The Changes in Letterforms Due to Technical Developments

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A brief historical survey traces the major technological influences on typography, beginning when Gutenberg transferred the handwritten letters of the medieval scribes into typographic forms, down through the development of machine composition, both in hot metal and photocomposition. Today new problems arise in connection with automated optical reading machines. Not only must the technical requirements of computerized composition be mastered, but we also have to consider the demand for new alphabet designs as an expression of our time, departing from historicizing elements of past styles.

Apart from historical changes in style, technical developments have changed our alphabet since the invention of typecasting. Today there may be the special problems of reading machines; tomorrow, perhaps, electrostatic printing methods or developments in laser-beam techniques. Gutenberg's most important task was to place the freely handwritten letter on a rectangular piece of metal. Besides a few artistic exceptions in relation to italics and script faces, this principle remained a basis of all type design for letter casting for more than 500 years. It is only the development of photocomposition in our days which is in a position to bring back, once more, the whole scale of handwritten variations of earlier calligraphs. Today, some of these photocomposition machines can ignore the technical limitations of the past and produce, by means of special optical arrangements and photographic tricks, modern solutions not thought of before.

The invention of the adjustable typecasting instrument by Gutenberg made it necessary to bring the handwritten image into a system which permitted a solution for the technical art of typecasting as well as the typographic design of the page of a book. Gutenberg and his successors tried to imitate the handwritten forms of the scribes by means of variety of ligatures. To produce the 42-line Bible of 1455, Gutenberg required

approximately 290 characters, abbreviations, and ligatures; Fust and Schoeffer also used several hundred characters for the Psalter of 1457.

All the same, the technique of book printing had followed its own ways since its invention. Contrary to the handwritten books, where the lines were not justified, in the production of the 42-line Bible the lines had already been composed into fully justified columns. This was only possible with the help of a complicated system of ligatures and abbreviations. Gutenberg and his contempories would have saved themselves much effort had they done without those. One can imagine what complication of the typecasting process and letter distribution this meant considering a total volume of 1280 pages with more than 3 million characters; this effort contradicts, indeed, all economic considerations of Gutenberg. The early production is, as can be seen, by no means a mechanic imitation of the medieval handwriting. I am no more of the opinion that Gutenberg intended to copy the handwriting process. He intended an improvement.

Many artists of the Renaissance occupied themselves with the letters of the alphabet, and some tried to put them into the order of a system of geometrical design. These constructed alphabets existed first in Italy. In 1463 Felice Feliciano designed such an alphabet (Fig. 1), two years before the first book was printed in a roman type style at Subiaco near Rome. In the sixteenth century it was mainly Dürer who tried to construct letters with "compass and ruler" (Fig. 2).

Another effort to create an ideal constructed alphabet should be observed, since it points towards electronic solutions for a digitally stored alphabet for photocomposition machines, in which the single elements of letters are built up from dots of lights. By edict of Louis XIV of France the Academie Royale des Sciences was ordered in 1692 to develop, under the chairmanship of Jaugeon, a new typeface for the Imprimerie Royale. The outline of these letters was fixed mathematically in a network of 2304 squares. The files of the Jaugeon Commission are available today at the Bibliothèque Nationale (Fig. 3). On close examination of the letterforms, however, it is observed that they are transferred rather inexactly from the drawn originals to the copper plates for the printing process. Granjeans, too, did not exactly follow the originals when producing the face, called the Romain du Roi, which

Figure 1. Alphabet of Feliciano, ca. 1463. The capital letters are illustrated in the small Codex of the Vatican Library. Original height 82 mm.

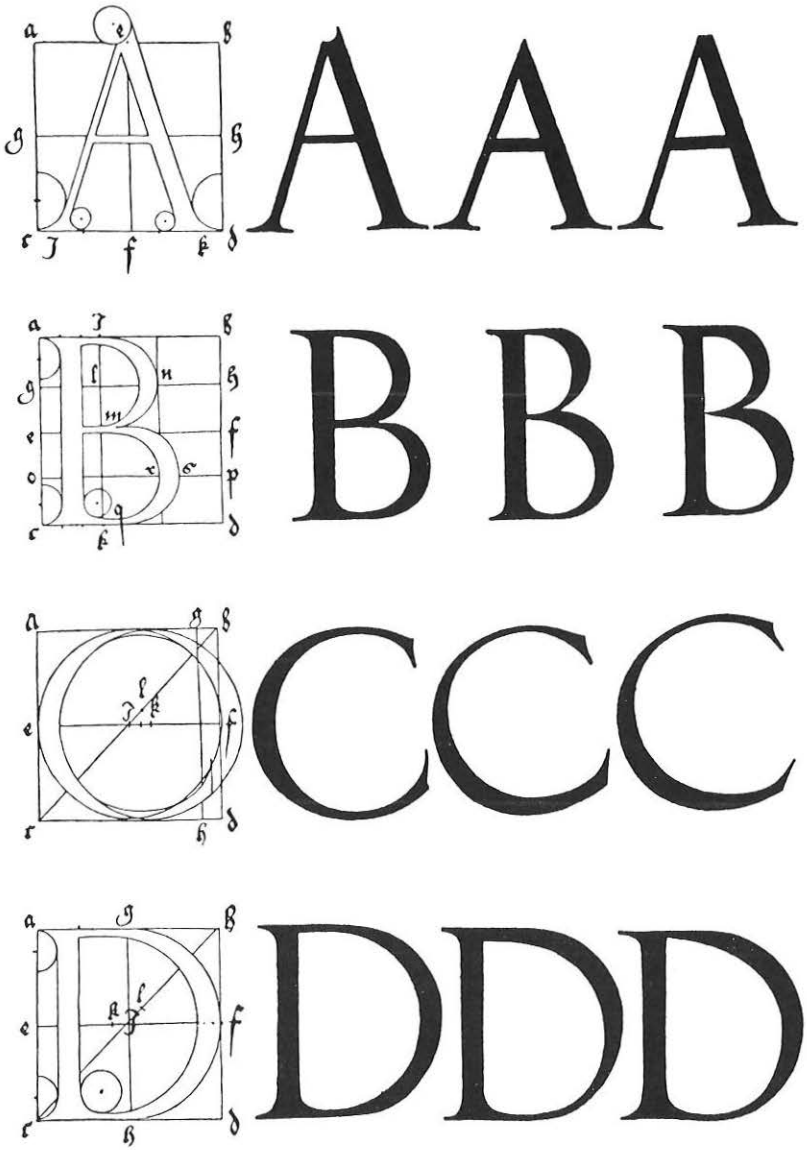
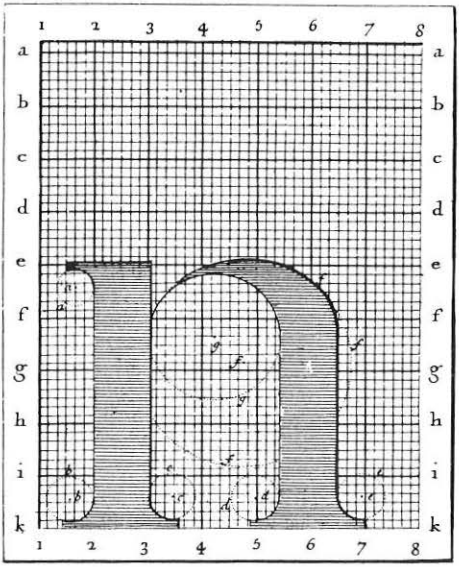
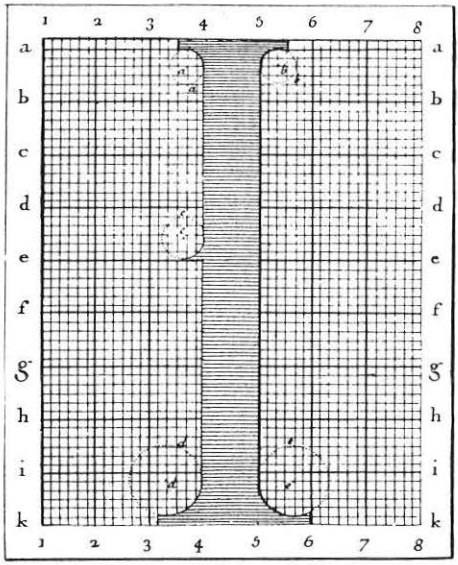


Figure 2. Some letters constructed by Albrecht Dürer, 1525.





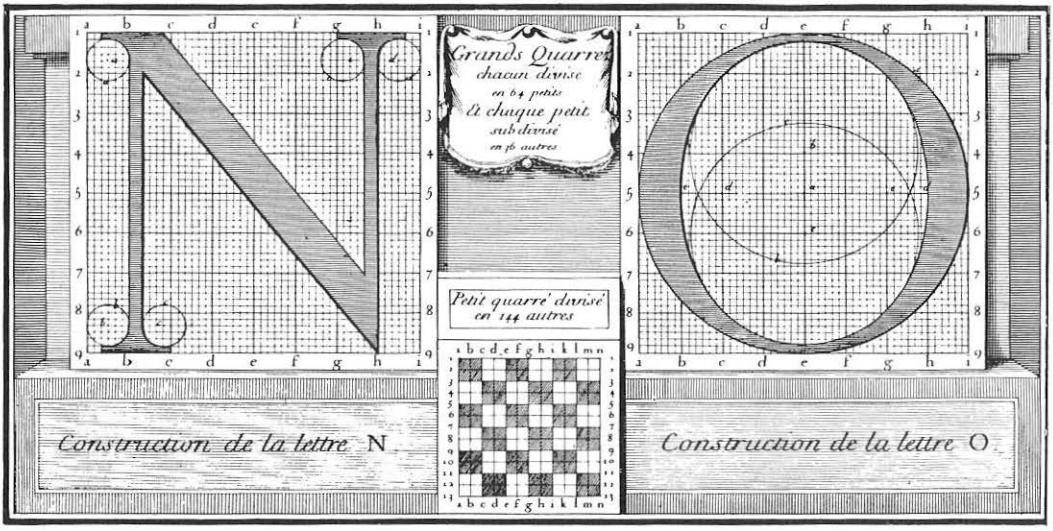


Figure 3. Examples from the alphabet developed by the Jaugeon Commission, 1692. The outline of the letters were fixed mathematically in a network of 2304 squares. Note the lower-case letter l with a minute horizontal flick or "trait" to the left for identification against the capital I and figure 1.

was used in 1702 for the first time. However, he had no possible method for the reduction onto the punch other than free drawing by hand. The form of the lower-case letter l is interesting; perhaps based on French examples of the sixteenth century, or to distinguish it from the capital letter I, it was given at the height of its x-line a minute horizontal flick or "trait" to the left. The Romain du Roi Louis XIV was the first typeface protected from imitation—by Royal Decree.

The change from the comparatively rough woodcut to the finer copper engraving required a change in letterforms. During the sixteenth and seventeenth centuries the serifs became finer shaped, the forms generally more elegant and cultivated. A further technical advance was brought about during the eighteenth century through "smoothed" paper. Baskerville was the first one to use it. The hand press continued to be used, however, into the nineteenth century, even if not exclusively with dampened paper.

In the seventeenth century accounting machines were invented, the first by Pascal in 1642, and a later one by Leibniz in 1673. They command special interest today as forerunners of modern data processing devices. Also, the binary system, the basis of electronic computers, was described by Leibniz at this early date.

The first automatic drawing machine was constructed by Jaquez Droz and Leschot in 1771 (Fig. 4). They programmed—to use an expression of our day—their three famous "wonder toys" with several programs. "The scribe" could write several texts with his hand and had a letter capacity of 40 characters, upper- and lower-case: a mechanical written alphabet. The movements for drawing a single letter on paper were controlled by cams. A simple, sans-serif type might have been reproduced comparatively easily, but it is surprising that it was possible to reproduce even handwritten forms. Only the repetition of details of the lower case e, r, etc., allows us to recognize the mechanical production of such a "handwritten" text. It must be considered that in this case a reproduction is not affected by means of the pantograph principle, but the hand moves in a natural manner, puts the pen into the ink, and the head follows the movement of the hand.

The next step was a program controlled by punched cards, which was first used with the mechanical loom of Jacquard in 1801 (Fig. 5). His knowledge of printing gave him the possibility to print his patterns.

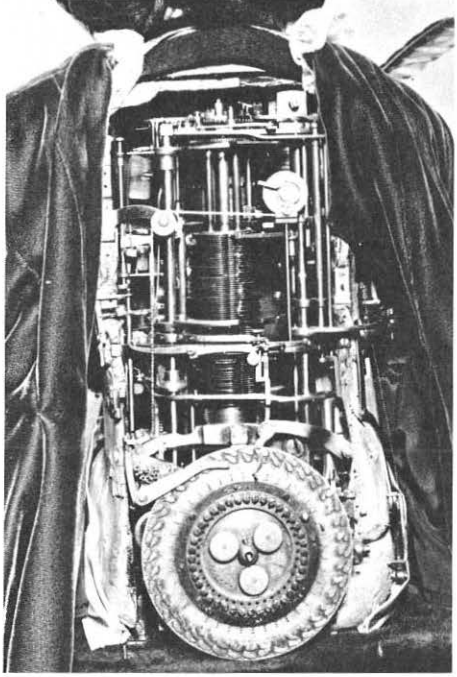


Figure 4. The inside and some lines of the Droz-Leschot automatic drawing machine, 1771.

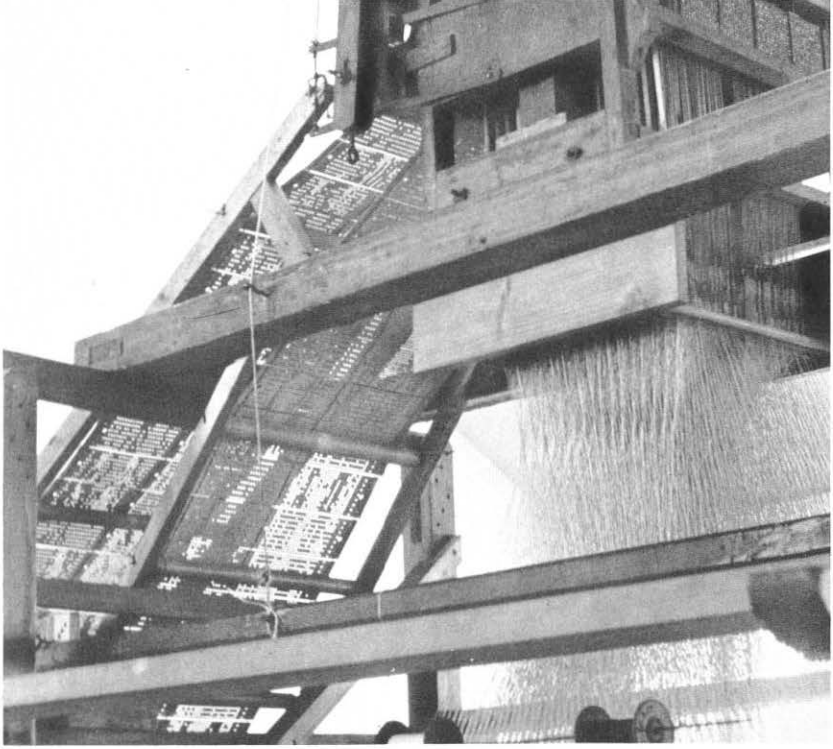


Figure 5. The Jacquard loom, first use of punched cards to control a printing pattern.

A few years later, in 1837, the Morse alphabet was invented; sequences of dots and dashes already used the principle of a binary coded alphabet. The Braille alphabet for the blind (1828) is also an abstract alphabet in which the characters are represented by combinations of dots, which combinations are in no way similar to the original shape of the letters. The punched paper tape of our days is not different in principle.

The punch cutters had worked their capabilities to a fine art in the course of the centuries. Perhaps this development was quickened by the invention of lithography in 1789, which very soon became a dangerous competitor of the book printing art, typography.

The English "script" typefaces, engraved in steel, could, from a technical point of view, be no further improved as far as their artistic conception went—although they were basically non-typographic. Also, the decorative alphabets of the nineteenth century command our appreciation as far as their technical achievements are concerned, though they are very often of rather doubtful artistic quality.

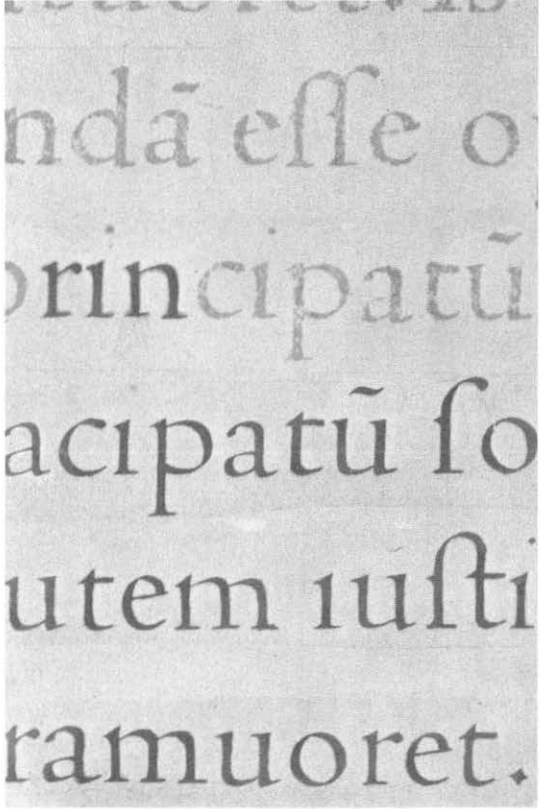


Figure 6.
Bruce Rogers' use of a broad pen to write over Jenson's original roman letters for the design of Rogers' Centaur typeface.

Photography followed the invention of lithography. It was, very soon after, to exert an indirect influence on letterforms. Emery Walker, in 1889, enlarged several roman letters from a Jenson edition of 1476 for William Morris. Morris overdrew the letterforms and thus shaped the Golden Type for his Kelmscott Press. The exaggerated thickness of the serifs might thus be explained since Morris photographically enlarged letterforms printed on dampened paper. The working method of Bruce Rogers for his Centaur (1914) is interesting in comparison. He used (as did Cobden-Sanderson) the same historical originals, i.e., Jenson. However, unlike Morris he did not retouch the characters with a brush but wrote with a broad pen (Fig. 6). Thus, he went the opposite way from Jenson, who used a written original and formed a letter. Rogers wrote the letter, or drew it with a broad pen, and thus brought it back to a pen-correct shape. It may be left open to debate whether or not this is the correct approach.

Essential changes in the basic forms of our alphabet are not possible. Readability and the letter as a character image, subconsciously known to us, must be maintained. However, several attempts have been made to equalize upper- and lower-case letters, to simplify the alphabet. Others have tried to reach better coinciding of the spoken and written form by means of special signs, in other words to develop a phonetic alphabet. Cassandre's Peignot typeface of 1931 was really pioneering work in equalizing the differentiating forms of upper- and lower-case letters; it was ahead of its time (Fig. 7). For the future, though, there will be many further possibilities to simplify our alphabet in parts. Against this, new developments of characters (however well considered) will have little chance to succeed in reaching general recognition. G. B. Shaw's testamentary wishes for a proposed British alphabet were honored by 450 proposals in 1958. None of them fully satisfied the public trustees. Finally a compromise led to a so-called "Shaw-Alphabet" in which Shaw's *Androcles and the Lion* was published by Penguin Books in 1962 (Fig. 8).

Since it has been possible to express Hungarian in a roman type, or the Turkish language in Latin letters, as was done in accordance with the Turkish alphabet reform by Kemal Atatürk in 1928, it should be possible to solve also other speech and writing problems with the roman characters known to us. Figure 9 is a page set in Futura designed by Deberny and Peignot for Vietnamese. A few additional special signs and special accents were sufficient for the representation of this Asiatic language. Technical problems and economic reasons make it more and more important not to complicate typesetting any further but, on the contrary, to attempt simplification.

The work of the type designer has not become easier. Not only has the scope to develop new alphabets narrowed, but technical aspects have limited it further. Automatic reading machines bring new difficulties and raise the question whether the traditional Latin alphabet can in the future also satisfy our artistic considerations.

I do not want to go into detail on the various purely technical alphabets of the past years. Mention should be made, however, of the best-known technical typeface, CMC-7. Although this so-called magnetic type has many advantages which should not be disregarded (it can be read by the eye and by a machine), it remains unsatisfactory with

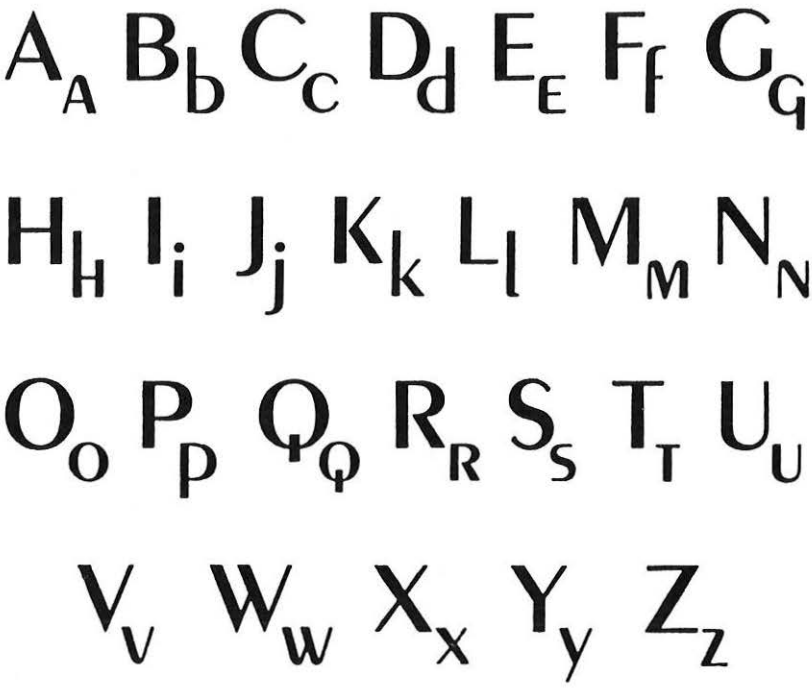
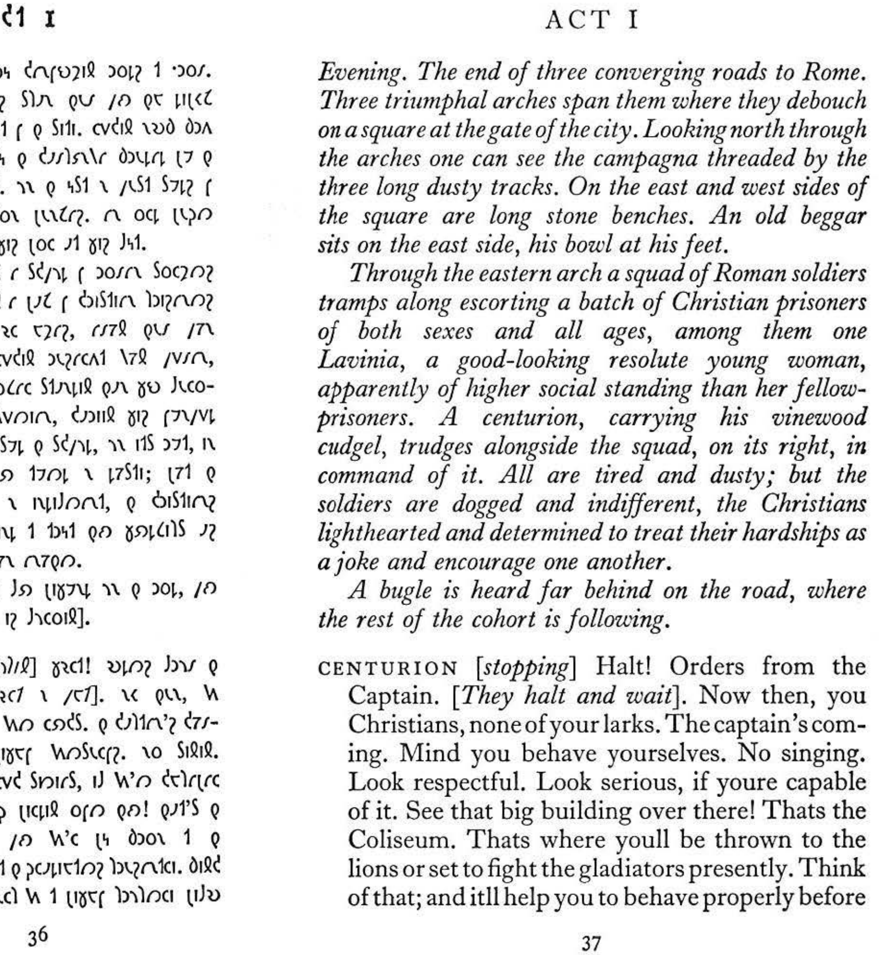


Figure 7. Canandre's Peignot typeface, 1931.


ACT I

Evening. The end of three converging roads to Rome. Three triumphal arches span them where they debouch on a square at the gate of the city. Looking north through the arches one can see the campagna threaded by the three long dusty tracks. On the east and west sides of the square are long stone benches. An old beggar sits on the east side, his bowl at his feet.

Through the eastern arch a squad of Roman soldiers tramps along escorting a batch of Christian prisoners of both sexes and all ages, among them one Lavinia, a good-looking resolute young woman, apparently of higher social standing than her fellow-prisoners. A centurion, carrying his vinewood cudgel, trudges alongside the squad, on its right, in command of it. All are tired and dusty; but the soldiers are dogged and indifferent, the Christians lighthearted and determined to treat their hardships as a joke and encourage one another.

A bugle is heard far behind on the road, where the rest of the cohort is following.

CENTURION [*stopping*] Halt! Orders from the Captain. [*They halt and wait*]. Now then, you Christians, none of your larks. The captain's coming. Mind you behave yourselves. No singing. Look respectful. Look serious, if youre capable of it. See that big building over there! Thats the Coliseum. Thats where youll be thrown to the lions or set to fight the gladiators presently. Think of that; and itll help you to behave properly before

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Figure 8. The so-called Shaw Alphabet. A compromise result of a competition with more than 450 proposals in 1958. Shown here as first used in *Androcles and the Lion,* published by Penguin Books, 1962.

Cho lưu hành thứ chữ nầy, chúng tôi tin chắc sẽ giúp ích rất nhiều cho nghề in chữ **Việt-Nam.**

Chúng tôi đã nhận thấy ở **Âu-Châu** kết quả của thứ chữ nầy rất tốt đẹp, vì lối chữ đã rõ ràng lại có vẻ mỹ thuật nếu khéo sắp cả ba kiểu chữ với nhau.

Figure 9. Vietnamese as an example of using roman letters for foreign languages. The basic Futura alphabet with a few additional signs and special accents can express this Asiatic language. Developed by Deberny and Peignot, Paris.

respect to its form. Since CMC-7 is mainly processed by special magnetic type readers for the checking business in banks, it is of lesser importance to our considerations; it is not concerned with the processing of large quantities of text for books or periodicals. The alphabets of high-speed printers of the first computer generation (UNIVAC 1956, etc.) are unsuitable, too, as far as our typographic requirements are concerned.

It was the design of OCR-B which brought the first step not only toward the unification of different computer systems but also toward an artistic solution. OCR-B is a typeface designed by Adrian Frutiger and technicians on behalf of ECMA in 1963; Frutiger himself has described its development in a previous issue of *The Journal of Typographic Research* (April 1967, pp. 137–146). OCR-B has proved that it is possible to combine technical and artistic requirements. These letterforms, appearing a little strange at first sight, will have to be considered in future developments of type forms.

To the technical requirements in the development of new type forms must be added changes in our reading habits. Until a few years ago, our eye was the only medium which traced the letters. It also was the only judge of good or bad legibility. The artistic aspect was predominant. The eye would discern the less perfect letter design of an alphabet, but, all the same, would finally recognize the meaning of a word or sentence. To distinguish between ß and B, or I and 1, or *h* and *h* (Garamond Italic) did not require much effort.

Our eye follows, when reading, the upper edge of the middle length (X-line). Attempts to increase this upper "reading line" to improve readability must be taken into consideration when designing readable letterforms in the future, especially typefaces for newspapers and periodicals. Times for quiet reading have become rare. The large amount of printed text which we have to work through daily compels us to read hastily, a fact that is not always considered. Many of our newspapers and periodicals present hindrances to fluent reading. There is, for example, often a lack of distinction between information, news, and supplementary commentary.

Beside the human eye there is, today, the electronic eye of the reading machines. For these machines, letters are not a problem of form but a problem of distinction, if we wish to keep the amount of reading

mistakes low in order to justify the use of these very expensive machines. Our eye is in a position—from experience and consideration of the context—to grasp even doubtful forms; we merely recognize them as non-artistic or difficult to read. A reading machine, on the other hand, would simply indicate a wrong or non-readable letter in such cases, or the machine would have to be equipped with additional storage means to compensate for such indistinct, doubtful characters in the text.

Many problems of form have to be taken into consideration for an optical as well as an electronically readable letterform, especially since equipment has already been developed which can read handwritten text as well as typewritten characters. There is not only the question of a letter distinction between i, and l and !, between u and n (in handwriting), between the number 0 and the letter o, or in American handwriting between  and  which are normally used for F and T.

Many sources for mistakes are mainly due to letters cast or set on too narrow a space. Two examples are rn and cl. Such critical letters are, as far as legibility goes, not only important in the small type used for book and newspaper printing, measuring only a few millimeters, but also for the signing in towns and on highways. The letters must not be placed too close to each other in order to safeguard quick recognition even under bad lighting or weather conditions. As far as numbers go, the differentiation between 3 and 8 (for instance in telephone directories or in companies' letterheads and bank account numbers) often presents certain difficulties even to the normal eye. The increasing importance of numbers (to think only of the postal zip code numbers for towns) should not be underrated, especially since they are the only characters which can actually be "read" by all people of this earth, regardless of language.

Turning to another aspect of modern typography, new problems arise in connection with the development of photocomposition. The manual typographic alphabet, dating from Gutenberg, was supplemented in the nineteenth century, through the invention of linecasting machines, by the mechanically produced typographic alphabet. Of the approximately 1600 patent applications filed in the nineteenth century for mechanical linecasting systems, only Mergenthaler's Linotype (1886) and Lanston's Monotype (1887) were actually used on a large scale. Both systems had a direct influence on the design of letterforms. In the case of Linotype, italic and bold faces had to be

adapted to the brass width of their standard equivalents. In case of the Monotype system—a system based on 18 width units—it was necessary to place all letters onto 12 different units, since the first 6 units were too narrow for letters or signs. Meanwhile, the systematic alphabet, based on width units, has become normal practice. For photocomposition machines, either existing alphabets which had been adapted to the special requirements by redrawing were used, or new letterforms designed which were really adjusted to the problems of this type of composition. Since it is generally necessary to produce several point sizes from one negative there are, especially in the case of high-degree optical reductions, differences in width and size disproportionate to the original letterforms. In a photographic alphabet the serifs of a 6-point letter are exactly half the size of a 12-point letter (if a 12-point negative is used). On the other hand, the serifs become too strong if a 10-point letter is used for the production of a 16-point letter. In a typeface used in linecasting the scale of point sizes could be adapted up or down; i.e., a 6-point letter was not, in all details, the arithmetic half of a 12-point letter.

Photocomposition machines working with cathode ray tubes and designed for extremely high speeds use the principle of the scanning spot similar to the methods used in television receivers. The Digiset machine uses an electronic memory to store the characters of the alphabet, a method that no longer uses a photographic negative of a character to electronically reproduce an analogue of it. This is a digitally produced alphabet and its resolution is determined by a line raster. By electronically influencing the deflection of the cathode ray it is even possible to produce an italic, a condensed, or an expanded reproduction of a character from the stored information of the standard character. Not all typefaces are suited to this method, and this fact should be taken into consideration when designing such faces, in order to achieve a somewhat satisfactory result.

The resolution of a character into a line raster—as done with the LINOTRON 1010, Digiset, or LINOTRON 505—requires some new reflections also, when designing the faces. Serifs become rounded at their ends and must be kept more pointed in design. Similar optical distortions must be considered in the case of sans-serif letterforms, especially for semi-bold alphabets; these, however, are of a purely technical nature similar to the problems facing the engraver when engraving punches.

Which tasks will be faced in the future? With the world population expanding at an extraordinary rate, printed reference books and periodicals will become more and more important. The population growth is estimated at approximately 6 billion people in the year 2000 (nearly double today's population)!

As far as we are concerned, the automated production of books will simply become a necessity, whether we like it or not.

In 1640, at the time of Galileo, approximately 600 million people lived on this earth; at the time of William Morris, in 1850, there were 1200 million; today the population has grown to approximately 3 billion people, of which more than 700 million are illiterates. This number represents more than one fifth of the world's population. Only 44% of 965 million children are going to school today to learn reading and writing. The only answer to the coming expansion of education is the automation of our book production.

In this area many tasks still remain to be solved by the typographers. According to the information of the World Association of Bible Societies, the Bible (or parts of it) had been translated—and printed—into 1280 languages or dialects by the end of 1966. These 1280 languages or dialects are spoken by approximately 96% of the world population. The remaining 4%, representing approximately 120 million people, use hundreds of additional languages, partially or completely unexplored. Even considering that a large part of these languages can, for various reasons, not be expressed with the basic signs of the Latin alphabet, there remain many interesting problems to be solved.

Russian efforts for a combined printing type which is supposed to make the Latin alphabet and the Cyrillic Azbuka suitable for more than a hundred languages and dialects in the Soviet Union are reported to be almost completed. A similar situation exists in some parts of Africa. Since Latin letters are familiar to a part of the population of these countries due to the use of the French or English language, an attempt should be made to use the Latin alphabet as a base to solve the special African language problems. I am thinking in this respect of Adrian Frutiger's Davanagari and new experiments in the Arab area, the Simplified Arabic and the non-kerned Alahram Arabic for newspaper printing.

Automation of typesetting of large amounts of text will be the task of the future technicians; to design readable and formally good letterforms for the coming technical developments is the task of the typographer. We should express our respect to the great achievements of the past by aiming towards a result expressing the spirit of the present, honest and just to our days, as is done in the areas of architecture and the fine arts. There should be no copying of the past centuries; we want to work towards a real expression of our time: letterforms as an integral part of the industrial forms of the twentieth century. We do not want to go back into the past, especially not to the forms of the nineteenth century, an easy neo-historicism which would permit us, thanks to our modern techniques, to copy and cheaply use the style elements of the past. Letterforms are no longer a question of style, they express our modern way of thinking—a way of thinking which is essentially different from the thoughts of the nineteenth century in respect to social, political, and artistic ideas.

This article is based on a speech by Hermann Zapf at the Tenth Congress of the Association Typographique Internationale held at UNESCO *in Paris, November 1967.*