

Line Scan Standards for Characters and Symbols: A Practical Study

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There are now several photocomposition machines available or in immediate prospect which produce the characters by means of a raster on a cathode ray tube (CRT). In the case of the Hell Digiset and the Alphanumeric machines the character generation data is stored in digital form; in the case of the Linotron and Purdy McIntosh machines the scan instructions for generating the character are derived each time they are required by rescanning an optical matrix in synchronism with the character generation.

There is in fact little published data on fine quality character generation and the task of deciding what line standards are required for specific tasks is therefore not easy. Analogies to the reproduction of characters on television tube faces is not a very good guide to the quality required.

Proofing Quality

The situation is complicated somewhat by the various tasks for which such images are required. In printing the first requirement is for proofing. If paper proofs are required at some stage, is it desired to know whether the characters or symbols earmarked inside the computer are, in fact, those desired at output. They can be represented by transformations or double symbols which are consulted in a table, but the time-honored practice of actually examining a proof which is an orthographic representation of the final printed work is not to be discarded lightly, without considerable retraining, since it materially assists page make-up as well as checking the precise sense. Similar requirements exist for editing purposes on CRT's. At first the text string

errors can be removed by using a simple and restricted letter-form generation, but the nearer one comes to final output the more need there is for "full quality" letter generation.

We need to know what this implies economically, since the fineness of scan affects not only the speed of output (and hence the unit cost) in direct ratio, but also the quality of the components used, the tube or tubes themselves, their lining up and maintenance, and the quality and nature of the driving circuits. There is little or no experience yet in the character generation field, but considerable experience in the facsimile transmission of photographs and in electronic scanning for engraving and color separation.

It is unfortunately true of the printing industry that the quality of initial image demanded is frequently much better than can be justified by the subsequent degradation it receives in processing, and little work has been done on the effect of noise in character generation and processing. We need to know in particular how low a line-scan rate can be used and still present to a "reader" a proof image from which he will detect errors with as good a certainty as he does from conventional proofing methods, and we need to know what line standards are suitable for low quality information printing (such as telephone directories) and for high quality "pleasure" printing such as books or glossy display printing.

Scanned Specimens

As a preliminary to more rigorous tests it was decided to use the facilities available on the K. S. Paul Colour Scanner to delimit the range of line scans which might prove to be useful in printing work and to attempt if possible, some fairly crude tests of readers' ability to detect errors from proofs of relatively low line scan frequency.

Two samples were procured,¹ one of Times Roman ranging from 6-point to 24-point in size, as a representative of a serif face, the other of Univers Medium from 6-point to 22-point size, representing a sans-serif face, both with italic as well as Roman upright forms. These were scanned at 250 lines/inch and 1000 lines/inch. Both the width of the original scan and of the reproducing beam will affect the result. The

¹ The original positives of type samples were kindly supplied by F. Holland of the Monotype Corporation and were made on the Monophoto. Mr. R. McIntosh of K. S. Paul Ltd. kindly arranged for the scanned positives to be made on the colour scanner.

reproducing beam width is 0.004" for 250 lines per inch and 0.001" for 1,000 lines per inch, as might be expected. The direction of scan was as closely as possible kept from top to bottom of the sheets, but no special precautions were taken to align them with the uprights of the characters. In the event, however, the scan angles were very close to the vertical.

In presenting the results, some difficulties were immediately experienced. In order to show specimens with low line scan frequency it is necessary to take the 6-point characters and enlarge them as far as 24-point (4x), which is bound to accentuate variations in the character outline caused by other noise sources. Further, on the Times Roman scan at 250 lines/inch it proved difficult to balance the exposure over the whole area, so that the 6-point section was not in fact as fully exposed in the "thin" portions. This spoils the effect of even the "cleaned up" enlargements, and it may be possible to attribute some of this loss to the fact that the scanner in this mode is operating near an artificially imposed limit.

In Figures 1 and 2 the basic data used are presented. They show a photo litho contact reproduction from the unscanned originals and from those scanned at 250 and 1000 lines/inch. In order to make it a fair comparison between these, and with trade practice, where usually two stages of film work are involved between composition and printing down to metal, negative plates were used and the positives were contacted to negatives. This, incidentally, allowed the original set of positives to be reversed laterally since they were made to read correctly emulsion up, whereas the scanned positives had been reversed and were correct for direct printing down to make negatives. All the reproductions are made from 3M Type R negative presensitized plates printed down on a vacuum frame and run on the small offset machine on cream wove paper. In order to have a closer comparison of various line standards the 6-point, 8-point, 12-point, and 18-point specimens have been progressively enlarged to 24-point and placed alongside the unscanned and 24-point scanned negatives in Figure 3.²

Finally, since comparison at 24-point is not, in fact, necessarily the most appropriate test, various intermediate enlargements have been used to present various sizes at various line scan frequencies (Figures 4 and 5). It should be noted that in *discriminating* words, characters, and

Text continues on page 62.

² I have to thank Miss A. Rutherford for performing the tedious and meticulous task of making the enlargements for me.

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Figure 2. Monophoto Times New Roman Series 327 scanned at 250 and 1,000 lines per inch; all reproduced from second-generation negatives.

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Figure 3. Reconstituted 24-point Times Roman 327 and Univers Medium.

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Figure 4. Reconstituted Times Roman 327 at various point sizes with various line scans per inch.

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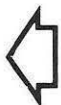
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Figure 5. Reconstituted Univers Medium at various point sizes with various line scans per inch.

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symbols (i.e., the process of character recognition) the 6-point scanned material can be said to be readable even when the enlargement of it seems very incomplete and crude. The processes by which the eye itself scans the image and assembles the information for the exercise of the discriminatory function needs consideration here, as well as the purely physical analysis.

It is recognised that this is only a preliminary to a larger, full-scale evaluation. Enlarging to give reduced lines/inch is not a rigorously valid procedure since the edge transmission of the scanning and reproducing beam is also enlarged. Ideally the scanner itself should be capable of variable line standards, and the tests should be conducted in a rigorous statistical manner to ascertain without the subjects' being able to influence the result by preference or bias. Further elucidation of the role played by noise introduced in later processes is essential to proper analysis.

Preliminary Conclusions

Some elementary information can be obtained from close optical examination of the original scanned positives. There is frequently an additional line shown halfway down the vertical side of a character, evidence of a sporadic, or perhaps regular change in sensitivity threshold, or perhaps of an undetected geometrical shape change. There are "doublings" and "drop outs" suspected to be of a statistical nature, unacceptable in conventional terms, but probably not significant to an unsuspecting reader. These preliminary results are submitted more to prompt further publication and to point the need for the scrutiny of work in parallel fields—character recognition and facsimile transmission, for instance—to see if it can assist in the establishment of rational line standards for the CRT character and line generation systems of the future. When more information is available, it may be that special designs of type faces are produced for this method of generation, just as, say, Univers was designed specifically for conventional photocomposition. Quite obviously from these preliminary tests, there are geometrical features which can be avoided in designing a face if maximum reproducibility and legibility are required with CRT generation, as well as the prospect of increasing the economic yield by reducing the line scan standards, e.g., by using a sans-serif face which clearly performs better than a serif face.