META-METAFONT

An exhibition organized by
The Herb Lubalin Study Center of Design and Typography
at The Cooper Union

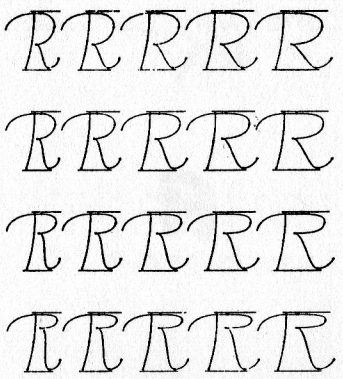
Metafont **is a computer language for designing digital typefaces, developed by the mathematician Donald Knuth at Stanford University. Knuth uses the term *meta-font* to mean a *font about fonts*. A meta-font is a description of typographic family traits: relations of thick to thin, height to width, x-height to cap height, serif to stem, etc. The particular language *Metafont* is a tool for designing *meta-fonts*.**

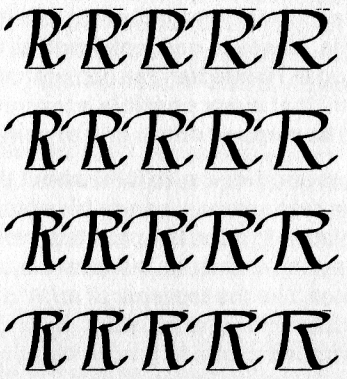
The members of the Caslon family belong to a meta-font; they share a more or less consistent 'style.' The 'rules' for building variations on Caslon could never be absolutely determined. The style of a Metafont meta-font, on the other hand, is totally consistent. The designer is forced to explicitly state how the character will be drawn in a vast range of circumstances. A Metafont meta-font is a rigorous verbal description. The limits of this description contain an infinite number of variations.

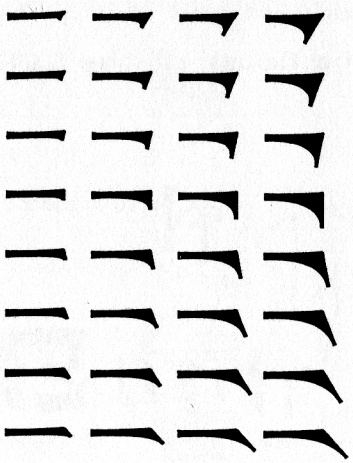
Metafont draws shapes with *pens* having a simulated width, shape, angle, and flexibility. The designer defines a path, describing the spine of the letter rather than its final boundaries. Given a few points, the Metafont language does most of the math.

Parameters **determine the style of a family of faces. A Metafont letter is a list of variables: pen angle, bowl shape, placement of weight, length of serifs; relationships of height to width, thick to thin, serif to stem. A Metafont family can thus contain both serif and sans serif faces. In Metafont, all type exists on a continuum of variables: a Helvetica 'I' *has* serifs; they are simply set at zero.**

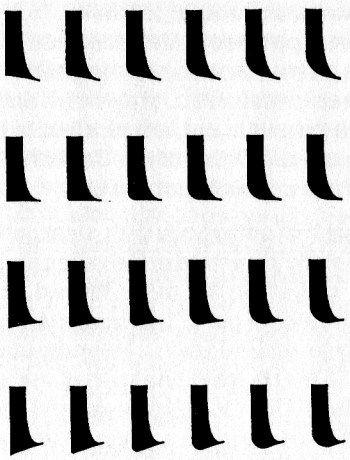
Knuth writes about Metafont: 'the programs are able to record the "intelligence" behind a design... to capture the designer's intentions rather than just the drawings that result from those intentions... The computer can enforce a discipline that helps its users clarify their own knowledge; this educational experience is really the rewarding thing. A Metafont program does not simply *record* the intentions behind a design; it makes the designer objectify 'intentions' into a description capable of being recorded. As a computer language that tries to 'think' the construction of







Terminal serifs with varying heel softness and terminal angle.



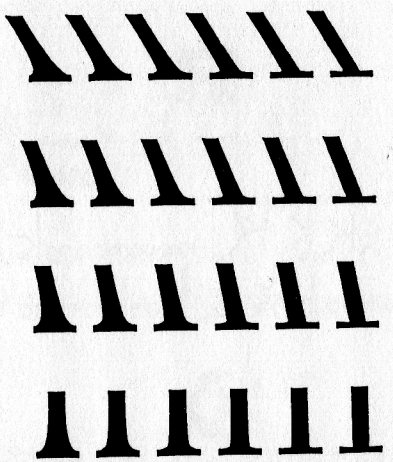
Arm characters with varying base length and base angle; Metafont chooses control points

letters, it forces the designer to 'think' the motions of the hand.

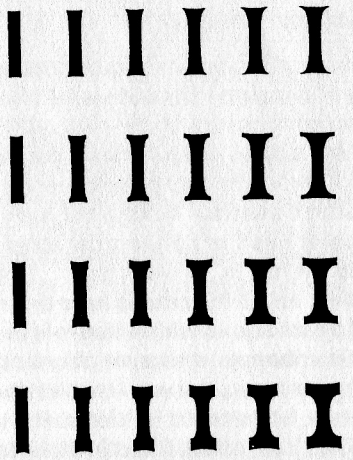
In other digital typography, the outline of a designer's drawing is translated, point for point, onto a grid. With Metafont, there is no original drawing. Metafont does not copy the outlines of a given shape, but works from the inside out, using precise parameters determined by the mind to imitate the motions of the hand.

A major application for Metafont is type design for laser printing. Because of its low resolution (300 d.p.i.), a laser font changes radically from size to size. Metafont is able to reconsider the shape of a letter for a given size, without demanding entirely new drawings.

Metafont, as Knuth describes it, has a humanistic mission; its value is not so much in the variety it may offer consumers, but in the discipline it offers designers. The Lubalin Center is not interested in the final 'look' of Metafont. We are interested in Metafont as an open, unfinished method for making and thinking about letters. The specific language *Metafont* is under continuous revision; the concept of a *meta-font* provides a frame for questioning the history and spirit of letters.



Serifs with varying mid-bracket pull and stem slant



Characters with varying serif length and serif thickness; Metafont chooses control points

Meta-Metafont is based on a series of articles published in the journal *Visible Language*. Work reproduced here provided by Neenie Billawala, Stanford University. The exhibition also includes laser fonts by Georgia K. M. Tobin, The Metafoundry, Dublin, OH. **Meta-Metafont** was open at The Herb Lubalin Study Center of Design and Typography at The Cooper Union, 41 Cooper Square, New York, NY 10003, from March 3 to April 4, 1986. It will travel to several additional locations. For information call Ellen Lupton, Curator, 212 254 6300 x211. George Sadek, Director.

The following articles about Metafont appeared in the journal *Visible Language*. Back issues can be ordered for $5.00, including postage. Write: *Visible Language*, 2643 Eaton Road, Cleveland, OH 44118.

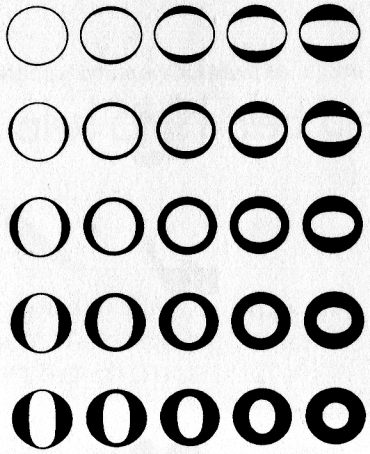
Donald E Knuth, 'The Concept of a Meta-Font, Vol.XVI No.1 Winter 1982.

Douglas R Hofstadter, 'Meta-Font, Metamathematics, Metaphysics: Comments on Donald Knuth's 'The Concept of a Meta-Font, Vol.XVI No.4 Autumn 1982. This issue contains numerous additional responses from the typographic community.

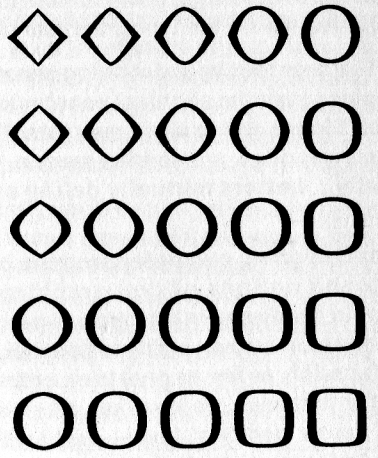
Geoffrey Sampson, 'Is Roman Type an Open-Ended System? A Response to Douglas Hofstadter,' Vol.XVII No.4 Autumn 1983. This issue also includes a reply from Douglas Hofstadter to Geoffrey Sampson, and a reply from Donald Knuth to Douglas Hofstadter.

Donald E. Knuth, 'Lessons Learned from Metafont, Vol.XIX, No.1 Winter 1985.

For information about Donald Knuth's specialized texts on Metafont and the TEX and Micro TEX typesetting systems, write: Ms. Patricia Wiley, Addison-Wesley Publishing Company, Jacob Way, Reading MA 01867.



Circular character in which stroke weights vary on top/bottom and on left/right



Circular characters in which control points move along horizontal and vertical tangents

Meta-Font, Metamathematics, and Metaphysics:
A Response to Donald Knuth's 'Concept of a Meta-Font'

Douglas Hofstadter

Douglas Hofstadter, author of *Godel Escher Bach* and *Metamagical Themas*, responded to the concept of a meta-font in a letter to *Visible Language*. Hofstadter isolated a rhetorical question from Knuth's essay (left) **and asked: What does Knuth *imply* about the nature of letterforms? Metafont can describe a type family with infinite variations. These variations, however, occur only within very definite limits. According to Hofstadter, the concept of a meta-font *implicitly claims* that every possible interpretation of the alphabet could be mapped onto a grid of parameters.**

Hofstadter offers another way to think about the alphabet. A letter is not an autonomous, geometric entity; instead, it exists only in relation to other letters. A letter is not made up of distinct geometric elements, but is rather composed of *roles*. These roles, like the crossbar of an 'A' or the bowl of a 'B, can be fulfilled by an inexhaustible range of forms. The way a role is satisfied in one letter carries over onto other letters, determining the style of a font.

The following quotes and images are from Douglas Hofstadter's essay, 'Meta-font, Metamathematics, and Metaphysics, *Visible Language*, XVI 4, Autumn 1982, pp309-338.

'This rhetorical question is fraught with unspoken implications... the idea that jointly parametrizing two typefaces is no harder, no different in principle, from just parametrizing one typeface in isolation... The psalm (left) **does not represent the marriage of two unrelated families, but simply exhibits many members of one large family... In order to jointly parametrize two typefaces in Metafont, you would need to find, for each pair of corresponding letters.. a set of discrete geometric features... they share and that totally characterize them... it is not inconceivable to move between the elegant swash tail of the Baskerville 'Q' and... Helvetica– but it is certainly not trivial...**

'It is conceivable that somebody with great patience and ingenuity could jointly parametrize Helvetica and Baskerville. But the real question is this: Would such a joint parametrization emerge out of two separate, independently carried-out parametrizations?... How about trying to imagine a typeface that is (say) one third of the way between Cirkulus and Block Up? Or... Explosion and Shatter? Shatter is indeed a 'variation on a theme,' the theme being Helvetica Medium Italic... Obviously, once you've seen such a variation, you can add a knob to your Metafont Helvetica machine, enabling Shatter to come out... But... no matter how many knobs ... you add,... you will have left out some possibilities...

Knuth's sentence casually implies the existence of a

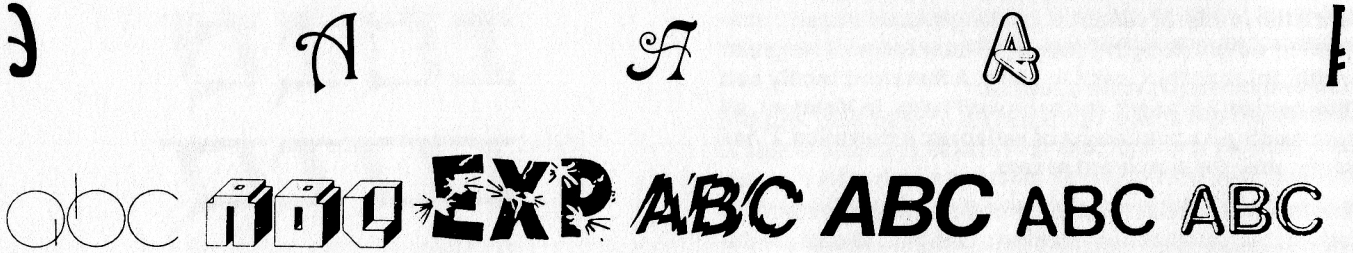


The ability to manipulate lots of parameters may be interesting and fun, but does anybody really need a $6\frac{1}{7}$-point font that is one fourth of the way between Baskerville and Helvetica?



The LORD is my shepherd; I shall not want. He maketh me to lie down in green pastures: he leadeth me beside the still waters. He restoreth my soul: he leadeth me in the paths of righteousness for his name's sake. Yea, though I walk through the valley of the shadow of death I will fear no evil: for thou art with me; thy rod and thy staff they comfort me. Thou preparest a table before me in the presence of mine enemies: thou anointest my head with oil, my cup runneth over Surely goodness and mercy shall follow me all the days of my life and I will dwell in the house of the LORD for ever

Donald Knuth's Metafont rendition of Psalm 23.





finite set of parameters, such that any combination of settings ... will yield a valid 'A', and conversely, such that any valid 'A' will be yielded by some combination of settings... Now how can you possibly incorporate all... typefaces into one universal schema? Can you find in them a set of specific, quantifiable features?

'It is a bold... assumption that one could get any 'A' by filling out a fixed questionnaire: How wide is its crossbar? What angle do the two arms make with the vertical? How wide are its serifs?... There may be no identifiable part that plays the crossbar role; or some role may be split among two or more parts... the Platonic essence lurking behind any concrete letterform is composed of conceptual roles rather than geometric parts... A role is... a set of tests... Not all the tests have to be passed; not all the criteria have to be met... there is a threshold point above which the role is happy, and below which it is unhappy... there are connections among roles so that, for instance, the way in which the 'crossbar' role is filled in one letter could influence the way that the 'post' or 'bowl' or 'tail' role is filled in other letters... one may have to convert 'crossbar' into some other role when looking for something analogous in the structure of another letter than 'A', such as 'N'...

'This sharing of roles is one aspect of the overlapping and mingling [of 'letter spirits']... There is a second aspect, which is suggested by the phrase 'typographical niche'... the presence of a 'post' role and a 'bowl' role in certain positions would strongly suggest that there is a 'b' present. Sometimes there may be evidence for more than one letter.. It is as if there is a very steep and slippery ridge between valleys, and a ball dropped from above is very unlikely to... settle on top of the ridge. It will tumble to one side or the other. The valleys are the typographical niches.

'The letter 'T' is very touchy about being penetrated by the post below, since even the slightest penetration is enough to destroy its 'T'-ness and to slip it over into 'T's arch-rival niche, 't'. It's a low ridge, and for that reason, 'T' guards it extra carefully... Letters mutually define each other's essences...

'A letterform-designing computer program based on the above-sketched notions of typographical roles and niches... would involve an integration of perception with generation, and moreover an ability to generalize from a few letterforms (possibly as few as one) to an entire typeface in the style of the first few... no less than a human, any such program will have a 'personal' taste— and it will almost certainly not be the same as its designers' taste. In fact, to the contrary, the program's taste will likely be full of... surprises.. since that taste will emerge as an implicit and remote consequence of the interaction of a myriad features and factors in the architecture of the program.'



Role splitting , Role combining · Role transferral Role redundancy

Spurious role added Role eliminated





Versions of 'h' and 'k' as rivals for the same typographical niche.

