the edition of 1535. New York: The Grolier Club, 1917; reprinted by Dover Publications, 1965.
 Goines, David Lance. *A Constructed Roman Alphabet*. Boston: David R. Godine, Publisher, Inc., 1989.
 Knuth, Donald E. *T_EX and METAFONT: New Directions in Typesetting*. Bedford, MA: The Digital Press, 1979.

Uppercase Easy Does It
 Puerto Rico 574 Argyle Road
 a b c d e f g h i j k l m n o p
 q r s t u v w x y z

Figure 7: (a) `CDR10` completed by means of a hacked-up `CMR10` font.

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Figure 7: (b) For comparison, the second specimen is typeset in Computer Modern at the same design size.