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*Design Review**

As should be clear from the bulk and the content of this report, and from the work of other investigators in the area, the problems of traffic control device design are many and complex. Nor do they all admit of solution at the present time.

What is clear at the present time is that there is the need for uniform design review procedures. These should be performance-oriented, and include not only proposed new designs but continuing re-evaluation of existing designs. Ideally, the procedures would be simple, inexpensive, and implementable at a relatively local level—using state universities and local consultants, for example. In all likelihood, this would not be feasible for some time, and does not in itself provide the national uniformity necessary. An alternative is to provide centralized, or centrally controlled and managed, facilities for continuing performance review of proposed designs. Such a function would be appropriate for the National Traffic Safety Research Center. Interested parties would then be encouraged to submit problems and propose solutions for evaluation. This policy would ensure that evaluations were rendered within the framework of the then-current system of uniform traffic control devices. As we have emphasized, this total systems viewpoint is necessary in order to avoid proliferating designs which, while independently effective for regional problems, conflict with the current overall system.

This paper has been excerpted from *An Investigation of the Design and Performance of Traffic Control Devices* (Document No. PB-182-534) which gives complete statistical information for the experiments plus an extensive bibliography of related research. The complete report also contains a detailed graphic design discussion of the problems of signs in the urban environment. Copies are \$3.00 from the Clearinghouse for Federal Scientific and Technical Information, 5285 Port Royal Road, Springfield, Virginia USA 22151.

Ligature Design for Contemporary Technology

Joseph S. Scorsone

Computer-aided composition has eliminated restrictions on the number of characters that can be stored practically in a font of printing type. A system of 27 ligatures was designed as an addition to both sans-serif and roman fonts. The development of the ligatures in News Gothic and Century Schoolbook typefaces is discussed and illustrated.

In a recent article, Aaron Burns (1968) writes of a new age of typography—a photo-electronic era which is about to revolutionize the present system of type composing. The computer, he points out, can be programmed to solve problems of letter spacing which, since the invention of movable type, were complicated by the walls of metal around each letter. Without this limitation, type can be set extremely close, which may contribute to its legibility as well as its aesthetic quality.

This new photo-electronic technology not only helps solve problems of spacing but also a problem Gutenberg faced when he attempted to cut his first alphabet. Gutenberg's first job case consisted of 290 different letters, ligatures, and abbreviations (Zapf, 1968). His first letters were fashioned after those of the medieval scribes; he copied many of the ligatures they employed in order to create a printed page indistinguishable from the hand-drawn manuscript. As the technology of printing evolved, the size of the printer's type case decreased because it was neither practical nor economical to have such a large assortment of ligatures. The ligatures in use today which have survived this evolution are ff, fi, fl, ffi, ffl, æ, and œ. With photo-electronic technology, the size of the font is no longer a problem since an infinite number of letters and ligatures can be stored in the memory of the computer.

The purpose of this study has been to design a system of ligatures (1) that would be compatible with an existing sans-serif and roman alphabet, (2) that could be used along with the normal 26-character alphabet without prior learning on the part of the reader, and (3) that would not be confused with other letter combinations and could be recognized easily when used in a word.

It has been argued that words are read not by recognition of individual letters but by their visual shape (Paterson and Tinker, 1940). The use of the ligatures may increase legibility since the shape of the word would be reinforced by uniting the letters into a more distinct visual form. And space taken up by the printed matter could be greatly reduced (and, thereby, cost also), since a normal page of text contains over two hundred of the proposed ligatures.

Selection of Bigrams and Words

Before the ligatures could be designed, it was necessary to determine what two-letter combinations (bigrams) would be employed as ligatures. The ligatures are composed of bigrams and words according to their rate of frequency in the English language. The bigrams in List 1 have the highest rate of occurrence in normal English text and are listed in the order of their frequency. List 2 contains the most common doubled letter in English (Pratt, 1939).

List 1

th	on	of	as	le	de	we	ng	ut	si	nc	em
he	at	ti	to	nt	ea	ve	ma	us	la	so	ac
an	nd	ed	ar	re	ne	ta	ce	be	ad	ll	im
re	st	or	ou	se	ro	tr	ra	un	li	ur	pr
er	es	ti	is	ha	om	co	ic	ch	rt	el	ot
in	en	hi	it	al	io	me	ns	wa	ca	rs	wi
ec											

List 2

ll	ff	mm	ee	rr	gg	ss	nn	dd	oo	pp	aa
tt	cc	bb									

Twenty-four bigrams were selected from these lists to be used as ligatures; "at," "of," and "the" were selected from a list of most common English words (Pratt, 1939). These word ligatures would not

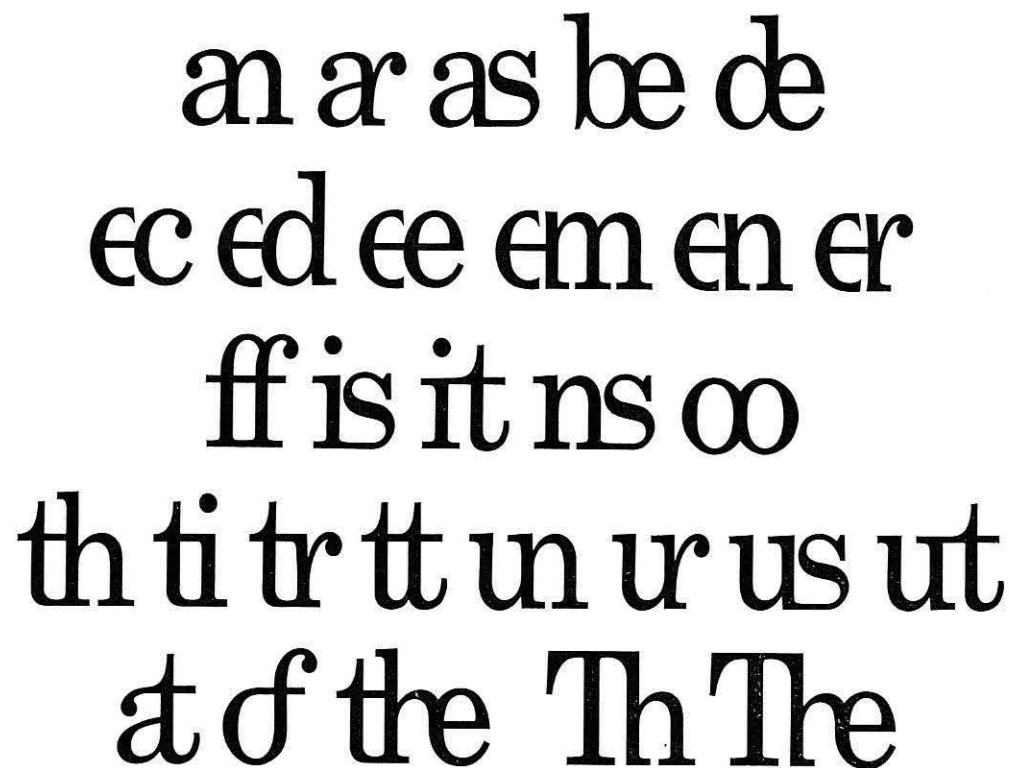


Figure 2. Roman ligatures to be used with Century Schoolbook.

recognition when united with other letters in a ligature. Another reason was the symmetrical distribution of thick and thin strokes on the letter o. This characteristic made a natural transition in the of ligature, since the thin stroke of both letters meet horizontally and the thick strokes coincide vertically. If the thick and thin strokes were distributed asymmetrically, there would have been an awkward juxtaposition between the weights of the two letters.

The ligatures can be easily adapted to most sans-serif alphabets without many alterations to the existing letter design. Adaptation to many of the existing roman alphabets would require major alterations, since there is greater variation in the design of the roman type families.

Designing the Sans-serif Ligatures

The initial task in designing a system of ligatures was to determine the most important elements of each letter combination; what elements could be discarded and what elements had to be retained. Numerous drawings of each pair of letters, in every conceivable combination, either stressed or eliminated certain features of each bigram. It was discovered that certain ligatures worked well as words but not within words, i.e., at, of, and the. They were retained only as word ligatures.

I tried not to deviate from the established weight of the sans-serif letter. To avoid concentration of black which would appear spotty when the ligatures were set in a paragraph, certain elements were eliminated from the letters; for example, the top of the vertical stem of the letters n and r in the an and ar ligatures, the bottom stem on the d in the de ligature, and the interior forms of both the at and the of ligatures had to be adjusted.

When one shape or stroke becomes an integral part of both letters in the ligature, you establish a "multiplicity of read." This phenomena can be seen in the an, ar, be, de, oo, un, at, of, and the ligatures. When this "multiplicity of read" could not be accomplished without destroying the recognition of the ligature, the letters were joined together eliminating much of the space between them, creating one distinct form out of the bigram.

Bigrams beginning with the letter e made it necessary to use two different styles. If the traditional e form were used at the beginning,

be used within other words but only by themselves. Only those letter combinations which could logically be united into a ligature were used. Not all bigrams can be joined together without destroying their legibility. Every letter has a side which is more important for its recognition. The letter a, for instance, has its most important elements on the left, while the letter r has its most important elements on the right. When a bigram is united into a ligature, parts of both letters are obliterated. In designing the ligatures it was important to retain the elements of each letter which were essential for recognition; most of the bigrams from the frequency lists could not be united without destroying these elements. For example, if the bigram re was united as a ligature, the right and most important side of the letter r would be lost.

The 27 bigrams and words which proved to be adaptable to ligature formation are contained in List 3; see also Figures 1 and 2.

List 3

<i>Bigrams</i>						<i>Words</i>
an	em	th	ar	en	ti	at
as	er	tr	be	ff	tt	of
de	is	un	ec	it	ur	the
ed	ns	us	ee	oo	ut	

Selection of Typefaces

The selection of the sans-serif alphabet was more arbitrary than the selection of the roman alphabet. Although many sans-serif alphabets could have been used, News Gothic was selected mainly because of the length of the stem on the lower-case r. On two of the ligatures which employed the letter r (ar and ur) the stem on the r had to be long enough to be recognized. This was especially true in the ar ligature, since the top of the vertical stroke of the r was removed.

The selection of Century Schoolbook for the roman counterpart was made for many reasons; e.g., it has horizontal square serifs. This characteristic makes the connection of two letters appear more natural than with a typeface having pointed diagonal serifs. As in the selection of the sans-serif type, the lower-case r was a factor in the selection of Century Schoolbook. This particular r has a long thin stem terminating in a large ball, which gives it excellent

an ar as be de
ec ed ee em en er
ff is it ns oo
th ti tr tt un ur us ut
a of the Th The

Figure 1. Sans-serif ligatures to be used with News Gothic.

Typography is the art of visual communication. It has one fundamental duty before it and that is to transmit ideas in writing. No argument or consideration can absolve typography from this duty. A printed work that cannot be read becomes a product without purpose. - Emil Ruder

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Figure 7. Roman ligatures used in a paragraph.

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Figure 8. A paragraph employing roman ligatures reduced to a normal text size.

On the whole, the roman ligatures appear to be superior to the sans-serif counterpart. The roman alphabet, with its serifs and thick and thin weight distribution, supplies more cues to the identity of the individual letters than the more simplified sans-serif characters. An example of this can be seen if we compare the roman ar ligature with the sans serif. The roman ligature has a very distinctive ball on the stem of the r as well as a serif at the bottom to establish recognition. The sans-serif ar ligature has only the stem of the r which has few distinctive characteristics.

The Technical Process

The ligatures were drawn 5½ inches high and were photographically reduced to a standard 60-point type height or approximately ½ inch. The ligatures were then juxtaposed with printed individual letters to make paragraphs, and then reduced to a normal text height of 10–11 points.

Ultimate use of this system of ligatures would require a computer and a photocomposition machine. The programming would have to be determined in conjunction with professional computer personnel.

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Type Design for the Computer Age

Wim Crowel

Although typography has always reflected the cultural pattern of its period, today's typefaces and typographic design are a reflection of the past, not of contemporary society. We must think in terms of our electronic media and contemporary forms of expression. A suggested approach for designing today's typography—based on a cell or unit system—is discussed and illustrated.

Leonardo da Vinci may not have been an important type designer; he was, in any case, one of the first who tried to bring letter-types into the framework of a construction. Many after him have repeatedly tried, with more or less success, to analyze the highly individual signs that letters are into a number of basic forms. In da Vinci's case it was clearly the constructor who felt the need to reduce things to simple principles; more-over, his constructions were inspired by his being a sensitive artist.

This attempt—to reproduce constructionally what the human hand created with care and devotion—never had many actual consequences for the evolution of type. Clearly, man's productivity could easily meet the existing demands, and the individual who looked a bit further stayed alone; economically there was no need.

Now, however, we have reached a period—the second half of the twentieth century—in which economic necessity has created machines capable of reproducing characters at a speed of several 1000 per second. In 1969 Leonardo da Vinci would have been able to contribute much to the development of the typesetting machine and especially to the evolution of types for it. We can assume that da Vinci, who reflected the trend of his time with extreme sensitivity, would have evolved a highly appropriate type, a type that would not be anachronistic to the space craft in which the first men landed on the moon. 時代的錯誤