Space Craft

David Kindersley

The proper fit or spacing of letters has been next to impossible using the type-bearing metal rectangular forms required by typographic engineering; rather, it has required the letter-by-letter attention of an artist/letterer. The advent of film composition and computer technology makes possible again the proper coordination of spacing and design of letterforms. In typography, space and letter are one. Optically adjusted text spacing will require attention to the subtleties of each letter's optical centre and the inner forces involved in our eyes' perception of these letterforms. The author's Optical Letter Spacer is described, and its application for reading research is discussed.

My interest in space craft began as a form of self protection when I was involved with the design of letters for mass-produced signs. These were the days before Letraset or any self-adhesive letter became available to the trade—let alone to the do-it-yourself millions. Apart from being sign written, letters were cast or stamped in aluminium. In this field of stamped sign making, spacing did not exist. The object was to produce at the lowest possible price direction signs and number plates for cars. The cast signs were better. The firms who made castings for industry tended to make cast letters. The tradition was good; the men were trained to use their eyes, and pleasure was taken in arranging the letters. This was a trade that produced the cast locomotive name plates which now are rare collectors' items. It sprang from the age when engineers were creators, but this trade was deteriorating. Why? The blame lay with the largest consumer, the Ministry of Transport, who directly or indirectly caused a standard to be upheld of mutilated letterforms.

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Author's address: Chesterton Tower, Chapel Street, Cambridge, England.

Although designed originally by Edward Johnston and others, they were altered out of all recognition when copied. Only by continuous badgering over many years has the M.O.T. changed its ways. Jock Kinier's fine Motorway alphabet is testimony to that.

Some of the misbegotten ways of the M.O.T. linger on today in number plates for cars. In 1948, I think, the Ministry issued a directive to the makers of number plates: no letters should be closer together than one-half inch. To be on the safe side, the whole sign-making trade carefully put all their letters and numerals exactly one-half inch apart. And so it is today on your car—and ever will be unless someone cares enough.

On the face of it, the proper fit or spacing of letters appears to be immensely complicated. Most printers will agree that it is not possible to obtain perfection unless it is done by an artist, letter by letter. Many typographers take the view that the right attitude toward a machine is to accept its limitations.

I am not a printer, but a letterer. The printer tends to accept unquestioningly the spacing offered to him. A letterer not only makes his letters one by one, but places each one in a precise position in relation to its neighbours.

I have never been able to accept the typefounders' allocation of space; it has seemed to me neither logical nor aesthetically pleasing. Nor is it economical.

The exactness of the spacing of early printing and the scriptoriums leaves little to choose from as regards the textural quality. So much is this apparent and in so many examples that few observers could have escaped the feeling that the discipline adhered to was, in fact, the exercise of some law. Later, engineers required a limited number of units for all letters.

However, at last there is once again the opportunity to have both the design and the space of letters correct. I am, of course, referring to the use of film negatives that in many cases can take the place of the bricks of type integral to the systems of printing devised by the engineers.

Firstly, is there a law that provides us with an even relationship between letters? I believe there is in the square law—at least this will do as a name for the moment. That it is something very close to this can be proved satisfactorily by anyone who takes enough trouble to apply various mathematical progressions to letters in a particular way.

The designer of a typeface should know about space as a tangible factor, equal in importance to the letter itself. Today, however, he seems mostly ignorant of this other part of letter design, and consequently creates difficulties which cannot be resolved satisfactorily; e.g., he makes forms in black which require a lavish use of space, without reference to economy. The complexity of allotting units to characters in a restricted die-case has made the alphabet designer despair; indeed, the typefounder has relieved him of any experience in this field. In effect, the typefounder says: you are the artist, do what you will and leave the spacing and fit to us. This is far from satisfactory, because space and letter are one; e.g., as soon as you draw a circle you have drawn a space.

Today, with the use of film negatives instead of type-bearing rectangles, once again correct optical spacing—letter to letter—can be considered. The difference potentially between metal and film from a spacing point of view, can be described as follows: (a) The normal spacing of metal type is that dictated by the rectangles within which it is just possible to place a letter. (b) The normal spacing of a film negative should involve letters only.

The fovea—the centre of the retina onto which we focus when reading—sees best under strong illumination and not at all well in the dark. The fovea scans the words on a page, but its receptors respond better to light than dark. (Would it be better to have our printed reading matter in white on a dark paper?) Space and not-space are, of course, interchangeable in theory. The eye, in fact, does not read; it supplies information to the brain. It is the brain that recognizes shapes, whether they be black or white.

Spacing as opposed to space: the forces involved must be equal. Equal "things" must have equal spacing. In the case of a line of similar symbols, the spacing set between the first two absolutely predetermines the spacing for the rest. Every change of shape calls for a modification in spacing so that it may remain equal for the eye. See Figure 1.

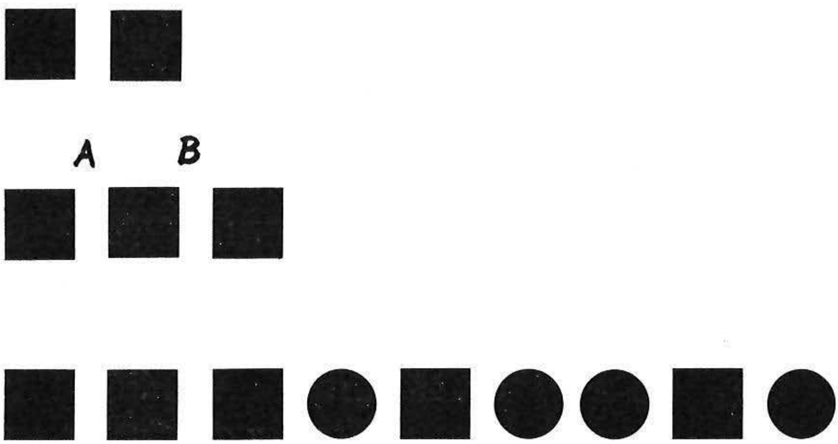


Figure 1. Spacing not space.

The next problem to pose is, "How holy are letterforms"? I will show you what I mean. Figure 2A is a fair and sensible "fit," but Figure 2B would offend many. Yet the spacing in 2B is "for the eye" the same; it is just set more closely. Printing with metal type has tended, for obvious reasons, towards 2A.

Figures 2B, 2C, and 2D all show the quality of pattern that is so desirable in spacing: the texture of text. At all costs, the result shown in 2E must be avoided. It is caused through an unwarranted belief in the sanctity of letters and is a hopeless compromise.

The advantages of optical spacing, with as little compromise as possible, are quite considerable. Letters form more cohesively into words and thus increase out pattern recognition. By and large, spacing is more economical, and a great saving of space is achieved between words. Words have necessarily to be set wide apart in metal type to make certain that the letters of a word belong to each other. However, if the inter-word, letter spacing is more perfect, the slightest change of rhythm will register. Figure 3 is an interesting example—perhaps overstating the point about word spaces—but I maintain that it is still quite readable. The longest line is equal to the justified

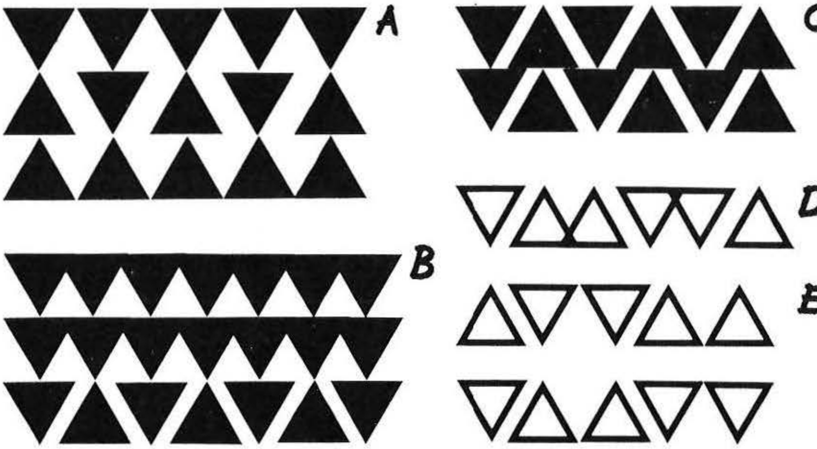


Figure 2. Spacing as pattern.

Figure 3. Difficult to read? Century Schoolbook set extra close in Letraset Spacematic. The extract is from *The Typographic Arts* by Stanley Morison.

Itwouldseemtherefore thatwhenengraversworking
forbookprinters resorted to scribes forthe patterns oftheir
punches theywere not obliged bytechnical reasons to do
so On the otherhand market and manuscript conditions
would inevitablyencourage the adoption ofcalligraphical
models This however does not prove that printing is or
was or ought to be based on calligraphy onlythat printing
then as nowwas a business The copying ofcalligraphy is
more difficult perhaps than the assimilation ofinscriptional
models but the calligraphical resultachieved by such imitat-
ive means is artificial As apermanentmethod it should have
been rejected because it is inconsistentwith the nature of
printingwhich is a departmentofengraving The imitation
ofcalligraphy is excusable in the earlyperiod ofprinting
because it was inevitable But while it is one thing to excuse
the printers ofthe fifteenth century for deliberately copying
hands familiar to theirpublic it is impossible to be so in-
dulgenttowards the sixteenth centuryprinters who repro-
duced the fashionable highlyflourished German calligraphy

Tears *Wet* A
Filthy *Yes* B
Party *Fun* C
Vowel *Oh* D

Figure 4. Capital and lower-case misfit. These examples of laziness appear all too frequently. They are derived from the rectangular limitation of metal type. "C"—Fun—shows what proper spacing should look like.

text width of the original printing. The x-height of Century Schoolbook is more than 25% larger, and the extract is completed with two lines space to spare. Somewhere between my setting and that of the average page lies a compromise which would result in a legible texture equal to the best of the early printers. That letters can be spaced closer than normal has, I think, been more than proved by Herbert Spencer in his admirable research programme at The Royal College of Art.

The quality of printing today can be as good as that of any period that has gone before; in fact better, when one compares the image imparted to the paper. Where typography falls down is in the relationship of one letter to another. This is as much a technical matter as any other part of the printing process. The machine compositor can do very little, if anything, to improve on the spacing provided by the matrices. The hand compositor can arrange his letters to obtain the best compromise, but I notice that he invariably follows the tradition and limits set by the machine. One frequently sees the mistakes shown in Figure 4.

Willem Ovink commented in his Beatrice Warde Memorial Lecture last year on the fact that capital letters are never spaced, and that it is high time they were. Whether capital letters are eventually dropped in text in favour of lower-case only, depends largely on what trouble is taken over the spacing of capitals at source. One simply cannot expect typographers—even if they have the ability—to space capitals by eye in these days of speed.

I am the last person to blame the providers of type for the work they do. In the absence of any vigorous objective research into the subject of spacing and its relation to the eye, the results are better than they should be. The May 1969 *Scientific American* includes the following comment on Gutenberg's printing type: "The character was not centred; each was cleverly placed on its block in a position such that when blocks were put side by side, the spaces between the characters were well balanced and there were no "holes" or concentrations of black in a word. This is indeed an art, requiring an aesthetic eye and meticulous care; even today, with all our technology, the placement of characters on their blocks is determined empirically by trials involving closer and closer approximations." Approximations to what?

There are too many factors to be held in the head at the same time. A trained eye can space a few words, but it is too much for anyone to arrive at a proper space for each of 100 characters or more so that there is anything like perfect interchangeability. Unless, of course, he happens to be a dedicated scribe working in a medieval scriptorium from sunrise to sunset, day in, day out. Many did just this. No, today our only chance is basic research with a computer to hand.

To my mind there is absolutely no reason why we should not all read optically adjusted text. Two requirements are needed of each letter: (1) it's optical centre, and (2) an ability to measure it's force, it's impact, in terms of the human eye. The first is needed to locate the letter on the centre of it's space, and the second is needed so that the letter will have an exactly commensurate space. To do these two things one must imagine how the retina and visual cortex receive and process the information collected by some 130 million receptors—7 million in the fovea alone! Overly simplified, the probable topo-

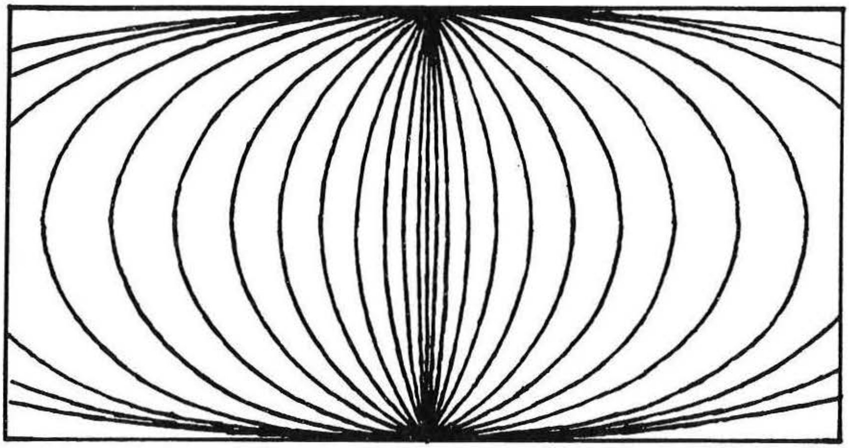


Figure 5. Topography of the reading eye. This "double parabola" wedge is made with a continuous tone from maximum density in the vertical centre to maximum light transmission at the four corners. Any horizontal section conforms to a square law progression.

graphy of the retina in terms of image impact must be something like my diagram in Figure 5. Each contour represents a square law increase from the centre. I have arrived at this form of visualization through collecting the eye-preferred centres of numerous letters and alphabets, and averaging the answers given. As far as I can tell from these results, people tend to agree about letter centres whatever eye sight they have. The greatest divergence of opinion—as you might expect—was with the centre of the capital L, generally the most asymmetrical of letters, and this was not more than 2% either way. Figure 6 shows the capitals C, F, and L with their centres as obtained by the computer, and agreeing with the eye.

The light wedge we use to obtain optical centres, in fact, is made on film so that the centre has the maximum density and the outside edge allows the maximum light transmission. The gradient from the centre to the outside edge being a "square law" progression. This wedge or filter is located in a central position in the Optical Letter Spacer (Fig. 7), and is divided vertically. Thus the light passing through either side can be compared. A clear letter on opaque film is moved to and fro laterally in the optical path between the wedge and the light source until the amount of light passing through both the

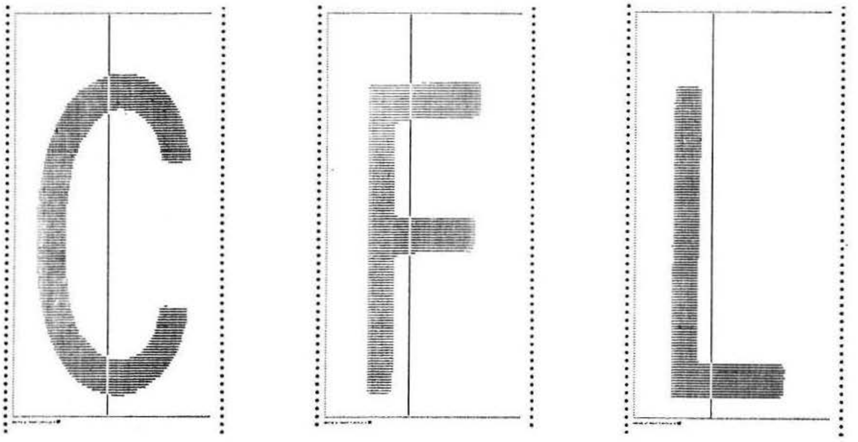
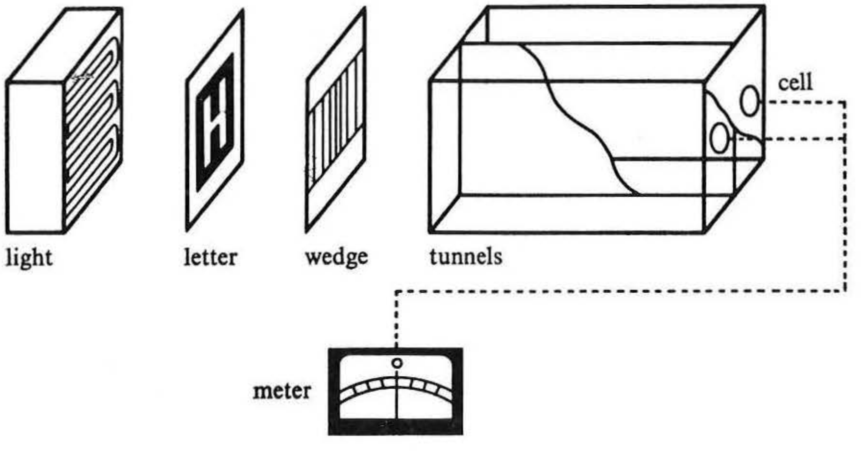


Figure 6. Computerised centres. Eye-chosen centres and the computer agree.

Figure 7. The Optical Letter Spacer. The instrument that has taken us so far, but not quite far enough, awaits its new wedge based on the double parabola.



letter and the wedge is nulled. At this point the letter can be said to be on it's optical centre.

The space required for any particular letter is directly related to its optical centre. The forces that fix the centre are, in fact, those that determine the space. Consequently, my system differs from any other in that it takes into account the space *inside* a letter, as does the eye. It is generally believed that space is something outside the letter and therefore all straight vertical strokes should be flanked by the same spaces, but just a little research by your eye will show this to be erroneous. For example, lower-case i, n, and m may well have different spaces to the side of their vertical thick strokes. Generally, the more space inside a letter, the less outside. The space of a letter should be equal either side of its optical centre; not something tacked on to either side of the letter. And no amount of fiddling will put the spacing right if this rule is not applied. The answer given by the Optical Letter Spacer, being in "light" values, has to be converted to millimetre widths. In order to do this it is necessary to obtain light values for shapes which are measurable. For this purpose we use rectangles of equal height with the letters. The light values for these can be plotted on a graph against their millimetre widths to give a smooth line. Thereafter it is a simple task to plot the light values of related letters on this line and read off their widths.

What we have made, in fact, is an analogue computer. The guts of the instrument is the light wedge. This part has always been made in my workshop, the profiles being accurately hand cut by my colleague, David Parsley. We have made hundreds, searching all the time for a similar function to the human eye. Though our results are very good I am not yet satisfied with the "weighting" of the wedge. However, one thing seems certain, the progression needed is the square law. The square law is in itself interesting because it has affinities with the behaviour of light, and perhaps equally important it is the law of inertia. Inertia seems to be exactly the right description for a letter's position—pulled neither one way nor the other.

One difficulty has been in establishing the correct weighting. Our wedge-making equipment allowed only the making of straight and circular wedges and simple combinations of both. What I wanted to see, we could not make. I needed the help of a computer. As luck would have it, a very distinguished professor at Cambridge University

Figure 8. *Codex Runicus Arnamag*, 14th century. An example of pattern and texture.

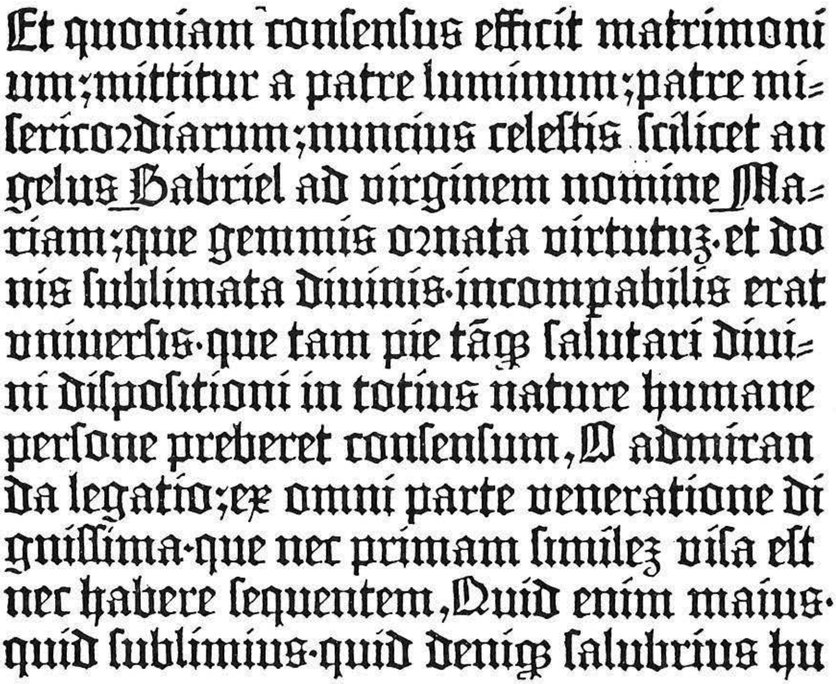

Et quoniam consensus efficit matrimoni
um; mittitur a patre luminum; patre mi=
sericordiarum; nuncius celestis scilicet an
gelus Gabriel ad virginem nomine Ma=
riam; que gemmis ornata virtutuz· et do
nis sublimata diuinis· incompabilis erat
vniuersis· que tam pie tāq; salutari diui=
ni dispositioni in totius nature humane
persone preberet consensum. O admiran
da legatio; ex omni parte veneratione di
gnissima· que nec primam similez visa est
nec habere sequentem. Quid enim maius·
quid sublimius· quid deniq; salubrius hu

Figure 9. Mainz, Johannes Numeister, 1479. The letters are mostly made up from the same basic thick vertical stroke (with slanted finishing strokes at top and bottom). Each piece of black requires the same compensation of white, which makes correct spacing easier.

asked me to design a letter-head. How much, he asked? I said, "the help of a computer." (Actually, Professor Otto Frisch had first been introduced to me by Evan Gill, who told me that it was he who had held the atom whilst Rutherford split it with a hammer!) Professor Frisch kindly introduced me to the Cambridge Computer Laboratory. Their understanding and kindness in putting up with my rough sketches and ideas deserves the highest tribute! We have worked closely together for six months. Broadly, we adopted two approaches to the problem: the symmetrical and the asymmetrical.

It remains my belief that the wedge is of a symmetrical character. For example, I can find no difference between the space requirements of a triangle with its base at the top or at the bottom. However, it must be stated clearly that the eye does read along the tops of letters; in other words, the centre of vision at any given moment will be found to be at the top of the x-height of letters (i.e., disregarding ascenders). Therefore, it has seemed sensible to continue an asymmetrical approach to the problem as well. However, if it proves necessary after further research to weight the wedge, it will be a very, very subtle amount.

I started out with the need to provide guidance for the spacing of letters on street signs, and it has lead one to a study of the eye. It seems that reading is done by a very small part of the retina—the fovea—which is about one third of a millimetre across. The receptors are not rods but entirely cones in the fovea. The interesting thing about the cone receptors is that they tend to have a single line connection to the brain, whereas rods tend to be bundled together and share a line. In effect this means that the fovea is extremely accurate but not as sensitive as the peripheral parts of the eye which are dominated by grouped rods. Also, the largest part of the visual cortex of the brain serves this smallest part of the retina.

Man's eyes are very versatile and highly accurate, but they are less acute than a hawk's and less wide-sweeping than a deer's. They are not as efficient at night as an owl's. Yet with all the compromises, they retain a staggering degree of adaptability and precision. They are capable of extremely rapid movement, of instantaneous shifts in focus from a book to a distant star, of adapting to bright or dim light, of distinguishing colours, of estimating distance, size, and direction of movement.

To sum up, I am really hoping for nothing less than a new typographical attitude to text faces—where alphabets are designed to fit together rather than to fit into rectangles. This means an appreciation of a letter's optical centre and the need to design a letter into the mathematical centre of its space. Economy and aesthetics will then go hand in hand.

Whilst alphabet designs proliferate, spacing is largely ignored. In my opinion the next evolutionary step for our alphabet lies in spacing, conjunction, ligaturing, and kerning. Words will take the place of letters. Already some children are being taught words before learning their alphabet. Research with the help of the opthalmologist is long overdue. The opthalmologist is aware that in 1973 no research has yet really revealed how the eye reads. Could anything be more important?

Finally, is it too much to hope that one day, perhaps using a CRT system, we shall be able to space letters at the time of printing. Such a system would enable an author and designer to work as one—creating the appropriate alphabet for the subject matter and bringing about an immediacy of expression that hitherto belonged only to the scribe. Surely it can now be seen that one single piece of stored information can deal with all likely spacing requirements.