

13

THE UNIVERSITY OF NEWCASTLE UPON TYNE

WITH THE COMPLIMENTS OF

The Director

C. J. DUNCAN

*Hand bound
in the
University Library
Newcastle*

Department of Photography
The Medical School The University Newcastle upon Tyne 1

gr

To the pioneer of
Computer Typesetting:

D. A. J. Heron
Y. S. Simons

Robert Brown

A. D. Smith

Long F. Smith

A. H. Shillington

G. L. Allen

H. H. H. H. H.

C. R. ...

H. M. H. H. H.

M. A. Smith

C. J. Duncan

London
3rd Feb. 1965

Report of Proceedings

Computer Typesetting Conference
London University July 1964

Report of Proceedings

Published by The Institute of Printing Limited
44 Bedford Row London WC.1

*Printed in Great Britain by
Northumberland Press Limited
Gateshead on Tyne*

Contents

	<i>Page</i>
Preface	vii
Introductory session	1
Problems of computer typesetting	21
Practical problems of the changeover	65
Some programming developments	87
Keyboards and keyboarding problems	151
Further reports on technical progress	175
Coding standardization	197
High speed photocomposing systems	211
Notes on speakers and chairmen of sessions	239
Glossary of technical terms	243

Preface

by Mr. Gordon S. Allen (President of the Institute of Printing).

Computer typesetting has captured the imagination of printers. Apart from those intrigued by the commercial implications of this development, the technologists with whom the Institute of Printing is primarily concerned have been fascinated by the requirement to combine in this new field the most sophisticated scientific techniques of data processing with the highest craft skills. Hitherto, printers have had even less need to understand the systems, languages and economics of computers than computer designers and programmers have required to learn the jargon, economics and basic typographical aspects of typesetting. The need for disseminating information is therefore greater in this case than for any other printing development at the present time. As a means of satisfying this need, the Institute has established a Computer Typesetting Committee.

The concept of this international conference was initiated by Mr. C. J. Duncan, of Newcastle University. The organization of the conference was carried out by the Computer Typesetting Committee. The thanks of the Institute are due to the members of this committee and to the secretarial staff of the Institute, in particular to the Assistant Secretary, Mr. D. A. Jefferies.

The conference was fully booked and delegates attended from fourteen different countries. The programme covered the whole range of current computer typesetting applications and problems. Modesty must not prevent the statement here that the conference was an unqualified success. The very high proportion of delegates who attended both evening sessions after long days of lectures starting at 9.0 a.m., the enthusiastic and pertinent discussions, and the letters received after the conference endorse this verdict.

If this publication appears in January 1965 or earlier as is planned, this team will have scored another success by publishing a fully edited set of conference proceedings within six months. Thanks are particularly due to Mr. Adam Maitland for the very large amount of voluntary time and effort he has committed to his task as supervising editor of these proceedings.

All the text has been typeset by computer methods: part of chapter 4 by the Rocappi general purpose computer system, and the rest by the Linasec special purpose computer method. Readers will readily understand that the speed advantages of computer typesetting are not at their most compulsive in the production of a 'once only' set of proceedings; indeed the decision to computer-set has provided an additional challenge and, because this is one of the first books in this country to be thus produced, it imposed certain typographic limitations.

There were many questions before us at this conference, as will be seen from the discussion sections. Not all of these questions could be answered; many will indeed have to wait for experience to provide the answers, but they were certainly fully and intelligently discussed. A number of papers announced ideas and equipments for the very first time and we believe that this conference has provided a valuable statement of what computer typesetting means and where the technology stands to-day.

MONOTYPE and MONOPHOTO are registered
trade marks of The Monotype Corporation Ltd.

The Institute of Printing appreciates and acknowledges the co-operation of all organizations which supplied photographs or other material for the illustrations appearing in these published proceedings and, in particular, the following:

Alphanumeric Inc (USA)

British Standards Institution

Cambridge University Press

Richard Clay & Co Ltd

Compugraphic Corporation (USA)

Fairchild Graphic Equipment (UK) Ltd

I.B.M.

International Photon Corporation (USA)

Linotype & Machinery Ltd

Mergenthaler Linotype Company (USA)

Rocappi Ltd

University of Newcastle-upon-Tyne

Westerham Press

Introductory Session

CHAPTER 1

Introductory Session

Chairman
Mr G S Allen

Speakers
Mr C J Duncan
Dr D G B Edwards

CHAIRMAN: We are about to hear a general paper on the subject of Computer Typesetting. There is nobody better able to give this paper than Mr. Duncan. It is almost by chance that it is the Institute of Printing rather than Mr. Duncan and his team at Newcastle University who are sponsoring this conference on computer typesetting. His plan for a conference in Newcastle earlier this year was frustrated by no fault of his own.

Mr. Duncan became involved in this subject through the best possible motives, that is, as one who wished to use computer typesetting to produce economic text. That is how he started but, in fact, he has done a tremendous amount of work in this field not only on the technical side but also in helping other people. In fact, until the Institute's Computer Typesetting Committee was formed, Mr. Duncan took that task pretty well to himself, acting as a general co-ordinator and providing liaison between the people working in this field.

Why computer typesetting?

Mr. C. J. DUNCAN (Newcastle University): I approach my task this morning with considerable humility. No one, I feel, knows better than I do how much we have to learn about the application of these juggernauts to our basic printing situations. None of us can know much yet about their operations in handling texts. Little has yet been done to delimit the conditions under which they will work. The most that can be said for our efforts so far is that they have shown the great extent of the ground work that needs to be done before their successful use can be assured. Our efforts have also revealed our addiction to the built-in inconsistencies of present methods of work, inconsistencies that are defended sincerely and stubbornly because we have yet to recognize that they have been imposed upon us by

the limitations in existing systems and the machines by which they are carried out.

Let us agree then to use this unique opportunity to examine what we are doing, and what we would like to do, and see if these new tools can assist us to improve both our targets and our attainments. Much can be done by critical but calm examination and interrogation, by calm judgment without undue dogmatism. We shall need to separate out quite rigorously those elements that are purely comfortable customs, those that are necessary conventions, those that are unnecessary 'graftings on' which we shall need to jettison later. Finally there will be a number of new conditions which, unwelcome or unfamiliar as they may be, we shall have to accept *faute de mieux* because they come as part of a package deal we cannot do without.

These methods will eventually come into their own as complete systems. Existing methods, when shorn of certain eccentricities and 'sports', form a relatively homogeneous and balanced system, but one of considerable range in the units and capacities employed. This is both a consequence of, and a cause of, the tendency to carry out mixed plant operations under one roof. I do not need to remind you that most, if not all, printers do more than one kind of work, and that this is characteristic of a bespoke rather than a standardized industrial process. The concentration of enormous productive power in a small unit, such as a digital computer or an ultra fast photocomposing machine, inevitably changes the balance of the machines that feed it and those that it feeds. This poses great problems of production while completely changing the method of operation and the balance of the plant in use. I believe it also implies, at least to start with, a change in the variety and style of the operations to be performed.

Why use computers at all?

The first reason why computers are being used and will continue to be used for typesetting is that we are producing large quantities of material on the computer printing-out machines which we desire to have replicated for dissemination. Further, computer users, who have devoted considerable effort and money to produce relatively error-free results, are not likely to tolerate gratuitous errors introduced by other operators using unrelated technologies. On the other hand computer print-out machines are designed to give only a small number of copies of relatively inferior appearance and there is a great desire to tidy this up into a form capable of being assimilated more easily before it is widely distributed. Present day high speed computer output is

suitable for internal circulation and not for use external to the plant. Computer users therefore demand from conventional printing processes the same low error rate and freedom from necessity to check, allied to an improved quality and a larger number of copies.

Secondly, printers themselves will need computers in their plants, if not for composition then for other purposes. The work undertaken by printers embraces categories for which sorting, updating and amendment are essential, and printers themselves must solve these problems economically as the costs of their traditional methods of storage, hand alteration or resetting increases. Otherwise the customers they serve will find it economic to take the jobs away from them and give them only the replicating portion of the task to run with ink and paper.

Thirdly, sheer social progress may bring us to it. There is some evidence, if not a lot, that human beings resent carrying on an endless series of trivial operations that they know a machine can perform just as well, if not better. At least young recruits to an industry may do so, and tend to opt for a better education or a better paid 'unskilled' job. These social human attitudes have economic results in that it becomes difficult to hold staff long enough to be properly trained and the cost of training rises, whereas machine operations have a constant, or even decreasing cost. Gradually the climate of opinion must favour the introduction of labour-saving machinery and the human effort must be devoted to improving performance *vis-à-vis* the human skill it replaces.

Where will computers be used?

Computers will be used first in very big plants which can afford to spend the necessary money to commission them and study their use, and where, for example, they already exist for other operations or can be seen to offer immediate advantages in the purely commercial fields of stock and inventory control, order routing, and material control. Big printing and publishing plants which have already installed large computers for such operations are bound to find themselves soon with spare computer and programming capacity which they may offer to other plants, or use them to improve their printing efficiency.

Next they will be used in large commercial organizations which need large quantities of printing, especially for internal circulation. Whether this be called printing or duplicating, the possibility of cheaply acquiring an improved quality from captive small-offset litho plants will be made available by computer

manufacturers and other entrepreneurs, and once seen to be feasible will be readily taken up. The traditional industry *may* get the actual replicating job handed on, provided it is not too fussy about what it will accept, and can replicate it at competitive prices.

A probable next comer is the publishing branch of the industry, especially where it is allied to a computer-using organization. Their attempts to streamline and fix their text preparation and editing procedures will eventually lead them to tape or similar coded medium, and may result in their controlling the production of the printing surface right down to the final 'tape' to drive the printer's composing machine.

In parallel with this development will be the introduction of computer setting into large organizations such as government agencies and authorities and smaller groups such as learned societies, which generate large quantities of material for general or restricted publication. Once they can conceive that their publication operations will be more economic, or more rapid, and require less effort, they are likely to plug into any available computer to secure this desirable result. The Services and the public utility corporations, and to a certain extent local government and the civil ministries, have already shown they are alive to the possibilities.

How will computer typesetting be introduced?

Firstly, with specific installations in large plants either for mixed purposes, or if specifically for typesetting, then as a result of a large standing job, particularly suited to computer control, and with a correspondingly long induction period for programme writing, 'de-bugging', and running in.

Concurrently smaller industrial units may prefer to 'plug-in' to a local computer service bureau. 'Plugging-in' has been impeded, (or would have been so if extensively required) by delays in this country in the introduction of data relay equipment over wired networks. Equipment is at last available, not yet in the variety and capability of that available in the United States, but of adequate performance and at a reasonably economic cost. We can now expect to see the expansion of service bureaux activities and they may eventually be able to provide computer typesetting programmes for their customers and an off-peak service at acceptable rates.

A third development, and one which holds some promise for the smaller units, in our rather fragmented industry in Britain, is

co-operation in both programme purchase and use and in the provision of computer capacity. A group of printers may find it possible to reduce costs considerably by sharing a suitable special-purpose computer and programmes for it, and be able to allocate its time to satisfy all users reasonably well. While this may call for an unusual degree of co-operation, it may be worth the effort.

When will computer typesetting come?

The short answer is as soon as it is satisfactory both operationally and economically. Both requirements pose formidable although not insuperable obstacles. The most likely first user is that branch of the industry responsible for lists, inventories, schedules, timetables and directories, which need constant revision, updating and amendment. Many combinations of machines already exist and are in use to perform these operations for the first copy economically and rapidly—it seems a short first step to translate this by appropriate composing techniques into a suitable matrix for replicating, which is the printer's task. You will know that this is already being done by a variety of people for a wide range of tasks in many different combinations, so the extension of this to other countries and to other tasks is a foregone conclusion.

Fairly soon this must be followed by automatic setting of a large amount of tabular data processed by computer for commerce, finance, scientific and governmental purposes. Most of this is relatively unsophisticated, typographically speaking, but for reasons mostly associated with the precision required and the variety needed within the framework, this has been fairly expensive by existing composition methods apart from the inherent error rate. Here is a field where the economies of introducing computer typesetting are more favourable than for some other types of setting.

This should be followed by the use of computers for verbal text setting, firstly the less attractive, cheaper, mass produced types, followed by the more sophisticated expensive setting, when the computer has learned to recognize and produce the necessary typographical refinements. From there it will proceed to much more sophisticated types of setting such as chemical and mathematical setting associated probably with photocomposition, provided the effort to write the programmes can be justified.

Finally, in this country at least will come its application to newspapers. At the moment the attitude of the unions to the introduction of some labour-saving methods is unfavourable, while the concentration of ownership in a few hands results in a

lack of competition in advertising and freedom to raise both the price of the paper and advertising charges. This means that there will be no incentive to the newspaper managements to introduce computers for typesetting, although they may be necessary for advertisement control and other accounting procedures. There are small independent areas in local newspaper publishing where computer typesetting may creep in, but unless there are radical changes in the climate of the industry it is unlikely for a long time. After all, it is not usual to print or publish a newspaper overseas, whereas it is commonplace for books, and even periodicals, and computer typesetting will ease the language difficulties.

What computers will be used?

There are fashions in computers as in other things, and managements tend to prefer the 'devil they know'. At first sight the most attractive proposition would seem to be to go to one of the giants such as RCA or IBM who can show that they have workable programmes and personal experience in the field, but only if they can apply these to your particular problems, and their prices are right. In the long run there is a lot to be said for having your own programming experience, or buying some, provided your organization is large enough. We shall hear more later in the conference about the shortcomings of existing programmes, so there is still time to start and all to be gained. Undoubtedly the use of a large computer installation part-time, at least for evaluation and feasibility studies, is most attractive, if only because the smaller installations at present available seem to be rather specific in their abilities and methods of use. In any case there is up and down this country at least a fair amount of time available on medium to large machines, and a reasonable chance of using some if the installation happens to be handy.

Next will come the use of the highly specific small computer tailored to a small range of jobs in a single or several associated plants. The Linasec at Richard Clay's is a good example of this. It allows a limited but valuable variety of tasks to be tackled with immediate success, at, I presume, economical rates. It trains and re-orientates a whole plant to modern automated text preparation. It raises problems of adjustments to skills, machine manning, mechanical performance, engineering maintenance, and computer operation, all of which will need to be solved satisfactorily. It does not, except to a limited degree, involve the user in elaborate decisions as to style, format and choice of setting parameters—'fortunately', I am sure someone will say!

As the printer gradually assimilates the uses of this small

special purpose limited machine, or as his experiments with the versatile, large, fast (and expensive) machine progress, he can expect to decide either to put in a machine exactly suited to all his operations, or a significant part of them, or to look around for a suitable bureau machine to plug into at night, say, provided the programmes are available, and the economics of transfer to and fro are reasonable. Where data links already exist for the transfer of commercial data, the use of a large central computer which will absorb large quantities of print data per second, transform it and retransmit back, will become feasible both technically and economically, and I fear the printer may soon become an automated plant, captive on the end of a line from the large central computer. The large computer will become essential once we desire to use a versatile multi-fount reading machine, or to do really complicated setting and to control ultra-fast composing machines such as ZIP and Linotron.

Sensitive areas in development of computer typesetting

I want now to review briefly those areas in which some definite and substantial improvements are required before the full capacity of the second generation digital computers can be used to the full. I take it that this is one of the purposes of our meeting together, and all these points will be dealt with in detail in our later sessions, so there is some point in introducing them to you.

The first area concerns input to the computer. Although there are a number of so-called multi-fount optical readers available with impressive specifications, they are expensive, and we have yet to hear of large scale successful use of them. Many people predict they cannot solve the larger problems of our industry, and Dr. Wilby has recently called for the adoption of the Bull CMC7 code for our input writing machinery. It is generally acknowledged that today the efficiency of the first keyboarding operation largely conditions the economics of composition. Included in this is the freedom from transcription error, or misinterpretation of an author's or publisher's doubtful copy, and the freedom from format error, or misemployment of the composing machine controls. The second we can remove by using computers, and it will be a useful gain; the first we cannot remove. The most we can do is either to reject the original as unsuitable for reading, which imposes on the author or publisher the necessity to remove the uncertainty, or we can employ a double keyboarding or optical reading before we do this to detect

and remove new errors introduced during keyboarding. Alternatively we can hand over the keyboarding (and its associated 'tape' preparation) to author or publisher—which has not yet been shown to be feasible—or ask him to prepare his text on a readable or compatible typewriter, perhaps one with a magnetic print-out (as is in use for some ledger account cards).

Certain it is that we need to be able to measure, assess and improve our keyboarding skills and to develop error reduction and correcting routines which will improve the economics of subsequent processing. For this reason I favour hard-copy production at the keyboarding stage. So far as I can see it has been omitted from current keyboards in use in the industry, because at the time they were invented it was not possible to produce a satisfactory hard-copy (although the interchangeable Hammond type segment did exist). This problem is still with us, and indeed the profusion of made-up tape typewriters is an indication that we have yet to solve it satisfactorily—and at a reasonable cost.

The second sensitive area concerns programming—and the best way to improve programmes for computer typesetting is to write them and use them. So far there have been so few written and used that we cannot be sure we know exactly the best way to do the job. In particular we are short of information on several counts. Firstly, on what precise typographical parameters are we free to manipulate, and within what limits should we vary them for various qualities of setting? Secondly, the programmes that have been used for actual printing jobs have not been subjected to sufficient public scrutiny and measurement, nor for that matter have the styles of printing they have been designed to replace! It is reasonable to suppose that users and the computer companies have carried out a number of statistical measurements, but not a lot has been published, and the standards by which assessment can be reliably made need to be publicly established.

The writing of a programme presupposes a knowledge of the precise styles that will have to be accommodated by it. Notice I did not say it fixes the style, but it must be written so that it can encompass it. There is no doubt that programmes would be simple if we had a relatively uniform style. It would, however, be sufficient if we had a consistency in our different styles. At present there is none, and I have yet to find any one feature except perhaps close, even spacing which all agree is a desirable component of style. House style, or good style, must be the last refuge of industrial anarchy in our present society, now that we are agreeing to adopt unified screw threads and a decimal

currency! Much nonsense can be written for and against the need for a uniform or consistent style. All I ask is that there should be good reasons stated and generally agreed for any major decision to allow variations; otherwise acceptable standardization should be sought. I am sure we can provide for adequate variety in our programmes—the computers are certainly capable of it, provided it is logical and consistent, but scarcely otherwise.

The third sensitive area concerns the traditional methods of proof-reading, the corrections of literal errors introduced by the printer, the accommodation of corrections, and the allowance or otherwise of alterations by author or publisher subsequently to the acceptance of the final manuscript or typewritten text. It is hardly to be supposed that the introduction of computers can or will leave these all unchanged. There may have to be the division of work into two kinds, those for which the freedom to alter, at a much increased cost, is preserved, and those for which it is given up. Our initial endeavour in designing programmes must be to delay the point at which we refuse alterations as late as possible, and this is bound up with the way in which we do our editing and correcting or altering, and the way in which we operate our final page proof machine. For the full answer we have to wait either for the next generation of composing machines (to see if they can provide us with cheap page proofs) or for someone to provide a service on a machine like the Xeronic with the typographical features we require and an acceptable price and delivery.

Fourthly, the existence of a large data processing industry already using cards and tape, and of a telegraphic system using 5-hole tape, and of a wire-tape system using 6-hole advanced sprocket hole feed tape, poses formidable problems of translation upon any new users who may wish to correlate any of these with the newer 8-hole one inch tape favoured by computer manufacturers. These become even more formidable when the variety of high density magnetic tape formats are considered, and the cost of conversion from one to the other, £30,000 being the approximate cost of the necessary equipment. Whatever happens, large amounts of machinery in use to-day will either have to be altered or replaced, or we shall have to go on using converters and translators for a considerable time, and at considerable expense. The printing industry, particularly the newspaper industry, is the worst off of all from this point of view because practically all the tape operated plant it uses has its own esoteric private code, and its own 'tape' format.

Last but not least, I come to the considerable problems of adapting the existing labour force to the changes to come in the

industry. Here is an argument for gradual change if there were none other, but the trouble is that for some types of operation we need rapid change if the work is to be kept inside the conventional industry. This is not an argument for panic measures, but equally there may be losses to the industry unless we stage a planned introduction. I believe that even the older craftsmen can enjoy the introduction of 'new improved' methods provided they respect the machine product and understand how it can be produced by automated methods. There is obviously a challenge here for management and union leaders. It would be presumptuous of me to say how they should proceed. I can only record the tolerance and pleasure I have seen upon the faces of keyboard operators and caster attendants when they have been told about and have seen the product of the modern machine marvels, and my own experience of staff is that they almost without exception are capable and willing to perform at a higher level than we assess them. This must mean changes in recruitment requirements, in the curriculum in the printing school, in further training, and in the importation of graduate engineers, scientists and programmers into printing plants. At this present moment, the training of scientists and mathematicians in the requirements of the printing industry presents the biggest problem. Even if the industry were willing, how could it attract, train and hold graduates in the intense competition for them to-day in all other fields?

As printing becomes increasingly involved in data processing techniques, so is publishing involved in the tremendous developments taking place in information retrieval and dissemination. We have already mentioned the effect of business and commercial data processing operations; in the past these were largely confined to the office duplicator. More of this data may find its way into printing plants with computer typesetting. Similarly the operation of powerful information retrieval systems may (as in the case of MEDLARS) produce more or different printed matter replacing some of the books and pamphlets already in production. No one can predict whether this will mean a concurrent reduction in material coming to the industry from more conventional sources, but it may.

The statistical approach

Finally, to be on a par with other business, actuarial and scientific operations, we need to realize that the preparation and processing of texts for publication is an operation susceptible primarily to statistical control and analysis.

An attitude which imagines that operations can be perfect, or that absolute rules and limits can be imposed on a living variable entity such as a language or its representation on paper by milliards of symbols, is not tenable. I shall hope to show later that we can subject it to statistical analysis and control, that this attitude is fundamental to machine control operation, and that it provides a healthy new outlook on a number of old problems. The printing industry, as far as text operation is concerned, will then be one of the last to yield to operations analysis, to recognize that the individual letter or word, to the general reader, has no valid identity of its own, but exists simply as a member of a statistical group.

The power and all-pervasiveness of modern digital computers cannot be gainsaid, and they will come to be used in typesetting operations.

Their use will affect operations powerfully, not only by reducing processing times, and reducing hard labour, but also, at the outset particularly, by imposing a clear-cut basic logic in our specifications for their use, so removing uncertainties which have crept into our traditional usages. The best way to learn how to use their power beneficially is to set to work to try them out, learning by doing. While a certain amount of ratiocination is possible about their use, the only truly profitable method is to use them for specific tasks and to analyse the results.

CHAIRMAN: Thank you very much, Mr. Duncan, for giving us that panoramic view of computer typesetting and allowing us to gallop right across this large terrain. We have, in that short time, covered a very wide range, which will be considered in more detail during the course of the conference. Therefore I hope that, in the short time which we have available for questions, we will keep our discussion fairly general, because there will be an opportunity of probing into the individual aspects later on in relation to the particular papers.

Mr. HOLLAND: You mention that there is a tremendous shortage of programmes, and I think we are all aware of this. How do you see the development of these programmes? Who do you think is really going to produce the right kind of programmes for existing machines as well as for future machines? Do you think this is a university job, an agency job or a job for the manufacturers of machines?

Mr. DUNCAN: I think it must be everybody's job; I do not think you can leave it to any one group. Programmers have got to be taught printing and printers have got to be taught programming; Universities like our own can help; the computer manufacturers must go into it to sell machines; the typesetting

people like yourself will be interested. There must be a broad advance, and it must be a parallel operation.

Mr. O. SCHWARTZ (Alphanumeric Inc. U.S.A.): You have mentioned some confusion with the use of many different codes. Has there been any attempt here at code standardization, such as the ASCII (American Standard Code for Information Interchange) code which we are trying to adopt in the United States?

Mr. DUNCAN: On Thursday morning we shall be talking about codes. I am not an expert on codes. I only know there is confusion.

Mr. FREIMAN: In my country I have undertaken to list all the printers who have IBM computers for accounting or for typographical purposes. My purpose is to send their names to the IBM Company, the theory being that if enough names of owners of computers or potential buyers of computers can be put together, the IBM Company in New York may roll up their sleeves and produce the programmes. A number of printers now have programmes for linecasting machines but none in America has a programme for the Monotype. In England you are bright enough to use the Monotype far more extensively than we are, so I think we shall be able to get a large number of names from people in England and on the Continent. If that list is large enough, the programmes will be forthcoming from IBM, perhaps more quickly than we think. Is there machinery for getting all these names together, because I think this will be the effective way to produce results?

Mr. DUNCAN: I am in full agreement with this. If we could twist the arms of one or two big manufacturers, I think it could give us the impetus we need. They have got the resources.

Mr. FREIMAN: Is there machinery available to us this week for getting these names together because there will be value in a list of this size? IBM will be receptive to that list, I am convinced, if we can produce it within a reasonable period of time.

Mr. DUNCAN: I only see one difficulty in England, which is that few printers have IBM machines, but there may be enough to add to your list.

CHAIRMAN: To answer the last part of your question, the Computer Typesetting Committee of the Institute would be the logical mechanism for obtaining this kind of information.

Mr. J. D. BESLEY (Hazell, Watson & Viney Ltd): I would like to ask Mr. Duncan whether he ever foresees the possibility of computer on-line printers providing plate-making facilities?

Mr. DUNCAN: The answer to that is, I not only foresee it but we are already doing it, are we not? We are using on-line printers to produce Duplimats, and I shall have some examples

here tomorrow of hyphenation charts to produce. It is not very good printing, but it is a strict answer to your question. I cannot say whether on-line printers will ever be of the quality which will make first-class metal plate comparable with deep etch, but they will get better; it is only a matter of time.

Mr. T. A. SKINGSLEY (London College of Printing): Do you foresee any possibility of the use of computers in typographical design?

Mr. DUNCAN: If you mean selecting a combination of pre-listed desirable typographical features, I see this as a distinct probability.

Mr. SKINGSLEY: Is there any work in this field as far as make-up is concerned?

Mr. DUNCAN: There are a number of experimental studies going on with make-up devices. Most of the people who have been thinking about this in the big companies and in the States on American Government contracts have, in fact, talked about automatic make-up features of some sort or another. This will be done in the newspaper field, I have no doubt, as soon as it will really work.

Mr. FORBES: Would you care to comment, Mr. Duncan, on some of the experiences which you have actually had in preparing information and putting a job through your experimental computer which leads you to feel that there are opportunities for human skills which are very basic in the composition area and which could be adopted and could make a great contribution in this area?

Mr. DUNCAN: The trouble is that our operations have been so basic and so fumbling that, in fact, without human beings at all stages we would never have got them through. I think I am going to exemplify this tomorrow. Anything which I have said must not be set down in writing as meaning that human beings will not be required; they will. There will always be hyphenation decisions in really tip-top work which will require human beings. Until we get very sophisticated in our programmes, we shall have to use human beings to have a final look at the plate. Take a situation where you have three hyphens, you can programme a computer to avoid three hyphens but only in some cases at the expense of sending the text back to the author and saying, 'Please delete three words', or something of this nature! There is always going to be room for human beings.

Mr. F. SIMMONS (NGA): From what you said, Mr. Duncan, with regard to reading of proofs, one would imagine in a page of figures that all you needed to do was to check the first

and last lines to ensure that the page was correct. Are you suggesting, therefore, that a computer will be so foolproof that the whole of the intermediary lines are, in fact, on the page and that no figure has been put in either wrongly or duplicated or triplicated in some way or that there are not hyphens at the ends of three consecutive lines? Therefore, can you visualize the whole job going to press without the necessity for it to be checked either line by line or page by page?

Mr. DUNCAN: I would like to be able to say that human beings are required. However, I can only tell you of Bozman's experiences as reported here. At the National Bureau of Standards (U.S.A.), they found, after checking the first one or two pages very, very carefully, that all that was necessary was for them to see that the first and last lines were there, and then they printed the results willy-nilly. I will not say that the result is error-free, but there is a high probability that it will be as error-free as it would be had it gone through the conventional process. More I do not claim.

Mr. W. J. JONES (London College of Printing): Could we go back to manpower just for a moment? Could Mr. Duncan give us his views on how the conventional skills in printing might be applied or harnessed to computer skills?

Mr. DUNCAN: This is right outside my experience, but it has been reported from America—and there are lots of Americans here who will say yea or nay to this—that the better people in the comp. room make fine computer operators. Of course, the trouble is that you do not need so many of them, to start with anyway.

Mr. FREIMAN: The first thing I learned in discussing automation was that one should not expect one hundred per cent automation. There is an undercurrent of fear which exists on both sides of the Atlantic that man will become outmoded. As far as I can see, man will never become outmoded until he blows himself to pieces! However, in this area I think we should look for a percentage of total perfection. I would settle for eighty per cent automation and be very happy, just as once we settled for automation when the Linotype and Monotype machines were introduced. The under-current of fear that man will be unnecessary is absolutely unfounded.

Mr. H. P. WHITTAKER (M. H. Whittaker & Son Ltd): Mr. Duncan said earlier in his talk that we shall have to get used to some changes. He said—I think I am right in saying—that we should have to be prepared to accept some specific changes in the craft of printing. I would like to ask Mr. Duncan to be more specific. Does he mean we are going to have to change

our alphabet? Does he mean we are going to have to get used to using less numbers of characters on our composing machines? Or does he merely mean we are going to have to get used to a change of format?

Mr. DUNCAN: That is a big question; less variety in format is one easy answer; as to fewer characters, this may be the case in certain circumstances, or you might have to pay more for more characters. At the moment, because a Monotype machine is so versatile, you can have practically anything you want, and I was almost going to say that you get it practically for nothing! When it becomes very expensive, then you have to make a different type of decision. This is the sort of hard thinking I was meaning.

We may have to adjust the types of material which we can afford if we go for machine processing. I would expect, of course, machine processing in the end to produce economies, otherwise I would not be here talking to you. We can only produce economies by putting ourselves into a somewhat straiter jacket.

Mr. G. CARD (Index Printers Ltd): Could Dr. Edwards or Mr. Duncan make a comparison between the accuracy obtained in computers as against typesetting machines? I believe this will clear the air. In talking about tables, it is said that it is only necessary to look at the beginning and the end of each page. I think the accuracy of a computer is at a much higher level.

Mr. DUNCAN: All I would say is, as far as we have been told by the telecommunications people and the computer people, that we have not yet really got down to the problem of error detection and automatic error correction. Very powerful techniques are used in telecommunications which not only detect an error but put it right before you are told there has been one. I can think of very elementary examples of how this particular technique could be used to tell you that it is not the same as it was when it was put into the computer. This is the sort of check computers do.

Mr. R. E. ROSSELL (Graphic Arts Industry Research Council): If a computer prints out 100,000 characters, how many errors would you expect? How many errors would you expect from a typesetting machine printing out the same number of characters?

Mr. DUNCAN: I always assumed that the computer printed 100,000 correct ones.

Mr. FREIMAN: I picked up a statistic the other day. In a certain large printing plant, the linecasting equipment produces one error every one-and-a-half hours, and Monotype equipment produces one error every three-quarters-of-an-hour. This is a far higher order of machine error, due to maintenance, no doubt.

CHAIRMAN: Thank you very much. I will have to terminate the discussion here. It is not really closed; we are only putting it into store, and will be able to come back to this subject later in the conference.

Editor's note

The conference, in fact, opened with a paper given by Dr. D. H. B. Edwards of Manchester University who gave a basic introduction to Digital Computers. This paper was intended to provide a general background for the assistance of those present who were not familiar with the subject.

Much has already been written to explain General Purpose Computers and a short bibliography of this subject follows:

Bibliography

- Thinking Machines*. I. Adler. Dobson (London) 1961.
- Digital Computer Fundamentals*. T. C. Bartree. McGraw Hill (New York) 1960.
- The Computer Revolution*. E. C. Berkeley. Doubleday (New York) 1962.
- Computers, Their Operation and Application*. E. C. Berkeley and L. Walnwright. Chapman & Hall (London) 1957.
- Faster than Thought*. B. V. Bowden. Pitman (London) 1955.
- Management and the Computer of the Future*. M. Greenberger. Wiley (London) 1962.
- Automatic Data Processing Systems, Principles and Procedures*. B. H. Gregory and R. L. van Horn. Chatto & Windus (London) 1960.
- A Simple Approach to Electronic Computers*. E. H. W. Hersel. Blackie (London) 1962.
- Digital Computer Principles*. W. C. Irwin. van Nostrand (London) 1960.
- Understanding Digital Computers*. P. Siegel. Wiley (London) 1961.
- Minds and Machines*. W. Sucklin. Penguin (Harmondsworth) 1960.
- Electronic Digital Computers*. C. V. L. Smith. McGraw Hill (New York) 1959.
- Teach Yourself Electronic Computers*. F. L. Westwater. English Universities Press (London) 1964.

At the conclusion of Dr. Edwards' paper discussion ensued:

Mr. FREIMAN: I would like to enquire whether there is any point in returning to a discussion of the analogue computer in view of its low cost for our industry.

Dr. EDWARDS: It seems to me that the analogue computer is not particularly suited for the sort of operation you want to do. Although I am not an expert on analogue computers, I would say that it does have an advantage in that it is made for one particular type of job rather than being a general purpose machine. A point I did not raise was this question of whether one should have a computer of one's own or whether one should buy computer time—and do the control by some other medium on computer-prepared media. From the sort of calculations which we have done, the only reason that we have gone to very big digital systems is that we can justify it economically, in that the big digital system is the one which does your job cheapest of all. Nevertheless, in initial experiments, very often because you do not have control of the computer, this is the part which you may feel lets you down. Analogue devices come in on the periphery of digital computers for doing things like graphical plotting. For such purposes analogue techniques are useful, but as an extra.

CHAIRMAN: I think it is true to say that Dr. Edwards raised the analogue computer to identify better the digital computer for our purpose.

Mr. F. C. HOLLAND (Monotype Corporation): You have shown us how things have progressed from using tubes to transistors. What do you think will happen in the future? Are there any major changes in the offing? I read an article a while back which mentioned the possibility of pneumatics, which I found rather surprising. Have you any comments on that?

Dr. EDWARDS: I do not know whether we had any connection with that. We have played with pneumatics from time to time. Where this sort of operation comes in very often is in an attempt to move things, like heads on recording surfaces. I do not think that we are talking about something which is in the same class as the first thing you mentioned, which is the change from valves to transistors. Pneumatic techniques can be useful but they do not create the same sort of impact.

Mr. E. FORBES (U.S. Government Printing Office): I should like to ask Dr. Edwards if he could say a few words about the comparative performance of wired logic, particularly for the computer composition portion of the computing work to be done. Have you given any thought to this or made any investigation of it? This is a special-purpose machine rather than a general-purpose machine.

Dr. EDWARDS: As I said earlier on, the special-purpose machine will certainly give printers much more control over what they are doing. It is made for their job. There are two ways in which you can go. It is much easier to do experiments by using

someone else's computer, and it is also much cheaper. When these experiments are done, one could then, perhaps, investigate the special-purpose machine for doing the job. Roughly speaking, this is the way we have always tackled things: that is, to programme the things first and see whether it looks feasible to do an engineering study. It is not that easy to decide straight away. People tend to regard the computing service which they use as something rather remote; it is a way of removing responsibility. This is partly why people prefer it. With a special-purpose machine, you are landed with it; you have got to make it work.

In connection with automatic typesetting, as I say, I feel a little embarrassed at appearing at this conference because I have no experience of this. The best thing to say is that I cannot answer your specific question.

CHAIRMAN: Thank you very much, Dr. Edwards, for your talk and for the answers to these questions. Even if you do know little about computer typesetting, you have given us a valuable insight into computers this morning.

Problems of Computer Typesetting

CHAPTER 2

Problems of Computer Typesetting

Chairman

Mr C J Duncan

Speakers

Mr R F Fullick

Mr R Boyd

Mr D Macintyre

Mr E J Coates

Mr J M Johnston

Mr H G Milner

CHAIRMAN: We are going to start, first of all, on books and solid text. I have a vested interest in this but I am not going to say anything until I have another go at you tomorrow.

The first speaker is going to be Mr. Fullick. You will have read his autobiography in the conference booklet so I do not propose to do anything more than to introduce him to you and ask him to open the proceedings.

Problems of a book printer

Mr. R. F. FULLICK (Hazell Sun Ltd): In this two-and-a-half days of theory and typographical philosophy upon which we have embarked, I at least feel myself fortunate in being able to state an incontrovertible fact: that is, it is extremely difficult for any speaker to follow Mr. Duncan!

One does not have to be long involved in computer typesetting to realize that it is somewhat like climbing a hill; when one thinks one has got to the top, one realizes that it is just a false crest, and all it does is to reveal another uphill area in front of one. This is certainly how I have felt in the year or so during which I have been engaged in this.

In this period, when interest in computer typesetting has been growing, there have been points of view put forward questioning the need or desirability of this line of technological research in the printing industry. Fears have been expressed for the position and future of those people who make up the industry in all its diversity, whether they be master printers or workpeople.

It might, therefore, be appropriate if I give an idea of the sort of feelings which activated my own company to give support to this new line of research.

In short, I think we are doing it because we really feel it must be done. We feel that if as a company we have resources available we have a duty to follow technological paths which are likely to lead to a more efficient use of the resources we have, a more economic use—we hope that this follows—and a more effective use of the men who operate those resources. It is our very firm opinion that a *prima facie* case has already been made out for computer typesetting as applied to general printing. Whatever Mr. Duncan's reservations may have been from time to time in his lecture this morning, I think that these are problems which are soluble and I hope and believe that the means already exist or are becoming clear to solve them.

I should like just to spend a minute or two longer saying what the problems of entering computer typesetting were, as we saw them as general printers. When I say 'general printers', I mean a fairly diverse group of diverse sizes, printing by the three principal methods—gravure, letterpress and offset lithography—and printing all types of work: encyclopaedias, registers, general books, magazines and other periodicals.

Clearly in the typesetting facilities we already had available, there were certain basic requirements which we had fulfilled by setting up the type of operation we had set up. We obviously had a need to accept all standards of copy and all types of copy, and to be able to handle it and convert it into type. It was obviously a need that we should be able to set to the high typographical standards which have grown up in the industry, even if honoured sometimes more in the breach than in the observance, which one considers to be the bed-rock of the way one works.

There was a need to have the ability to set books of complicated design or with frequent changes of face or unusual make-up. While it is possible to reduce these problems to quantitative terms so that they can be handled by an electronic machine, such as a computer, clearly these problems were not going to be solved all together. We found that there were general problems which really came out of these basic requirements that we had set ourselves, which had to be considered very carefully before we could think of introducing computer work. Clearly we have got to be able to use the product of a computer, which means that any printer who has intentions of this sort must have tape-driven typesetting machinery and filmsetting machinery. He must have the ability to convert the copy he gets—and he knows what sort of copy he gets—to a suitable form of computer input: that is to

say, his resources must be easily modified and the type of skills which he already has must be easily adjusted so as to be able to translate his copy into a form which can be read by the computer. He must satisfy himself that the computer will be able to set the type to the highest typographical standards.

Perhaps, in thinking of the computer, we had overcome one hurdle by the concession which printers and their customers had, in effect, made in accepting phototypesetting. It meant that they had accepted that the type character would have the same proportions whatever size it was reduced to or enlarged to by optical means, rather than each size having its own proportions based entirely on aesthetic considerations. This was a step on the path to the quantitative analysis of typographical work.

A further problem is that the proofs have obviously got to be quickly and easily available. We may find here that Mr. Duncan does not agree with us. As far as possible, it seemed to us that any computer system we embarked upon should be able to be equated with our present methods of typesetting. We should make available in one form or another proofs of the same sort as are at present available to customers—that is, proofs from which the same work could be done. They may not be typographically exact but they should be of the same general nature. This was a serious problem as far as we could see it from an examination of the earlier systems of computer typesetting, which seemed to be mainly designed for newspapers, the method being that of going from an input paper tape to an output paper tape.

We felt that there was a need to have the minimum disturbance of one's existing organization and skills, and that any new system which we took on should be able to be translated smoothly and logically to new skills: that is, we should with our available management organization be able to absorb a computer without considerable upset.

Finally, we felt that at least in the long run, if not in the short run, any new system should have to show economic gains.

Those then were the main problems which we set ourselves to solve. It is no part of my brief at this moment to say how we set about solving them. That I hope will become clearer in the next day or two.

CHAIRMAN: I am now going to ask Roderick Boyd—and many of you will know him—to talk to us about the approach which has been adopted at Clay's to problems associated with retaining operator control.

Monitor controlled computer processing of bookwork

Mr. R. BOYD (Richard Clay & Co. Ltd): Mr. Duncan this morning quoted five particularly sensitive areas in the application of computers to printing: firstly, improvement of input methods; that is the keyboard; secondly, the programmes; thirdly, the possibilities of correction systems; and, fourthly, code standardization; and fifthly, mobility of labour. Of these five, the first and third—that is improvement of input and correction systems—seemed attractive to us as book printers as being the immediate potential area of great method improvement, within the framework of an existing typesetting system. The monitor controlled special-purpose computer is attractive, at least as a first step in this field because, again as Mr. Duncan said, it throws up many of the practical problems which are common to a programmed computer operation.

The first problem is to relieve the keyboard operator from making all justification decisions and as many non-productive key strokes as possible. Secondly, a tape-merging system can allow corrected tapes to be produced before the casting operation. With existing equipment and its fairly high machine error rate—that is, hot metal casting equipment—this is only of doubtful benefit but we are looking towards filmsetting, probably with a low machine error rate. There is a third useful by-product for the book printer in a continuous tape system: that is, that a book page set can be produced in a variety of type faces from the original or corrected tape.

With existing typesetting systems there is a very little leeway in the cost structure to allow for additional stages without additional expense. For instance, a typical cost in this country for keyboarding and casting a straightforward 256-page novel on a manually-operated slug machine is £81. Unfortunately, a standard tape perforation system and a tape-operated slug casting set-up make only very small savings in this figure and it is only by great economies in the perforation stage, maybe casting and possibly correction, that the additional steps of tape processing can be paid for. It is therefore probable that something less than fully automatic operation may be acceptable, provided the input speed is fairly high and the hourly rate relatively low.

I mention Linasec by name, because that is the particular monitor controlled computer we are using. This does not necessarily imply that it is the best available equipment and other systems are continuously reaching the marketing stage. There are

two types and I specifically refer to Linasec I. I imagine that its functions are well known to most people here. Although described as a monitor-operated machine, within certain parameters it is fully automatic. It depends on just how wide you are going to make those parameters as to how much monitor intervention you have. For instance, the interword space available on the casting machine is divided into three parts on Linasec. There is the absolute minimum available below which you cannot go. There is the absolute maximum, and then there is an arbitrary figure, of say, 40% below the maximum. Provided a word space falls within this first 60%, the machine automatically passes to the next line. If no word space falls in this area, the word by which the line is overset is displayed on the cathode ray tube (Fig 1). When this happens there are three possibilities: firstly,



FIG. 1.

hyphenation by any of the left hand group of buttons at the appropriate point; secondly, if the word is unsplitable it can be removed completely to the next line, in which case the interword button is pressed; thirdly, if both hyphenation and interword have been tried and the word still remains on the screen, it indicates that the remaining 40% of band expansion is not sufficient to fill out the line. The monitor then presses the bell button followed by the interword button. This puts a caster stop code in the output tape and add-thin space codes can be punched in by hand or the thin spaces manually inserted on the casting machine.

A further control panel is mounted on the right of the display tube (Fig. 2). Measures are pre-set on a dial. Position A is whatever measure is set up on the set of adjustable wheels. I will deal



FIG. 2.

with the calculation of measure when I come to the counting section.

Positions B, C, D, E, F, G, H are all pre-set measures, such as 22, 24, 26 and so on, ems. One of the most useful controls has proved to be the switch marked 'continuous' on top and 'line' below. If the monitor feels that he is approaching a difficult point for instance, an initial letter or indentation—he can simply switch over to line and then by pressing the line-release button one line at a time is allowed to escape through the restriction.

The type face is controlled by an independent plug, and at present this caters for 90 different character widths. A modified plug to take 180 widths is either promised or available. This will probably be required if the use of Linasec is to be extended to more complicated composition.

The basic unit of counting in the Linasec is a fifth of a point.

Fig. 3 is part of the conversion scale. The Linasec units are in the left hand column and the appropriate measurements of the character in thousandths of an inch on the right. For instance, 37 Linasec units go from .1010" to .1032". Any character falling within that range is allotted 37 units. Although this may not seem a very accurate system only allocating each character somewhere within .0025" of its correct width, in practice it appears to work very well, and the one thing we never suffer from are tight or slack lines.

WIDTH COUNT CONVERSION

Linasec Count	Brass Widths
30	0815"—0843"
31	0844"—0871"
32	0873"—0899"
33	0900"—0926"
34	0927"—0954"
35	0955"—0982"
36	0983"—1009"
37	1010"—1032"
38	1038"—1065"
39	1066"—1092"

FIG. 3.

One of the unexpected problems which has occurred is that of winding and unwinding tapes. The photo-electric readers are very sensitive to tight or kinked tape, and if either fault develops the output tape can soon become nonsense. This is the sort of thing that one tends to ignore when one thinks about computers but it can very quickly make a loss out of a profit.

The other big problem in introducing a further tape-handling stage into the process of typesetting is that there is the possibility of additional errors creeping in. Particularly in the case of a book

printer, there is a very long time lag between the various stages of composition. For instance, perforating, processing, casting and proof reading can easily cover a span of a fortnight. Therefore, an uncorrected repetitive error, perhaps at the keyboard stage or on the monitor, has serious repercussions. In fact, in the absence of any other system the first thing which happens is that the monitor on the line-casting machine sees something going wrong and you find that you have as much as a fortnight of tape up the spout! To minimize this risk we run a daily test tape on Linasec, and this gives known results in the output tape and the counter. This has been very satisfactory and such errors as have been shown up appear due to punch adjustment and not Linasec itself. We have been very lucky in this respect, probably not so much luck as good equipment design.

As far as production is concerned, the operating speed of Linasec is 110 bits per second. This figure includes all function codes and end-of-line signals. The amount of work produced does vary from job to job. Generally speaking, the fewer the spaces in the line, the less the output. So large type sizes in short measures and even an excessive number of long words can be detrimental. Whenever possible, if we get confronted with an excessive number of add-thins we do try and punch the extra code into the output tape for automatic insertion on the casting machine.

Fig. 4 is a cross-section of work which we did in June 1964. This shows the type size measure and the space band which we are using. In fact, we have tried two different types—TTS bands and 8-20 bands—the former are very coarse wedge and the latter are finer wedge. The no-hyphen condition arises when a word occurs on the screen which already has a hyphen in it or, for instance, an em rule and you decide to split it in the fixed space; it prevents a hyphen appearing in the output tape other than one which is already there. The bell column is the number of times the monitor has to press the bell stop for add-thin. On the right is a brief summary of the figures; the final figure of lines processed per minute varies between the 44 and the 58 lines a minute. Generally speaking, the smaller type sizes—that is the last three of our Platin—figure fairly well. There is an unexplained one at the bottom giving only 46 lines a minute. These averages include the time taken to change tapes, put new tapes in, and interruptions. Whether you average that over an eight hour day I do not know. We have not really run full time yet.

A considerable difference can be made to the average figure if the first space band expansion is increased to 80%, but in our opinion this gives us an unwarranted amount of extra type matter, about two lines a page.

Typical Linasec I Outputs June 1964

Measure and Type	Space Bands	Tapes changed	Monitor Interventions				Lines per add thin	Lines per intervention	Lines per hyphen	Lines processed per minute
			Inter word	Hyphen	No Hyphen	Bell add thin				
10 pt. 22 ems Baskerville	TTS	3 input 2 output	173	192	50	16	158	6	13	44
11 pt. 21 ems Juliana	TTS	4 input 2 output	n/a	n/a	n/a	13	254	n/a	n/a	55
10 pt. 21 ems Plantin	K 30	2 input 1 output	75	56	6	10	143	9½	25	51
9 pt. 21 ems Plantin	K 30	4 input 2 output	118	110	17	10	277	11	25	55½
9 pt. 21 ems Plantin	K 30	1 input 1 output	23	20	1	1	640	13	32	58
9 pt. 21 ems Plantin	K 30	2 input	82	88	20	5	249	6	14	46

FIG. 4.

The time to change over from one job to another is very short, five minutes or less. All the monitor has to do is to change tapes and possibly, the counting magazine and the measure on the control panel.

One thing which we felt about a monitor-operated computer was that it could cause the least possible disruption to our plant. We felt that a machine of this type could make very good use of the staff which we have available. In fact, our Linasec operator is a Monotype keyboard operator via a Fairchild TTS perforator. I think that it is essential for the monitor to be able to read the output tape. In our case it is TTS code, so his time on the Fairchild perforator was to good advantage.

I come now to the savings which we hope to accomplish. The most difficult saving to estimate accurately is also the most important: that is, increased keyboard efficiency. Before we committed ourselves to Linasec we made some initial trials with one extra operator, and this showed that an increase from 10,000 in an hour on justified work to 15,000 ems an hour on unjustified work was possible. In practice, what we hope to achieve is somewhere around 20% to 30% average increase over a roomful of perforators.

One of the reasons that this is so difficult to estimate is that the percentage increase for a good operator, either Monotype or Fairchild going to unjustified tape, is considerably less than for a poor keyboard operator. It helps the lower end of your talent considerably more than the upper end.

Another saving that computer justification—if I can call it that—brings is on the linecasting machine itself. Tape processed by Linasec is almost entirely free from either slack or tight lines and also the lines where the keyboard operator has forgotten to press an end-of-line key at all.

The division between monitor-operated computers and programme computers is becoming very tenuous.

As an example of this, the same column of 12 ems measure was set four different ways on Linasec I and II and gave the results shown in Fig. 5.

Alteration of the spacing parameters only made a difference of five lines but removed the necessity for monitor intervention; the machinery did the whole justification operation. The final column admits letter spacing. There is a very considerable drop in time between column A and column B. That is where the big saving takes place. There is less difference between C and D, though D has dispensed with the monitor entirely.

The Chairman and Mr. Fullick both touched on one of the remaining problems of book-work setting, that of producing a

Automatic Line Ending	No. of Interventions by Monitor	No. of Lines made	Time in Seconds
A Space band only (Linasec I)	21	89	60
B Space band + en	11	89	40
C Space band + en + space band	1	90	40
D Space band + en + space band + letter spacing	Nil	90	40

FIG. 5.

tape embodying all the corrections before committing it to the casting or setting process. Linasec does nothing towards this at present, but I would like to say a few brief words about a system that does.

Robotype is the first automatic merging system specifically designed for printing. The keyboard in this case is a modified IBM typewriter. It produces a justified tape and also the hard copy on pre-numbered paper, part of which is shown in Fig. 6.

Each line is given a discrete code. The codes shown on the left hand side appear in the output tape. These, of course, match the appropriate lines on the hard copy. This hard copy is read and a correction tape generated by punching the required correction line numbers on an auxiliary keyboard before the correction is to be inserted. This is essentially a line-for-line correction system. There is no question here of saying that you want to add a single word into line 18. In this instance line 18 must be re-typed and it makes an over-run you have got to re-type line 19, and so on until reaching the end of the paragraph, or the making or saving of a complete line. It is, however, a very simple system.

Editing facilities of this type can be built into a monitor operated justification computer; but there is still a very important missing link, which Mr. Duncan and Mr. Fullick and, I suspect, everyone else who gets up to talk will emphasize: this is the print-out device. Robotype avoids the need for a print-out device by producing the hard copy at the initial keyboarding stage.

Therefore, as far as the future is concerned, the next objective in a computerized typesetting system must be the application of a satisfactory and economic print-out device which will give a proof for correction and re-perforation of a final corrected tape before starting the high-speed casting or film-setting operation.

SHEET NO.

What didst thou say? King, I bid you remember that exceeding great as is your glory to have vanquished Manfred, yet to conquer oneself is a still greater glory: wherefore you, to whom belongs the correction of others, see to it that you conquer yourself, and refrain this unruly passion; and let not such a blot mar the splendour of your achievements. "

Here stricken at heart by the Count's words, and the more justified that he acknowledged their truth, the King heaved a fervent sigh or two, and then:- "Count," quoth he, "that enemy there is none, however mighty, but to the practised warrior is weak enough and easy to conquer in comparison of his own appetite, I make no doubt; but, great though the struggle will be and immeasurable the force that it demands, as thou hast galled me I by your words, that not many days will have gone by before I shall without fail have done enough to show you that I, that am the conqueror of others, am no less able to gain the victory over myself. " And indeed but a few days thereafter, the King, on his return to Naples, being minded at once to leave himself no excuse for dishonourable conduct, and to recompense the knight for his honourable treatment of him, did, albeit 'twas hard for him to endow another with that which he had most ardently desired for himself, none the less resolve to betow the two damsels in marriage, and that not as Messer Neri's daughters, but as his own. Wherefore, Messer Neri consenting, he provided both with magnificent dowries, and gave Ginerva the Fair to Messer Matteo da Palizzi, and Isotta the Blonde to Messer Guglielmo della Manna, noble knights and great barons both; which done, and at heart beyond measure, he betook him to Apulia, and by incessant travail did so mortify his vehement appetite that he snapped and broke in pieces the fetters of Love, and for the rest of his days was no more vexed by such passion.

After such a sort then did this magnificent King, at once

FIG. 6.

CHAIRMAN: I think we have been brought down to earth satisfactorily by Mr. Boyd. I will now introduce you, if I may, to Duncan Macintyre from Westerham Press, closely associated with Mr. Fullick. He is going to tell us something about the Rocappi approach to this problem using fully automatic computer programmes.

General purpose computer

Mr. D. MACINTYRE (Westerham Press Ltd): I shall not cover the Rocappi process very fully because that will be covered tomorrow. I shall cover the uses of a general-purpose computer to the average book producer.

My company a year ago decided to go into a research project for computerized typesetting because, rather like Mr. Fullick, we agreed that there was an inherent necessity to cover composing room methods by using more modern equipment, such as is now offered by the electronics industry. We looked at various newspaper setting programmes and decided that these were too crude for standard book setting, where you are setting a large chunk of text to a relatively accurate measure and where word-spacing and letter-spacing criteria are considerably tighter than on average newspaper setting. We decided on a general-purpose computer for the following reasons. We ascertained that we could accept varying types of input; by that I mean that we would not be limited to one specific perforator. The tape had to contain certain function codes, and provided the perforators produced these function codes and produced either a five or six-channel tape we could accept them into the computer and translate them into a computer code by means of a translate table. This would enable us to accept a perforated tape from a printer or a publisher or, if necessary, from an author. We could also produce these tapes ourselves, of course.

We found that a general-purpose computer could be programmed so that we could control our own inherent house style which we were proud of. Also it could be changed relatively simply to conform to customers' house styles.

The items we were interested in controlling were word-spacing, letter-spacing, removal of widows, short lines, and multiple hyphenations occurring sequentially. We were interested in a general-purpose computer for providing necessary intermediate stages, such as a proof stage where we could get a simulated galley-proof, where we could incorporate corrections and, if necessary, produce a corrected galley-proof and, subsequently, a page proof by means of a computer print-out. This computer print-

out, as has been mentioned before, is usually in caps only and it is on continuous stationery.

We instituted a system whereby we could indicate by means of certain signs, such as asterisks, full points, underline, and so forth, the various typographical changes on this print-out, so that it would be a relatively simple matter to indicate changes into italic, bold, and upper and lower case.

We were also interested in the computer's ability to store this intermediate information on a magnetic tape so this could be updated extremely quickly and was easily accessible, and the ability to output to varying types of typesetting equipment. Within our system we can output to a standard line-caster, or to a photosetter. If the job being computed has to change from Linotype Baskerville to Monotype Baskerville, it is possible to recalculate and come out with a tape which after subsequent conversion goes on to a Monotype unit. This may be of only academic interest but we were particularly interested in this for controlling production in a large printing group, where we may have an urgent job which, originally scheduled for one piece of equipment, could be switched to another unit.

The print-out unit we use is an Anelex printer. It has 64 characters available on it at the moment, and the possibility of getting a very large increase in the number of characters, certainly to cope with additional type faces such as bold, italic, and so on, is pretty unlikely at the moment. We were getting an extremely good speed factor from the print-out in the order of a maximum of a thousand lines a minute. This was useful to give us the intermediate stage or proof on computer print-out to give to a publisher. As yet we have had no direct contact with publishers reading these print-outs, but as you will see tomorrow they are not as hard to read as you would imagine. They require a bit of re-orientation but, as you will note, there is a table printed at the top of these print-outs, giving you a legend of what the various codes are used for.

I do not want to steal too much wind from some of the people who will be talking about this system in detail, so I will close at that point and see if there are any questions.

Questions

CHAIRMAN: We have a good deal of time left for questions. I think it would be a good idea to put them to the individual speakers.

I will take the Chairman's privilege and ask Mr. Boyd a question! In relation to keyboard operation and keyboard speeds

which are all very sensitive to the need for accuracy in measuring and definition, Mr. Boyd used the term 'good'. I should like to ask him whether he means 'good' or whether he means 'accurate' or whether he means both.

Mr. BOYD: I think it is very difficult to define 'good' unless you define the keyboard operator. A good Monotype keyboard operator, I would say, would be an accurate keyboard operator producing something like 10,000 ens and above an hour. In our experience there is a risk at this sort of speed that the man will beat the justification drum. He is still a good operator, he still has his fingering right, but he is impatient. This is the sort of thing that continuous tape or removing the justification decision can do. It removes this source of error and prevents it from having the disastrous effect it does at the moment.

CHAIRMAN: If you could get 15,000 ens out of the man with one per cent error, this would be better than getting 10,000 ens with no error percentage, would it? Have we any equations at all?

Mr. BOYD: We have no equations for error. Our basis of thinking is that if we take as many non-productive decisions away from the man as we can, we are not going to increase our error rate. We hope we are going to get a rise in speed as well.

Mr. G. CROUCHER (William Clowes & Sons Ltd): May I bat on the same wicket? I was most interested in this test of an increase from 10,000 ens to 15,000 ens. Was that one operator on the same copy? How long did the test continue and can you give us any further information about it?

Mr. BOYD: It was one operator. It was on the same copy. It was on a Robotype type keyboard, so the operator had to wait—although perforating without line endings—for the carriage return on the typewriter. The test was not long. It was four hours; in fact it was a morning shift.

Mr. P. GARDNER (Northumberland Press Ltd): Could I ask Mr. Boyd to expand a little on the choice of work for unjustified tape processing?

Mr. BOYD: I think the limitations of Linasec are the limitations of the slug casting machine. If it works on a slug casting machine, it works on Linasec. That is a generalization but it is probably not far off. Of course it is no good thinking that you are going to make money out of poetry on Linasec.

CHAIRMAN: Does that mean the Linasec would not handle poetry?

Mr. BOYD: Poetry, being centred, has very little benefit. In fact, the keyboard operator would have to set it as it were going

to appear in the output tape. Linasec would centre every line if you wanted it to.

CHAIRMAN: What we want is a poetry tape processor rather than a Linasec. Experience on Linasec is parallel to that with the directory tape process which ran for months and months.

Mr. BOYD: -I felt diffident about saying that it is completely reliable. Ours has only been going for four months. Apart from some difficulty with the lower case 'i' in the first week which kept disappearing, it has been extremely good.

Mr. C. F. NASH (International Printers Ltd): I am rather interested in the costing aspect of the Linasec application, particularly as you said, Mr. Boyd, there was a saving on time on the casters. I should imagine you would have to pay for your Linasec operator out of the extra output you get from your TTS keyboards. I realize that must be done. However, could you give me any figure with regard to the percentage saving on time on the casters, if you are using the Linasec as opposed to conventional TTS tape?

Mr. BOYD: We had been operating casters from Fairchild: that is justified-generated tape, too short a time to get accurate figures on this particular point, but a tight line in a caster causes a stoppage and loss of production out of all proportion to the fact it is just one tight line. To break even with Linasec in this country I would suggest comparative figures of 13,000 ens an hour keyboarding and $5\frac{1}{2}$ lines a minute out of a casting machine. We are working up towards this $5\frac{1}{2}$ lines a minute, and the one thing we have deleted is tight and slack lines, which is quite helpful.

CHAIRMAN: Is your figure of $5\frac{1}{2}$ lines for 100% of your 42-hours?

Mr. BOYD: The $5\frac{1}{2}$ lines is for the 100%.

CHAIRMAN: Every hour of the day?

Mr. BOYD: This is what you have got to get to.

Mr. F. C. HOLLAND (Monotype Corporation Ltd): I am familiar with the problem of handling spools. Could you comment on any problems you are having in retrieval, storage, filing and re-use of these particular kinds of spools which you now use?

Mr. BOYD: Storage of them is no particular problem. Storing them so you can find them again is quite a problem! That is what retrieval is. No. We are really only just starting now. We thought first of all that we would index them by publishers, the main object being that if you get the book to do again in Plantin as opposed to Georgian you have the tape there.

I now think we should also have a cross-index of titles. There is no really inexpensive answer to the storage problem except to pile it up and put labels on it.

Mr. HOLLAND: Are you deliberately cutting your tapes after a certain number of lines or do you let it go as long as possible for a given Linotype or slug machine?

Mr. BOYD: This is quite a valid question. Unfortunately, the standard clockwork tape winder available in this country is about 5" or 6" in diameter, and you have to change these in a remarkably short space of time on Linasec when you are processing at 100 a second. We are trying to build up the whole system to cater for 10" diameter reels of tape which last quite a long time. We will have to cut to 10" diameter. There is a physical problem of handling above this size.

CHAIRMAN: For an automated industry the computer people seem to be naïve about handling these large quantities. They do not seem to have taken any of the technology from the film-cutting business. Things made out of old gramophones are probably the right means of handling these big reels. Have any of our American friends experience of handling large quantities of tape? I have seen large quantities in American magazines and journals. Has anyone got any mammoth spools?

Mr. F. H. SMITH (Monotype Corporation Ltd): Mr. Boyd was telling us a little earlier about the monitor on the Linasec. Is he implying that it is the same man all the time, or does he find that he has to switch this round with the electronic operator or something of this sort? Does one man sit and watch the screen all the time?

Mr. BOYD: Yes, he does, and he is kept fairly busy too. A lot of his time is spent in preparing tapes for input and making sure they come off at the other end all right. We have one man on the job at the moment. You could rotate operators but we are anxious to find out what errors we are getting and where they occur. If we had to find out which operator had made them on which machine, it would be another complication.

Mr. A. H. PHILLIPS (HMSO): Mr. Macintyre said that he would process any author's tape which had the printing functions on it. Has he found any author who has been able to put these on successfully?

Mr. MACINTYRE: No, not at the moment.

Mr. A. H. WALKER (Linotype & Machinery Ltd): With reference to Mr. Boyd's last remark about the Linasec operator, I have seen a Linasec operator handling tape from five perforators and operating a Linasec from the five perforators. In addition to that, he is coping with an allotter, taking the tape from the

Linasec for the slug casting machine and in his spare time—and he has some spare time—operating a non-justified perforator as well.

CHAIRMAN: Did you sign him up straight away? Might I ask you whether he had a lot of hyphenation decisions to make?

Mr. WALKER: Yes, I would say he had. He was probably hyphenating every seven, eight or ten lines.

Mr. BOYD: Was it a Linasec I or a Linasec II?

Mr. WALKER: It was a Linasec II.

Mr. E. D. HANSON (Compugraphic Corporation): I feel there may be some misconception here. This man is monitoring a Linasec. He is also directing the output to line casting machines and collecting the output from various keyboards. He also operates a perforator. He is doing these jobs in separate half or up to four hour stints, and not simultaneously.

CHAIRMAN: Only one question has been put to Mr. Fullick or Mr. Macintyre. We will have another go at you tomorrow. The system Mr. Macintyre was describing was the Rocappi programme. I should like to hear more expressions from the floor about the use of these 64 characters. I had already made up my mind several months ago that a 64 character set was no good to anyone. Has anyone got a strong opinion about the 64 character set?

Mr. R. A. FREIMAN (Random House Inc): There is a company called the Stromberg Carlson Co. who have a 40-20 print-out device. They have now made an enlarged one which gives you on a video principle about 128 characters. It comes out in microfilm. You then have to depend on yet another company for an enlargement and a print-out. Generally speaking, the print-out is made by electrostatic processes, and it is far from satisfactory from the legibility point of view. It is a burden to the author to read this. I am searching for better systems of producing the enlarged print-out. I wonder if anyone can lead me to anything in this country.

Mr. H. O. SMITH (Crosfield Electronics Ltd): I wonder whether any of the book printers or publishers present could give any opinions on whether a typescript print-out proof—that is an author's proof—has already been found acceptable. We ourselves have discussed this with a number of publishers, and the reception of the normal 90 character hard copy is distinctly unfavourable. Could any book printer or publisher give his views with regard to specialized book-work where there are a good number of characters which are not normally contained in the 90 character fount, let alone this awful 60 character fount? I would

be interested to hear of any experience which has been obtained in this field.

Mr. J. J. DIKKERS (Royal Printing House, Holland): We have some experience of a similar idea. We produce a magazine which we compose on the ATF photocomposer. We use the hard copy of the Flexowriter tape punch which gives Roman and Italics in red as the proof for the publisher who gives the order for this magazine. We are transmitting these proofs in a facsimile system so the red does not appear red. We do not have any difficulty at all with that, as they know the standard of typography of the machine. They just want to see that all the characters which should be there are there. That is the main point. When you are setting straight text—a portion of the book you are going to produce—you can use this as an example of what it will look like. I think any reasonable publisher should accept that.

CHAIRMAN: Speaking as a publisher and an author, I do not intend to be reasonable. I know I am putting your point of view to Mr. Dikkers about that. Nothing is going to force me to do this. This is the attitude. Of course one can rationalize what one is doing; we all can. We can all think of the Anelex. I can think of the 128 characters. We can demonstrate that this will work. The question is not whether it will work but whether people will adapt themselves to it. It is a question of whether the industry will adapt to it.

Mr. DIKKERS: We are in contact with other clients for the same system. We showed them how we would give them their proofs. They were all quite co-operative. This may be because the price of the text composition was quite low. I think that is a very important point. Of course it is possible to have an exact galley proof by running the photocomposing machine on inexpensive paper but this is much more expensive than the hard copy from the original typescript. I have had no trouble at all, but then perhaps Dutch publishers are less difficult.

CHAIRMAN: It is very interesting for us to know that someone is making this particular breakthrough.

Mr. R. BENNETT (Butler & Tanner Ltd): We have not tried giving a print-out or a typescript proof to the publishers. We have not dared, frankly. However, it might be all right, I should have thought, with a newspaper or a magazine where you can train your editors, but to try and train every author in the country to accept something which probably looks to their uneducated eyes a great deal worse than the clean typescript they sent to the publishers in the first place is asking too much. We may be able to train publishers but I should not have thought we

could train the author to do this until we get a good print-out system.

CHAIRMAN: You would agree, I think, that there is a growing body of authors, particularly engineers, mathematicians and scientists, who are becoming accustomed to computer print-out. Therefore, on that particular front—it is a very narrow front—things might get better.

Mr. E. HOUGHTON (BBC): We have produced a print-out from time to time, and we have quite a number of authors. That is as far as I can go, I am afraid. I find that in trying to train authors it depends very much upon the relationship between the author and the publisher. I think too you must bear in mind that the printed message, often in a different format, reads differently to authors. I have found that an author is quite happy with a typescript, but seeing this in type he will want to alter it, because it does not put over what he wants to say. Education depends mainly, I would say, on relationships. There are very good authors who will never alter anything. There are would-be authors who will do anything you wish in order to get into print. There are authors who are not too much concerned about printing, in which case you get over the problem by saying 'We will pay 2% of authors' corrections. The rest comes out of your royalty!'

Mr. DIKKERS: I must add something to what I was saying a few minutes ago. We make the charge for corrections in the typewritten text very low but we make it very high for the final page make-up proofs. That helps, I must say!

CHAIRMAN: This is a rhetorical question. Give it a rhetorical answer: why do you make the cost cheap in the original typescript and expensive in the final page proof?

Mr. DIKKERS: Corrections in typewritten text are quite expensive but the other ones are really expensive.

Mr. HOLLAND: I take it most of the remarks which have just been passed are to do with proofs earlier on in the general typesetting process. I know quite a number of people using filmsetting equipment. It is my experience that their customers require a high-quality proof at some stage before the job is actually printed. I am thinking here of typesetters as distinct from printers, who are shipping their product from Britain to America, or Germany to America, and they must send a very high-quality proof before the job will be accepted. With the spread of international trade, I cannot see that the present computer output will ever be much use in this sort of commercial activity.

Mr. K. PAYNE (Willmer Brothers & Haram Ltd): I do a substantial amount of typesetting and educational work for the

American market. I agree with the last speaker. They will murder you for leaving the tail off a comma. I do not know any publisher who would accept this type of print-out at this stage.

CHAIRMAN: They also pay, do they not? They are willing to pay your prices, so you go on as you are.

Mr. PAYNE: Oh yes.

Mr. DIKKERS: I do not agree with you. I think there are two kinds of proof: one is the text written out correctly and the other shows what your work looks like. The first proof is the one which the author can change, to which he can make deletions or additions. That is the cheap copy which shows all the characters are in the right places. The second copy comes after the phototyping operation which is going to be sent out as a specimen of your work. Unless you have tried to convince a publisher that he is far better off accepting the paper proof, he will never know.

CHAIRMAN: You are not talking about quite the same thing. He is talking about your second proof, your production proof or whatever you like to call it, to which you are heavily committed.

Mr. C. BARBER (Rocap Inc): I should like to draw your attention to computer print-outs where we do not have lower case. We have 64 caps and one or two very funny looking symbols in terms of typography. However, using the system which we hope to discuss tomorrow, I can tell you from our own experience that everyone can use an intermediate stage. If a customer is not going to accept a computer print-out, then that is that; you just cannot sell him one. It does not matter how well you can put symbols over characters, he wants to read what is not first-class type, and you can pick these things up in house corrections very, very cheaply. Therefore, it really boils down to this; are you willing to read proofs which are not good and save money? How much money are you going to save in reading poor proofs? One typesetter in Philadelphia collected statistics to show that he was saving a considerable amount of money through using computer print-outs and a correction procedure we were able to make available for him. I can quote a computer composition company at Flourtown, Pennsylvania. They have a Linofilm installation, and their Linofilm is going on a two-shift basis fed through a digital computer. This is a hard fact, a production fact.

CHAIRMAN: It is creeping in. It is a very frightening thing. We have got to face it, that is all.

Mr. FREIMAN: Is it not a fact that it is the printer and his staff in the composing room who tend to be more afraid of these

computer proofs than any customers might be? He does not get a chance to see them.

CHAIRMAN: Has anyone any experience of this? Might I add to the composing room staff, the readers? I rather had this feeling. I do not think it is an unkind thing to say. It is a very natural thing. They are not used to it. They are very spoilt.

Mr. FREIMAN: Management too.

Mr. BOYD: When we had to decide what type face we were going to use on the Robotype keyboard, IBM supplied us with samples of all the possibles. We chose Charter at six lines to the inch. These samples went to our readers and it was they who selected it. I do not think that your own readers are your main obstacle, provided upper and lower case are available with a reasonable degree of legibility.

Mr. BARBER: I should like to add another point with respect to the attitude on the composing room floor. I can quote four installations where computer tape or computers have been used. Having once made the men aware of the system—and there is always a great deal of interest, perhaps a certain amount of apprehension—and the sort of functions which would become available to them within the system, in my experience I would say that I have only received a great deal of help and encouragement. I know of one installation in Washington where the entire computer is currently manned by men from the composing room floor, and it is doing very, very well.

CHAIRMAN: I can only echo this experience. When I have taken rolls of Monotype tape into the composing room and talked to keyboard operators and caster operators, I have seen the look of joy which comes over their faces when they realize that they are part of a new development in typography. I think they do enjoy it. I believe we under-estimate them when we say that fear is a preponderant part of their attitude. I think fear exists just as much amongst the management as it does amongst the men, to be quite frank.

I am now going to introduce to you three potential users of computer typesetting, two of whom say, quite blandly, that they are trying to keep away from computer typesetting.

We have Mr. E. J. Coates, who is interested in publishing indexes and bibliographies. We have Mr. J. M. Johnston, who prints time-tables, and we have Mr. H. G. Milner, who will be telling us a little about the newspaper problems.

Mr. Coates is Editor of the British Technology Index, published by the Library Association. This is the third attempt in England to produce an index of articles on technology which are current. In association with the British National Bibliography

there is a unit which produces this technology index. In fact they also produce lots of other bibliographies. Without further ado I will ask Mr. Coates to tell us something about these problems.

Bibliographical indexes

Mr. E. J. COATES (Editor, British Technology Index): I will begin by underlining what Mr. Duncan said in his paper this morning, when he made the point that the needs of information retrieval would, in themselves, inevitably lead to the development of computer processed information output in multi-copy printed or print-like form. From this standpoint you might regard much of what I have to say as a straw in the wind that is blowing away from traditional techniques.

In this short contribution I have been asked to say how the editor of a bibliographical index views the prospect of computer typesetting and what the particular requirements of bibliographical indexes are in relation to this impending development.

As a preliminary I shall have to describe the non-conventional printing system used not only for my own publication, the British Technology Index, but also for its associated indexes, the British Humanities Index and the British Education Index, as well as for the British National Bibliography, the British Catalogue of Music and the British Film Catalogue. The pioneer and largest of these publications is the British National Bibliography, which went into production by this method in 1961. The present performance of the system is naturally the yardstick against which we shall weigh the possibilities of computer typesetting. Mr. Duncan placed the production of lists high among the probable applications of computer setting. A bibliographical index is, from the production standpoint, simply a list of items each only a few lines long, arranged in order and published, in the first place, in a current issue, and then combined in single sequence with other current issues to form a cumulative volume.

There are various conventional ways of achieving this. The simplest method accepts the need for two keyboardings and two readings, one of the material as it appears in the current issues, and then all over again for the same material after copy has been interfiled for the cumulative volume. To avoid double keyboarding and reading, letterpress type or a litho reproduction pull from the initial setting can be retained and used again for the cumulative volume. In the case of letterpress this must mean that the printer carries out interfiling either against a set of rules provided by the customer, or against cumulative interfiled copy; the customer must, of course, receive a proof to check on the

interfiled order. If repro. pulls for litho are used, someone, printer or customer, is required to cut them up into units each bearing one item of index material. These small pieces of paper have then to be interfiled and mounted for photography in the cumulated order. In saving a keyboarding we let ourselves in for a load of physical manipulation of either metal or litho master material. As far as the litho process is concerned card holding frame systems, such as Cartoprint, are designed to mitigate the effort and skill needed in physical manipulation.

The non-conventional method by which the British Technology Index is produced probably varies little in cost from the conventional processes with single keyboarding. Two 'layers' of cumulations would almost certainly show cost advantages, but our present publication programme comprises only 'single layer' cumulating. However, the peculiar virtue of this process, to us, is that it saves time. This is all-important in our case because the utility of our publication is very much bound up with the shortness of time-lag between the date upon which an article appears in the technical press and the date of the B.T.I. issue which records it.

The system comprises preparation of master copy by Varityper, transfer of this copy to film by Fotolist camera, and running off by offset lithography. To expand this a little, we have our matter typed, one line per card, on standard size 80 column cards, by Varityper. At a given point each month batches of Varityped cards are mechanically counted out into column lengths, spacer cards being inserted where the end of a column would otherwise split an entry; the cards are next fed, at a speed of 7,000 per hour, into a Fotolist camera which transfers their content to film. The film, with column units clearly indicated, is then manually mounted into two-column pages and used as a correction proof. Corrections are made by re-running column units of the Varityped cards through the Fotolist and remounting. Finally, the corrected film is printed down to lithoplate and copies are run-off by ordinary offset lithography. Our master copy is thus in the form of boxes of 80 column cards which are manually interfiled with copy for previous months to form, at the end of the year, completed copy for the annual cumulation which is then similarly processed through the Fotolist to make master film for litho reproduction.

Timings for the monthly issues are as follows:

Close issue, edit cards, insert cross reference cards:	2 days
Count out columns, Fotolist, mount pages, supply	
proofs, take up corrections	4 $\frac{3}{4}$ days

Print down to plates, run-off 1500 copies of 100-120
pages, fold, stitch and cover 6 days

I think this schedule in itself compares favourably with the best that we could achieve with conventional methods, but I would stress that the most significant time gain lies in the fact that setting takes place during the month concurrently with indexing, whereas with every other method setting commences after the month's issue has been closed and sorted.

What are the limitations inherent in Varityper setting? We probably would not find it economical to use more than two types, a bold for headings and a thin sans serif for text. We could use three to practical advantage, but probably at some loss of cleanness of appearance. We have no right-hand justification, but this is no loss in a compilation of this kind. Left-hand justification is occasionally faulty owing to problems in setting the carriages of these machines. Vertical spacing between lines is, of course, not very versatile on this equipment.

None of these limitations seems to me of great importance for a bibliographical index. However, I now refer to some more pervasive weaknesses in the system which we can bear only for the time being. The first is that Varityping on to 80 column cards is too expensive and slow in operation to permit us to draft our entries straight from the journals into Varitype. We supply preliminary conventional typed copy, with corrections indicated, to the Varitypists. The question of corrections is more serious. I mentioned a moment ago that Varityping of master copy goes on simultaneously with indexing and that this is a significant contribution to the high currency performance of the Index. In practice index copy is presented for Varityping day by day in small batch sequences from the editorial desk. It is quite essential to see these entries altogether in full sequence, but our system of contemporaneous setting carries its own penalty in that we do not get an integration check until setting has been completed. This integration check of one line per card copy is inefficient, slow, and laborious, and in fact some errors go through to the post-photographic stage where they are easy to detect, but expensive to correct.

Finally, and linked up with this question of easy editorial control at integration stage, is the not very happy situation surrounding the interfiling. If we employ high grade indexers to intercumulate, integration problems and mistakes are spotted at a high cost in cash and boredom. If we employ filing clerks, their work cannot be effectively supervised and they will not recognize problems as they arise. These rear their heads again only at the

post-photographic stage when their correction will again be expensive.

When we think of the possible amelioration of these rough spots through computerized typesetting, we must of course not overlook or sacrifice essential assets in our existing system. Technical information bibliographical guides, in Great Britain at least, are themselves struggling for a wider acceptance, and I do not think that our newly converted consumers will accept standards of visual clarity lower than those we obtain with Varityper. The very complexity of concepts in a technical index makes the use of bold type essential for marking a clearway through the apparent maze of indexed material. I do not, therefore, think that direct computer print-out at its present stage meets our minimum requirement. On the other hand all the work that is going into creating programmes for justification is probably not required for this particular product, although as our material contains, I think, a higher than average proportion of long words, we could not altogether avoid the problems of word splitting.

A general point to be made is that an index publishing organization is not likely to think of computerization in its typesetting application alone. There are two clerical tasks in index preparation for which we should want to exploit computer facilities.

You will probably appreciate that a team of indexers cannot produce consistency in their work unless they maintain a continuous record, in single sequence, of all fresh decisions made. These fresh decisions accumulate for B.T.I. at the rate of about 1,000 per month. Each has to be recorded and filed in an authority file. The cost of maintaining this authority file is by no means a negligible item in our costs, and the problems relating to its rate of physical growth are frankly alarming. If our material were being computer processed for setting, then it might be practicable to print-out week by week a continuous cumulation of our decisions. The virtue of the manual authority file is, of course, that the indexer has to consult only one file for a decision and I imagine that continuous cumulative print-out of decisions might become prohibitively expensive beyond a certain point. A weekly continuous cumulation running for two years by computer print-out would be the minimum one could substitute for the existing authority file.

The manual authority file is also at present the store for cross reference copy for the printers. Together with the record of each heading is placed printer's copy of all cross references leading to that heading. Each month before we can go to press, some

thousands of these references have to be extracted from the store by checking the headings of waiting entries against the authority file. An alternative to storing cross reference copy in this way would be to get a computer to generate cross references from the headings given. Cross references in the Index are of two types. Those of the first type are constructed from a simple programme based on the actual component words in the heading, and I imagine the computer would have no difficulty whatsoever in handling this. Cross references of the second type represent linkages between concepts in a classification scheme, and it would clearly be necessary to feed this scheme, which would be of some complexity, into the computer as part of the programme for the operation.

To summarize: The British Technology Index requires, in the first place, a typewriter giving by-product tape with really easy facilities for correction. This tape will include a code for bold type. The entries it contains will initially be in arbitrary order. The tape will be fed into a computer programmed to do the following:

1. Sort the material, discard duplicate headings, and give tape print-out which would drive a composing machine. The output tape would include codes for bold type; indentation on the left; right-hand termination limit but not justification; also codes for capitalization and end of column.
2. Merge monthly output tapes for cumulation.
3. Generate cross references from headings by means of a term manipulation programme and a classification of concepts programme.
4. Check all headings against a store of already used headings, sort and print-out new ones together with cross references, mentioned in (3) above, weekly. Cumulate or merge each week's new headings and references print-out into a 'snowball' running for two years.

I am glad to leave details to others who know more of these things than I do; the important point of integration corrections, for instance. Would it be more economical to have a visual as well as a tape print-out of the index material and pass corrections to the computer? Or might the balance of cost still lie in making up corrections at the post-composing stage? Is the last possibility an argument for using a letterpress composing machine as against photosetting?

I have not said anything about the general economics of computer production on indexes, again because I hope to have the answers from others better informed. My impression is that, in the context of present charges for computer commercial hire

time, computer techniques are not likely to be competitive with older methods given the actual scale upon which bibliographical indexes, on this side of the Atlantic at least, operate.

It is, of course, open for a number of indexes to combine together to hire larger and, presumably, inherently less costly units of computer time than they would need separately. This is a possibility that publishers of periodical lists of all kinds might actively explore.

CHAIRMAN: I think that is enough to indicate to the conference that there is a lot in indexing and bibliographies.

I should now like to press straight on and introduce to you Mr. J. M. Johnston who comes from the publishing side of the time-table industry. He is, in fact, responsible for the ABC World Airways Guide which is published by Thomas Skinner & Co. and is printed by Index Printers at Dunstable.

Computers in the production of time-tables

J. M. JOHNSTON (Thomas Skinner & Co. (Publishers) Ltd): I should like to start by saying that I know very little about computers and probably even less about typesetting. I do, however, think I know a little about time-tables. Perhaps that is a very good reason for my having been asked to come and talk to a conference on Computer Typesetting. I might add that we are not contemplating the use of computer typesetting, at any rate until we can find something which is very much faster than is possible at the present time but, contrary to many others who have spoken here, we are in fact using a computer print-out for reproduction.

I would like to say how we came to use computers for the production of time-tables. Some six or seven years ago we were approached by an organization of some twelve or thirteen European airlines. This organization of major Western European airlines was known then as the Air Research Bureau; it is now called the European Airlines Research Bureau. They approached us to see if we could produce some sort of quick reference time-table between the principal cities of Europe. Air traffic was growing rapidly and the work of those engaged in booking reservations and the like was becoming so great that they needed to be able to find particulars of all the possibilities available between any given pair of cities in the minimum possible time. If one could bring these together in some form of quick reference presentation, then it would be very much simpler.

This involved not only flights such as BEA or Swissair from London to Zurich direct, but also flights via Brussels or Paris where one would change aircraft. In addition, on certain days of the week, one can fly by other airlines which are going to points beyond. They wanted all this information in a single table together with the fares, so that the booking clerk or reservations officer of an airline could in a few seconds, by looking in one place only in the Guide, find all the possibilities.

We started off by producing this manually. Straightaway I told the airlines, through the Air Research Bureau, that we could not possibly contemplate the compilation of transfer connections. This was far too big a task and would require an enormous staff of very skilled people. So, in the initial stages, the airlines themselves actually produced the transfer connections whilst we looked after the through flights. Very soon the Air Research Bureau started using IBM punched cards in the IBM offices in Brussels for the production of the data for through flights. These were useful to the airlines in preparing transfer connections and to us in dealing with the through flights; although they were not by any means complete.

After a year or two the airlines said that this task of working out the transfer connections was getting far too big for them. As this section expanded it proved very popular. We sent around a questionnaire and the general response we got was that this was most valuable and should be extended to the rest of the world. We are in the process of doing that now.

We could not have undertaken this had we not been able to turn to computers to deal with the job. The quick reference section of this Guide, which within the next couple of years will include services throughout the world, is now produced by computer which also works out the connections between airline flights.

We were told that it would probably take some nine months at least to write the necessary programmes. In practice we had three of our own staff trained as computer programmers. They had the assistance of a London University man who was then with the computer company. He devised the system and my people wrote the programmes under his tutelage and with his help. We managed to get it done in five-and-a-half months. But we still did not deal with the fares. All this information had to be typeset and added to the computer output. Indeed, in the early stages although the information was produced by computer, the whole thing was actually typeset from the computer copy, after the necessary amendments had been made by my editorial staff. It became perfectly plain, however, that we were losing the speed of

computing and that we had to find some other means of reproduction. We now use the computer print-out.

The computer is a wonderful instrument provided everything goes according to nice fixed rules, but when you start dealing with airline schedules you are up against hundreds and thousands of exceptions to rules. Very little seems to go according to plan. For example, we have to take into account when making up the connections as between one flight and another that there is a certain minimum connecting time which must be allowed. In other words, if you are making a connection at Paris you cannot depart from Paris on another flight less than forty minutes following the arrival of the flight from London—or from any other point. Then, of course, the airlines decide that despite all this they will in fact allow thirty-five minutes in this particular case! We have all sorts of problems and difficulties such as that.

We have been able to overcome these to a very large extent. However, I should perhaps say that, for those things which it is impossible or impracticable to programme on the computers, we do possess a typewriter which has exactly the same type-face as the computer. This is no reflection on the ability of the computers nor—and this I would emphasize—on the excellence of the programmes which my people have produced. I think I can fairly say in regard to the schedules that the information which comes from the computer is precisely as accurate as the data fed into it—unless the computer hiccups from time to time as these things have a habit of doing. One of the features of our operation is that we are in fact stretching the computers to their maximum. We use just about everything they have got. We do not have sufficient work to justify our own computer at present. However, as a computer has now become an integral part of our editorial operation and processes, it is obvious that we will have to install our own computer as the work load increases.

We feed in our information on the standard 80 column punched cards. The flight information is coded up and fed in flight by flight, carrier by carrier, together with fares and headings information and instructions to the computer about the manufacture of transfer connections. This also contains certain other relevant data which has to be used. Some twenty-five programmes later we see the print-out coming off at 600 lines per minute—in other words at 10 lines per second. I suppose the figure would possibly be nearer 500 because we do in fact get a reproduction of Bold typeface. The place names are overprinted four times, using what is called a space suppression feature on the machine, giving a fair representation of Bold type.

We feed in this information and we are completely bound as

to time. Unfortunately, however, the airlines of the world—and there are some 350 of them—are not anything like as punctual in supplying the information to us. We do try as far as possible to deal with late information and here again the typewriter is most useful. Headings and fares are closed rather earlier than flights because information on flights is more vital. They are changing most frequently and consequently are the last to close editorially. If headings for a new service are not already in the Guide they obviously cannot be produced on the computer. It does, however, point out to us that there is a heading missing on the print-out. The heading is then typed on the typewriter and inserted. As I have said, we feed in a flight. For instance, you might have one which goes London/Rome/Athens/Istanbul. We want this in alphabetical sequence because the great feature of this quick reference section is that you can turn up whatever place you are starting from alphabetically. Copenhagen is followed by Coquilhatville in the Congo, and so on. The destinations are also in alphabetical order from each place. Flights are firstly in chronological order and secondly in day order. We do separate through flights and transfer connections, but do not show transfer connections outside Europe to any extent at the present time. This is purely a question of space and they will eventually be included in the Guide. Through flights are shown first and transfer connections follow.

Take the flight London/Rome/Athens/Istanbul. From the point of view of editorial work information is fed in purely in flight number order by carrier or airline. The computer takes them each in turn and produces London to Rome, London to Athens, London to Istanbul, Rome to London, Rome to Athens, Rome to Istanbul, and so on with all the relevant information as to frequency, any restriction of period of operation, class of service, type of aircraft, and of course flight number.

If there are traffic restrictions over a particular sector, as there very often are, then this is fed in on the cards which are used for feeding in the flight information. This automatically suppresses that sector which, therefore, never appears.

We then have a whole series of flight sectors from A to B to C to D, and so on, all in any old order. These 30,000 sectors or so are sorted on the computer in about four minutes into the order in which they will appear in the Guide. These sectors are then used to produce the transfer connections.

We then bring together the tape which gives the instructions for preparing transfer connections and also other details, with the headings and fares tape. Fares are computed from the basic one-way fare to produce the round trip fare, and then converted

into other currencies, also by computer. We then have to bring together this welded tape, containing heading information and other bits and pieces, with the tapes of through flights and transfer connections. These three tapes are brought together in one operation and put on to a single tape. Even this is not ready for production. It is still not in the form in which we require it. Whilst the computer is printing-out, at the rate of 500 lines per minute, it is in fact processing the information and re-arranging it in precisely the order in which we want it to appear.

CHAIRMAN: It is fair to say, Mr. Johnston, that you sounded a warning at the start. This is new material which is not finding its way into the printing industry except at the last stage. There is a moral here, and a certain amount of encouragement. If you could produce a better and more legible Guide, would you possibly use a typesetting computer? If it offered the same advantages, the same flexibility and the same speed of operation?

I would now like to introduce Mr. H. G. Milner, who is Controller of Technical Development of the Manchester Guardian and Evening News Limited. He is going to deal, I am afraid rather briefly, but nevertheless very cogently, with the newspaper problems.

Newspaper composition

Mr. H. G. MILNER (The Manchester Guardian & Evening News Limited): When I was asked to highlight at this Conference some of the problems which would be encountered by the introduction of a computer into the composing room of a newspaper, I was somewhat apprehensive because I felt that there should be a common pattern into which most forms of composition fall, and therefore many of the technical answers may well have already been found. On reflection I realized, however, that there are indeed many setting problems which can be more directly identified with newspaper production. In fact this is borne out by perusing a typical British newspaper. I would say that a greater variety of composition can be seen in any one issue than in most other single publications or items of print.

What then are the problems that can be identified as being special to newspapers? I suggest that they can be listed under three main headings:

- (a) Time—or lack of it.
- (b) Flexibility.
- (c) Economics.

Dealing with the problems in that order, I cannot emphasize

too greatly the part which time—or lack of it—plays in the production of the daily press, and more particularly the evening paper. The press is very conscious of the part which time plays in its constant competition with other news media which are continually striving to make inroads into what once was the sole province of the newspaper.

I am directing my observations at the evening rather than the morning paper problems because of the greater emphasis placed on the necessity to publish up-to-the-minute reports of events as they are taking place, such as results of sporting fixtures, in order to encourage casual or street sale of evening papers. At the same time it must be recognized that it is a necessary function of a newspaper, in which the composing department plays a large part, to publish live news as quickly as possible and to stimulate the enthusiasm of the reader by giving the latest information on sporting events.

The computer may have a ready application for the setting of feature material and matter which can be set in advance, but it is problematical how it can best fit into a pattern where short 'takes', or paragraphs, are of necessity the only way in which late copy can be broken down in order to meet press-times. This observation might seem to be somewhat of a contradiction in terms when one considers that the main purpose of a computer is to speed up composing room operations; it is, however, in the practical application of this technique that doubts arise. Unless the pattern for the production of newspapers changes and a new editorial concept is recognized, the contribution that a computer could make to composing room efficiency on, say, the production of a Saturday Sports Edition, would be relatively small.

Let me pose the composing problems which are contained in the production of such an edition in the hope that this conference can go some way to provide the answers. In order to emphasize my point, ignoring the columns of advertising, the contents of a typical sports paper can be split as follows:

- (a) Features and pre-set matter.
- (b) Reports of events.
- (c) Results and tables, etc.

As I have already said, I see no insuperable problems in setting feature material and pre-set matter, and even accommodating the early descriptions and reports of events. However, as press-time approaches, every available typesetting unit is concentrated on small paragraphs, set in various sizes and faces of type. This increases in intensity until the final scores begin to arrive. These are the factors determining a press-time. From then on the

emphasis is switched to the collating of final results (which have been pre-set) and the up-dating of league tables.

In addition, results are fed to the late news department for inclusion in the stop press columns of the later editions of the evening papers and are also used to supplement the results given in the first editions of the sports paper. The time allowed for this final phase is around 10-12 minutes. Can this be achieved with a smaller labour force and a higher degree of computerized typesetting? In other words how would the computer fit into this production pattern? Would there be an appreciable saving in time by the use of a computer to produce football results? Could league tables be handled more quickly and efficiently?

I have emphasized the importance of time in the production of sports editions because this should be one of the slickest operations in the newspaper calendar.

Service to the reader is of primary importance at all times. That last piece of news, the result of the last race, information on up-to-date cricket scores are produced by small teams of individuals whose efforts a computer might find difficulty in surpassing.

In as few words as possible I have tried to give a clear picture of one aspect of composing room production. Admittedly these have been centred on the problems of an evening paper, but I am quite sure it will be readily appreciated that if evening paper requirements are satisfied in this direction, then the solutions can equally well be applied to the possibly less urgent setting problems of the daily morning press. However, one must not dismiss too lightly the setting problems of the morning press, more particularly those who are involved in providing an extensive financial service. Market closing prices must present a problem of their own, as an examination of the financial columns of the daily press will show.

I now come to my second heading—Flexibility. I understand that the extent to which word hyphenation is possible depends on the capacity and complexity of the equipment and its programming. I feel that for the purpose of this particular problem of setting, my observations must of necessity be related as far as possible to the relatively inexpensive computers which have been designed primarily to satisfy the needs of the composing room, rather than the larger, all-purpose type of computer. I hold the view that a computer coming within this range could rather be introduced to satisfy the requirement of classified advertisement setting, features, and other like material, than 'hot news'. But there are many questions which as yet remain unanswered.

Dealing with the problems of classified setting, it is perhaps

worth while to run briefly through the way in which this type of work is handled in our own organization. Copy is received by hand, post, or telephone, and charging is done on a wordage/lineage basis, i.e. the average number of words per line is calculated according to type size, measure, style, etc. In order to contain the words into the chargeable number of lines it is often necessary to use contractions, but it is only during the setting of the advertisement concerned that the operator determines how, when, and where a contraction should be made in order to satisfy the lineage and consequent charging requirements. It should be fairly obvious that the necessity of giving the operator this licence has been built up from many years experience and that although the style of each office specifies the way in which certain words or items can be contracted, it is left to the skill of the operator to devise how best and when this shall be done.

To emphasize my point here is an example, fictitious but nevertheless typical:

BANBURY £2250 fhld. det. 3 bed,
2 recep. gas c.h. gge. lge gdn. Jones
& Jones BAN.6743 before 6 pm.

Obviously this advertisement had to be contained in three lines only. It will be appreciated that there are several ways of contracting the same word—not always intelligible, but often acceptable. This is but one of the many problems which the computer would find difficult to solve in the setting of classified advertisements.

The operative words at the start of the advertisement are, in our case, set in bold letter followed by roman, the first line being set full-width and the following lines in the same advertisement indented. Does this create problems? We have found that the limitations of the teletypesetter keyboard prohibit the use of certain fractions, signs, and miscellaneous sorts. Presumably the same problem would still exist even though continuous unjustified tape, or primary tape, was used as the medium for feeding information into the computer. A scrutiny of any Stock Exchange list emphasizes the necessity for maximum flexibility in composing.

Of necessity all classified advertising does not conform to one set pattern. There are many instances of varying measures bringing problems of justification, in some cases the inclusion of two-line letters before and after the description, whilst tabular setting is also evident. Could this variety of setting be catered for in the type of computer designed primarily for composing room appli-

cation? Or will it be necessary to move into other and more complex computer fields?

A typical example of matter which could be contained under the heading of future and/or pre-set material, is the racing page. In its make-up appear runners, riders, tips, write-up, and so on.

This brings me back to my original point—is the computer flexible enough, or perhaps I should say, can the computer be so programmed to provide this multiplicity of setting requirements?

No doubt the economics of computerized typesetting will be discussed in detail at subsequent sessions of the conference. I expect to go away much better informed and in possession of facts which will allow me to make definite decisions and recommendations. To illustrate this point, I recently received a facsimile copy of a page of a newspaper which had been produced on a computer in two minutes! Surely this information is incomplete—two minutes does, I feel, represent the time taken by the computer to accept the tape from a battery of keyboards and produce the output tape for subsequent conversion to typemetal or film, as the case may be. If one accepts the role of the computer to be just this, then several pertinent questions arise. I suggest that some of them are:

- a. The numerical relationship of keyboards to linecasters and filmsetters, etc.
- b. The anticipated increase in production by the use of unjustified tape.
- c. The consequential savings resulting from the changes in (a) and (b).
- d. The increase of costs in the maintenance of this highly technical equipment.
- e. The incidence of breakdown and measures necessary to ensure continuity of production.
- f. The method of dealing with corrections.

The foregoing points have all to be examined in relation to concentrated peak setting requirements, time factors, and the consequent service to the editorial department and, in finality, the reader. One must not lose sight of the capital cost of equipment and programming, but this is rather a problem for the individual company concerned than one for general discussion.

CHAIRMAN: Mr. Simmons has said that he proposes to postpone his contribution until this evening in order to allow time for discussion of the three papers which have been presented. I am now going to ask Mr. Simmons to take over the Chair.

Discussion

CHAIRMAN: As Mr. Duncan has said, I was going to give a little paper dealing with the human aspects of the problem of computer typesetting as far as the employees in the industry are concerned. If you are agreeable I will present my paper at this evening's informal session and now throw the rest of this session open for questions and discussion on what we have heard from the three excellent papers which have been presented.

Mr. PHILLIPS: I could not quite understand from Mr. Coates whether he was hoping the computer would provide all the capitals in the bibliographical index. If so, what guidance is he giving to the programmer?

Mr. COATES: We must have upper and lower case. I think this could probably be coded at the initial typing stage.

Mr. S. G. DYMOND (NGA): Speaking as a working compositor, I find myself in slight disagreement with Mr. Milner. It may be that he runs his newspaper differently from ours. He has spoken about time. I start work on edition at 5 p.m. and I finish at midnight, but the amount of time which the compositors are given to produce the newspaper is not seven hours; it is two-and-a-half hours. That is the time we have in the composing room to work on the copy, at least for the first edition. As you probably know, stories do not come in at the time you want them to come in; stories come in as events happen throughout the world. The number of men we have at the Daily Express are able to produce that newspaper in two-and-a-half hours. The question I would like to ask is: Can a computer produce this newspaper in two-and-a-half hours?

Mr. MILNER: The time required by a computer would be considerably less—but that is not the complete answer. The computer is interposed between the operator and the casting equipment. It is the first and last of these three operations which condition the time factor.

Mr. R. PRESCOTT (Dun and Bradstreet Ltd): I was very interested to hear what the various speakers had to say because they were talking, more or less, from the publishing angle. I would like to take up one or two points which Mr. Coates made.

First of all, I was surprised to hear him say that Fotolist was not saving him money because my experience is that this is the one field where you can save money. Another point I would like to ask him is why he is using the system of hand-sorting when he is using a conventional punched card which could be punch filed, taking the first step towards automation. This, I feel, is very

important and we would like to know his reasons. As to the question of whether a computer would be acceptable, I believe I am right in saying that one of the publications from the National Bibliography is accepting an IBM typewriter as an alternative to Varityper, using Varityper headings.

A question was raised with regard to the print-out from a computer. I think we have got to realize that there are certain stages in this. We have heard to-day that the time-table for the airlines is acceptable without upper and lower case. I have seen other publications in America with a one case print-out. The problems there are the problems of the technical use of a computer and are nothing to do with typesetting at all. There is no typesetting problem. There is a straight print-out which is photographed. We know that certain computer manufacturers in this country are working on line computers. There are line computers, the IBM, which can do upper and lower case. There are one or two trying to get two typefaces on it. If you want two typefaces you have got to pay more because programming costs will be higher and it slows your line printer down. If you want to become more complex and get even more type faces you can use a photocomposing system which at the moment is very expensive. I do not think this has been emphasized enough.

The point is that at the moment the photocomposing units which are available are only operated by paper tape. To produce paper tape in a computer is very expensive and also the photocomposing machines at the moment are very slow. In fact I would say that we have not approached this problem yet. As far as I know, not one piece of paper tape produced from a computer has been put through a photocomposing machine in this country. I do not say it cannot be done, but we have a long way to go.

We have to look at this question of what we want. You have the flexibility of the computer which can do certain sorting jobs adequately and very easily. This is what computers are produced for. When we come to the question of print-out, we have got to make up our minds what sort of standard we are aiming at. If we are aiming at a higher standard, then with the limited equipment which is available at present the costs are going to be very, very high.

I would like Mr. Coates to deal particularly with the points I have raised.

Mr. COATES: Perhaps I could take Mr. Prescott's questions in the order in which he posed them. First, he says that he is surprised that Fotolist does not save money. Yes, so am I, but this is something we have discovered. As I have said, there appears to be little or no saving for current issues plus one cumulation.

However, if you get to cumulations of cumulations—which is quite a possibility for us though we have not indulged in this one yet—then the saving does become apparent. This may be surprising but it is our experience.

Hand versus mechanical sorting. We have also looked into this question. Again I am afraid the use of human beings rather than machines works out more cheaply, largely because none of the sorting equipment completely does the job. It has to be helped out at the last stage and this helping out is relatively very expensive.

IBM Executive typewriter headings on the British National Bibliography would be quite acceptable. We did in fact use them in the early issues of the British Technology Index, but the machines themselves were unsatisfactory and we had to discard them.

Mr. PRESCOTT: Our experience on the Fotolist is not the same as yours. The savings were up to 25%, even using the card once.

Mr. R. W. DRAPER (Birmingham Post and Mail): Mr. Duncan said this morning that he thought daily newspapers would be the last to enter into the field of computers and that new methods of production and presentation would have to be considered. Was he referring to the standardization of column widths and type characters?

CHAIRMAN: Unfortunately Mr. Duncan is not here to answer that.

Mr. BARBER: I will try to answer your question. I can tell you that it can very easily be applied to a newspaper application, particularly on the Photon 513. A programme has been written, and has been in production since May of last year, whereby together with any line length—let us say from within the limitations of the machine, from 6 pica to 43 pica—you can call on any 16 faces in any one of 12 sizes, which is essentially 192 founts. Text, justified left, right or centre, or indented, can be forced through the programme for any line length and ultimately they print-out the paper tape to drive the Photon 513.

I should like to add to that. For newspaper application in hot-metal, at West Palm Beach, Florida, they can handle any line length from 8 pica to 22 pica. I know they are going to 22 pica and I believe they have some six hot-metal founts available. I can extend that to line application. The system in Swarthmore has 100 faces available in any of the sizes which come with the Linotron.

In answer to your question there is no need at all to standardize your faces or your line length.

Mr. FREIMAN: If the newspapers will be the last to enter the field, why have the computer manufacturers sold about a dozen computers to newspapers? I can give you the list. What are they doing with them? Are they all experimenting?

CHAIRMAN: All those you are referring to have been bought in the United States. None has been purchased in this country.

Mr. W. P. JASPERT (Print in Britain): It seems to me that most of these American newspaper computers are being used for classified advertising and for accounting, but not necessarily for typesetting. I have visited twelve of them—which is almost the whole number—and the majority of them have two Linotypes standing in the corner. When they have late news, this type of copy is set manually on these machines. The computer handles it much quicker, but it still has to be keyboarded first and it takes too long to take it over.

Mr. HOLLAND: Surely an advantage here is the faster throughput of typesetting at the keyboard stage. This is because the computer can handle the matter of justification and hyphenation, which allows the keyboard operator to put through more work in a given time. If our friend from the Daily Express has two-and-a-half hours to set the news, he may, with a 50% increase, drop this back to an hour-and-a-half. This means that the newsroom can handle news an hour later. Surely it is in the interests of all newspapers to be able to do this? I do not think it will make their operations any easier—they might be even more frantic. They will just be closing down their newsroom an hour later for a given edition and this is surely beneficial.

Mr. HANSON (Compugraphic Corporation): Certainly the answer to late news is not a simple one, but I think a computer system which can handle this must include provision for getting tape from a keyboard where it is generated to the computer, and from the computer to the linecasting machinery, without any manual handling of the tape. This is a perfectly practical thing to do. If you can get a 50% increase in productivity of keyboarding, then as Mr. Holland has said, this is just as applicable to the last-minute news as it is to news or stories available ahead of that.

Mr. MILNER: News is not made—it just happens! This is something that you cannot measure with a slide rule and say that within a given time you are going to have a given quantity.

Mr. HANSON: My point is that if you can increase your keyboard production by having a man producing unjustified tape, you may well be decreasing your elapsed time because that tape can be directed into a Linotype machine and be cast as it is

produced. It is the computer system where you have to take the tape from the keyboard to the computer and then carry it from the computer to a linecasting machine which is not applicable to late news. Where your tape handling is automatic, I think it is applicable.

Mr. FREIMAN: On that point, I know of some people who have built a conveyor belt between the computer and four Intertype linecasting machines. The copy is in the form of very short takes and they claim to motivate the four machines at a 30% increase in speed. I think this is a worthwhile experiment.

Mr. W. H. RYLANDS (NGA): I wonder if any person at the conference who is experienced in this field can throw any light on typesetting for computers. I have been to Germany and North America and have found from investigations that the girls, or men, on keyboard setting for TTS are doing this for fewer hours. The time in some instances was brought down to five hours actual production as against eight hours on manual setting, which again offsets the economic value in this respect. Has anyone any experience of this?

CHAIRMAN: How many hours are the tape perforators in the United States being operated on this sort of setting? Are they in use for long periods or short periods?

Mr. HANSON: In general they are manned just as manual machines. Whatever hours apply to manual machines also apply to tape-operated keyboards.

Mr. RYLANDS: The point at issue is that the girls, in Germany for instance, contend that the speed they were asked to do on the TTS keyboard resulted in mental fatigue; they could not go for more than five hours in a day. It was accepted that five hours was the maximum time they could operate at speeds of 12,000 to 13,000 ems an hour. You will find that TTS people in the States say that they were competing in hours against the manual system. Again, the standard of typography on the Continent and in the States relating to hyphenation of words differs from our own with a consequential effect on output. They have various typographical hyphenations which we could not tolerate in this country.

Mr. F. S. ANGELL (Fairchild Graphic Equipment (UK) Ltd): In the United States we have many people working a seven-and-three-quarter hour shift on TTS who are giving a very high production. You will find that the same thing exists in Holland where I am now stationed; there are any number of plants working on TTS production and no problem of fatigue.

Mr. D. R. NASH (Hazell, Watson & Viney Ltd): I would like to make a point about the setting time. As regards the 13,000

ems an hour for five hours, we can do the same amount of work in eight hours at a slower rate with no fatigue.

CHAIRMAN: I think you would agree with me that we ought to convey to all the speakers our best thanks for a very good and most interesting session. Each of them has done exceptionally well in his own particular field.

Practical Problems of the Changeover

CHAPTER 3

Practical Problems of the Changeover

Chairman
Mr F Simmons

Informal Discussion

CHAIRMAN: I hope that this session this evening is going to be a free-for-all session, and that you are going to enjoy yourselves.

As I said this afternoon, I want first of all to give a paper which I intended to give earlier. I want to talk to you for a few minutes about the human aspect of computer typesetting.

The human aspect

This conference is mainly concerned with technical progress and problems related to computer typesetting, but I would like for a few minutes to draw your attention to some of the human and social implications of this impending revolutionary change in our industrial techniques. May I say at the outset how much I appreciate that the Institute of Printing has recognized that there is a trade union point of view on this important subject, firstly by inviting me to serve on their Computer Typesetting Committee, and secondly by leaving a little gap in to-day's programme to enable me to say a few words to you on the matter.

You will not be surprised to hear me say that, whenever a new technique is introduced into our section of the industry which is likely to supersede a particular operation previously performed by the members of my union, our first question is 'Will it create redundancy?' and if so, then we ask 'Can we avoid such redundancy by the re-training of the redundant personnel in the new technique?' That sort of exercise is relatively simple in a workshop where an old type of machine is removed and a new type of machine takes its place, but computer typesetting promises to be a very different kettle of fish because of various outside factors which are somewhat removed from the shop-floor level where most of our existing or previous industrial problems are expected to be dealt with.

To begin with, it appears that very few employers will have their own computers because of the prohibitive cost, and one can expect to see a relatively small number of regional computer trade typesetters who should comfortably produce all the type or film required by the whole of the printers in their respective areas from whatever original copy, punched cards, magnetic or perforated tapes are supplied to them. Or, alternatively, if they have no metal-casting or film-producing machines, these computer trade typesetters may merely produce the magnetic or perforated tapes which will be supplied to their appropriate printer customers to use on their own hot-metal or photo-composing machines. Whichever of these two alternative methods is used, there is obviously a danger of a large number of our existing keyboard operators in the printing industry becoming redundant so far as the initial keyboarding is concerned, unless we can take such steps as will ensure their future security.

We shall naturally insist that wherever possible our keyboard operators shall undertake the new forms of keyboarding (especially in trade houses), but it may also mean the establishment of a number of trade-union keyboard departments in customers' premises rather than, or in addition to, the normal keyboard departments in printing offices. In making that suggestion, I visualize that some commercial organizations already have, or will have in the future, their own punched card systems for record purposes and up-to-date data processing, and that those same cards will be periodically sent to the printer for the printing of a directory or something of that sort; or, as a further example, you might find a large municipal authority which decides to have a punched card system as a means of keeping an up-to-date electoral roll, with a view to sending it to the printer when necessary for the printing of the electoral register, using the same punched cards in conjunction with a computer converter to produce a tape which would subsequently motivate the hot-metal or film-composing machines, or even Fotolist or Listomatic cameras.

On the other hand, a publisher may decide to produce his own unjustified, unhyphenated perforated tape of a novel which will be subsequently printed in two entirely different editions, leaving the computer to produce two further tapes—this time justified and hyphenated—for the hard-backed edition in the first place and then using a different type face and format for the paper-backed edition. In those sort of circumstances, I fear that there are far too many people who will readily and loudly claim that the punching of computer cards or the operation of a tape perforator divorced of justification or hyphenation is a mere

girl's job, but may I stress that if this policy was widely adopted it would inevitably lead to large-scale redundancies amongst our existing trade union members. If the employers concerned prefer to use girls as straight copy-typists, then they could not expect them to exercise the same kind of initiative or to apply the typographical knowledge and expertise that one would normally expect from a craft-trained male operator in relation to original copy from the author or customer.

There is also the possibility of other new categories of employees coming into the composing side of the industry—those who are capable of programming the computers, and those responsible for the servicing and maintaining of computers and other electronic equipment to be used in the ultimate production of hot metal or film. I therefore pose the question—would it be feasible or sensible to create large-scale redundancy on the one hand, and to witness the influx of an entirely new labour force on the other? I readily accept that none of our trade union members can match the skill or brains of the computer experts who will speak from this platform this week, but there are many of our members who, because of their war-time experiences (either in the Services or on munitions), or by reason of their more recent peace-time hobbies, possess a useful basic knowledge at least of such things as radar, signals and electronics, would be capable and willing to play a part in the development of this new technique of computer typesetting.

We should also bear in mind that we have more and more apprentices coming into industry with fairly high educational qualifications in mathematics and other allied subjects, which surely make them adaptable for some kind of special training in computer programming at our more advanced technical colleges or by attendance at special courses of training at one of the universities interested in computer development. I am aware too that there are many young journeymen who are very keenly interested in learning about computer typesetting.

At this point, may I say how pleased I was to-day to see H. M. Inspector of Printing Schools and a number of printing school teachers present at this conference, for so much will depend upon them as regards training. Which leads me to ask about future training methods for our apprentices in the composing departments. Is not the advent of computer typesetting, and the rapid speeding-up of filmsetting methods, going to mean an entirely different approach to technical training for compositor apprentices? I believe that our apprentices will still need initial training in the basic principles of typography, but that this will be given either on full-time preliminary courses at the technical

colleges upon leaving the normal secondary modern or grammar schools, or certainly during the first two or three years of their apprenticeship, but they will then need to specialize in these new techniques in the latter part of their apprenticeship. During recent years in this country there has been a shortage of compositors (both hand and mechanical), and the employers' organizations have repeatedly asked for an increase in the apprentice quotas, but our members are already suggesting that with the sort of technical developments taking place around us such as computer typesetting we shall have to examine very carefully the possible effects upon the labour requirements of the industry, and then we shall need to decide whether we ought to control the labour force by reducing the number of apprentices, or whether the solution to a superfluous labour force would be to reduce still further the working week. Whatever happens, I am sure that employers and trade unions alike will be anxious to maintain the post-war policy of full employment; in fact, they have a moral obligation in this respect.

I feel certain that employers and manufacturers will be wondering if the trade unions in this country are going to be co-operative in this new venture, or whether we are going to adopt the negative role of the Luddites, and I would therefore conclude my remarks by saying that my union has never opposed or retarded technical progress as we recognize that we would be foolish to do so; on the contrary, we wish to take our rightful part in these new techniques in order to help along such progress and at the same time to protect the security of our members and of the families dependent upon them. As a measure of my union's interest in this subject, I can state that one of the computer experts in this country very recently addressed, by invitation, the whole of the members of my National Executive Council, and another expert has but two weeks ago given an appreciation course on the subject to those particular officers and members of my Council who are constantly concerned with composing-room developments and problems. At this Computer Conference we have no less than twelve members of my Council present, apart from myself, and we are now endeavouring to arrange in the near future a short full-time course of training on computer typesetting (with a possible insight also into TTS and photo-composing techniques) for selected members of our union (according to age, experience and adaptability); they will be invited to undertake such training at our expense, provided that their respective employers will be generous enough to allow them to have the necessary time off for that purpose.

You will see that we are prepared to help in the cause of tech-

nical progress, and we sincerely hope that employers and manufacturers will reciprocate in the same spirit, and thus enable us to ensure that we do not leave any victims of redundancy along the route which we are now about to take towards this entirely new conception of automated composition.

Before we have a general debate, I have a note from Mr. Alan Mayne, an independent consultant, who would like to ask one or two questions on the subject of computer typesetting in relation to mathematical texts.

Mathematical texts

Mr. A. J. MAYNE (Consultant Research Scientist): I would be interested to know what work has been done in the United Kingdom, the United States and elsewhere on the computer typesetting of mathematical texts. The only such project I have heard of is the American Mathematical Society's study of the use of the Photon machine for the composition of mathematical reviews. This started receiving support from the National Science Foundation of the USA about two or three years ago. I have heard no recent news about it and would be very glad if anyone could give me a progress report on it. I think this topic is especially important as it opens up the possibility of reducing the very heavy cost of mathematical typesetting by a factor of at least two, if not considerably more than that. The result of this will not only affect redundancy but it will vastly improve output of mathematical text. It is already increasing fantastically. There will be a steady flow of work for the skilled workers in this field.

I would like to end by saying a few words about a research project I have in mind myself in this field. I am thinking in terms of a three-stage system, an auxiliary device, digital computers and phototypesetting. You will know about the last two but you will not know about the other one. I have already thought up an outline specification for an auxiliary device. You have a keyboard rather like that of an ordinary typewriter with some extra symbols and facilities attached to it. This keyboard would generate a flexible visible display which would be recognizably similar to a line of mathematical text. It would have facilities for easy alteration in the correction of errors and would automatically prepare a paper tape or magnetic tape or other readable computer medium, giving a full record of the line as finally constituted. This tape or other medium would be fed into a computer which, using a suitable programme, would output a correct tape for the phototypesetter. I am perfectly satisfied that the best design of

phototypesetter—the Lumitype with a special disc attached to it—seems to be large enough to use good-quality mathematical print. The system which I have outlined could also easily be adapted to many other phototypesetting jobs.

Mr. C. BARBER (Rocappi Inc): We have given quite a lot of attention to the idea of setting mathematical texts because we felt a most important problem would be solved for us if we could make use of this. I would say that for the last seven years Fortran has been available for digital computers, starting off with the 650 and going right through the 700 series in IBM and the 301 and the 501. All the computers are currently able to read Fortran. The language is already formulated for mathematical text inasmuch as Fortran can accept mathematical equations. All that is really required is a series of sub-routines which can read Fortran and interpret them into a typesetting language. I think, having realized this, the problem is well on its way. This is most certainly the way the problem should be tackled.

Mr. MAYNE: I would be half in agreement with that. I should point out in this connection that if the Fortran scheme were adopted, it would mean, in effect, that the mathematicians would have to make a decision to make some changes in their normal notations. This may or may not come about in the course of the next few years. What I have in mind is a system which can deal with existing mathematical notations, which I think the mathematicians would say they find easier to handle than the Fortran, although the Fortran is very useful for computer programming purposes. I doubt myself if it is going to be generally accepted for ordinary texts.

Mr. BARBER: I have the feeling that Mr. Mayne has not used Fortran very much.

Mr. MAYNE: I have not used it. I have read quite a lot about it, including the Algol.

Mr. BARBER: Without reservation I would say that a mathematician, a physicist or an engineer in any of the fields of applied science, assuming he is good in his field, within three hours can be trained to code in Fortran. I will guarantee that. Having established that you can train a man to work in Fortran, you can assume that he will not have any difficulty with it. That is why I think this is the answer. We are dealing with a first-class man, a man who is capable of writing a book and a man who has ideas which he wants to present to the reading public in general. I do not know of a more simple approach because you are forced into a symbolic representation of equations. If there were a more simple answer to the Fortran language, I am quite sure by now that IBM would have dropped Fortran and established Gotran,

which is a more simplified form of Fortran. We would have forgotten the Fortran and used something like Gotran. I think Fortran is the answer.

Mr. A. H. PHILLIPS (HMSO): Mr. Mayne and Mr. Barber are on entirely different wavelengths. There is no disagreement between them but misunderstanding. The point is that Fortran is perfectly all right for addressing the computer. What Mr. Mayne wants is a conversion technique which will take a Fortran input and turn it into conventional mathematics. All you need there is a programme on the right sort of filmsetting equipment. This can be either Monophoto or the Photon. This will take a Fortran output and convert it into the conventional mathematical notation.

Mr. A. BEAVEN (National Cash Register Co. Ltd): I think that last point is a very good one because it does illustrate the difficulty which computer people are going to run into if they do not consult the industry they are seeking to serve. On this question of Fortran, I was reminded of what Mr. Duncan said this morning about being unreasonable. It would be unreasonable to ask the mathematicians or physicists to accept Fortran notation for print works, but there is a danger here. Algol users have tended to succumb already to the rather peculiar needs of computers. Algol started off by being a better version of Fortran, and they had a character set which was 120 characters. In the face of the inertia in the computer industry they have restricted their character set. What they ought to have done was to have insisted on having the full range, 120 or 512 which is what you may need, as only then will the computer industry be forced into further development to satisfy the reader—and the reader here is the author or the public or the users of the printing trade. I feel that if we think of means of communicating with the computer and get that confused with what we are outputting, we shall finish up with something which is a restriction that we should not really have to apply. There is no reason why you should not have a full character set if the thing is tackled properly.

CHAIRMAN: If there is no further discussion on the point raised by Mr. Mayne, Mr. Gordon wants to raise a question.

Newspaper composition

Mr. C. H. GORDON (King & Hutchings Ltd): My point is an extremely elementary one after the recent questions and answers. Having recently changed over to the web offset newspaper technique, our composing section has already suffered several blows in the changeover from conventional methods to

new techniques. What concerns us at the moment is how far computer typesetting has advanced. In other words, is it possible—or has anyone done this—to produce a page similar in size to a newspaper broadsheet or tabloid from hard copy as tape through to a bromide or a negative ready for plate printing down? If no one has done this, is this likely to happen with computer typesetting in the near future?

Mr. BARBER: I can tell you for sure that the Photon 513 in May of last year has gone to positives for display ads. In April and May of 1964 we were going full page to line film. Within the last two weeks or a month they have gone full page to ATF in America.

Mr. O. SCHWARTZ (Alphanumeric Inc. U.S.A.): I have a question for Mr. Barber. He has talked about full page. To my knowledge there is no photographic typesetting equipment to-day which will set a line to 48 pica ems. When he talks about a full page, does he really mean doing a small column and then piecing together the various columns to make a newspaper?

Mr. BARBER: In the system I am thinking of—the 513 and the Photon 530—this will become largely a function of the mark-up man. If your mark-up man is sufficiently versed in this system—and it is quite a hard task to make your mark-up man completely familiar with the potentialities of the computer programme and the computer system—I would say there would be no problem in setting up the 42 pica. I have not seen this done. I can truthfully say that I know I could do it, knowing the programme for the 513 as I do. It would mean a quite elaborate training period for the mark-up men.

Mr. F. C. HOLLAND (Monotype Corporation Ltd): A filmsetting machine has been available for eight years which sets up to 60 pica ems. The limitation of 48 mentioned by Mr. Schwartz is not quite correct. However, that is still less than the average newspaper page. Apart from that, however, I do agree that there is a filmsetting machine which can in one swipe do a whole newspaper page. All the filmtypesetting machines will do a book page.

Mr. R. PRESCOTT (Dun & Bradstreet Ltd): Is there a machine installed in this country?

Mr. HOLLAND: Yes, the Monophoto is installed.

Mr. PRESCOTT: I think we ought to try and differentiate between what processes are in America and what processes are in this country. America has done certain things which we have not done in this country. When speakers get up to speak, they should say in which country their experience has been, whether it is America or this country.

Mr. GORDON: I should like to come back again, if I may,

with the second point of my question, because to us it is quite an important one. Can I take it from the members here that we can expect to get columns of photocomposed material, either bromide or negative, which would then have to be pasted out, or do we expect some time to be able to go to full page make-up with the half-tones obviously excluded? I am also thinking of display ads.

Mr. HOLLAND: The answer to that is that we merely await the production of a new filmsetting machine which will handle a piece of film of full newspaper spread. Such a machine does not exist yet.

Mr. BARBER: I know of someone who was considering setting everything he could in half the size—and he actually required this, in particular for display ads.—and then blowing it up. With the 513 this is more than feasible. I have not been to this installation for a year or so, but I would not be at all surprised if we were to find that it could be done.

CHAIRMAN: We have disposed of the questions of which I was given prior notice. Does anyone else wish to raise any questions or to make some rude comments about what I had to say at the outset? We are in general debate from this stage onwards.

Mr. B. W. KING (Orbit House Services Ltd): There was some talk this morning about using the services of the service bureau for computer typesetting. I wondered if anyone here had any practical experience of using a computer on a service bureau basis for this work. I have been associated with a service bureau for some time, and it has been my experience that each of my customers considers himself to be more important than all the others put together. It is extremely difficult to meet the schedules. It would seem to me that if the use of a computer for this sort of operation is an integral part of the print production, there are very good grounds for having your own machine.

This leads me to the other point which I should like to make arising out of what the Chairman said. This concerns programming. Again, from my own experience, we have always found that it is easier to take people who have knowledge of the work which we are going to do and teach them how to write programmes than to try and do it the other way round. I would have thought that the best programmes would have been written by people who have solid print experience rather than people who have experience of computers. It seems to me by the very nature of these programmes that they will mutate for some while until we actually get them right.

CHAIRMAN: Would you say that the service bureau idea is very much different from the present system of trade typesetting houses in relation to hot metal?

Mr. KING: I have no experience of using that. I am not a print man. I would have thought the difference was that in an ordinary computer service bureau you can be doing work ranging from hire purchase to analysis and mathematical work. As a computer man I would say that the application is relatively slow in that you have got to punch out paper tape which could gum up the works. I am talking from the service bureau angle.

Mr. J. WILLATS (NGA): I would not want to make any rude comments about what the Chairman has said—far from it—but I would like to hear further information from our American colleagues at this Conference. The theme so far has been that the most developed country which has got computer type in it has been the U.S.A. I would be very interested to know how the human problems, which to me are very, very important—and perhaps are the cardinal point of this conference—have been dealt with in the United States. From reading magazines dealing with the introduction of computers into that country in industries other than our own, this does seem to have created a terrific social problem. I am wondering if anyone here in our own industry can tell us how this problem has been tackled in the United States as far as people in print are concerned.

Mr. SCHWARTZ: Prior to coming to Europe about a month ago, I had a meeting with some people from the International Typographical Union in the United States. Among them was Elmer Brown, who is the President of the Union. I represent a small but young data-processing company. The basic reason for our being in the print industry is to enter the printing publication industry. Many people have asked us what we are going to do about the union question, how we are going to handle the union problem. To avoid this problem, we had a meeting with the people from the ITU. We explained to them what work we were doing, what we saw as union problems and what we thought might be the solutions to some of these problems. It was the consensus of opinion of both ourselves and the people from the ITU that there were really no human problems. The ITU had found certain solutions as a result of many strikes in the United States. One of their solutions was that typesetters displaced by computers would take the role of punching out paper tape. This solution has been very distasteful to typesetters themselves. They feel that they will be brought down a peg rather than raised up a peg.

We also indicated to them that we felt, with the coming of computers into the printing publications industry, it would open up probably one of our biggest markets. This is a market which does not exist to-day, but it is one which will exist for the

computer people themselves. I do not know anything about the amount of information which is printed or produced in this country but in the United States 500 million pages a month are produced by high-speed line printers. A good deal of that will go to Graphic Arts type printers when they can operate at the speeds of the present high-speed line printers. Many applications which never existed before will exist within the next ten years, such as using computers in language translation, where a computer and a high-speed photocomposition machine will change a publication from one language to another. This represents certain markets which never existed before.

Both we and the people from the ITU felt there would be a re-training problem for their people, but that this market is a very explosive one and that within five to ten years they would be printing and publishing ten or twenty times the volume they are doing at the moment. They did not feel that they were being automated out. On the other hand, they felt they must go through a re-training programme for their typesetters in order to upgrade them to the status of operators or programmers. They felt that they would get more work in the next ten years than had been handled in the last hundred years.

Apprentice training

Mr. J. H. LODGE (Melbourne School of Printing and Graphic Arts): I am concerned with the education of apprentices. Your remarks have interested me very much in regard to changed thinking in the training of apprentices, Mr. Chairman. You mention the linking up of training in the use of computers, teletypesetters, filmsetting and the like. I could not agree more with that. To take that thought a little further, do you think you people on the union side would agree that it is time we got rid of some of the outworn regulations which apply not only in England but in Australia? One of these, for instance, is that a boy must serve three years as a hand compositor and learn a set of skills. We then take him off that set of skills and try and teach him mechanical composing. Would it not be better if we got rid of that outworn attitude and said that we will choose a boy capable of using these modern devices, whether for filmsetting, TTS or whatever, and train him after a short period of composing room procedure straight on to these mechanical devices?

CHAIRMAN: I think what is happening in relation to filmsetting and certain other techniques is that there is less and less opportunity in the workshop itself to learn the elementary basic principles of typography. This is particularly true in the trade

typesetting houses, which may now become computer typesetting houses, as these are mostly concerned with keyboards. There is a practical problem about training at workshop level. The answer to this is that more and more educationalists in this country are thinking in terms of full-time education at the technical college. It may be that the responsibility of teaching the boy the basic principles of his craft will belong to the teachers rather than to the journeymen at the trade because of the more advanced techniques which are being used by the journeymen themselves. Already it is obvious from the experiments which are taking place in relation to full-time preliminary courses, full-time sandwich courses and now full-time block release courses, that more and more responsibility is being placed on the printing school teachers. That is why I am so pleased to see a number of them here, not only from this country but from other countries as well.

Mr. W. H. BLANCHARD (NGA): Surely the answer to Mr. Lodge is, as the Chairman has said, inherent in the basic principles of teaching the craft. Inasmuch as the City & Guilds themselves enforce the procedure that they shall have a preliminary training before they go on the mechanical side to learn the basic principles of typography, that should be a godsend to the employer. There is no demarcation at all. To my mind, it is a very good thing.

CHAIRMAN: In all our discussion, we must remember that there are representatives here from many countries.

Mr. J. D. BESLEY (Hazell, Watson & Viney Ltd): I should like to take up a point the Chairman made when he was talking about the fact that we would have to re-train keyboard operators for these new techniques, such as perforating tape for computers. I should like to know the Chairman's view and that of his union on the fact that probably within the next two or three years there will be optical readers and scanners which will only need to see a clean typed copy before them to translate this copy into magnetic tape which can be fed straight into the computer. This means that we are putting back the business of perforating or keyboarding one further step and putting it into the region where a female in an office could handle it. It requires no typographical skill whatsoever. Would it be your union's intention, Mr. Chairman, under these conditions to see that there would still be keyboard operators, as we know them to-day, operating and producing clean fair copy?

CHAIRMAN: I think the attitude of the trade unions is that if there is going to be redundancy then the redundant personnel should be the first people to be considered in relation

to any new jobs which are created. You have talked about clean copy. The operators in the industry who have to deal with these things very rarely see clean copy; they see all sorts of copy, in fact. Someone has got to produce the sort of copy initially which is going to save time at a later stage when it comes to turning it into perforated tape or film. The people who are going to make the most sensible job on copy for subsequent reproduction by any method you know in print are the people who have been in print for many years and have been trying to produce a reasonably clean proof. All we are saying, whether it is a punched card, whether it is a punched tape or whatever is required to be produced from the original copy which comes in from the author, is that this should be the work of the people who would otherwise be thrown on the scrap heap. We realize in relation to filmsetting that some of the men who have previously been hand compositors, readers and keyboard operators, will have to be re-trained to some extent because of the new techniques which they are now practising. We hope these men, in relation to copy preparation and later on in relation to programming, and so on, can be re-trained in some of the jobs concerned in the new techniques. They must be absorbed into this new section of the industry. That is all the trade unions are asking. We are not suggesting that we should capture every job which is going but we are saying that the people who are in the industry should be adequately protected.

Mr. PHILLIPS: I think there has been a certain lack of perspective in this discussion because what we are talking about has not clearly been defined. There are two entirely different uses of the computer. One is to produce something which has gone through the computer because the computer is serving a function in compiling the output and has been an essential part of the mechanism. It has no connection with printing whatsoever. The other is to use the computer to save some of the operations which are now done by the skilled keyboard operator. In the second case, all you have said is perfectly correct. In that case I would think that the compositor should be trained from the time he comes in as an apprentice and should learn some of the techniques of programming because this will be his function. A great deal of time at the moment is being wasted through people doing programmes who do not understand typographical layout and do not realize that a lot of the things they are doing could be done in a simpler manner if they knew what kind of end-product they wanted to begin with. I can cite several examples where mathematicians are arranging cards to be punched. To take a concrete example, one could have an engineering firm making

spare parts—spare parts for motors, if you like—who have put in a computer in order to invoice these parts out to their customers who want them. They can do, therefore, all their trading with this equipment. They will get an advice note—a delivery note—out of that computer and all the necessary data to deal with their accounting. If they want to publish a spare part list, they can also get a tape out of their computer, which will be acceptable to one of your members who is operating, shall we say, a filmsetter. He could put that on the filmsetter and get out a list.

CHAIRMAN: This is happening in one instance where punched cards are coming in from the customer, are being put into a machine, converted into 8-channel tape, and are then converted to a 31-channel tape for the Monotype keyboard. This is happening. I thought you were going to tell us that there are two types of computers with which the industry would be concerned. I may be wrong here but this is my impression of the position. There is a computer which is going to produce a tape, and in turn that tape will be sent to a customer to operate on a photocomposing machine or a hot-metal machine. The computer will do no more than produce a tape. We understand there will be computers eventually which will be linked with photocomposing to the extent that a tape will be fed into the computer and certain manipulations made so that it will produce a piece of film to the right column depth and the right column width, and will eliminate not only the tapping of keys but also the make-up and imposition of the pages. This will be done electronically. I do not know how far that experiment has progressed so far. We have been hearing about someone producing an unjustified tape which is then sent to the computer which justifies it, does the hyphenation, and so on. There is another aspect, and that is the photocomposing angle, whereby pages will actually be produced from a computer in film without the necessity of make-up of hot metal or film.

Mr. PHILLIPS: I would say there is no photo or filmsetting machine working on line with a computer. As far as I know, the Linotron, which is the latest thing still on the drawing board, is not intended to work on line; it is intended to have a separate input. I would feel that the printer will have the film-setting equipment and he will have quite enough on his plate in understanding and working this filmsetting equipment. He will have even more on his plate if he is going to do some of the programming. He will be glad he does not have to generate the punched cards.

Mr. HOLLAND: A lot of the things which Mr. Simmons said earlier are very closely related to this possibility of redund-

ancy. All thoughtful people, of course, are worried about this. However, let us suppose there is not going to be any redundancy. There is a shortage of compositors right now. All printers would be only too happy to lay their hands on a few more skilled people in this grade. It could well happen that with the expansion of printing at the rate it is expanding now there will be a continuous shortage of compositors. This being the case I have sympathy for what Mr. Schwartz said about this problem of re-training when computers are injected into a typesetting process. It seems to me absurd that you should take a skilled compositor, who has served his full apprenticeship, and put him into a job which is that of a stenographer. Whilst this is also a skilled job, I do not think it requires the exercising of judgment and the making of decisions based on long experience. It seems to me that where you would use a computer, then you should have a very simple keyboard operation for continuous unjustified matter. What are your union's feelings on this, Mr. Chairman? Do you think you would accept—assuming there was no redundancy of course—a lower grade person who does not necessarily have to have an apprentice training, or even a stenographer, to operate a simple tape-punching typewriter or some tape-punching keyboard?

CHAIRMAN: In certain instances we have agreed to the type of worker you have in mind because there is a shortage of labour. We are expecting the position to be reversed when the jobs of existing readers and keyboard operators are eliminated, as then there will be no further need for the sort of operators you have in mind.

Automatic reading

Mr. G. CROUCHER (William Clowes & Sons Ltd): I was interested in the optical scanner, particularly as I thought it might be useful in printing for *The Mathematical Review*. I would be very interested if Mr. Besley could tell us where we can obtain these. I would like to know what kind of tape it is and what it will read.

Mr. BESLEY: I raised a question about optical scanners. I do not know the details of these except that people like RCA are actively pursuing the matter. I think you will find that they are from 6 to 8-channel tape.

Mr. R. F. FULLICK (Hazells Offset Ltd): The optical scanners I have seen write from magnetic tape. Before we all get too excited about the things they will do, the copy, whether it is clean or otherwise, has got to contain all the typographical

instructions and has to be prepared by someone with typographical knowledge; otherwise what it reads will simply be gibberish when it gets to the computer typesetting operation.

Mr. PRESCOTT: We are rather overlooking the fact that conventional typesetting methods are going to be with us for some years to come. I look at it this way. There will only be a small group of printers in this country who will have their own computers, quite possibly with all the other equipment. There may be certain equivalents to trade houses which will have computers. Even so, there will be lots of jobs which will come in to a printer who will not have time to send it away to be done by a computer bureau; in fact, it will be too expensive. It will be easier for him in that case to hand-set it. We are thinking that computers will solve all the problems.

There is this question of expense. No one has said very much about the savings on computer typesetting. For the people using the Photon, the savings are very marginal indeed at the moment. I do feel that conventional typesetting is going to be with us for some years to come, especially on smaller jobs.

Mention has been made—to change the subject—of trade union people and redundancy. I feel there is even more to the problem than that because, as I see it, the actual typesetting, or whatever the equivalent to typesetting is going to be, will be taken right out of the printers' hands. It is going to be put into someone else's hands, the publishers' hands or someone else.

In my own case, an organization which employs purely clerical people, we will, in fact, be doing our own typesetting in some form or another, whether it is tape or a card. We are non-union. The point is that your people may be made redundant, but you are going to find it very difficult to go along to such an organization and say, 'Look here, these men are redundant. Twelve of our people have got to come in and work the machines.' This is where the real problem comes in, unless these people can be absorbed.

Mr. A. C. McINTOSH (Unwin Brothers Ltd): I think I can safely say that I am fairly widely regarded as an amateur in these matters. Perhaps the questions I have to ask will be treated in this spirit.

I would like to ask, first of all, if we could have a definition of what computer typesetting is, so that we shall know precisely what we are talking about. There seems to be a lack of unanimity on this matter. This is perhaps the function of one of the members of the Computer Typesetting Committee.

Then I should like to ask why the Computer Typesetting Committee is limiting itself to the boundaries of whatever

definition it is going to give us. Perhaps we ought not to be thinking just about typesetting, any more than we ought to be talking any longer about filmsetting. Perhaps we ought to be thinking about over-all systems rather than bits of equipment and parts of a process.

Someone was talking about automatic readers, and so on. This is largely pie in the sky. By the time you have produced a typescript sufficiently clear to be read by one of these devices—let alone Mr. Fullick's point about the codes you have to put in—you have already reached the stage when either you can photograph that straight away or you can use the tape which you could have produced in the meantime. I can see no use whatever for reading devices in the field of printing for a long time.

I should like, if I may, to make a few points on the subject of mathematics. We must make a distinction between display mathematics and mathematics within the text. There is really no problem about mathematics within the text. Anyone can do this on any one of a very large number of processes. Display mathematics is another matter. We are in danger of being like a conference of atom scientists talking seriously about designing an atom-powered matchstick! This just is not practicable and will not be so for an awful long time, as far as I can see. There are far better methods for setting mathematics more cheaply, more quickly and more efficiently using labour which is already there and producing an entirely acceptable result without going near a machine, let alone a computer. If one separates the display mathematics from text, then there is a fairly simple problem of amalgamation, just as with display headlines. Thank goodness no one has asked whether we can draw diagrams by computers. That also seems to me to be too far away for very serious consideration at the moment. No doubt someone can draw diagrams by computer, and no doubt we will now hear about it!

Why justify?

There was a comment about the basic principles of typography from Mr. Simmons. Without being impertinent I would like to question the basic principles of typography. We have been going on for hundreds of years on the assumption that we do a justified page and a square page area. Someone at the Institute of Printing Conference earlier this year—or it may have been last year—said that no radical change had been made in the design of a page since whenever ... There are, in fact, changes going on. Before we spend any more hundreds of thousands of pounds or millions of pounds on justification, and how to put in hyphens and where,

perhaps we ought to be considering rather more seriously whether to justify and whether to put in hyphens except in certain highly limited and highly specialized areas. I cannot see why a page of type must be square either on the right-hand margin or at the foot, although I can see the very good reason for it being in a fixed position in relation to the centre fold of a book. But beyond that I cannot see any point whatever in having a square page. Indeed, if a dispassionate, unbiased study could be made by non-printers and non-publishers I think we would find that 99% of the reading public does not give a damn! Therefore, perhaps an awful lot of time is being wasted and an awful lot of money is being wasted worrying about justifying. The question I am really asking is 'Why justify'? If you do not have to justify, then you solve many of the problems! This is one of the basic principles of typography.

I should like to say one final word if I may. There is this question of the typist. We have to be very careful in advertising to avoid what nearly went into a newspaper once: that is, 'We want girls who are both clean and fast'.

It seems to me there is a problem in distinguishing between the able and the non-able on the present craft side. To talk about craft skills and computer typesetting in the same breath seems to me anachronistic. Possibly we should stop talking about craft skills and get rid of an awful lot of typographical skills so that we come down to a bit of rationalization and common sense. Regarding some categories of work, it is quite obvious that the keyboarding operation, for example, is going to become simpler and simpler in proportion to the preceding operations which are going to become more and more complicated. I do not think we need to consider the complexities of the following operations which are all inside little black boxes. I have an endless faith in the ability of the technicians who produce these black boxes but I have no faith in our ability to sort out the problems preceding the keyboarding which are not confined, in fact, to the printer or indeed to the publisher. Eventually, however, there will be a simplified keyboard operation which will be standard throughout the industry. As regards the dignity and pride of these experienced craftsmen, I am wondering whether we should use them on keyboards. However, I see a pressing need for a great deal more skill in the preparation of copy, whatever it is going to be used for later on. Perhaps we ought to be talking about that.

Mr. G. S. ALLEN (President of the Institute): Perhaps this conference is intended to define what is meant by computer typesetting. We hope that by the time the conference is over you

will all have been exposed to so much in this field of computer typesetting that you will have a pretty good idea of what it is all about. In the meantime, I would, for the want of something better, simply say that computer typesetting means the use of some form of general-purpose or specialized computer operation as part of the typesetting process. However, I do not think we should spend a lot of time debating whether that is a good definition or not.

Secondly, there was the question why the Computer Typesetting Committee of the Institute should limit itself to the definition which I have just given you. The reason, I think, is that it is a complex subject which involves a lot of understanding of what to printing people is a complex technology and it involves for the computer people what is quite a complex process. The reason for limiting the Computer Typesetting Committee of the Institute to this purpose is that we have a big enough task communicating and getting across these problems from the printing industry and the computer people to one another without extending our terms of reference. Perhaps when we can have a body of some 200 people who are really absolutely clear about all aspects of computer typesetting, and we have got some reasonable standards of language on which work can be based, then it might be desirable to extend the terms of reference to a data processing committee. In the meantime I think we should concentrate our efforts on this particularly important and rapidly developing field.

Mr. DIKKERS: I would like to add a point on this question of whether you should or should not hyphenate. I have two examples, both of them from the newspaper industry. One is from a newspaper in Rotterdam which decided not to use hyphenation in small ads. They made two changes at the same time: the first was to stop hyphenating; and the second was to switch over from 6 points to 5 points. There were a lot of complaints, but these were solely related to the 5 points size which some people could not read. One of the delegates at this conference has in his pocket a copy of *Vrije Volk*, which is one of the largest newspapers in Holland. There are about four pages of this which are not hyphenated, and we were studying the results this morning. We were all very pleased with it. It looks very nice and is appealing.

I should like to make another comment from the point of view of reading technique, reading speed. I presume you all know that the reading of non-hyphenated text is much easier and far quicker than the reading of hyphenated text. I think studies have been made both in the United States and in England on the

reading of the same text, hyphenated and non-hyphenated. The results on the non-hyphenated text were much better.

CHAIRMAN: Was the newspaper to which you referred also unjustified?

Mr. DIKKERS: Entirely unjustified.

Mr. MAYNE: Mr. McIntosh was saying earlier that computer typesetting for display mathematics was not really practicable. I think he has missed the point of my remarks completely. My opinion is that the productivity of mathematical typesetting will go up vastly when the new systems using computers are brought into effect. I would point out, whatever printers may think about the subject, that the mathematicians are going to get extremely impatient and are not going to wait a year to have their books set in mathematical type. Rather than have that happen, they are getting to the stage of saying, 'Hang the printing. We are going to issue it duplicated using photo copies of what we have written down and typed out.' I think that situation can be avoided with computers. I envisage a possibility of setting up books in one month instead of one year, using such methods.

There are various technical points—and I will not go into these here—which make the use of computer methods quite obvious.

Mr. HOLLAND: I do not think we should forget the fact that most of us make our living by selling an art form. Typography is an art form in just the same way as sculpture and architecture. I think we should examine very carefully any tools we use, such as, for instance, a computer which may make our lives a little easier but the use of which might result in degrading our business. We should only accept the use of computers as a tool where it is able to maintain our standards and, better still, improve them. Except in unusual circumstances we should resist strongly any tendency to accept a lowering of standards in typography.

Mr. MCINTOSH: We set our own standards a very long time ago. We are the only people who bother about hyphens. We create the problem by imposing straight right-hand margins. No one else cares about margins. A typist does not have to worry about hyphens and margins unless her boss says that he wants hyphens and that she should make the right-hand margin straight. If we question these standards, I do not think we are degrading our business. I would suggest that we should test them to see if they are still valid. It is ridiculous to say that people will not accept appalling hyphenations. Appalling hyphenations are going on all over the place. We are the only people who worry about them. We create the problems.

Mr. HOLLAND: I was thinking generally there and was not giving a detailed reply to Mr. McIntosh. I had my tongue in my cheek. I agree with a lot Mr. McIntosh has said, even to the extent of doing away with right-hand justification. I would like to see this well tested though. I would like to see anything tested which can be accepted as an improvement, but what I was mainly thinking about was the greater use of these print-out reproductions. I would not like to see a spread of this to the point where good quality book-work turned up as a sort of reduced-down print-out. As in the case of other art forms you have specialists who are the arbiters of what is right and what is wrong rather than the general public, although, of course, the general public influence matters. Mr. McIntosh is a member of a publishing company, and no doubt these things will be put to the test. I think we ought to be very careful about using a tool 'willy-nilly' and readily accepting degradation of our standards.

Mr. BLANCHARD: Whilst I deplore the American style of hyphenation where any four-letter word can be hyphenated, I feel the point Mr. McIntosh is making shows a lack of education in the younger generation which has come into the printing trade. I have deplored this time and time again at meetings I have attended. Lack of education, particularly on the English side, is deplorable. Any master printer here this evening could say without his tongue in his cheek that many apprentices coming into the industry do not know the rudiments of pure English.

Mr. P. GARDNER (Northumberland Press Ltd): I would like to make one rather basic point reverting to the question of whether you are going to be able to get young female copy typists producing lashings of unjustified tape. I think it would be advisable for people to know what the cost of a high turnover of labour is before they think too seriously about this. It is worth finding out exactly what it costs them to hire and then train in their own particular house methods a person at any particular job. They might find that it works out far better to re-train craftsmen. It is far better too to think about this at the beginning because, even if you are going to pay more for it, that is preferable to putting up with a very high turnover of labour.

CHAIRMAN: In drawing this session to a close, I am very much obliged to all those who have contributed to the debate. I think you will agree that it has been a most enjoyable session.

Some Programming Developments

Some Programming Developments

Chairman

Mr Adam Maitland

Speakers

Mr C T Ross

Mr Colin Barber

Mr T Archer

Mr D Ellis

Mr C J Duncan

CHAIRMAN: I first knew Charles Ross a few years ago when he was Manager of the NCR Financial Computing Centre and successfully bullied my firm into taking on a guinea-pig role in reproducing the computer processed data for gilt-edged lists of certain stockbrokers. At about the same time I also saw him working on a development study of the back pages of the Financial Times which we printed. These were the pages mentioned yesterday by Mr. Milner. It is because of the very practical work which I know he has actually done on these subjects that I look forward to hearing him speak to-day.

Mr. C. T. ROSS (Computaprint Ltd): I feel that half my task—commercial programmes available—has already been done for me by Mr. Duncan in his exhaustive and, if I may say, excellent article in Penrose. In looking at the programme for the rest of the day it is fairly clear that we are going to be told a lot of detail about a number of the programmes which are available. In the next hour or so, therefore, I want to try and give, as far as I can, a clearer insight into the problems and techniques of actually working with computers. To do this I am going to explore just two specific problems which I think will show the sort of atmosphere in which a computer user lives.

A number of people have already said—and I can only repeat it—that we are only on the brink of the computer age, and the decisions which we make in the next year or two will radically affect the speed at which we are all going to benefit from this new form of power.

Choice of computers

Everybody has talked during this conference about computers, but computers cover quite a large subject. There is a very wide range of machines, developed for special tasks. Therefore, you cannot just say, 'I will have a computer'. The very first decision which anyone has to make, if he is going to do anything with computer typesetting, is which computer is he going to use.

First of all, therefore, I want to follow up the problems which are involved and the decisions which flow from this point. Secondly, I want to look at the subject of the control of accuracy in a computer typesetting system, the whole job from beginning to end. This covers that area of proof reading and proofs which seemed to cause a lot of discussion yesterday. In discussing it I am going to talk about a system which makes the computer proof-read its own work. By going into this question in detail, it will show up a number of the strengths and weaknesses of computers rather better than if I talked in generalities. I shall also be able to illustrate this particular point from a job which is being done every week in this country.

To begin with, then, let us consider the start of a computer project. One problem facing the prospective computer user, whether he is buying a computer or whether he is using time on someone else's machine, is the wide variety of machines from which he can choose. Not only are there a number of different types available from different manufacturers but within each type there is an almost infinite variety of specifications which make a very considerable difference to the capacity of a machine.

To take an example of this, a small specification machine may have a small Immediate Access Memory. Returning to what Dr. Edwards said yesterday, I am referring here to the 'memory unit'. Perhaps not all of the programme will fit into that Immediate Access Memory. This means that, as the job is done, parts of the programme have to be transferred backwards and forwards between the Backing Memory and the Immediate Access Memory. This is a well-established and effective technique but it is very time-consuming, and time is money. The larger specification machine might well be able to accommodate the entire programme in its Immediate Access Memory. Generally speaking, the larger the machine, the larger the Immediate Access Memory. However, the programme we have written for the small machine may well take just as long on this larger machine because without touching the programme it will still take information backwards and forwards since that is the way it has been written.

On the larger machine the cost per hour is probably twice or three times as much.

Amending a programme is a dangerous business. It can be likened to sewing a patch into a tapestry of a crowd of people. After much detailed care and close work fitting the patch into the old tapestry strand by strand and stitch by stitch, it is quite possible when you step back and look at the tapestry as a whole that you have left out the legs of some people and the heads of others. In a tapestry this may not be important but in a computer programme it is going to be serious. The embarrassing thing about a programme error is that it may not be obvious immediately; it may only come to light a month later.

There has been a steadily growing tendency for sections of computers to be interchangeable; units that work on one size machine will work on another size machine, but it is only with the ranges of computers which are being announced currently that true interchangeability has arrived.

The problems of which size of machine to opt for in the earlier stages arises right at the very beginning of a computer project. It is a mistake to think that you can just try any machine and hope for the best. To use a very large machine will give the smallest cost per unit of operation but one may well find that one is then restricted to using only computers of that size or equivalent size. In the case of a breakdown or an extended period of maintenance, the nearest stand-by machine might be far away. On the other hand, a machine more in line with present requirements might soon prove to be suffocatingly small.

Programming

A similar problem arises over the decision how to construct the computer programme. I should like to continue with my analogy of sewing a tapestry. The computer programme is made up of many hundreds of tiny little steps. In themselves each of these little steps is almost meaningless but these build up to patterns and bigger patterns and, eventually, to a complete production job. Like a tapestry, a finished job may be neat and elegant or untidy with pieces worked over many times with parts obviously unpicked and re-sewn and it may be a curious shape with bits built on the top or sides so that it is not a nice square tidy operation. To do this job a very considerable knowledge is required of what you are computing with. In other words, the programmer requires a very considerable knowledge of the job to be done at the printing end. The effort required to get a complicated computer job running is very considerable. When the job is

actually running, the optimum is that one should sit down with the computer people knowing about typesetting and the typesetting people knowing about computing and write that complete programme again. Of course, many people do not, in fact, do this because it is a very heavy capital cost but the savings can be dramatic, not only in the computer time used but in the whole system. Both sides must know what the other side does. In everything that is said about computing, I do not think that this aspect can be stressed enough.

Circumstances are now beginning to change and these effects tend to snowball. More and more small programmes or sub-routines are being constructed. Usually when a programme is first written it solves a particular problem only, but after experience of running that programme has been gained it can with some care be turned into a general purpose programme, solving many problems of a very similar nature. There are at the present time, for instance, some six justification programmes which fall into this group. Our would-be computer user may be in a position to choose from many existing programmes to help him get off the ground, but regrettably here comes another problem.

As computers have been developed, so different programming methods have evolved. To start with there are two completely different methods of storing information in a computer, even in a digital computer. One school of thought says that if you are storing a number, 1234, you store that whole number, one thousand, two hundred and thirty-four, as a pattern of about 11 binary digits or bits. On the other hand, other manufacturers like to code each character—the 1, the 2, the 3 and the 4—separately. Each needs to be four or five bits. Therefore, one system uses 11 bits and for the same number the other system something like 20 bits and a totally different pattern. So you can see that you cannot just take the programme for one machine and put it on another for that very basic reason, if for no other.

Again, one group of manufacturers tends to like the idea of a programming technique where each instruction does the tiniest possible single job; the principle is that the whole system is more simple. Other manufacturers design for more complex jobs. They do some of the work for the programmer and do a number of operations within the one instruction.

These two sets of groups do not mix, which immediately gives you four different techniques. Nearly every manufacturer has developed his own techniques within those groups.

The knowledge and experience which has been gained by a group of programmers for one particular machine is, of course, extremely valuable to a group of programmers building up a

similar scheme elsewhere. However, returning to our tapestry, it is very clear that it is one thing to give someone instructions on how to sew a tapestry and a very different thing to set down and actually sew it. The situation is exactly the same with a computer system. Talking about the system which has already been planned is very helpful. Actually writing the programme and then testing it (to use our expression, debugging it) is very different. Therefore, at the present time the vast amount of experience which has been gained in solving particular jobs can only be, and has only been, exploited perhaps to one or two per cent of its potential. It is true to say that a number of computers have been bought because of the programmes which have been available for the machine rather than because a particular specification is the best one.

Auto codes

Yesterday, Dr. Edwards spoke of 'auto codes' and auto-coding techniques. It would be helpful to go into that a little further because it is very important. To reduce the problem of writing computer programmes the idea of the 'sub-routine' has been taken rather further. To carry out a multiplication on a simple computer can be done by a loop of instructions built into the machine which takes the number to be multiplied and adds this into the answer box; it then subtracts a one from the multiplier which is then tested to see if it is zero. This test instruction takes the computer round and round this loop of programme until the multiplier is zero and hence the multiplication has been done correctly. Every time the programmer wants to multiply he can write out in detail the four or five instructions. However, we are human, and in writing out that little set of instructions every time we might make an error, which will catch up with us in the long run. On the other hand, you could write out a set of instructions, which might be a little longer than the simplest loop but which covers every possible multiplication with every possible size of numbers which you are likely to use. Then when you want to do your multiplication you call for that little sub-routine. You might go a step further and refer to it as 'MULT'. You could write that in your computer programme and then get the computer itself to bring down your little sub-routine when you say MULT.

I would like to take that a step further. If you are writing a programme—say, a justification programme—and you are calculating the length of a line from a number of characters, you can store all the values of the widths of characters, and so on, in

different boxes or lines, and as you go through the programme you refer to the piece of information in line 3706, and so on. However, remembering those numbers is quite a job. You find at the end of the programme that a certain piece of information is larger than you originally thought, and you need to use the box next door. The box next door has something else in it so you have to move everything else up. You go through your programme and amend every reference, and perhaps write 3607, instead of 3706. You could, therefore, go one step further and refer to all the items which you are dealing with by a set of letters. Then at the end of the programme you decide how big each piece of information is going to be, then decide where you are going to put it. You can then get your computer to put in the correct numbers where you put the letters. It is much easier to remember for line length 'LINLENGTH' written in your programme than 3707.

Let us take a small example of this. For instance, the boxes containing the widths of the characters would be referred to as WIDTH followed by the letter required. You could refer to the number of each type character found in a line as CHFOUND (CH for character). At the end of the programme the size of the numbers is worked out and the box numbers assigned. Therefore, the justification programme when it is written down might appear something like this:

```
MULT WIDTH 'O'. CHFOUND 'O'  
ADD TO LINLENGTH  
REPEAT O=A THROUGH Z
```

MULT is our programme which says multiply. We want to know what to multiply. We want to multiply the WIDTH by the number of that type of character found, CHFOUND. Then we put in 'O' meaning a number to be further defined.

Having multiplied each letter by the width of that letter in the linecasting machine, one then wants to add it into a total to find the total length of the line so one puts ADD TO LINLENGTH. We want to repeat that operation for all the characters in the alphabet so we say, REPEAT O=A THROUGH Z. You can see that it is fairly easy to remember what one is talking about at each stage and one is not getting too confused with a whole series of numbers.

Having got to the end of your programme, you decide that the width of a character found might require so much space in the computer. The line length is going to be larger as you add all these numbers into it. Having given numbers to these various items, you would then proceed to list all these names which you

had given. You would give these to the computer coded into paper tape and the computer itself would turn it into the sort of programme which the computer would work on, and which people used to write until quite recently. In fact, that little job written out directly would be something like 50 instructions and would normally be written like this: 30 : 16, 03: 11.43: 107219. It is much easier for someone who has spent all his life doing one particular job, typesetting, to write these letters than to write the numbers. Conversely, if he were a mathematician it would perhaps be easier for him to write numbers than to write letters. I know which I would prefer to do!

The computer programme which, I was saying, converts this into the numbers used in the computer, is called usually a 'compiler', and the words quite frequently referred to are an 'auto code' or a 'programming language'. Theoretically it is only one step to write different compiler programmes for the same language for different computers.

Let us go over some of the points we have been looking at. First, there is the problem of the firm starting on the small machine which then wants to use a bigger machine. Without modification the programme will run just as slowly on a big machine as on a small machine if it is written in numbers, but if it is written in words, it is put in the compiler for the bigger machine and the compiler will decide where the programme goes, and perhaps that same programme will run in a quarter of the time on the bigger machine. That is the order of magnitude. Again, if the firm wants to use the machine next door because the machine has broken down, the programme is run through a new compiler. It is all very simple and straightforward. That means that the programmes written and tested for one machine can actually be used on another computer.

Immediately you say, 'That's all very well. I write a programme and half kill myself. I spend thousands of pounds and the firm next door comes in and pinches it.' In fact, far from making it easy for others to come in and copy the pioneer, this means that the pioneer can sell his programme to others if he wants to and get back some of the expense incurred in writing it. He might even make a profit from writing the programme. On the other hand, he can still keep it if he wishes to. Further—and this is the important commercial aspect—he has written it; he has it working perhaps a year earlier than his competitors.

Sadly, however, and perhaps not surprising to relate, this utopian situation of programmes running on all different machines does not completely exist. The first reason is a practical one: compilers have not reached the degree of sophistication

that is necessary for the complete interchangeability of programmes between computers. As computers are designed in some cases for different sorts of problems, it would be very inefficient indeed to run one programme designed for one type of digital computer on another one. However, there are many computers which are broadly similar where this ability would be tremendously useful. The other reason is that manufacturers of computers, being human, and also being in business in competition, have tended to develop their own programming languages with compilers for their own machines. You have different types of computers, different types of programmes and different types of languages. However, by virtue of the fact that on occasions the customer is right, one language has compilers written for it for different machines, certainly all the ones which people have mentioned to date. This is a language called FORTRAN, which was designed originally for solving mathematical problems, hence FORMula TRANslation. That has itself got four different varieties or four different generations, to be specific. However, it has been expanded. The fourth edition has been expanded to have fairly substantial data-moving facilities. It has, in fact, been used by one person in writing computer typesetting programmes; he has only used this language.

The printing industry as a whole has a great opportunity in coming to the computer world rather later than, for example, mathematics, where there are thousands of sub-routines and programmes written, working, and tested, which can be used. If everybody in this country involved in computers for printing decided to work in the same programming language, then the pace of computer development in this industry would move forward something like ten times faster than if, as is much more likely, everybody moves ahead in his own system, and his own programming methods, which are only of value to himself. It is interesting to note here that the people who will gain the most from taking this decision will be the ones who are going to put the most effort into building computer programmes in the near future. The reason for this is that by working in a unique programming system an organization is building obsolescence into itself and storing up for itself tremendous trouble, because at best that company is going to limit itself in the future to computers from the same manufacturer. This may be no disadvantage but it could be very important indeed. At worst, if there were further radical changes in design, which is highly likely, it might not be able to take advantage of these without writing the computer programmes all over again for the new machine. That would involve a truly enormous cost.

Let us think for a moment of what was said yesterday. Mr. Duncan said that he thought it was a good idea to use the accounts department computer for typesetting. All right, but the accounts department system presumably has been bought to do the best possible job for the accounts department, which may be the best system for doing typesetting but it is very likely that it is not. So you build up a number of programmes on that machine, and then you decide you want computer typesetting. You are either stuck with a larger edition of the same machine or you have to sit down and programme right from the start again for the machine which will do the best job for typesetting.

Coming back to the Airways Guide, we were told yesterday of the complexity—and I can believe it—of writing the programme for the Airways Guide. Now we hear that perhaps that company might itself buy a computer. However, now they have no choice as to which computer to buy; they can only buy the computer for which that programme was written unless, of course, the Airways Guide programme was written in one of these languages which can be converted from one computer language to another, in which case it is all right. At the beginning of any project it is important that these long-term thoughts are taken into consideration.

I should like to talk for a moment about going to a computer centre. Someone said yesterday that he was planning to go to a computer centre for something. At this stage, quite reasonably, he has not the remotest idea whether it is the right computer for his job. He builds up an enormous quantity of work which can only be processed on one machine. If by chance that happened to be a computer of £3 million to £5 million, he is going to have a job to justify that when he wants to buy his own.

The accuracy of computers

I turn now to the second subject, the accuracy of computers, meaning the accuracy of man in connecting up, putting the data in and rolling out reels of tape, and the accuracy of composing machines.

There were many comments yesterday about proofs; first proofs, page proofs, galley proofs and super-quality proofs. I think the consensus of opinion seemed to be that a final proof after the last typesetting was vital; indeed, one could say that this was stated categorically. I disagree completely. In my opinion, the days of proofs and proof reading are very definitely numbered.

Let us look at the three phases of printing by a computer. The initial problem is to get a string of words into the computer's

memory accurately. One is interested in characters being the right characters in the right place with the right full points, and so on. The problem of in-putting data into a computer has exercised the minds of the computer world ever since that world was born. It is of the utmost importance that we can get information into a computer accurately, and be certain that it is accurate. I am going to leave that point as we shall presume that it is possible to get information into a computer correctly.

The second phase covers the problem of the format in which the final print is to be presented. This stage has the problems of house style, page size, point size, measure, cast-off and one can include justification, hyphenation and the computer operations. In all the work we are doing at the moment, with one exception, we are advising at this stage that an accurate proof is printed to check the accuracy of the parameters, or terms of reference, set by the editors, to tie up any loose ends in the justification and hyphenation.

The third phase consists of converting the output of the computer into the image which is placed upon the press. One here stumbles across a problem which is a little difficult to explain. The computer has no 'common sense' whatsoever. It does not have the remotest idea of what is coming in. It goes through its sets of instructions quite unaware of what it is dealing with. While the computer programme is being planned and written, almost any degree of flexibility can be built into the system, but once that system has been completed and tested and put into production, it is utterly and completely rigid within its terms of reference. This is tremendously different from a room of comps. You cannot shout down the line and say: 'Hey, I've changed my mind', because the computer is not listening.

Within this framework a computer can check its own operations to the nth degree. Therefore, while the data are in the memory of the computer, the programme can keep the data completely accurate. When I say that, I do not mean 99.9% accurate, I mean 100% accurate. Once the data have got outside the clutches of the computer, the same regretfully cannot be said.

Computer output for printing at the moment, as we heard yesterday, is either to a high-speed line printer or to paper tape which does something else, or possibly to punched cards. The mechanical parts of these pieces of equipment are understandably open to error. The high-speed line printer is going at 1,000 lines a minute, maybe more now, and there must be—as there are—very efficient ways of checking back what the computer is doing. There is a limit, however, to what metal and springs can be expected to perform. Again, if you are punching paper tape at

300 characters a second, which is now quite feasible, you are cutting holes with pieces of metal, you have got springs and everything else, and it is expecting a bit too much that those machines should not from time to time make the odd error.

I have no intention of quoting the error rates for various pieces of equipment, such as the linecasting machines or the photo-composing machines. Let us just say they are not 100% accurate. In every system so far, the medium of connection between the computer and typesetting equipment has been paper tape. When you punch paper tape it is possible that all those punches do not come down every time in precisely the right place. Let us be clear about this. The accuracy is incredibly good but error is possible. Next, you read the paper tape. You can read it photo-electrically or you can feel it with little pins coming up. The first method is better than the second. If you can imagine a computer which is about to punch 300 characters in the next second, the pull on that paper tape is very substantial. It does not follow that the spacing between each code is going to be good enough for the reader next down the line. Therefore, there is a prime source of error, let alone the errors created after the paper tape has been read in a composing machine, where the worst culprit is the gravity-powered linecasting machine. Because these errors can be introduced from outside, proof reading is still necessary at the end of the computer typesetting operation. But proof reading is thoroughly unsatisfactory. If we look for 100% accuracy in all the mechanical equipment, then perhaps we could think of doing away with proofs. I do not think I need to go into the advantages of removing those stages here. Let us just say they are fairly substantial, not just directly in removing the need to check the work but also in the time taken to do the corrections.

A year ago we ourselves were faced with a particular problem; we were generating statistics from which Europe's bankers were going to move large quantities of money. We had to print these and a mistake would have been a very expensive error. What is more, looking at a lot of figures is, perhaps, the most difficult proof-reading operation of all. We did not feel we could look at the first line and the last line and say that it was all right. To make matters worse, time was at a premium. The system we have developed gives us a mathematical undetected error rate from the memory of the computer to the press of less than one error in 100 million characters. This particular system has opened our eyes to an avenue of economy which in the production of books and other printing work could eliminate completely the need for proof reading.

This typesetting system is basically the same as we demon-

strated to the Institute of Printing in 1962, but we have taken the development somewhat further. First of all, the computer generates in its memory a line of information to output. The computer produces paper tape and, as it is punching, it adds up the values of each code, just the binary values of every single character, whether it is a character or a function. At the end of each line the programme puts that total out on the tape. At the end of a page, the programme tells the operator it has finished the page, and the operator takes this piece of paper tape and immediately puts it straight back into the computer again. The computer has a simple programme which reads through that tape, adds up all the characters, not attempting to say what they are, and checks the total at the end. When this tape is right we take it to our typesetting device, which has an input unit, a setting unit and an output punch, the output punch operating from the mechanics inside which create the image. Here this tape says 'print a 4', so it prints a 4 and punches a second tape. At the end of the page we compare the two tapes. We are comparing what we have asked to be produced and what has been produced. If there is an error, the computer prints out a little note saying 'line 4, 7th character might be an error'. In the year we have been running this system we have discovered something like ten errors evenly spread over the whole system: two in 'output', three in 'input' and four in the checking system.

We have, therefore, provided ourselves with a means of knowing what we have done. We have used the mathematical capability of a computer to check up on something which is totally unconnected with the computer. It is a very simple technique. Its main advantage is that we know where we are. You will say that the final proof is a check not only on accuracy but on the quality of the work, the spacing, the caps, the cast-off, the hyphenation, the quality of the image, and so on. Currently we are checking all this with a proof, as I said, but let us have a look at these things.

Spacing, house style, caps, whether things are indented correctly, whether we have three hyphens consecutively at the end of a line, and so on, are all programme considerations. When we trust the programme, we then do not need to check the proof to see that it has indented the paragraph correctly and that it has not started the top of the next page with the end of a paragraph. We do need to check that the string of words is correct but, as I said, that is right back at the beginning. When the words are right and the programme is trusted, no proof reading is necessary. The typesetting, computing, electronic proofing and printing can be integrated as one smooth production line.

We have talked to a number of manufacturers about the possibility of this feed-back system, and we are getting somewhere with some of them.

In closing, let me say that we can see that the computer can help us gain accuracy in all the operations inside the machine and outside the machine. It can help us write our programmes. It can help us organize our factories and, if we let it, it can help us organize our whole industry. I hope that by taking these two examples I have highlighted the limitations and the potential of these devices. The potential goes much further than just hyphenation.

Standardize—now!

However, the amount of knowledge and experience in this whole field is and will continue to be quite small and hard to come by. If the printing industry works together on these problems, particularly by adopting the same programming language and the same coding ideas, and coding systems, that precious effort, instead of being frittered away by a dozen teams tackling the same problems, could build up a solid body of productive knowledge which could help the industry to attain a commanding position. Real co-operation could save this industry, without any exaggeration at all, millions of pounds.

The Institute of Printing has set up the machinery in the form of the Computer Typesetting Committee to help with this problem. In due course this Committee could encourage people to work on different problems and different aspects, and act as a clearing house for actual work done. It is only to be hoped that, in this multi-million pound industry, managements will be sufficiently far-sighted to take this opportunity. There is one word of warning. Just by good luck we have that opportunity now. It will never return.

CHAIRMAN: Your applause reflects the great interest in the paper we have just heard. We now have some time for questions.

Questions to C. T. Ross

Mr. A. BEAVEN (National Cash Register Co. Ltd): This is going back to the auto code special-purpose assembly language. I was interested to hear that Mr. Ross feels you can get very much better results than Mr. Barber seems to expect on auto codes. In the light of this, I would like Mr. Ross to tell us about his practical experience with Fortran, since at the time he started his experiments the machines on which he was working had all

got at least Fortran and Algol compilers or translators available. If he did not use Fortran, why didn't he?

Mr. ROSS: The people who have been using Fortran for printing operations have been doing this at MIT. The reason why we did not use Fortran in the NCR Computing Centre was that when we were concentrating on looking at one set of equipment, the need for using general purpose auto codes was not so apparent. One's interests there were largely in selling one set of computer equipment. From the need to buy my own computer now and, therefore, to look at the entire range of the market, some of these problems come rather more sharply into perspective.

Mr. C. F. NASH: (International Printers Ltd): I wonder if Mr. Ross would care to elucidate the point about his correction method by the feed-back in the computer system. As I understood it, the final output tape was refined by a process of feed-back reference through the computer to produce a final tape which was very, very nearly, 100% correct. Was this the only form of output or did he actually produce film or a printing image at the same time?

Mr. ROSS: The operation is, first of all, to produce all the answers in paper tape number one. That goes back into the computer to check that the punch on the computer has performed accurately. Number one itself goes into the typesetting device. At that point we produce a black image on a white piece of paper or litho plate. Paper tape number two contains what has been put on to that master or piece of paper, and that goes back into the computer as a check against what has appeared in the typesetting process.

To show how this technique has developed from the computing side, we use paper tape number one again the following week to go into the computer at the beginning of the calculating section, and we use last week's output as a gross error check on this week's statistics. This gets over the problem of a computer having a hiccup.

Mr. V. CORRADO (Mergenthaler Linotype Company, U.S.A.): You said that you had a frightfully simple solution to hyphenation. If the answer is do not hyphenate, would you expand on it?

Mr. ROSS: Certainly. Luckily the answer is not 'do not hyphenate'. One thing about hyphenating if you are looking for perfection—as in the words, pre-sent, pres-ent—is that you must at some stage bring in a human being. The advantage of the Linasec is that as a last resort a human being can make the decision. You can do quite a lot of hyphenating by the computer

where there is no doubt about what you are dealing with. However, in any book there is likely to be only about 10% of the lines where a word is hyphenated. The computer can very cheaply go through its magnetic file and hyphenate as it needs to. Where the computer has any doubt, if I can put it that way, it can print out the word involved, with indications of permissible hyphenation points. This would be a cheap and simple process. It is then up to an individual to decide precisely where he wants his hyphen. You can put that back into the computer, and you have got hyphenation part by computer and part by human being. That is a simple and inexpensive system to design and organize.

Mr. J. D. BESLEY (Hazell, Watson & Viney Ltd): This method of feed-back to determine errors would not cover the initial errors introduced by input mistakes. How do you attack that problem?

Mr. ROSS: I tried to divide the problems into (1) getting the string of words into the computer, and (2) getting them set correctly. I did not attempt to cover (1) as it is to be covered in a discussion of keyboarding and input later. If you do not get a satisfactory answer later I will come back to it myself.

Mr. J. McCAUSLAND: Would Mr. Ross explain how he completed the production of the yellow sheet which he handed round?

Mr. ROSS: The perforated tape produces the figures. The vertical lines, the column headings and the descriptions down the left-hand column are pre-printed on to a paper lithographic plate. The figures go in on the typesetting process. We have an extra little system to ensure that the correct lines are opposite the correct pre-printed information. That paper plate goes straight on to an R.20.

Mr. B. R. HATVANY (Burroughs Machines Ltd): With respect to your second tape, Mr. Ross, what action is it in your typesetting machine which activates the punch mechanism? This action should obviously occur as near as possible to the output of the typesetter. More important, the production of all your paper tapes would be obviated by the manufacturing of a comparatively simple link connecting all typesetters direct to the computer via a buffered data communication network.

Mr. ROSS: As regards the first point, this device is a typesetting device and is of a similar nature to a typewriter. The second tape is generated from the movement of the type bar coming into contact with the litho plate. It is quite possible when the type bar comes up that it does not actually strike the litho plate correctly. This we can do nothing about. We merely know that the type bar has come up and the right part of the bar should be at the litho plate.

As regards your second point, yes, we could link the typesetting devices to the computer on line. I suggest it does not follow that because you have got them on line to the computer you would exclude errors. We do not do this for the reason that if you keep all your units separate, a breakdown in any one unit does not stop everything. We find with this check-back system, which is very simple, if one typesetting device is not working properly we can easily take it out of the line. We have nothing of a non-standard nature. From my experience of this, I feel that having data transmission lines directly into a computer just adds another problem.

CHAIRMAN: I am afraid we must stop now, thanking Mr. Ross again.

Mr. Colin Barber will now speak to you. He is, in effect, an engineer turned printer. He has with him his colleague, Mr. Archer, a trained printer who has taken up this specialized form of engineering. I will first call upon Mr. Barber.

Mr. C. BARBER (Rocappi Inc.): This paper involves three of the programmes currently in production use in the United States: the first is the Perry programme for the hot metal linecaster; the second is the Perry Publications programme for the Photon 513, and the third is the Rocappi system. The Rocappi system is a combination of all the logic procedures which we have developed in the other two programmes—plus.

Perry programmes

The Perry hot metal system contains some 3,000 combinations of typographical niceties, things like line length, indent, and so on. The Perry Photon 513 went from the order of 3,000 up to the order of 1,000 million. This involved leading and a great deal of layout combinations. The Rocappi system is currently of the order of 10^{18} . We are hoping within six months to extend this to the order of 10^{30} .

I would like to draw your attention to the fact that I am not a printer. Two years ago I did not know what a pica was; I had never heard of one. I have worked with some very clever printers, printers who would not dream of letting me change a single concept. It has been our habit at Rocappi—it was forced on us initially and I have grown to like it—not to try and change any standards in typography. Our hope is to simulate the craft. This is the way we see it. We do not want to have to introduce anything which will be any more revolutionary than the computer itself. We want to keep the same make-up procedures wherever we can.

I have one or two notes here on topics which have been mentioned previously, and I should like to go over them very quickly.

The first concerns error detection in paper tapes. I could say that it would be possible to devise a system to realize whether or not you meant 'chunk' or 'skunk', according to the text immediately adjacent to the word. I am sure such a system could be devised. The problem would be that the diagnostic interrogation which would be required would most certainly exceed the logic that the rest of your programme required. A point worth realizing, therefore, is that computer memory is physically restricted. Fair enough, you may say, we know that there is no such thing as a 9 million pica line; someone has obviously made a mistake. This may have been a 19 pica 9 point line or something of this sort. Interrogations of this kind can and have been incorporated into computer programmes. You must realize that until computer memory becomes infinite, interrogation for error must be limited. Let me say also that the timing associated with these interrogations—although we talk in terms of milliseconds or microseconds—the simple steps described this morning all take up a material amount of time. I would like to give you one or two instances of this for the programmes as a whole when they are accumulated. The Los Angeles Times programme, for instance, operates 8 point 11 ems at 300 characters per second. The Rocappi system does not go that fast. We are doing a lot of other things which the other programme did not do. As a consequence, for the same text we go at about 220 c.p.s. For the Perry system for hot metal typesetting the speed is 80 c.p.s. This is because of the processing time within the computer. The magnetic tapes which are used by the Perry system read and write at 10,000 characters per second; however, the processing speed through the computer is 80 c.p.s. You must realize that any operation, in particular these diagnostic interrogations, take a great deal of execution time in memory.

I would also like to say a few words about sub-routines and automatic languages. A sub-routine really is a sequence of logic which is going to be used over and over again. If you did not put it in a sub-routine form, every time you wanted to execute this particular operation you would have to write down those instructions in memory, hence consuming your memory, apart from generating more errors.

Although an automatic language (let us take Fortran) gives the engineer, the printer or any applied scientist the ability to communicate with the machine after a very short training period, the basic machine language which is generated from the compiler in-

structions is very wasteful in terms of memory and all the more wasteful in terms of time of execution. No one is going to install a computer unless he is going to save money by having a computer. If a computer could only operate at ten characters a second, we would not be here. It is because computers can operate at rates of 80, 200, 300 characters per second on justification and hyphenation that we are here. This speed is dictated by the number of instructions and the way they are given. Any compiler generates an enormous amount of redundancy. I think it is generally accepted that a compiler merely demonstrates feasibility or should be used to execute one-off procedures. It is in the stressing of gears or the bending of plates, and problems of this kind, where you have to employ engineers who do not want to be bothered about optimizing a computer programme but at the same time have to rely on a digital computer, that symbolic line language really means something.

With that preamble, I would like to discuss the three systems in question.

The programme for Perry on the hot metal linecasters was started in October, 1962. Two men were assigned and the project was completed and in production by the middle of January, 1963. I say 'in production'. The night foreman used to tear his hair and he became almost an alcoholic! We did go to production in January, 1963. It was only through that man and other composing room staff that we were able to determine the deficiencies in the system. The consultant made available to me at Perry Publications was a man called Robert Spearman—a man with a vast amount of experience. It was written primarily for straight matter for newspapers. It involved 12 font line-length combinations, typically 8 point Regal on 11 pica line. Similarly, the programme could operate on classified ads and double column material. The programme required 20,000 memory locations of an RCA 301 computer, 6 magnetic tape stations, a paper tape reader and punch and a high-speed Anelex printer.

I would now like to say a few words on hyphenation. Mr Perry was very anxious not to mis-hyphenate anyone's name. I think there are about 20 newspapers and magazines over the length and breadth of Florida within the Perry Organization. At that time, no one had a method of character interrogation in order to determine points of hyphenation, and we decided to go along with a stored dictionary. The dictionary was derived from Webster's Dictionary and Webster's Geographical Gazetteer, a list of names, the Palm Beach Register, and a list of local street names. In Florida you have all these funny Indian names

which you cannot hyphenate correctly according to any logical rules. The point is that these words did go in and we found that we could hyphenate accordingly. Statistical analysis showed that the points after the third, fifth and seventh characters yielded the correct points of hyphenation more often than any other positions. As a consequence of this, although all words were included on the dictionary master file, words such as dic-ta-tor (splitting after the third and fifth) and a-ba-cus (the first hyphen you can forget because you would never hyphenate with one character on a line), demonstrating three, five, seven splits, were actually omitted from retrieval files other than the master, the idea being that if a word was not found in the dictionary you automatically assumed that it was right to split after the third, fifth and seventh. This meant that we had less words to store in the dictionary.

At this point, the Perry hot metal machines were being driven by hand-justified, Fairchild perforator produced tape. Someone asked a question about storing tape the other day. I wish you could have seen two weeks hand-generated justified tape. We were knee-deep in tape! This tape, having been accumulated, was put through the computer and analysed for words in excess of five characters. This having been done, I was able to establish an order of occurrence with respect to the first character. In other words, I discovered more words started with an 's' and a 'c' than with an 'x' and a 'z'. Dr Edwards was telling us yesterday about retrieval. If we can arrange a file for retrieval in such an order that we can get out the most commonly required words fastest, then we have gained something. Therefore, this is what was done. A hierarchy chosen from some 40,000 words was developed. This hierarchy was arranged symmetrically. In other words, say I had more words beginning with 's' and 'c' than with 'x' and 'z', I would re-arrange that hierarchy so that 's' and 'c' occurred in the middle and 'x' and 'z' on the outside, and within a first letter group everything is in alphabetical sequence. As a consequence, the dictionary file was such that words beginning with 'x' and 'z' were positioned at opposite ends of the file and 's' and 'c' in the middle. From the developed file, words within a first letter group were distributed in quadrants on each of four magnetic tapes. A quarter of the words beginning with 'c' were put on one magnetic tape. A table was formed such that when a word required hyphenation the computer knew which tape to go to for that word. The position of the tape was monitored at all times and we were able to go out and retrieve the word. Words which were not found were required to be split after the third, fifth or

seventh character. Almost 100 per cent accuracy was obtained in the system, bearing in mind that the system was considerably slowed down due to retrieving information from magnetic tape.

I am going to say again that the hot metal programme made available some 2,000 to 3,000 combinations of typographical parameters such as, fount, line length, quad left, right and centre, justified lines, and so on. This has been in production since January, 1963.

I would like to say a little more about hyphenation in general. Excluding a random access device—a random access device enables you to pick off something at the same speed irrespective of its position in the file—a stored dictionary may become a prohibitively slow method of determining points of hyphenation.

Methods of determining the correct points of hyphenation within a word based on the character content of the word are faced with fundamental requirements such as a representative alphabet or preferred syllable structure. By 'representative alphabet' we mean that, if we put in 'v' and 'c' for all vowels and all consonants, we would find that we do not have as many unique words as the dictionary would lead us to believe. It can become almost impossible to interrogate the entire word at one time; so what the computer has to do is to interrogate parts of the word—three, four or five letter combinations—and then determine whether or not it can hyphenate the word. A great deal of statistical analysis has to be made in order to determine which is your best representative alphabet. It is true that in most words beginning with CON you can be quite sure you can insert a hyphen correctly. However, very few cases are as good as that. Most of them lie in a very grey area, and sooner or later you are faced with the problem of saying: 'Am I going to form tables where, in 80 cases out of 100, I know I will hyphenate correctly?' It is not only a question of what accuracy is required; it is a question of the correction procedure you may have available. Mr Roy Gift of the Los Angeles Times went into this absolutely alone in October, 1962. His was a first-class piece of work. David Kelly of Rocappi formed his tables based on the Perry dictionary and we are now using these in production.

I would like to give you one example of why no one can hyphenate absolutely one hundred per cent correctly, not even with the Perry dictionary. Take the words 'pres-ent' and 'pre-sent'. Unless you have a grammatical interrogation, how do you know whether it should be pres- or pre-? I would suggest that one can be very sceptical when it comes to analysing claims of perfect hyphenation.

I would now like to talk about the Photon 513 programme. This was started in March, 1963, and was in production by July, 1963. It was written really for display advertisements.

The Photon 513 made available 12 sizes in 16 faces, any line length up to 42 picas and leading variations all under 6-channel paper tape control. It was clear from the beginning of the project that the 3,000 combinations which we had in hot metal were just nothing when one had 192 variations of font alone. Therefore, a parameter message had to be developed.

The circuitry on the Photon 513 made available justification for any tape perforated line containing the requisite function codes. In other words, if you had a line which had eight space bands and you gave it to a Photon 513 as a justified line, the 513 would look at the line, realize the variable space codes, and would itself distribute the deficit between the inter-word spaces automatically.

The Rocappi system

I would now like to talk to you about the Rocappi system. The name means research on computer applications in the printing and publishing industries.

The corporation was formed by John W. Seybold in September, 1963. The analysis and design started in October, 1963. An RCA equipment complement, consisting of four magnetic tape stations, paper tape, reader and punch and an Analex printer, was installed in March, 1964. The first live production runs were made in April, 1964. We did a 'Book of the Month'. We had a bit of bad luck on the punch. Had it not been for that, our first run would have been classic, I believe. Subsequent runs have been much better.

We have the ability to accept input from any known conventional paper tape perforator. We can justify and hyphenate. We have correction procedures to insert and/or delete material at will. In other words, we can kill from the third word in line 90 to the eighth word on line 737 and insert one word, two lines or the Encyclopaedia Britannica.

We have done certain work in layout and positioning, certainly in advance of the 513 programme. We can de-justify and re-justify automatically at speeds up to 300 characters a second. Having produced a book in 8 point Baskerville on 30 pica line, we can go back and do it again in 10 point on 22 pica, all from magnetic tape.

We are doing some tabular material. We are on the verge of releasing a programme for pagination that is so many lines per

page and inserting line numbers, et cetera. This has fallen behind somewhat. It will not be in that condition for very long.

We are storing all manuscripts on magnetic tape. We are prepared to deliver tape either to convertors or directly to any known typesetting device. Let me say again that these figures are quite significant: Perry hot metal, 2,000 to 3,000; the Photon 513, 4×10^9 ; and Rocappi, 10^{18} . I am not going to say very much more about the Rocappi system except as far as its parameters are concerned.

Clearly, with so many parameters, the method used for the 513 falls short. We choose one code on a 6-channel paper tape which, we will say for the sake of argument, is a beta. When the computer sees X after beta it knows automatically that the next three characters define the line in pica and points. If it sees beta followed by a numeric it knows that you require a symmetrical indent. If it sees beta beta followed by a numeric it knows you want a hanging indent.

I am now going to hand you over to my colleague, Mr Archer, who has been very much concerned in the design, programming, and production.

Mr T. H. V. ARCHER: Mr Barber has outlined the principles of the Rocappi system for you and has left me to tell you how these principles work out in practice and what problems we have faced in getting into production.

I will discuss the system in the order in which a job is now processed at Swarthmore, Pennsylvania, and the order in which we shall be processing shortly in this country, starting with perforation of the original input tape.

In Swarthmore we have a number of different makes and types of perforator, the idea being to find out which is best, while making the system compatible with as many different devices as possible. We have two Friden machines, a Justewriter and an LCC, a Dura (called Bradma-Dura over here) similar to those used at the Los Angeles Times, and a Fairchild TTS keyboard. Generally, we have found the six-level, no-parity, mechanical machines cause less trouble than the more sophisticated electronic machines. We consider it important that the computer is kept going as continuously as possible; avoidable stops, due to punch errors on the perforators, waste valuable time. Therefore reliability and consistency are big virtues in our eyes, and the absence of a parity channel is an advantage in that, although a bad perforation will come up as the wrong character, it can be corrected at a later stage, and it does not stop the computer. The vast majority of the paper tape processed at Swarthmore is not punched by us. Most of our

customers over there are printers or publishers who have their own paper tape perforating equipment. They perforate their own tape; we process it and send them back output tape to drive their respective typesetting machines. Of course, there is the correction stage in the middle of this; the customer usually perforates his own corrections. The tape generated by our customer is naturally coded according to our requirements as far as function codes are concerned, and we also specify what various keys on the perforators should be used for; thus the one-unit key on the Justewriter is used for Quad Left and the three-unit key denotes an em space. We have to define these few limitations as, although ours is a universal system, conformity of input is essential to smooth production running.

We found that an operator can learn to perforate for our system within a few hours, provided he or she is a reasonably competent typist and knows, or can learn quickly, a few simple fundamentals about typesetting. Generally, an operator can quickly attain a speed of 10,000 keystrokes an hour and, with experience and practice, 15,000 keystrokes. A speed of 20,000 per hour is perfectly possible with a good operator. I should mention at this stage that we place no reliance on the hard copy produced by many types of perforator as, almost invariably, this does not give an accurate record of what is on the paper tape. For example, all machines have a delete key for obliterating errors on the tape, but I have not seen a machine in which this key is coupled so that it obliterates the character on the hard copy. Again, many of the function code keys do not print at all and these are most important if you are to rely on the hard copy. We therefore treat the typed sheet purely as an aid to the operator in that errors are more easy to spot on a typed sheet than by trying to read paper tape perforations.

Mr Barber has briefly told you the function codes employed in the system, so I will not enlarge upon them to any great extent. When assigning function codes, it was our main concern that the number of keystrokes be minimized as far as possible. Quite apart from the productivity angle, this does mean that the operator has less to remember, and initial training is considerably easier. The function codes available at present (and we are constantly adding new functions to the system as development progresses) allow us to tackle any kind of straight matter, a good deal of display work, and the less complicated forms of tabular setting.

Now, I'll go on to discuss the various phases of the operation. As Mr Barber mentioned earlier, the system is split into a number of programmes, each producing output for the other,

while retaining flexibility in that you do not have to pass the job through a fixed system, and the path can be varied according to the requirements of the job.

The Rocappi prephase

In order to integrate the programmes effectively, an introductory programme was written which we call the Prephase. This sets up the correct production programme in memory from over 500,000,000 possible programme variations, the ingredients for which are stored on the Rocappi Programme Library Tape. The programme identifies the type of input code it is going to receive and sets up the correct translate routine for this code. It then pulls in the typeface tables which will be required for the job and associates with each typeface size combination (which we call fount) the appropriate function code. This means that all our function codes for fount definition are flexible, in that a particular function code only has a fixed meaning with reference to the particular job for which the programme has been set up. Thus function code J, for example, might mean 10 point Times Roman for a particular job. It would mean 10 point Times Roman throughout this job, but on the next job it could mean 8 point Baskerville or 6 point Caledonia, or any other fount required. This, of course, simplifies considerably the job of the operator in perforating function codes.

Other function codes have fixed meanings from job to job; thus function code X always means that the following three numeric digits indicate the line length selected in pica ems and points, and function code 'quote' means that the following three numeric digits indicate leading of so many points (up to a maximum of 999, of course). The Prephase also allows specification of the set width to which the particular fount is to be set. Thus, for example, on an ATF B8 machine it is possible to set in 9 point Times Roman to a number of different set widths variable in increments of $\frac{1}{8}$ th set. Any combination of set size and point size, within the fount selected, may be chosen. Another function of the Prephase is to set up the correct spacing parameters within the justification-hyphenation programme.

I must divert a little on the method of justification in order to clarify this matter of spacing parameters. The variable width space—which we call a spaceband, not from any particular hot metal affiliations, but merely to distinguish it from a fixed value space—has a minimum value which varies according to the output device and the unit system employed. For a Linofilm machine, the minimum value would normally be four units but

it can be varied from typeface to typeface. In order to justify the line, the width of these spacebands is naturally expanded to a given maximum limit. It is this maximum limit which is variable through the Prephase. Therefore if you wanted tight spacing, with a high frequency of hyphenations, you could specify a four unit minimum with perhaps a three unit increment, giving a seven unit maximum space. Conversely, if rather wider spacing with less frequency of hyphenation was required, a five or six unit minimum with perhaps a six unit increment, giving an eleven or twelve unit maximum space, could be specified. So, by careful use of the functions available, the style of setting can be almost infinitely varied and yet be considerably more even than can be achieved by a keyboard operator on a conventional system. Thus, if you specify a minimum and maximum limit, the lines will always be spaced somewhere between these limits, except in the case where the hyphenation routine (correctly or incorrectly) considers a word to be unhyphenable. This I will deal with in a few moments. Generally we have found that when a customer specifies really tight setting we can set on the computer a good deal tighter than a manual keyboard operator can set. From a design point of view this opens up a new variable for the designer to juggle with. The weight of colour on the page can be varied, not only by the face and the leading but also by the tightness or looseness of the line. If you asked a manual keyboard operator to set consistently within fixed limits, it would be almost impossible for him to comply. The computer programme is designed to do just this.

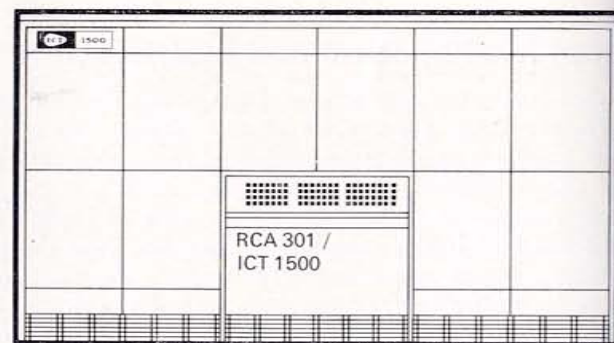
As I mentioned earlier, the stages through which a job passes in the computer are variable according to the nature of the job, and certain phases can be omitted or not, dependent on the customer's requirements or the type of setting. Phase I is one of these dispensable stages. The programme was written in the early stages to provide an unjustified, unhyphenated print-out of the input tape in order to correct literal and typographical errors before going to the slower and more demanding hyphenation and justification routine—Phase II. We still use Phase I and it is extremely useful when we get very poor perforation or when the customer wants a quick print-out. I would emphasize that it is considerably faster than Phase II, the actual process speed being of the order of 400 characters per second. The text is stored on magnetic tape which, after correction, can then be passed through Phase II for justification and hyphenation (Fig. 1).

Ilocappi hyphenation and justification

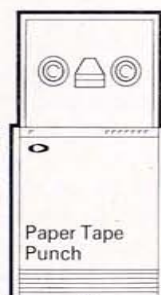
So either from magnetic tape or from paper tape we come to Phase II—the basic programme of the system, around which all other ancillary routines are oriented. Into this programme we read the unjustified text matter at between 500 and 10,000 characters per second, dependent on the type of input. This is then justified into lines of the lengths specified (you can change line length, as and when required, during the run) making allowance for indents, left, right, centred and hanging, for extra leading, for changes of typeface and size, for quadded lines left, right and centred, for quadding from the centre to make the matter come out flush left and right with a large variable space in the centre, such as that required on some tabular matter, and for leading out lines as required in indexes and certain directory work. The output is stored on magnetic tape and a comprehensive print-out is produced showing exactly—or as nearly as is possible within the limitations of the present generation of high-speed on-line printers—what has been stored on the tape and what the output will look like. Obviously, it is impossible on any present-day computer print-out, on a machine which can only print capital letters and symbols, to show in its true form the intricacies of the final typeset job with its justified lines, its upper and lower case, its changes of face and size, the indents and quadding, and so on. We have spent a great deal of time and effort, however, in producing a print-out from which the final appearance is discernible and which can be marked up for corrections with almost the same ease as an actual typeset proof. We have found, in fact, that a printer's reader, once familiarized with the coding of the print-out, can read it for errors just as easily as a true galley proof.

This is the sort of thing we see when we look at one of our print-outs. At the top of every job passing through Phase II there is a heading which contains the job title, the date and the number of times it has been processed through Phase II. This is used at a later stage for a standard data-processing procedure, that of label checking to ensure that the right batch of corrections is being processed against the right magnetic tape. Then the various typefaces selected for the job are listed. A coding for the particular output device appears, and a list of shift symbols with their meaning.

Looking at the actual text output, one sees above the first line an indication of the line length. In order to show which letters are upper case and which are lower we have to overprint

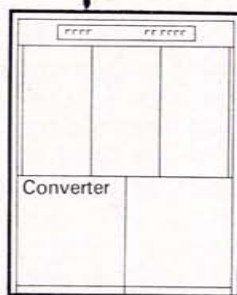


Compute (Create code structure required by typesetter or subsequent conversion process)



Punch out tape

Tape



Hot Metal
Linotype or Intertype TTS equipped linecasting machines Monotype (by using a converter now in development)

Film or Paper
Intertype Fotomatic
Photon
Monophoto (by use of a converter now in development) Linofilm (by a converter now in development) And certain high speed machines now under development!

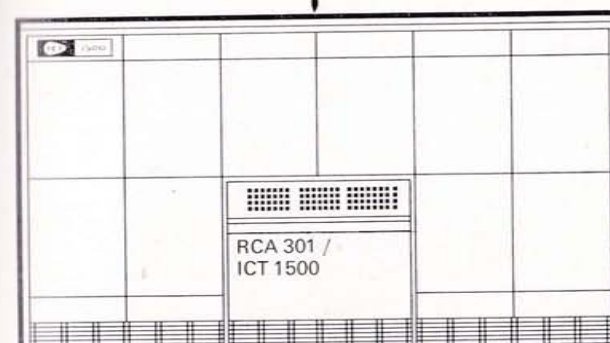
FIG. 1.



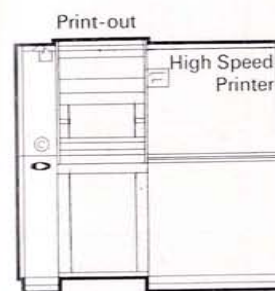
Tape perforation



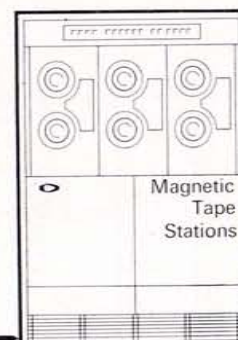
Read tape



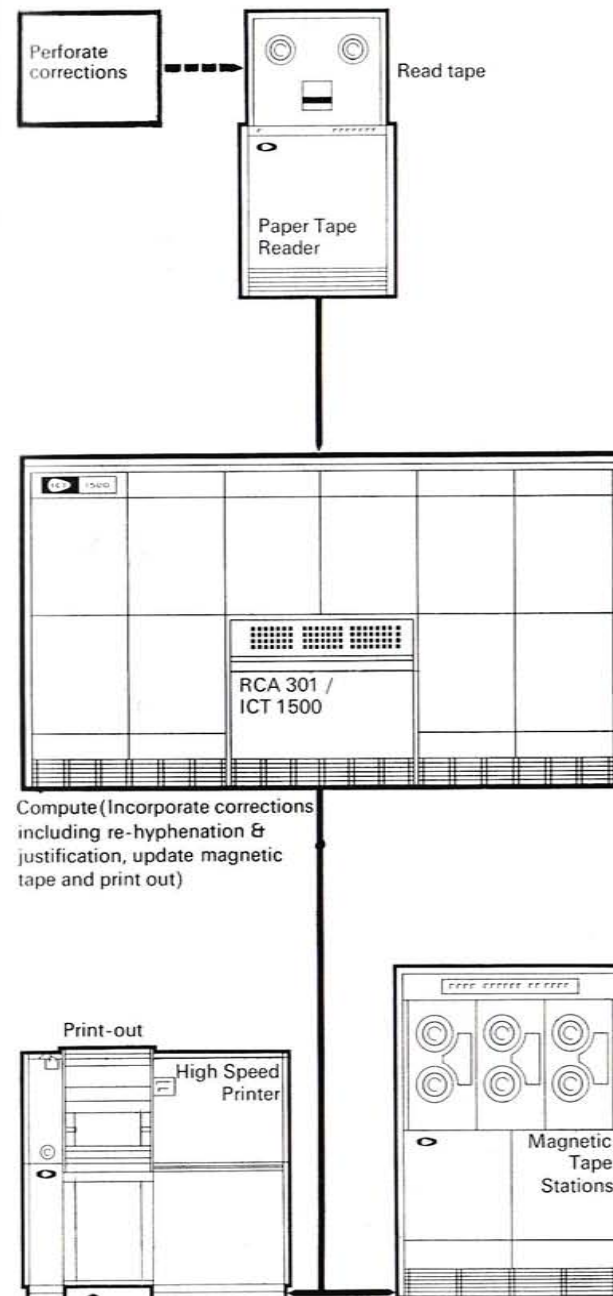
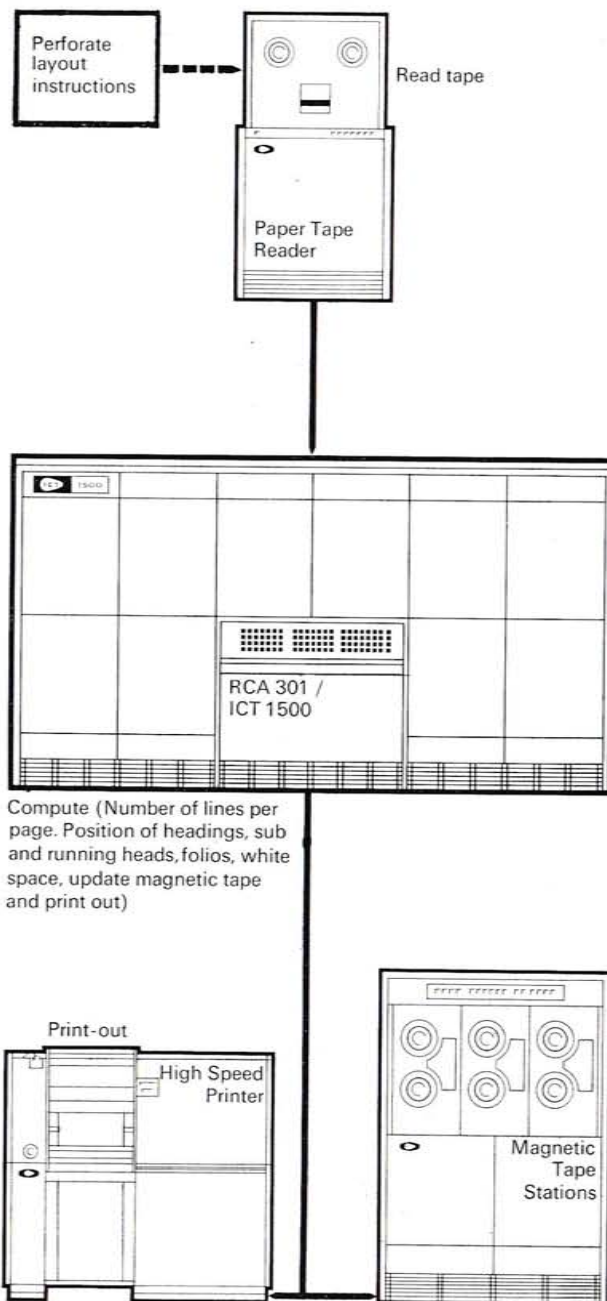
Compute (Justify, hyphenate, 'write' magnetic tape and print out)



Print-out



Magnetic Tape Stations



the characters; we use the full point for capital letters. We show other code symbols over letters where we have to record a change of typeface or size. Other overprinted symbols indicate quadding right or left, spaces, leading, and so forth.

Hyphens at line endings show up as 'equals' signs to distinguish them from hyphens in compound words, the vital difference being that the former come and go on successive passes through the system.

The only points I have not yet covered on Phase II are speeds, both of setting up and running, the problem of hyphenation and the correction facility. Speeds first. The time to set up a Phase II programme for a particular job is about 14 minutes. This varies of course according to the number of typefaces required, and I should mention here that we can hold in high-speed memory the width values of up to fifteen different typefaces and that we can specify up to twenty different founts, that is, combinations of face and size, in any one job. The running speed of Phase II varies also, of course, with the size and the measure. With a 20 pica line in 10 point the speed would be around 175 to 200 characters per second. As the size increases or the measure gets smaller, the speed drops and vice-versa.

Now, hyphenation. Mr Barber has covered the basis of the routine, so I won't describe how it works. Our rate of correct hyphenations is about 90 to 94 per cent. This is not a high figure compared with some hyphenation programmes, but it is good when you consider that the routine is purely logical and has no exception dictionary of any kind. The reasons we decided to do it this way have already been discussed, and we are not in the least worried that our routine is not 100 per cent accurate. We are continually improving it, but we have a correction routine which is quite exceptional, and we have an infallible method for correcting hyphenations. While we have to correct literal and typographical errors, the extra work involved in perforating corrections to 6 per cent wrong hyphenations is negligible when you consider that absence of an exception dictionary adds considerably to the speed of the Phase II pass. How many hyphenations occur on a 40 line page of straight text set in 10 point to 20 picas? The average is about two. This means that out of every eight or ten pages of text that have to be corrected, one bad hyphenation will have to be corrected too. This is a small price to pay for the increase in speed and the reduction of cost.

Corrections by Rocappi

Now, the correction routine. This was originally written within Phase II but, because we were limited by our original conception to a 20,000 position memory and we did not want to segment the programme (that is, split it into parts and draw in a new part when required) as this would slow the process down enormously, we were unable to put in the requisite logic to check for badly perforated input on the correction messages. We just had not the room in memory. Since we found it impossible for an operator to perforate 10,000 corrections (as might occur in a very large job) without making some mistakes, and since, wherever the message codes were perforated incorrectly, the programme would 'hang' and be extremely difficult to restart, we decided to make this a completely separate routine. As it now stands, we find the operators make about 5 per cent errors in coding correction messages and we just make a second pass through the correction routine to insert these missed corrections. The correction routine is extremely fast—it runs at an average of about 500 lines per minute—650 between corrections. The print-out it produces is not the same as Phase II. We decided that the presentation of this print-out need not be nearly so involved as Phase II, because all you want to see is whether the correction went in at the right place and whether the insert was perforated correctly. We print-out asterisks as an overprint over all words inserted and there is an indication of a pure delete function. A new magnetic tape is produced which can be corrected again and again, if necessary, before going through another de- and re-justification pass. I ought to have stressed that the correction routine does not justify the lines—it merely validifies and inserts the corrections. By this method it is possible and practical to produce absolutely correct output tape for the typesetting device—free of all errors, and in need of absolutely no manual or mechanical correction at any subsequent stage. Thus, as far as filmsetting is concerned, this is the complete answer to the high cost of manual stripping and has many advantages over tape-merging and other mechanical methods.

Obviously, after the correction pass, a second run through Phase II is necessary. At this stage it is possible to change completely the typefaces in which the job is set or the spacing parameters. By correction, of course, you can change the line length, the depth of indents—or you can take the indent out altogether. In fact, by combination of the correction routine

and the re-run through Phase II, there is complete freedom to change anything you like. It is even possible to change the output device at this stage—say from film to metal—though this may in some cases be difficult, due to the inherent differences between output devices. Naturally, also, once your text is correct, full advantage may be taken of normal data processing procedures: sorting and updating, indexing and cataloguing can be done if required.

Having got the output hyphenated, justified and corrected on the magnetic tape, there are two paths open. Either the matter can go straight to Phase IV for the production of paper tape to drive the relevant typesetting device or it can first be processed through Phase III.

Page make-up

We have a Phase III programme in Swarthmore which was designed for the American market, and which works extremely well. The function of Phase III is to make up the matter from the galley output into pages, putting in running heads, folios and chapter headings, picking out footnotes and references, putting in captions, and so on, and at the same time eliminating widows, short lines at the top of a page, hyphenations breaking over a page and other typographical horrors. This programme was designed for book production in the United States and, unfortunately, typographical standards are very different over there. For instance, they will sometimes allow two pages of a book to have a different number of lines, provided that facing pages remain the same depth. So a new Phase III programme is at present being written for Europe, and on this I can give you no performance figures at present. The American programme produces around 10 pages per minute and it is to be expected that the European programme will be a little slower, but not by very much.

Rocappi output

The final (fourth) Phase of the system is the output Phase in which tape is produced to drive a filmsetter or linecasting machine—or indeed any typesetting machine driven by paper tape. There is a separate Phase IV programme for each output device, but they all produce the standard RCA 7-level paper tape. Obviously, it is necessary to convert for Linofilm, Lumitype, Monophoto and the new ATF B8 machine. We have at present

output programmes for the Linofilm, for the ATF, both B and B8 models, and for TTS Linecasting equipment. We are working as well on output programmes for the Monotype and Monophoto and for the range of Photon-Lumitype equipment.

Output is of course coded according to the converter concerned. Thus for the Linofilm our output is coded for a converter produced by the Navigation Computer Corporation in the States. Since the Linofilm tape has 15 channels, we have to produce three rows of five channels per character. The sixth channel is a synchronization hole perforated on the first row of every three-row character, and used by the converter to synchronize the input tape with the output tape. The seventh channel is parity, which is ignored by the converter. Other outputs for other machines are organized in much the same manner. For teletypesetter equipment and for the ATF there is not the same problem, in that the number of output code combinations required is 64 and thus we produce one row per character—the only difficulty being that of advanced sprocket. For Monotype we shall be producing two rows of holes per character as, although 31 level tape is used on these machines, the maximum number of holes perforated across the tape for any character is, I believe, four and therefore not what we call a filled code; by no means all of the possible combinations are used. The same system of two rows per character will be used for the Photon-Lumitype machines working from 8-level tape, and coding for the 200 and 513 machines will be direct from the computer punch.

The speed of the various output programmes varies, of course, with the number of rows per character. On all our output programmes we are limited by the speed of the paper tape punch which, although it punches at 300 characters per second and is therefore the fastest paper tape punch in the world, is still the slowest device in the computer system. Linofilm output is therefore produced at 100 per second and TTS and ATF at 300 per second. We can also calculate output speeds for Monotype which will be 150 characters per second and the Photons which will vary from 150 to 300. I should mention also that we have found that the actual output speeds on many typesetting machines are increased—particularly in the case of TTS linecasters where the absence of tight or loose lines makes for considerable increase in average output speeds.

Now—the future. I have mentioned many programmes that are being written at present. The next programme to be written will be a generalized tabular setting routine, able to handle

multi-column multi-justification work. When I say 'generalized', I mean that the programme will handle any type of tabular format, still retaining the present Phase II facilities—indent, quadding, etc., within the column. Another programme for which there will be great demand will be one for setting mathematical and chemical formulae—something that could be handled by a computer and filmsetting machine very much more easily than by conventional methods. With the introduction of Lumizip and Linotron ultra-high-speed filmsetting machines we shall give thought to speeding-up the system by the probable use of a bigger and faster computer, such as an ICT 1600 or IBM 360. We feel that we now have a production system for high-speed computer typesetting in the book-work, general and magazine printing fields, but our task is by no means complete. We can see no end to the continual research undertaken over the last year. As soon as we provide the system with a new facility, someone always suggests another to be programmed. The field is enormous and incredibly exciting.

CHAIRMAN: The discussion is now open; let us cover both the last two papers—very practical, useful papers for which we are most grateful.

Mr G. B. TAYLOR (Computaprint Ltd.): Could I ask Mr Barber for his comments on the possibility of the extension of dictionary methods of hyphenation, using the newer magnetic card type of so-called random access device?

Mr BARBER: This is a brand-new field. I believe that it is the answer to hyphenation problems without any doubt. I have a proposal in right now, in the hope of obtaining the requisite peripheral gear to be able to write the programme. I think this is definitely the answer.

Mr A. H. PHILLIPS (HMSO): Can you tell us the form of this magnetic card?

Mr BARBER: Let me say that all information used in a digital computer is represented by a series of on/off conditions. In a punched card you either have a hole or you do not have a hole. On a magnetic card you have electrical impulses stored which are retrievable and you are able to pack them into very, very small areas. This is all it amounts to—a punched card where you can get minute punches, in effect.

Mr BEAVEN: There is one such device known as 'cram'.

Mr R. A. FREIMAN (Random House Inc.): Have you run through the Monotype yet?

Mr BARBER: No, we have not run through the Monotype.

Mr FREIMAN: What about different Monotype layouts?

Mr BARBER: In answer to that, I would say that we will have Monotype available in not more than six weeks at the very outside. Our system, as Mr Archer defined, is through the programme library tape, and one face is as available as another once on the library tape.

Mr FREIMAN: I meant 15/15, 15/16, 15/21.

Mr BARBER: Quite definitely. Having established a general table which defines a particular face for a particular typesetting device, we then have everything ready to introduce as many tables as we like. Typically, we have some 85 Linofilm tables right now. We set off with two. We went to 85, and we are prepared to get to 8,000.

Mr A. MacNAGHTEN (Short Brothers and Harland Ltd.): I would like to bring up the question of the relative speed and efficiency of programmes written in interpretative languages and programme computing language. I maintain that a translated programme which started off in Algol, or even Fortran, can be just as efficient as one written in basic machine language, if not more so.

Mr BARBER: This is a question of the programmer's ability to write in basic machine language. If you got a man to write any formal translation routine to the very best of his ability, then got him to write a programme which you wished to compile and to write that very same programme in basic machine language, I am willing to bet that you would see a vast difference. I know this from personal experience.

Mr MacNAGHTEN: I believe people would contradict this.

Mr TAYLOR: I would like to put a question to Mr Archer. Instead of converting his centre feed sprocket tape to advance feed sprocket tape, why not alter the feed head on the TTS unit, which is a simple operation?

Mr ARCHER: This is possible. We have tried this method, to be fair. There are various little devices which are available for putting on the feed head on the reader of the TTS machine. We have not found these very reliable. This is the real answer. If they had been reliable, we would have used them.

Mr R. C. FIFE (Univac Division, Sperry Rand Corporation, U.S.A.): I would like to ask Mr Archer a question. In your correction routine you use a number to designate the first word and the last word or space of a deletion. Have you tried using the word of text preceding and following the deletion for further accuracy?

Mr ARCHER: I think I can see what you are getting at. You

mean if someone mis-counts. This is what Mr Barber meant when he was talking about diagnostic interrogation for bad input. Within our present system we can diagnose almost any bad input but we do not meet your point right now.

Mr FIFE: Do you think it would be a good idea to attempt something like this?

Mr ARCHER: Yes, but it would require a lot more punching on the input tape.

Mr R. SMITH (Waterlow and Sons Ltd.): When Mr Archer was telling us about print-out units this morning, he said that one would need a different legend or key for each different job. Does he really mean each different job? If it comes from the same type of perforator, or if someone sends you a lot of jobs from the same perforator, would you get the same legend or key?

Mr ARCHER: As I explained, the legend is produced for each job. The reason for this is that the type faces which you specify for that job are indicated. The over-prints which are related to those type faces are specified. We print out, purely as a mechanical item, the coding on the print-out for use by the reader when he reads the copy for corrections. This is a purely mechanical thing. We print it out every time purely because it is easier to have it on the top of the print-out. However, we have to print out the typeface information because that varies from job to job.

Mr C. KILPATRICK (T. and A. Constable Ltd.): Why do the Americans think it necessary to depart from the established practice of having an even depth of page?

Mr ARCHER: I cannot really answer this question, in that it is a question of what one calls a standard or established practice. Are they standard or are we standard? The point is that it is obviously easier for the Americans to make up their books, so they have variable depths of page.

Mr FREIMAN: Can I elaborate on that for the sake of my friends back home? On well made books we are as meticulous as you are. On lower cost books we would rather not go to the trouble of re-setting to avoid a widow. There is trickery involved. Some publishers will allow the printer to fake the leading on pages in an effort to minimize the discrepancy between two facing pages which are a line short, followed by two pages which are a line long.

Now I have the floor, I would like to ask a question, if I may. It may be of some value, since we are all so vitally interested in this question of hyphenation. It may be a question which delegates may want to discuss amongst themselves. Mr

Higonnet has a system in which every word is hyphenated as it is put in the original input. The computer is adjusted to take advantage of only those words where a hyphen is required and skip the others. He maintains there is only a 4 per cent loss in computer time.

Mr ARCHER: The big disadvantage of perforating all the possible hyphenation points in a word is that you have got to establish these hyphenation points. Your keyboard operator has got to look these things up for every single word in the manuscript. The number of extra unproductive perforations is vast, although it does give you perfect hyphenation. We, in fact, use a similar system, in that where we have a hyphenation error we do exactly the same thing. Where we have a hyphenated word which is hyphenated wrongly, we replace that word with a word which has discretionary hyphens in it. The computer either takes one of these hyphenating points or it does not hyphenate the word at all.

Mr H. J. LOTT (C. Tinling and Co. Ltd.): Could Mr Ross enlighten me on the speed of the setting machine, used for the sample?

Mr ROSS: The official speed of this device is something like 12 characters a second. If you count up the number of characters on the page, ignoring the spaces, the full stops, and so on, we work on something like 5 characters a second.

Mr E. HOUGHTON (BBC): This is a general question and it may be a naïve one, but I am trying to see the general shape of things to come. We have heard—and I think for myself anyway this is apparent—that it is extremely difficult to programme a computer. We have heard subsequently this morning of package deals for programmes. Is it likely that we will have to make wide provision for training people to programme computers or is it more likely that we will have, instead, a very few highly technical people making programmes and selling them as package deals?

Mr BARBER: I would like to say about programming in general, that some of the very best programmers whom I have ever met have been persons without a great deal of academic background. The ability to programme is the ability to realize your problem, arrange it in your own mind in a set of sequential steps, and translate it into a computer language. It becomes something of an art when you have to optimize these programmes. By 'optimize' I mean that, if you realize a particular logic sequence is going to occur very often, then it is essential that it is executed within the memory of the computer as fast as possible, and you are prepared to allow quite a lot of

memory to do it in. Alternatively, with a logic sequence which occurs very infrequently, you do not care how long it takes. In programming we constantly find that once the initial stage has been got over, which is a kind of fear, people start to like programming. I think that is the most important thing. In my experience, good programmers have been people who have enjoyed doing it immensely. I suspect that the best talent in computer programming for typesetting has yet to be found. It is in your composing room, in your proof-reading rooms, and in your current systems.

With regard to the point about package deals and whether they will become available, I think they will. If you go to ICT and IBM and get a computer and you say that you would like the transcendental sub-routines, they will give you a little package with a rubber band round it. Within this package you can compute sines, cosines, arc tangents, etc. Ten years ago these things were not available; maybe seven years ago they were not. Right now it is not possible with one exception to go out and get a sub-routine in typesetting, except for hyphenation. I think this has been by accident rather than by design, inasmuch as hyphenation is something in addition to the actual typesetting logic. In my opinion, both will be available soon, either free with your computer or through service bureaux such as Rocappi.

CHAIRMAN (Now Mr F. SIMMONS): Before I ask our speakers to revert to their minor roles as members of the audience, I would like to thank them on your behalf, not only for three excellent papers but also for the very generous way in which they have dealt with the questions they have received from the audience.

I now call upon Mr Ellis, who is a computer programmer with experience at the Los Angeles Times. He is now with ICT at Putney. He joined them in September, 1963, having gained previous computer experience during vacation periods. He has been working on computerized typesetting based on the system in Los Angeles. I am sure he will have something useful to contribute to this programme. I have much pleasure in asking Mr David Ellis to speak to us.

The Los Angeles Times

Mr D. ELLIS (ICT): I have been asked to speak at very short notice, so I hope you will forgive me if I am not quite as articulate as I might have been had I been given longer warning.

I am going to talk about the Los Angeles Times programme, about which I hope I can claim to know quite a lot, having visited Los Angeles recently and seen their system working. I have, in fact, brought back the programme with me, and we have it over here now under development.

The Los Angeles Times claims to publish more lines of type than any other newspaper in the world. Their normal daily edition runs to something like 120 pages, which will not seem very unusual to our American friends but is quite something for an English paper. The Sunday edition, of course, is around 300 pages; it weighs about four pounds!

Since the beginning of 1963, the Los Angeles Times has been using an RCA 301 or, as I prefer to call it, an ICT 1500—that is its name over here—to speed up the process of transferring their reporters' stories to the printed page. It was the first use of a high-speed computer for this typesetting business. The bulk of the credit for the development of the programme must go to three members of the Times' staff, Roy Gift, Dow Parkes and Lynn Abbott. The latter two of these three have been newspaper men for some years and they obviously had a very good idea of the problems to be encountered in producing a programme for typesetting. As the results show, they also had a very good idea of how to do it.

The computer configuration required for this programme is a very small one, so it is reasonably cheap in comparison with other systems. It consists of a store, capable of storing 20,000 characters, a paper tape punch and a paper tape reader. There is no need for any other peripheral equipment, no magnetic tapes, no other random access storage devices whatsoever, which of course keeps the price down considerably. The punch used by the Los Angeles Times is a very fast one, which produces 300 characters per second. This is quite an expensive piece of equipment, considerably more expensive than the normal paper tape punch which only produces 100 characters per second. I feel that a 100 character per second punch would be fast enough to cope with the output tape required by any British newspaper.

The paper tape reader is the normal one which goes with this machine. It reads at either 500 or 1,000 characters per second. This basic system can be expanded in many ways if required. In fact, all that is required for typesetting is what I have mentioned but, if other things are required of this computer, further equipment can more or less be plugged in. You could have up to 14 magnetic tape decks, a card reader, a card punch and a random access storage capable of storing up to 176

million characters. These can be added to the system with absolutely no change in the basic computer.

Input to the programme takes the form of punch paper tape, as usual. It can be prepared either on a normal teletypesetter perforator which gives 6-channel tape or by a tape-punching typewriter which normally produces 7-channel tape. The tape produced by available tape-punching typewriters is not in standard TTS code but the input is converted to this by the programme. While TTS code is always acceptable, any other code may be used provided the programme has been correctly modified to accept it. This input tape is naturally prepared without any consideration for justification or hyphenation, and as a result an increase of 40 per cent in output is claimed. Wire service tape is also used as input. This arrives already justified, but as the Times uses 9 point type, which is an unusual size for a newspaper, and wire service tape is usually justified for some other point size, it is necessary to de-justify and de-hyphenate this tape. This is done by passing it through the computer to produce a tape which may be rectified and rehyphenated for the point size required. It may seem strange to de-justify and de-hyphenate a tape but it does not take very long. Part of the beauty of this system is the fact that, once the initial story has been captured on to paper tape, there is no need to re-perforate if another printing is required in a different point size or a different line length. You need only capture the story once. By changing the parameter message which goes on the front of the tape you can have it justified virtually to any point size, any line length you like.

Some reporters produce paper tape as a by-product of their normal typing operation. This originally was the idea of the system: all reporters should have a paper tape punch attached to their typewriters. It was found that they were not really very skilled typists! For one reason or another they do not punch tape very often; in fact, average typists generally produce the tape. However, some reporters still do this. When they have finished, their hard copy is edited. Then their hard copy and the unedited tape are sent to the computer room. More often than not, at this point it is necessary to make some corrections from the hard copy. This does not require a second keyboarding. A correction tape is easily produced and spliced at the beginning of the reporter's tape which is then fed to the computer. The method of locating insertions or deletions is based upon a count of lines and words.

I have an example which I can give you. 'The first rain of 1964 fell.' If we were to pretend that this was the third line of a

piece of copy, and on editing it was decided that they would like to change '1964' to 'the new year', this would be done by punching an input tape merely containing 030405, the new year: 03 indicating that the correction is to be made in the third line; 04 indicating that the correction is to be inserted after the fourth word of that line; 05 indicating that we are to continue processing with the fifth word in that line as it originally stood. The correction tape is read in before the story. The computer scans the story and a count is kept of the number of lines processed. When it comes to the fourth word on the third line, it will insert the correction after the fourth word and then things will continue normally.

In justifying lines a unit system of 40 is used. I believe unit systems differ between America and this country. America is considered to set the standard in this, using 18 units, whilst over here we use 32 units. Yet again this programme uses 40. Character widths in any font being used are stored as some number of 40ths and the column width is also measured in the same unit system. The computer programme contains information concerning five different founts at any one time, and each fount may be used to produce lines of two lengths. It is a simple matter to insert information concerning any particular fount into the programme by feeding in a table of the character widths for that particular fount. The five at the moment are sufficient to cope with all the different sizes of type required by the Los Angeles Times. I see no reason, if someone were to require more than five founts, why they should not have two programmes. I do not think anyone would complain about the amount of storage space it would use up. Using this stored information, the computer assembles each line until it reaches a point where the last word will not fit. This word is then removed and calculations are made to determine if justification is possible by the use of additional space between words. Firstly, it considers the possibility of justification by space band expansion alone. Secondly, it considers the possibility of insertion of thin spaces between words. Thirdly, it considers the possibility of insertion of en spaces between words. Finally, it considers the possibility of the insertion of ens and thin spaces.

Hyphenation by logic

If all these fail, the fall-off word is examined to see if it can be hyphenated. Originally it was hoped to overcome the problem of hyphenation in a similar manner to that used by the Perry system—that is, by storing a dictionary of words with

possible points of hyphenation indicated. It was decided not to use this method but to try and develop a purely logical approach which would not require any peripheral equipment such as a magnetic tape or a magnetic disc file which cost a great deal of money, and whilst their speeds of operation are really very great they are slow in comparison with the speed of working inside the computer. This hyphenation problem was considered by members of the staff of the Los Angeles Times even before they knew how to programme a computer.

The chief requirement obviously is that the part of the word before the hyphen does not mislead the reader into expecting something different from what he actually finds at the beginning of the next line. It is virtually impossible to define a rule for hyphenation which will satisfy everyone, and even dictionaries often suggest several possibilities as to the point at which a word may be hyphenated satisfactorily. The hyphenation logic employed in this programme is based on a set of rules formulated with the aid of Webster's Dictionary. Only these rules have to be stored, not the words, hence only one-quarter of the computer's storage is used by the hyphenation logic, less space than would be required to store 500 8-letter words averaging two hyphens per word.

I will mention a few of the qualities which this method has before going on to explain in more detail how the system works. Let us consider the accuracy of the system. The logic has been tested with 20,000 words, and the results were found to be 99 per cent accurate. This is a remarkably high percentage, considering it is a purely logical system. Speed is another very important factor. The average time taken to hyphenate any word is 15 milliseconds, which is considerably less than the time taken by any other system requiring storage such as magnetic tapes, where it can take up to one second to hyphenate a word. The cost, of course, is very important in this system. Since the logic is contained entirely within the computer, the cost of random devices storing thousands of words is eliminated, and this results in a vast saving in cost.

The logic is very difficult to explain briefly. In fact, it was built up over a considerable time and no really simple explanation can be given, but I shall endeavour to do so! First of all, vowel (V) and consonant (C) patterns in the word are classified as one of four basic types. It considers groups of three letters each beginning with a vowel: VVC, VCC, VCV (not E) VCV (E). The computer scans the key letter sequences to see if they follow the rules governing these types. If so, an immediate solution is reached. If exceptions are indicated the computer follows

special logic paths in which key sequences and neighbouring letters are analysed. It determines if there are sequences of letters which commonly precede a hyphen. Eventually the nature of the exception is defined and a solution is reached. Various techniques are employed in using letter sequences as a key to division.

Among them are table look-ups in which the cumulative effect of any three letters of the alphabet can be weighed and various paths taken as a result. In dealing with exceptions, which are more numerous in English than any other language, the computer sometimes leaves the sequence it is directly concerned with and looks backward or forward two or three letters in order to make its analysis as complete as possible. As I said earlier, this logic was built up by the Times over a period of several months and was improved continuously in accordance with information fed back from the proof readers. If any incorrectly hyphenated words ever appear, action is immediately taken to modify the programme to hyphenate the words correctly in future. This may all sound unbelievable, but the programme is being used every day and is producing good hyphenations most of the time, being about 99 per cent correct.

As an example let us consider ENTERPRISING. Let us assume this has been indicated as the fall-off word to be hyphenated. The first thing the computer does is to assign values to the vowels and consonants. It is 0 to a vowel and 2 to each consonant. Spaces are assigned a value of 1. (Thus ENTERPRISING equals 10220222020221). The first vowel is located. This is readily seen to be E. Then the next two characters are considered and found to be consonants, so we go to the routine VCC, where in a table the possibility of hyphenating between N and T is looked up. We have a table with various letters along the top and down the side; where columns intersect, a code is given to indicate whether or not it is possible to hyphenate between these two letters. In this case the table would indicate that it is perfectly all right to hyphenate between N and T. It would consider the possibility of fitting EN together with a hyphen on to the line to justify it. If this did not succeed, it would carry on to the next vowel, which it would find to be E followed by R and P. Once again, it would go to the routine VCC, to look up whether it was possible to divide between these two. In this case, once again, it would say it was possible and would, therefore, again try to justify the line by putting a hyphen in at that point. If, in fact, it were not possible to hyphenate and justify it would come on to the next vowel, I, followed by S and I, which is a vowel-consonant-vowel, with the second vowel not

being E, VCV (not E). It would go to this particular routine which would indicate the possibility of hyphenating between the I and the S. But at this stage it goes ahead and finds the ending ING followed by a space. Therefore, it reverses its decision to hyphenate between I and the S and decides instead to hyphenate between the S and the I, and this is how it would hyphenate. These are the possibilities which the programme would give: EN-TER-PRIS-ING. It would then attempt to justify the line as it did at every stage and hope that by this time it would be able to justify it. It might be, of course, that the paths of logic would lead to the conclusion that it is impossible to hyphenate a particular word. In this case this particular programme considers letter spacing. All the words in the line are considered and either one or two or all of them will be letter-spaced as the situation requires. At the moment, this is how the programme stands, but if any particular user were violently opposed to letter spacing, this section of logic could readily be removed. I hope this has given you some idea of how this hyphenation logic works. It is rather difficult to give a general idea, but I hope I have succeeded in doing so.

When each line is complete and justified, it is transferred to a punch area together with all the necessary signals for the linecasting machine. When the area is full, the data is punched out at 300 characters per second in what we call the simultaneous mode, which allows us to do further computing while the punching is carrying on. The output tape drives Intertype and Linotype hot metal machines in Los Angeles and compatibility has been established over here.

At the moment, we at ICT are involved in experiments with all the major composing machine manufacturers in this country to produce tape which will drive their machines effectively. Whilst this programme is obviously orientated towards producing newspapers, we shall use it as a basis on which to build a really effective, economic system to produce type for books in the near future.

CHAIRMAN: Before I bring in our next speaker, I will give you a few minutes in which to put one or two questions to Mr Ellis.

Mr McCausland: Could Mr Ellis say how many productive workers were employed at the Los Angeles Times before and after the introduction of computers? Could he say in conjunction with that how the page content has been influenced and also the time-table?

Mr ELLIS: I am afraid I did not go into the staffing problems over there. I was told that, as a result of introducing

this computer, they did not have to lay off anybody. They looked ahead and saw that they would use less staff and, therefore, they took on less men in the year previous to the installation.

Mr H. G. MILNER (The Manchester Guardian and Evening News Ltd.): I wonder if you could enlighten me on the subject of compiling corrections into the tape. The sample you put on the board was misleading as far as I am concerned. You mention the third line and the fourth word. If I am correct in assuming that this is continuous tape, how can you tell which is the third line?

Mr ELLIS: I did not make this very clear: the third line of the hard copy which has been produced by the reporter or the other person perforating the tape. This is the line to which I was referring, the actual line on the printed hard copy.

Mr MILNER: This is the hard copy which does not contain hyphenation at all. Is it the code of the tape which gives you this information?

Mr ELLIS: We can determine where the third line is quite easily. There must be an end-of-line code every time a line is punched. There is a code at the end or a space at the end which indicates that this is the end of a line. In this way we can count.

Mr BEAVEN: What would be the correction when the third, fourth and fifth lines have to be deleted? Is it one correction or should every line be corrected? When the line is deleted, does that line have to be corrected or all the lines subsequently?

Mr ELLIS: One line can be deleted. If you do this in the same way, the first character given would be line 3. You would put a 0 to indicate that you were going to begin corrections at the beginning of the line. Then you would put the number of the last word and nothing else. All that line would be deleted and you would carry on with the next line. If the next line needs a correction, this will be a separate correction.

Mr W. H. BLANCHARD (NGA): In your last sentence you said that computer typesetting was more orientated towards newspapers than book-work.

Mr ELLIS: I was referring to this programme in particular which is being used to produce a newspaper. I was suggesting that we can modify it to produce books.

CHAIRMAN: Thank you very much. I must bring the discussion to a close now. I would like to take this opportunity of thanking Mr Ellis for giving this paper at such short notice.

Progress at Newcastle University

I now have great pleasure in calling upon Mr Duncan to tell us about the Newcastle University programme.

Mr C. J. DUNCAN: At Newcastle the programme evolved for the Ferranti Pegasus is now being rewritten for our new English Electric KDF9 Computer. The opportunity will be taken to remove some of the untidiness associated with a programme that has 'just grown' and to provide a suitable flexibility, so that any reasonable variation in essential parameters can be introduced by data table as required. Sub-routines will be incorporated to give facilities such as different matrix case arrangements, variation of character widths, or of the order and weighting to be given to various inter-word or inter-letter spacings in calculating the justification. Sub-routines will also be included for separate hyphenation, and for merging and correcting. The aim is to allow each of these to be developed and subsequently improved without affecting the operation of the other routines. As far as economics is concerned, it is of prime importance to devise the optimum processing routines within the computer, since, although the overall costs may at present be largely determined by the rates of read-in and read-out, this need not always be the case, and much will depend on the precise method of print-out finally adopted.

Retained as its central feature is the minimization of word splits in the original programme, a feature we wish to recommend heartily to other users since it reduces other problems so significantly.

Hyphenation routine

The hyphenation routine now incorporated is based on that originally drawn up by 'Mitra' with a number of small but important modifications. Originally two letters could be turned over but, because this proved somewhat unpopular it has been changed to three, while not less than two letters can be left behind.

From the outset we were determined not to incorporate any dictionary. A test of some 20 suffixes which could be lopped off by reference to a table only reduced the number of unacceptable splits by 16 per cent, and every attempt to codify prefixes or suffixes created nearly as many unacceptable splits as they removed. Our experience, which seems to be paralleled

by the size of the dictionaries in use in American systems, or the incidence with which the statistical routine is resorted to in the IBM 1620 programme, suggests that by logical rule alone some 90 per cent of the vocabulary needs to be in an exception store if 100 per cent acceptable splits are desired.

Our first tests were on various groups of words—most of which had already been split by other routines: RCA, IBM, Mitra, Dolby, and others—and we also took a random selection of 471 words from an available text, which yielded 74 per cent acceptable splits. Our first difficulty was to find an authority on what was right and what was wrong, and we found those in English texts confusing and, in some cases, contradictory. It was not part of our task to rewrite the authorities, so we promptly adopted the American criterion and resorted to Webster's Dictionary, using the New Collegiate Edition (with reservations as to its applicability to British usage).

CA-LIBRATER CALIB-RATER
 CA-LIBRATOR CALIB-RATOR CALIBRA-TOR
 CA-LICHE
 CA-LIFORNIAN CALI-FORNIAN CALIFOR-NIAN
 CA-LIFORNIUM CALI-FORNIUM CALIFOR-NIUM
 CA-LIGINOUS CALI-GINOUS CALIGI-NOUS
 CA-LIPER
 CA-LIPH
 CAL-ISTHENICS CALIST-HENICS CALISTHE-NICS
 •CALKER
 CA-LIGRAPHIC CALI-GRAPHIC CALIGRA-PHIC
 CA-LIGRAPHY CALI-GRAPHY

Fig. 2. List of word breaks produced in a sample of words taken from the U.S. Government P.O. Manual Part II (example).

Our next test was with a random selection of 20 pages from the U.S. Government Printing Manual Part II, which yielded 1964 words. The results were first scored by counting all the splits and taking the percentage of these produced successfully by the computer, which was 70 per cent. In fact, some 151 of these splits were not given by the programme at all and so were not incorrect. The adjusted score was then 73 per cent (Fig. 2). A further significant result was the number of words on which the programme could not produce a satisfactory split—this was 20.5 per cent of the sample. After reflection, we decided that a fairer way to score would be to allocate a score of one to each word, and allow a fraction for each correct hyphenation, so that all words, whatever the number of splits in them, were equally weighted. This lowered the performance of our programme to 69 per cent. We felt reasonably encouraged, since these were relatively difficult words, and probably they would not otherwise have been included in the Manual Part II at all.

As by this time we were sceptical of all authority, we decided that the best way of all to test our routine was on a random sample of British usage and to collect about 1,000 word splits that had actually found their way into publication. We took for this purpose two Oxford and two Cambridge books, extracted from them all the words split, eliminated the duplicates and alternative spellings, itself a considerable task, and marked all with the word break positions used and the positions given by Webster as acceptable (Fig. 3). When offered to the computer programme we found ourselves with a somewhat unexpected result: unexpected because we had thought American practice, based on root division, would be more logical and therefore coincide more closely with the rules than the British practice of division by sound or pronunciation. At all events the percentage acceptable word divisions given by the programme for the Oxbridge words was 85 per cent and the proportion agreeing with Webster positions was only 79 per cent (Fig. 4). Further, although there is no immediately obvious connection, the difference was almost exactly the same as the number of words in which the Oxbridge word breaks actually used did not agree with a Webster position—only 5.4 per cent. This would seem to indicate that most Oxbridge word breaks would be agreeable to Americans. For the converse I can give no verdict, but it should be remembered that we have coded only one Oxbridge position per word while the average number of Webster positions is almost two per word.

Further, there is a change in the score if we delete from the account the Webster positions which call for only two letters to

be carried over. The programme will then provide 87 per cent of the acceptable positions, which is nearly as high as some of the other and more highly developed logic programmes for English will go. We have seen word breaks in Dutch from Professor Corstius' programme which he claims are 100 per cent acceptable and this may, of course, be possible. We are not

OXBRIDGE-WEBSTER	COMPUTER	O	T	S	
AN/SO/L-UTE/LY	AN/SO/LU/TELY	0	3	2	
AN-/SORB	AN-/SORB	1	1	1	
AN-/SORB/ED	AN-/SOR/BED	1	2	1	
AN-/SOR/BEN/CY	AN-/SOR/BENCY	1	2	2	
AN/CEL/E-R/A/TED	AN/CELER/ATED	0	2	2	
AN/CEN-/TU/ATE	AN/CEN/TUATE	1	2	2	
AN/CON-/MO/DATE	AN/CON/MO/DATE	1	3	3	
AN/CON/MO-/DATE	AN/CON/MO/DATE	1	3	3	
AN/CON-/PA/NIES	AN/CON/PA/NIES	1	3	3	
AN/CORD-/ING	AN/COR/DING	0	2	1	
AN/CU-/MU/LA/TED	AN/CU/MU/LATED	1	3	3	
AN/CU-/MU/LA/TION	AN/CU/MU/LA/TION	1	4	4	
AN/CU-/RATE/LY	AN/CUR/A/TELY	0	3	1	
AN-/QUAINT/ANCE	AN/QUAIN/TANCE	1	2	1	
AN-/QUIRE	AN/QUIRE	1	1	1	
AN/QUI/SI-/TION	AN/QUI/SI/TION	1	3	3	
AN/DI-/TION	AN/DI/TION	1	2	2	
AN/MIN/IS/TRA-/TION	AN/MIN/ISTR/A/TION	1	4	3	
AN/MIN/IS/TRA-/TIVE	AN/MIN/ISTR/A/TIVE	1	4	3	
AN-/MIS/SION	AN/MIS/SION	1	2	2	
AN-/MI/RA/TION	AN/MIR/A/TION	1	3	2	
AN/U/LA-/TION	AN/U/LA/TION	1	2	2	
AN/VAN-/TAGE	AN/VAN/TAGE	1	2	2	
AN/VAN/T-AGE	AN/VAN/TAGE	0	2	2	
AN/VER/TISE-/MENT	AN/VER/TISE/MENT	1	3	3	
AN/VER-/TIS/ING	AN/VER/TIS/ING	1	3	3	
AN/VO-/CATE	AN/VO/CATE	1	2	2	
AN/FORE-/TIME	AN/FORE/TIME	1	2	1	
AN/TER-/NOON	AN/TER/NOON	1	2	2	
AL/EX/AN-/DRINE	AL/EXAN/DRINE	1	2	1	
AL-/MOST	AL/MOST	1	1	1	
AL-/PHA-/BET	AL/PHA/BET	1	2	2	
AL/TER-/NATE/LY	AL/TER/NA/TELY	1	3	2	
AL/TER-/NA/TIVE/LY	AL/TER/NA/TI/VELY	1	4	3	
AMAZ-/ING/LY	AMAZ/INGLY	1	1	1	
AM-/BAS/SA/DOR	AM/BAS/SA/DOR	1	3	3	
AM-CH/RO/NIS/TIC	AMACH/RO/NIS/TIC	0	2	1	
AN-/CIENT	AN/CIENT	1	1	1	
AN-/NOUN/ED	AN/NOUN/ED	1	2	1	
AN/NOY-/ANCE	AN/NO/YANCE	0	2	1	
ANON/Y-/MOUS	ANONY/MOUS	1	1	1	
AN-/GUER	ANS/VER	0	1	0	
AN/TE-/ROOM	AN/TEROOM	0	1	1	
AN/TI-/BODY	AN/TI/BODY	1	2	2	
AN/TI-/MO/NY	AN/TI/MONY	1	2	2	
ANY-/THING	ANY/THING	1	1	1	
ANY-/WHERE	ANY/WHERE	1	1	1	
AP-/PEAL	AP/PEAL	1	1	1	
AP/PEAR-/ANCE	AP/PEAR/ANCE	1	2	2	
AP-/PEAR/ED	AP/PEARED	1	1	1	
TOTAL		50	41	108	91

Fig. 3. Sample list of word breaks produced in words already split in Oxbridge books, with Webster breaks also shown and scored.

quite so happy with a 100 per cent claim by Dolby and Resnikoff, and have extracted from an example they have provided for us the word breaks to check against our programme. Of the 70 word splits on the Dolby-Resnikoff sample, our computer programme will score 65 agreements, i.e. 93 per cent. On the other hand Webster gives a total of 133 splits in these words—our programme yields only 108 of these—81 per cent, whereas all but one of the D-R actual splits agree with Webster. We have also extracted a number of words which it appears their programme may have refused to attempt to split; this may be significant if the proportion is high, since it must result in wide spacing. It is a lower grade solution to refuse to split incorrectly than to split correctly, but how to score in these cases is more difficult to decide.

In our view it is the total incidence of word splits, correct or incorrect, which is the final practical test. On normal book widths of 500 Monotype units we would expect to reduce the incidence of word breaks so materially that the possibility of an unacceptable word split from our pure logic routine is far lower than that from any other system that is less perfect than 95 or perhaps 98 per cent. I give more figures on this later.

One final word on suffixes. Since we normally pack as many words and as much of the last word into the line as the spacing variations allow, we are commonly left only with a few letters to carry over. Hence we are considerably influenced by any decision to allow or not to allow two letters, such as -ed or -ly, to be carried over as these will recur frequently; in the sample measured there were 18 variants which were permitted by Webster. Prefixes are less important since only in narrow measure

SUMMARY

HYPHENATION TRIALS JULY 1964

$$\text{Computer/Oxbridge Score} = \frac{812}{960} = 84.58\%$$

$$\text{Computer/Webster Score} = \frac{1445}{1839} = 78.57\%$$

$$\text{Oxbridge Splits not agreeing with Webster} = \frac{52}{960} = 5.42\%$$

Fig. 4: Summary: Newcastle word break programme.

will early breaks in a word become essential, and generally they will only affect the narrower tolerance settings, although a check at Oxford showed ('Newspaper Typography', by A. Hutt) a high proportion of words starting con- or com-

Statistical analysis of spacing parameters

We have naturally been interested in the precise performance thrown up by our minimization procedure, and it was relatively easy to write a subprogramme which gave us the statistical distribution of spacing used in setting a sizeable piece of text by our programme. At the same time it seemed a reasonable assumption that the spacing of the lines adjacent to that being read might be compared by the reader's eye and, if the difference were too great, this might be considered objectionable (or perhaps 'noticeable' is the correct adjective). This had never been stated to us as an operational requirement, but curiously enough it was later stated categorically by Oxford that a difference in spacing of not more than four units between adjacent lines would be acceptable. So we took out group counts for the differences in spacing between adjacent lines and have plotted these also.

The performance of computer setting obviously depends upon the limits given to the programme. In this case (Look! No Hands!—Peirose Annual, 1964) we attempted to match by computer the quality of the hand keyboarding and so obtained beforehand details of the spacings that had been used, and the number of word breaks required on a small hand keyboard sample. The results of this survey were 531 lines, 7.5 per cent with spacing values over 10 Monotype units, and a second more detailed count of 958 lines gave 90 lines, i.e. 9.4 per cent, with over 9 units and 103 word breaks (10.8 per cent). We therefore chose 13 units as the upper limit for our word spacing and, after consultation with Herbert Spencer, the designer, three units as the minimum, although the hand keyboarding at Percy Lund, Humphries had a normal 4-unit minimum. We knew the lower limit of three units would materially improve the computer programme's performance, but we were influenced by the knowledge that a number of houses use a three unit minimum either as a routine or for special classes of work, and that below three may be used in an emergency in difficult work. In any event the appearance, using 3-unit minimum word spacing, is most acceptable and, in fact, only 25 per cent of the lines are set below 4 units and only 15 per cent below $3\frac{1}{2}$ units.

The net effect of this setting, as checked in the first galleys,

was a total of six word breaks in 1,875 lines, and the statistics showed only 10 per cent of lines with over nine units spacing and only 22 lines between 12 and 13 units. Further, only 19 per cent of adjacent lines had differences of more than four units, and the greatest difference was ten units occurring three times (Figs. 5 and 7).

Our next check was to go back at leisure over a slightly

Inter-word Spacing Statistics

Analysis of actual word spacing used in four samples of book text setting—line length 576 M.U.

- (i) Computer typesetting Penrose Annual.
- (ii) Hand Keyboarding Penrose Annual (Printer 'A').
- (iii) Hand Keyboarding Printer 'B'.
- (iv) Hand Keyboarding Printer 'C'.

PERCENTAGE OF TOTAL LINES WITH INTER-WORD SPACING ABOVE LIMIT SHOWN				
SPACING OVER	COMPUTER SET	HAND KEYBOARDING		
		'A'	'B'	'C'
4 M.U.	75%	100%	97%	99%
5 M.U.	52	84	78	79
6 M.U.	36	55	55	55
7	24	29	34	30
8	16	15	17	14
9	10	8	8	5
10	6	3	4	2
11	3	<1	<1	—
12	<1	—	—	—
No. of lines sampled	1875	1075	897	1029

Fig. 5.

larger additional sample of the Penrose Annual—some 1,075 lines. To our dismay this was set (statistically, anyway) to a rather better standard—either the material was different in style or the first compositor had had an off day. However, the figures show only 8 per cent of lines with over 9 unit spaces and only 7 per cent of adjacent lines with space difference of more than 4 Monotype units.

At least we learned one lesson—that we know when we set limits in computer setting they will produce the desired result. With hand setting, obviously, we cannot be so sure.

The fact that we had used different lower limits for the computer and the hand keyboarding prompted us to choose a cumulative way of plotting the results. Both the ordinary and the cumulative histograms give a misleading visual interpreta-

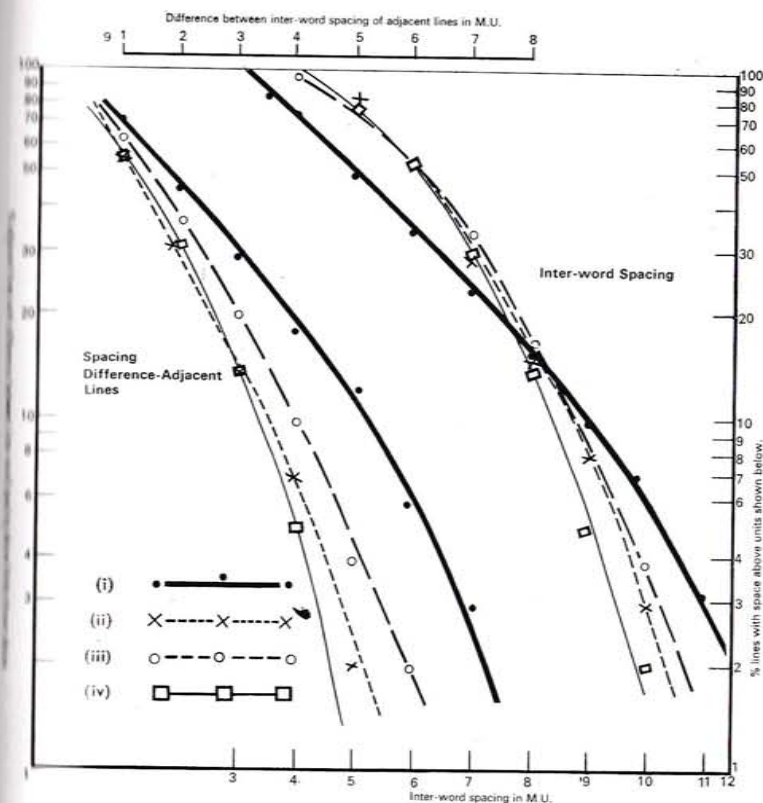


Fig. 6. Curves showing inter-word spacing, and differences between inter-word spacing of adjacent lines as proportion of total lines set.

Statistics—differential inter-word spacing—adjacent lines (i), (ii), (iii), (iv) as in Figure 5.

PERCENTAGE OF TOTAL LINES WITH DIFFERENCE BETWEEN INTER-WORD SPACING MORE THAN				
	COMPUTER SET	HAND KEYBOARDING		
		'A'	'B'	'C'
1 M.U.	72	56	65	57
2	48	31	38	32
3	30	14	20	14
4	19	7	10	5
5	12	2	4	1
6	6	1	2	—
7	3	—	1	—
8	<1	—	—	—

Fig. 7.

tion, but the percentage of total lines remaining with inter-word spacing above any given unit value can be plotted on semi-log paper to give gently curved lines, and with sufficient separation can reveal the characteristics of the setting reasonably well, although not all parts of the diagram have equal weight (Fig. 6). This is due to the logarithmic nature of the percentage scale used.

Then we obtained from two more printers the spacing used between words for work of closely comparable Monotype unit widths, 576 and 582 respectively. These were analysed and plotted. There was a difference in the nature of the setting; that of Printer C was reported speech usually 2 to 3 lines long, allowing for some foresight, while that of Printer B was a scientific journal with rather more difficult words. The figures when plotted gave results superior to the computer (in fact they were set ostensibly to closer limits, and this showed in the statistics), and in the case of Printer B the differences were particularly close to the optimum maximum of 4 units, only 56 lines or 5.4 per cent having spacing differences over 4 units.

The conclusions we come to as a result of these analyses, which we hope to extend with the co-operation of other eminent book houses, is that the number of word breaks in book lines can be very significantly reduced by computer hyphenation without materially altering the quality of the spacing used. In this particular case, due to the rather inferior setting in the first hand keyboarded material counted, we probably opened up the computer parameters a little too widely, so reducing the word breaks to only 6 in 1,875 lines.

Letterspacing—addition and subtraction

The line length being fixed, and also the upper and lower limits of word spacing, there remains only one spacing parameter for us to manipulate; that between the individual letters themselves. Westerham Press some time ago were good enough to prepare a small test piece with the space between letters increased by small amounts to determine how much could be inserted before it became noticeable and objectionable (Fig. 8). We decided that perhaps 0.3 Monotype units could be inserted before it could reasonably be detected by an ordinary reader, and of course this device would only be resorted to in exceptional circumstances—perhaps only 1 or 2 lines in each 1,000 lines set, so that it could not be objected to as a constant feature of the setting. It is not in this case used in the way that letterspacing is used in setting British (or American) newspapers, since the minimum space used in linecasters is nearly always noticeable and very frequently unpleasant.

When we attempted, however, to find a use for the insertion of minute amounts of letter spacing, we found we had none. Our need, as explained above, was exactly the opposite—we needed to be able to subtract space from between letters. For mechanical reasons the Monotype Keyboard handbook recommends that no more than 0.25 units be subtracted, although this limitation does not apply in filmsetting. In practice we found that it was rarely necessary to subtract 4 line wedge settings (0.002 inches) from between letters, and this is 0.230 units for sizes of 11½ set and above.

Having discovered how to subtract space and how to code for it, we proved the method at the Newcastle School of Printing (Fig. 9). We had more difficulty in applying it to our existing sample of 6 word breaks in 'Look! No Hands!', since the original rolls had been destroyed and we did not wish to write a new Pegasus programme to include the letter-spacing routine. Laborious hand counts and calculations were required, because

recognised as less satisfactory, and a more acceptable solution is to recast a larger unit of text. Further developments in photocomposing machines will allow them to be more fully exploited by computers, and it is to be expected that editing and proof-correcting procedures will undergo significant changes as the actual preparation of print becomes faster and cheaper. Ferranti Ltd., are well in the fore in providing the means of introducing these remarkable innovations in printing technology.

This important section of the equipment is built around an I.B.M. unit-spacing typewriter with a normal fabric ribbon. Each key operates a pair of contacts and the resulting signal is coded by a diode transistor network to operate a Westrex BPPE 110 5-channel tape punch, running at the rate of 50 characters per second. The accompanying computer programme is also fed into Wegasuson 5-channel paper tape and this necessitates using a double row of 5 channels each, produced by extra logical circuitry. Eventually, 8-channel logic and 8-channel punch will be fitted. This relatively cheap system is silent, reliable and produces a legible paper copy as well as a punched paper tape.

The first word-splitting computer programme demonstrated in the U.K. was developed last year by Mr. P. K. Mitra of the Indian Statistical Institute - a Columbia Plan Fellow working with Ferranti Ltd., - and it has been incorporated into a text-editing and justification programme for use in the Ferranti sales department's internal literature. It produces results which are not quite 100 per cent correct, but the result is satisfactory for the class of work involved.

Fig. 8. The insertion of additional space between letters in Monotype Setting (example Westerham Press).

Original Unit Value of Word Space	New Unit Value of Word Space	Unit Value of Letter Space
0.21	6.0	0.67
8.7	5.0	0.61
9.9	7.0	0.58
9.63	9.0	0.1
12.0	9.0	0.5
10.5	9.0	0.38

Original A, 73 characters, 587 units, 30 ems wide, wordspace justification, 3/2 of each other's actions; and, after their return, they were condemned to forget, or, at Original A minus 'at', 71 characters, 572 units, wordspace justification, 4/10 of each other's actions; and, after their return, they were condemned to forget, or, INCREASED LETTERSPACE LINES

Plus 0.07 MU or 1 FW — letterspace justification 3/9, wordspace justification 4/5 of each other's actions; and, after their return, they were condemned to forget, or, Plus 0.2 MU or 3 FW — letterspace justification 3/11, wordspace justification 3/9 of each other's actions; and, after their return, they were condemned to forget, or, Plus 0.27 MU or 4 FW — letterspace justification 3/12, wordspace justification 3/4 of each other's actions; and, after their return, they were condemned to forget, or,

Original B, 69 characters, 563 units, 30 ems wide, wordspace justification 5/6 at least, to suppress, whatever they had seen, or heard, in the world. Strangers, who Original B plus 'at', 71 characters, 578 units, wordspace justification 3/11 at least, to suppress, whatever they had seen, or heard, in the world. Strangers, who DECREASED LETTERSPACE LINES

Minus 0.07 MU or 1 FW — letterspace justification 3/7, wordspace justification 4/1 at least, to suppress, whatever they had seen, or heard, in the world. Strangers, who Minus 0.14 MU or 2 FW — letterspace justification 3/6, wordspace justification 4/6 at least, to suppress, whatever they had seen, or heard, in the world. Strangers, who Minus 0.2 MU or 3 FW — letterspace justification 3/5, wordspace justification 4/11 at least, to suppress, whatever they had seen, or heard, in the world. Strangers, who Minus 0.28 MU or 4 FW — letterspace justification 3/4, wordspace justification 4/15 at least, to suppress, whatever they had seen, or heard, in the world. Strangers, who

Keyboarded, cast and printed at the College of Art and Industrial Design, School of Printing, Newcastle upon Tyne, June, 1964.

Fig. 9. The insertion and subtraction of minute amounts of space between letters (School of Printing: Newcastle).

the Monotype drum is scarcely accurate for this degree of refinement and finally, after considerable vicissitudes, the 6 word breaks were reduced to 1 by reducing the inter-letter spacing, the last word break being tidied up by moving over 1 letter, and this would now be as it would be produced by the logical word break programme (Fig. 10). We are therefore left with 1 word break in 1,871 lines, reasonably well set, and this word break acceptably split, whether this be by programme or by a human decision at page proof stage. We regard this as a workable proposition.

A small side-light on the vagaries of programming showed up

in this exercise, since we discovered that the line after that with an inserted hyphen does not quite justify correctly; there is obviously a programme error which we need to find and remove.

The processing of 'Look! No hands!'

During November and December 1963 a 25,000 word article for the 1964 Penrose Annual entitled 'Look! No hands!' was prepared for publication using the available programme, which did not then contain a fully tested hyphenation routine. An attempt was made to try and conduct the operation as if it were a normal manufacturing routine. Before commencing processing the spacing parameters on some hand-keyboarded work had been analysed and the results were used to choose approximately the same limits for the computer processing.

Keyboarding proved to be a relatively strenuous operation on our IBM Type B input writer, and a skilled typist found it difficult to exceed 6,500 ens per hour without encountering the automatic double keying lock-out which caused skipped characters, back-spacing and retyping (for which the computer was programmed). Although we were working from a relatively clean typescript, the need for absolute accuracy required several correction stages. The first was after first typing, when lines or paragraphs were retyped, checked and spliced into the original input tape, with the 'hard copy' pasted over. The actual typing took 28 hours, the spliced corrections $7\frac{1}{2}$ hours.

To offer it to the Pegasus a translation to Pegasus code is required and, at this stage, to enable us to detect any undiscovered programme errors, of which we believe there still are some, an intermediate print-out on the normal Creed Teleprinter was used. This resulted in further corrections, and further splicing into the computer input tape. This was then run, the translation and the computer run to output tape taking $10\frac{1}{2}$ hours (about $6\frac{1}{2}$ for translation and 4 for processing).

At this stage conversion to Monotype 31 hole roll was necessary, and took a good few hours. As there had been some breakdown on the computer output punch, known but not corrected immediately, it was expected there might be troubles to be picked up (on this occasion) at the galley stage.

The galleys when cast proved to be reasonably clean. The caster attendant reported that 'a few lines were too short and a few too long on justification figures'—about once per galley of 100 to 150 lines. There were a number of substituted symbols which were not included in the original table look-up but, apart from this, and a repeated section of nonsense caused by

the use of reduced inter-letterspacing to avoid word breaks

Diamond 156-12 (11½ set) 576 MU

A

collationary pressures and the development overseas of large vigorous printing industries, recently and well equipped and uninhibited by outmoded labour conventions, needs to change both technologically and in its labour

collationary pressures and the development overseas of large vigorous printing industries, recently and well equipped and uninhibited by outmoded labour conventions, needs to change both technologically and in its labour

S 3/6 HS 1/15

C

eventually be possible even if 'translation' results in some inefficiency. Instructions to computers have to be in a language immediately comprehensible to them and so arranged that the time used is minimized for an

eventually be possible even if 'translation' results in some inefficiency. Instructions to computers have to be in a language immediately comprehensible to them and so arranged that the time used is minimized for any

E

The Linofilm system however embodies one important 'first' - the Composer, which is essentially a selective rephotographing device completely under the control of the layout operator. With this editing and re-arranging

The Linofilm system however embodies one important 'first' - the Composer, which is essentially a selective rephotographing device completely under the control of the layout operator. With this editing and re-arranging

S 3/6 HS 1/6

F

extent in English. They clearly envisaged that the output would control both automatically operated line-casters and other more advanced photocomposing machines. A general description of the progress up to that time was given

extent in English. They clearly envisaged that the output would control both automatically operated line-casters and other more advanced photocomposing machines. A general description of the progress up to that time was given

S 3/4 HS 1/4

Hand keyboarded and set by Cambridge University Press, July 1964

Fig. 10. Removal of hyphens by reduction in inter-letter spacing ('Look! No Hands!' example set C.U.P.).

punch malfunction, all was well. There were then 6 hyphens in the 1,871 full lines.

Then the fun started. Without my knowledge the readers got to work and altered 396 lines, creating a total of 46 new hyphens (11½ per cent). A breakdown of the reasons for the altered lines was as follows: 4 for small caps, 6 for spacing errors, 353 for transcription of cyphers into written-out figures

such as 'thirty-one', and 18 for the deliberate computer transcriptions of characters such as the £ sign which were not in our character set.

The only lesson to be learned is of course to 'follow house style', or to make sure the readers are instructed in what the programme will do.

At this stage a number of deletions were made to shorten the text (283 lines) and these caused one or two errors on the page proofs which, although they were not a result of computer typesetting, needed to be accommodated by it.

The nett effect was an acceptable piece of text setting with no real opportunity to check the economics of the process at this stage, and the need to codify the setting style even more rigorously than we had attempted to do.

Future operations

We do not at the moment propose further trials or modifications to our hyphenation routine, except as a part of general tests of the new programmes. We do plan to provide in the programmes a place for a letter space subtraction or addition subroutine, to be called in as a 'customer variation'. The general form of the programme will be on the block system, but some careful consideration will have to be given to decide the balance between the flexibility appropriate to a demonstration or trial programme and the need for an economical production process to minimize the processing time in the machine.

The overall picture we have at the moment of the input is that all the variations in format instructions shall exist on a set of pre-punched, pre-checked, edge-punched cards bearing their own format operation codes, red ribbon shift and plain language write-out, so that these can be automatically inserted as required into the text string. If at the same time we can automatically insert a progressive line count into the system, we may do so. The first editing again may very well be carried out on folded edge-punched cards, once again with visible write-out on them, as these are easier to handle and this facilitates reading the correction itself. At the moment we are testing the Dura Mach 10 (Bradma) input machine for this purpose; we are of course limited by the character sets available in the 'golf ball' head, and we would very much like an automatic carriage return which does not interfere with the actual speed of typing and encoding, i.e. an automatic carriage return linked to a larger storage mechanism. The vital thing at this stage is accuracy, as well as speed and ease of correction. It would be

attractive to be able to edge-mark an overprinted tape at the correction points so that skip reading is really fast between corrections.

As to output printing of page proofs, we would like to demonstrate a 120 or even 240 character set on the IBM Chain Printer 1403. This requires a converter from English Electric magnetic to IBM magnetic code (£30,000), a special chain and some time on an IBM 1403—just for demonstration purposes.

I have not mentioned the codes and keyboard layouts we shall adopt. So far as is possible, we shall try to follow an International or British Standard for these.

CHAIRMAN: Now let us have some questions on Mr Duncan's most interesting paper.

Mr A. C. McINTOSH (Unwin Brothers Ltd.): Without being impertinent, I would like to ask Mr Duncan how significant he considers his researches to be. I would like to amplify that if I may. I have lost any sense of perspective which I had before starting on this conference. I do not know the size of the problem which we are considering. I am wondering whether Mr Duncan, or indeed anyone else, has any ideas regarding the proportion of the total composition output of the industry likely to be affected by computer typesetting. Of that proportion, what further proportion will be affected by such considerations as 'where to insert a hyphen'? Might it be possibly a small fraction of 1 per cent?

Mr DUNCAN: As you know, Mr McIntosh, my efforts during the past twelve months have been largely devoted to creating this bridge between the traditional methods of typesetting and some of the things which might have to happen if we were to use computers for, shall we say, 75 per cent or 85 per cent of the amount of composition which is used. I do not know what percentage could be involved. These efforts must be viewed against the background of trying to match up to an existing standard and seeing whether this is possible before deciding whether one wants to.

Mr McINTOSH: I accept this point and I know perfectly well that the activities which are going on in relation to trying to get type processed through computers are essential. At the same time, I wonder whether a very small sum of money by comparison with the hundreds and thousands of pounds which are going into this technology at the moment might be devoted to some fundamental study of readability, typefaces, sizes, hyphenation, justification and supposed standards of typography. If that study were undertaken on a national basis or an international basis—which, as far as I know, has never been attempted

—it might eliminate a lot of the problems into which a tremendous amount of effort is going.

Mr DUNCAN: I take your point. If I had read my paper as I wrote it, you would have seen that I had one or two tenets to propose. One is that we should never accept any typographical rule unless it is based on reason and could be demonstrated to ordinary people as a logical thing. I can quote you hundreds of examples where Cambridge, Oxford, Monotype all give me different reasons for doing what is called 'good practice'. None of them is based—or very rarely—on sound logic, and many remain unproved.

As regards investigating all the things you have suggested and doing proper tests on readability, I would say that a hyphen should be anywhere in the word where it does not impede the progress of reading and does not affect the sense. Since you have the Americans hyphenating in a different place from the British, you can obviously condition people quite satisfactorily to different forms of hyphenation. The fact of the matter is that we are not in the mood to apply objective tests as yet.

Mr McINTOSH: How do we get into the mood?

Mr DUNCAN: By demonstration of scientific work with which you cannot argue and about which you cannot have an opinion; you must follow it.

Mr FREIMAN: There are people who are conducting studies in legibility, but printers are fully occupied with another problem. The two can be separated. The General Electric Laboratories at Nela Park have done a great deal towards scientific testing. Your London County Council School Board has done something quite useful, published in a book by the Oxford University Press. The University of Indiana is conducting a study on behalf of libraries. The Reader's Digest is conducting a study on how to produce editions which will be helpful to people with poor sight. Printers are confronted with the problem that the British are facing competition from all over the world where costs are lower; the American printer is in a far worse state; his costs are even higher. I can cite an illustration where one particular job was quoted as \$30 a page in Philadelphia, \$23 a page in New York, about \$15 a page in Britain, \$8 a page in Leyden in Holland and, if we could have taken two years for extra proof reading, about \$4 a page in Japan!

That is the kind of problem with which Mr Duncan is trying to help the British and American printers.

CHAIRMAN: I think we must stop now. If you have any further questions for Mr Duncan, there will be an opportunity at a later stage, I have no doubt, during the conference.

Keyboards and Keyboarding Problems

CHAPTER 5

Keyboards and Keyboarding Problems

Chairman
Mr F Simmons

Speakers
Mr R Boyd
Mr C Barber
Mr F C Holland

CHAIRMAN: Our next session is under the heading of Keyboards and Keyboarding Problems. The three gentlemen, in the order in which they are going to speak, are Mr. Boyd, Mr. Barber and Mr. Holland. They are going to give you their practical experience of these various keyboarding problems, and I think you will find it a very interesting session. One of the qualifications for my being in the chair is that I was originally a Monotype keyboard operator before I became redundant and got another kind of job!

Keyboard design

Mr. R. BOYD (Richard Clay & Co. Ltd): Whatever one feels about monitor-operated versus programme-controlled computers, the need for a satisfactory input device is a common factor. The application of computers to typesetting only emphasizes the scope and the need for a radical re-thinking on keyset design. Keyboarding is already one of the most important aspects of the whole typesetting operation, yet apart from modified typewriters no really new keyboard design has been put into satisfactory commercial use—that is, in the printing trade—for the last 20 years.

One may imagine that the keyboard is a relatively simple piece of equipment, but our experience—and I am sure that of the others speaking now—is that, in fact, it presents a unique combination of mechanical, electrical and human problems.

Before actually starting on keyboards, I would just like to add to yesterday evening's observations on optical scanning. Shortly before this conference began, I had a visit from a representative

of one of the larger manufacturers of this type of equipment. We actually managed to get down to hourly rates. It is quite feasible to read typewritten copy in caps and lower case but the cost for a 150-page novel, which they would process at a line a second, is approximately £56, while the cost of manual perforation at, say, 10,000 ens an hour, is about £53. In other words, it is £3 less to perforate. It is admitted that the scanner would produce an error-free tape but, on the other hand, it also requires perfect copy and that would mean re-typing at further cost.

There are two quite separate possibilities in basic keyboard design: firstly, single key pressing; that is, the sequential pressing of keys as on the typewriter or Monotype keyboard; secondly, multiple key pressing using both hands simultaneously. To each of these can be applied all the various criteria such as weight of key depression, key travel, key spacing, layout, and whether or not you want hard copy.

Since we are ultimately interested in speed, minimum fatigue and accuracy, I would like to deal with the possibilities of multiple key pressing first. Therefore, I would draw your attention to our reporter in front of the platform who is keyboarding a verbatim record of what I am saying. I know it will be word perfect because I have already tipped her off that printers spell en e-n and em e-m and only the fact that this is a computer

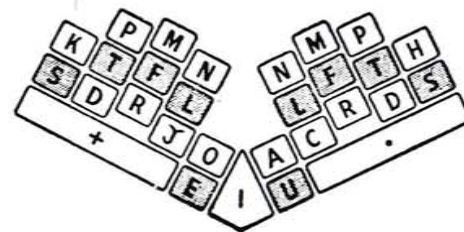


FIG. 1.

typesetting conference will keep us from referring to them as 'nuts' and 'muttons'! Leaving this aside, she is now keyboarding at a rate of 120 to 150 words a minute with a top speed of 180 words a minute. Even these lower figures are four to five times faster than a good average keyboard operator at 10,000 ens an hour.

The output cannot be reckoned in terms of ens from this keyboard but, if we did, it would be equivalent to 40,000 or 50,000 ens an hour. Figure 1 is the keyboard layout of the Palantype machine. Both hands rest on the keyboard and the 'home' keys

SKPTD+MFRNLJOEAUUI*NLCMFRPTDSH

T +
 S T I N
 T I
 O E U F T
 P R O I N
 T I N
 K O M
 P E U
 T A I R P
 T E I N
 S O N N
 K FR N
 S

FIG. 2.

are shaded. She often presses more than one key at a time, sometimes with the same finger.

The other fact which contributes to the very high speed of this keyboard is the fact that the output of this keyboard is phonetically spelt. The actual wording of Figure 2 is: The Institute of Printing Computer Typesetting Conference.

A very much simpler multiple key press device is the 10 key typewriter in which the fingers and thumb rest on the keys permanently. This has given very satisfactory results, as far as rapid learning is concerned. However, when we come to dealing with up to five alphabets at least, in our simplest case, it would involve depressions of three or more keys at the same time, and this does not appear to be consistent with high speed and accuracy.

These are potentially keyboards of the future and both would certainly require new computer programmes for conversion.



FIG. 3.



FIG. 4.

However, the fact remains that some of us have already got computers operating in this country and we must find a more immediate solution.

The electric typewriter connected to a punch output is attractive because it is an off-the-peg answer. However, it is very sparse on buttons, and the siting of essential auxiliary keyboards to one side results in a slowing up of the whole operation. Also, with certain exceptions which have been strengthened for the print

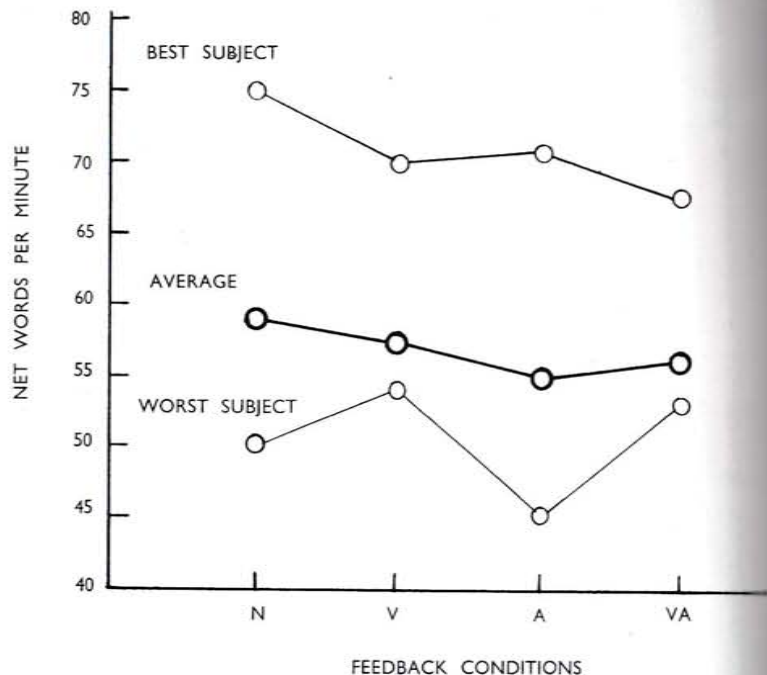


FIG. 5.

ing trade, the mechanics of the ordinary office typewriter do not seem up to the pounding it gets as a keyboard for our purpose.

Figure 3 is a modified IBM Executive typewriter for connection to an output punch perforating 6 channel TTS code.

Figure 4 is the complete installation showing the large number of auxiliary buttons required in addition to the typewriter.

One point which I would like to discuss—and I hope that other people may have views on this—is the value of hard copy at the keyboarding stage. Whether or not we require it for auto

correction purposes, I believe it is of very doubtful value to the keyboard operator.

Figure 5 shows the results of some tests made by a large American concern using a group of six different subjects typing under various conditions. 'N' is the normal typing condition when the typist had hard copy and could hear what she was doing. 'V' is what happened when a board was placed in front of the hard copy and so removed the visual feed-back. 'A' is the removal of audio feed-back, i.e. the subject could see what she was doing but wore earphones to remove all keytap noise. 'VA' is the combination of visual and audio feed-back being removed; in other words, she wore earphones and had a board in front of the typewriter. This test showed only a very slight fall-off, when the visual feed-back was removed. There was, however, a greater fall-off when the audio feed-back was removed. For some unexplained reason the position improved slightly when the visual and audio feed-backs were removed. The implications of this test, as far as keyboards are concerned, appear to be that we can dispense with hard copy but that we must think carefully before making punches soundproof.

Possibly, as a corollary to this, we have found that a keyboard operator put in a room by himself does not do as well as he does if he is sitting alongside someone who is also keyboarding at a fast rate.

If we are to obtain true touch-typing conditions, the keyboard must be kept fairly small, at least within the span of an operator's hands. In effect, this does mean a single alphabet keyboard whose condition is controlled by function buttons. There is always the possibility of using plug-in keyboards on more complicated work, such as large amounts of accented or mathematical setting. However, the advantage which we are really seeking still remains: that is, having a standard main keyboard.

The most difficult aspects of the keyboard to experiment with are the key pressure required and the reaction and travel of the keys at the moment the signal is transmitted.

This has a very considerable effect on the speed of a keyboard.

A new type of keyboard is one in which the operator starts the depression of the key manually and it is then pulled the rest of the way by a solenoid (Figure 6). This has the effect of pulling the key away from the operator's finger and it spurs him on to the next one!

There is another feature which I think is worth mentioning on this keyboard; that is the way in which it sends its output information (Figure 7). There is a row of nine photocells (only three of which are shown). When a key is depressed, a binary coded

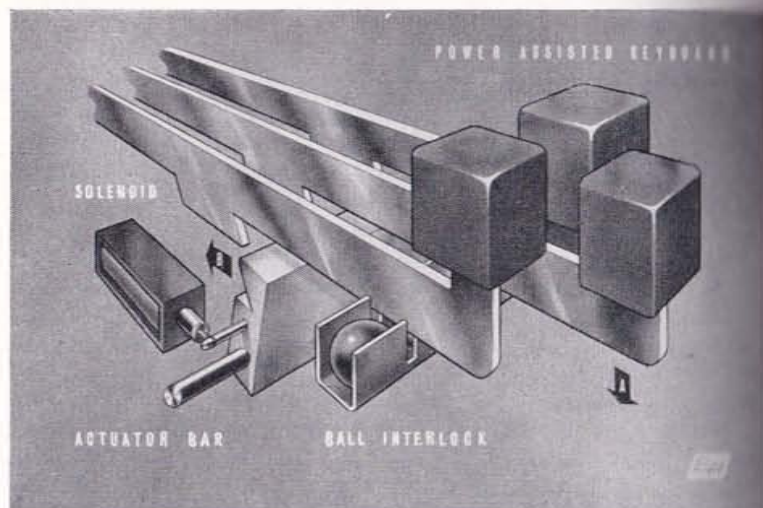


FIG. 6.

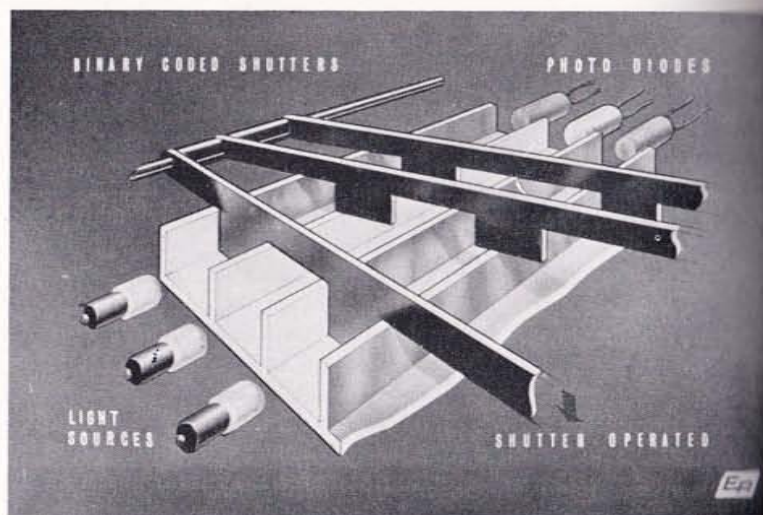


FIG. 7.

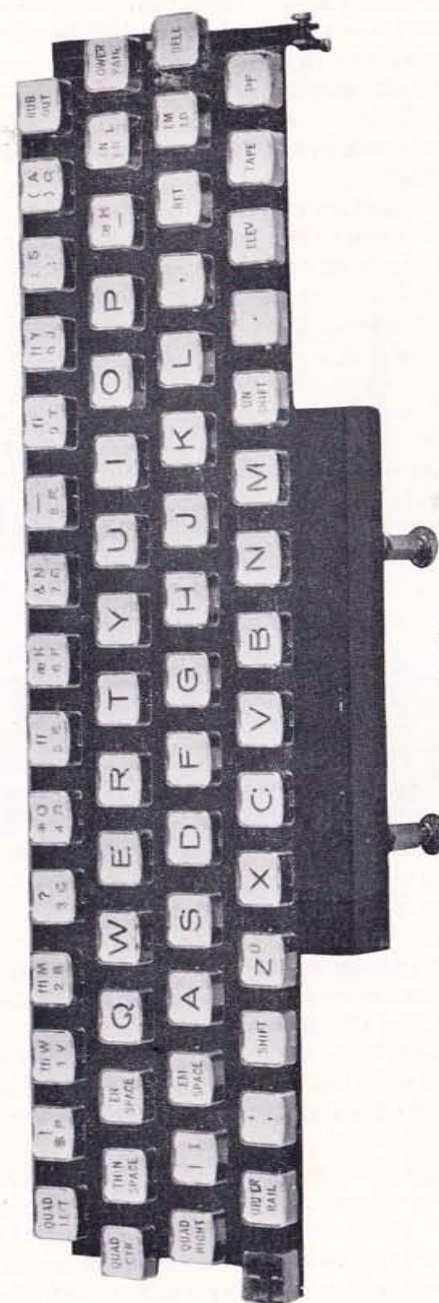


FIG. 8.

shutter corresponding to the particular key falls across a bar of nine photocells; the resulting binary coded light data is fed to an amplifier or logic circuit, as required.

The action of this particular keyboard is very good. Again, like so many keyboards, it has yet to be developed to meet our particular requirements, but I understand that it is now made in a 64 key version.

Figure 8 is a standard make of keyboard which someone else is going to cover. I only show it at this juncture because there is considerable congestion on these buttons. Here you can see that there are four characters on one button on five alphabet work and we are thinking in terms of a keyboard which will potentially give us up to ten alphabets.

One of the things which immediately strikes one in making the change from Monotype to a 6-channel keyboard is that a great deal of time is spent in non-productive key strokes apart from justification. On typical novel work, up to $7\frac{1}{2}$ per cent of the total key strokes may be non-productive, i.e. Shift and Unshift. Using a keyboard with some electrical logic built in, this figure can be reduced to $3\frac{1}{2}$ per cent.

One of the reasons for these non-productive key strokes is simply the limitation of the TTS code. A number of punctuation signs and small capitals, and all the figures, have to be preceded by shift codes. The same logic box could also automatically en-code the small caps from the main alphabet key buttons.

Figure 9 is a typical layout for a keyboard to minimize non-productive key strokes. The main difference from standard layouts is that it has been expanded vertically by one row. Additional buttons for ligatures and punctuation marks are provided and in so doing if any of these, due to the limitations of the code being used, have to be preceded by a shift code, it may be punched in automatically. The buttons on the right are the function control buttons. 'SC' puts the keyboard into a small cap mode when all main keys will give an upper rail signal preceding and some will give the shift as required.

One of the benefits of computer processing is the possibility of automatic word deletion. This means that the keyboard operator does not have to back space and kill, hence the 'word delete' key.

This keyboard has a total of 82 buttons and gives ten alphabets. The distance between the buttons is very important. On the one hand, we want to keep it compact but we have also found that the standard typewriter spacing is too close for our keyboard operators. They have a sort of 'finger congestion' after a few hours

operation. Therefore, we increased the distance between button centres on the typewriter by $\frac{1}{16}$ " to thirteen sixteenths; this is $\frac{1}{16}$ " less than Monotype or Fairchild. The optimum button pressure appears to be about two to three ounces but possibly more important is to avoid any spongy feeling.

Although it is no part of any exposé on keyboards, the punch itself is a most important part of this equipment. A speed of around 30 characters a second appears to be necessary in order to prevent the keyboard operator from occasionally beating the punch on adjacent letters, or, alternatively, the transfer from a



FIG. 9.

right to a left hand. To eliminate this possibility entirely, rather than lock the keyboard we would prefer to see a single character store between the punch and the keyboard. If a mechanical interlock is fitted, it admittedly prevents an error occurring in the output tape but I believe it would also prevent the keyboard operator from reaching maximum speed. I think Mr. Duncan may have something to say about this.

In spite of what I said earlier about not requiring hard copy, we would like to see the ideal keyboard equipped with an edge printing punch, that is one which punches holes in the tape and prints alphabetic characters on the tape. This would be most useful for checking purposes when training operators or the

correction keyboard operator, and also for letting people further on down the line know exactly what is what. Punches of this type do exist but at the moment they do not appear suitable for attaching to a keyboard. There is a keyboard which incorporates edge printing. I think one of the other speakers will deal with that.

Since we are talking about computer typesetting, there is another possible approach to keyboards upon which I would like to dwell briefly, typified in two machines: Starparts and Monotron. Both of these are putting part of the computer, or part of a calculator, into the keyboard to give automatic justification at the keyboard stage. On the Starparts board, when the operator approaches the end of a line, return and elevate signals are punched in automatically, whenever a word space falls at the right point. There are various systems incorporated for backing up and tighter spacing. The second keyboard is the Monotron. Again, there is automatic perforation of the justification code.

Finally, having talked about various types of keyboard, I would like to comment on the most important aspect of this keyboard of the future, whatever it is: that is, the selection and training of operators. Cybernetic or teaching machines exist for Army Teles operators, and a keyboard training machine would be a natural development from them. What is most important to us is that since they give preliminary results in a relatively short time they could be used as a means for selection to get the best suited operators for the job. To develop a machine of this type would cost about £5,000 apart from the expense of initial trials.

Therefore, to end up, I would say that the whole question of keyboards and training is yet another case where some future co-operative effort will yield really worth-while results.

Direct use of keyboard with computer

CHAIRMAN: Mr. Barber will now give the second paper, and we will leave the discussion until after the third paper by Mr. Holland.

Mr. C. BARBER (Rocappi Inc): I would like to confine what I have to say to a keyboard for use direct with a computer, in particular the ICT 1500, or the RCA 301, which accepts with its current reader a 6 or 7 channel paper tape. The language of a computer like the RCA 301 is such that every character—and there are 64—is a combination of six bits. If you introduce a parity level, you can automatically check whether or not the tape is correctly perforated, in as much as either an even or odd number of holes is perforated for any one character. In one case there is

a discrepancy: this case is the delete code where the machine can accept an odd number of holes defining the character. I say 'can accept'. It merely sees seven holes and dismisses that character as being completely redundant. This has many advantages. I would like to tell you that if you used a Fairchild Gutless Wonder perforator, which has been used at Los Angeles, at Perry, and we use it at Rocappi, the delete code is merely six holes. That code, when fed into the computer, has to be deleted within computer memory; it is fed in and processed. If you have a parity check you do not have to feed in the delete code at all, as it does not hit high-speed memory. There is one catch about parity; the automatic checking does not seem to work. The problem you run into is that the parity checking logic within the perforator will let you down. As a consequence of this, the computer will hang or stop, apparently because it is receiving an illegitimate character, or more often because the incorrect parity has gone in.

Hard copy: I do not think that anyone using a computer system which has a high-speed printer available and a correction routine available should consider a hard copy producing keyboard for one moment. If you have an Anelex printer—a high-speed printer of one kind—you can read your information in, print it out and correct it through a correction routine better than a girl can read what she is perforating. In any event, how far back is the girl looking? If she is perforating at top speed she does not have the time to look back.

Someone said that it might be advantageous to perforate corrections. I disagree. As Mr. Archer described this morning, interrogation of the correct parameter can do everything which the hard copy will otherwise give you.

Writing on the tape: We had a Navcor perforator which wrote on the tape. But it wrote 72 characters out of phase. The characters were quite legible. We decided against it, except for very early stage diagnostic purposes and for training people. We were trying to get high keyboard speeds, and operators do not have time to read anything. All they have time to do is to cut the tape, and the easier you can make it for them the better.

There is a feature on the RCA 301 which does exist on other computers. When you are reading gapless paper tape, in order to read at very high speed the braking mechanism does not grab the tape just when it should do. Say you require to read 130 characters at random in gapless tape, there is a possibility that the brake slips and you miss three or four characters, which is disastrous. As a consequence of this, if you are reading gapless paper tape you must start reading at lower speeds. I am referring to 1,000 character readers as being fast; 500 as slow.

A way out of that situation is possible if the perforator counts the characters it is cutting. If you know that your paper-tape read instructions within the computer will never exceed 100 characters, and that after every 100 perforations the perforating device itself throws in three blank tape feeds, then this will allow you to read at that very much higher speed of 1,000 characters a second.

I agree absolutely with Mr. Boyd about shift and unshift. It is a 'must' to have a shift lock and also a key which you push down which generates a shift code and releases the shift which generates an unshift. The Navcor perforator was essentially designed for our system and did this.

We cited the Rocappi system, and in any system you are going to have to get into some sort of function representation, i.e. beta J, beta X or beta anything you like. Beta J, as Mr Archer described, could be Baskerville 10 point; beta K, Times Roman 12 point, or anything you fancy. We had a blank set of keys on the Navcor perforator—and I still think it was a good idea—so that, when you hit a particular key, two perforations were made, beta and J. Therefore, with one key stroke you were generating two codes. The bank was typical of that on any typewriter.

As you hit beta J, a little light came on; so the operator knew he was in beta J. We not only had beta J but we had rho J as well; in other words, we had two separate function codes.

With small caps, as Mr. Boyd said, you have a problem on the rail, shift, unshift, and the tape is a mess when you read it.

What we are able to do in our system is to let beta L represent small caps in a particular fount. Having done this, all you have to do is hit the alpha characters and you are away. With one key stroke we are in the small cap mode and would stay in it.

With respect to ligatures and computers, let us forget all about ligatures in terms of perforation. Let us take the name 'Griffin'. We are producing unjustified tape. If the girl puts a ligature in there for 'ffi' and during the course of the process we discover we have to letter-space that line, it is going to look funny with 'ffi' in the middle of it. What you have to do—and can do very, very easily—is to perforate 'ffi' normally, forget that ligatures exist altogether, and let the computer programme in its final stage determine, (a) whether or not that 'ffi' is in the lower case, (b) whether or not this line involves any letter spacing, and (c) whether it is in a fount where you have a ligature available. This is in the system right now.

Word deletion: I do not see any value in word deletion if you have a good correction routine.

I do not know a great deal about the selection of operators, but

I can tell you what my experience has been. If you take a man who had been perforating tape for a typesetting device, such as the Photon, and introduce him to a computer system, it has been my experience that you get the best generated tape from that man. It is far better to do this than to bring in someone else, no matter how high his IQ or his educational qualifications are. A man who has previously been a keyboard operator, given a keyboard and the rules involved in a computer system, turns out wonderfully good tape. I have worked in an installation where they have hired girls for perforating tape. What I would like to say about girls who are just regular typists is that you note a tremendous difference between a good one and a bad one. You will take in one girl and, no matter how much time, how much understanding and how much patience you apply, you cannot train her into the system. On the other hand, another girl can be really efficient in two or three hours.

A Monotype point of view

Mr. F. C. HOLLAND (Monotype Corporation Ltd): I concur fully with what has already been said on this matter of keyboard speed, particularly with the figure of 10,000 ens per hour, although I am aware that this conflicts with Mr. Archer's 20,000 ens per hour. I do not think that either of us is necessarily wrong; it is a matter of which you call an average.

I am thinking in terms of the whole printing industry, both nationally and internationally, using different languages with the tens of thousands of keyboard operators working machines on which plenty of information is already available. I have the feeling that some of the higher speeds quoted are quite honest extrapolations from specially selected keyboard operators. I think perhaps that some of the men with whom Mr. Archer deals are above average as far as good operators go, and may also be paid more. People associated with newspaper work, as we have already heard from the Daily Express members, may work at high speed for 2½ hours and then spend the rest of the shift relatively unproductive. You will not get accurate figures of average keyboard speeds from such sources, and I would like Mr Archer to agree to differ from me in this: I will say 10,000 and he can say 20,000.

I maintain that this speed is very important, as the whole typesetting system depends upon it as a fundamental pacemaker where a keyboard input is the necessary starting point. To explain what is meant, I believe that a computerized typesetting system can have 3 different kinds of input. The first is what I call

'Prime Printing', where original manuscript has to be processed into some kind of punched tape because at that time no tape exists. The second is where this originally cut tape can be used with a suitable computer programme to generate other typesetting operations of the same text but in different typefaces and formats. The third is where computer sorted information, already existing for purposes other than typesetting, is used at some later stage for the production of typesetting.

It has to be realized that I am mainly thinking of the first category, where the keyboard is the essential input, when I state that the keyboard sets the speed of all subsequent operations. The second category mentioned obviously deals with the elimination of a keyboard operation, as does the third category. At present the great bulk of typesetting comes within this first category and I feel that this prime printing needs a keyboard input, and will for many years to come.

Productivity can be calculated in many different ways. One way, I suggest, is to think in terms of man/hour productivity in the whole typesetting system, where you divide your total staff engaged in typesetting into your total output in ens per hour. The number of men in a given system will depend on a number of factors, one of which is the kind of computer in use.

Let us say you use a computer which puts out punched tape at 100 characters per second so that, with the usual delays caused by loading up spools of paper and the working pauses that are normal in computer operation, you might have a regular output of 85 usable character punch codes per second. This figure would therefore be the maximum punched tape input to your computer.

10,000 ens per hour at the input keyboards is around 3 characters per second. Dividing this into 85 characters per second at the computer means that you would need 25 to 30 keyboards to keep one average computer in operation. If Mr. Archer's figure of 20,000 ens per hour is correct then you would need only 12 to 15 keyboards. In any case, you have a through-put of work in the region of 250,000 ens per hour, which is a sizeable amount of typesetting!

Progressing further into my thesis, it has to be realized that there must always be other men in the typesetting system; there will have to be attendants for the computer as well as the typesetting machines themselves, regardless of which actual machines are used. What I am trying to say is that when you calculate your man/hour productivity you will inevitably have a figure that is always less than the average keyboard speed in ens per hour, no matter what comes after the keyboard stage in the way of

machinery and equipment: so that it is very important indeed to get the best speed from your keyboard stage, because it sets the whole productivity of the system.

Because of this, good keyboard design is immensely important, and we do require keyboards that enable the operator to waste the least possible amount of time and generate the greatest number of usable punched codes.

I feel the same way as the other speakers about hard copy at the keyboard stage. I do not think it is necessarily a good thing, but a compromise could be a keyboard which does not have a print-out, but has a big jack plug connection at the back into which a suitable typewriter accepting electrical signals could be plugged. Thus you could have it both ways. Of course, if you are setting in Greek or Russian, you will have to get the right typewriter and this could lead to a lot of typewriters standing by. At this time I would like to point out that what has been said before in this conference has not touched very much on foreign language work. Yet we cannot afford to forget that just to the east of us there live several hundred million people using print, and they do not speak English. Mainly, they speak more complex languages requiring accents and suchlike. I believe that a keyboard which is going to be useful in the future should reflect the need to print in many different languages and should enable the operator to change rapidly from one language to another with ease.

Slides

To illustrate the possibilities open to us in the future, I show the Monotype standard key layout. I apologize for the advertising, but for those not familiar with this machine I should explain that it uses two banks of keys with a total of 334 in this arrangement. Incidentally, this keyboard cannot be used for computer typesetting, as it does not punch standard narrow tape required by existing computers.

The two banks lift off and may be replaced by others having keys of different languages or signs to enable rapid transit from typesetting in one language to another or one font arrangement to another.

Possibly the electric typewriter of the future, used in typesetting operations, would be similar to Figure 10. I would like to see 360 keys arranged in two banks. The left hand bank could utilize the lower left hand alphabetical keys for capital and lower case Roman characters—the capitals being obtained by a shift key with automatic insertion of the necessary punch codes in the tape output. The middle and upper part of the left hand bank would

whole world which are setting unjustified tape. We have hundreds of thousands of conventional keyboard operations which do justify. Whether we can accept the extrapolations based on a few hundred to say what is going to happen in the future, I do not know. It seems likely to me anyway that there should be quite considerable increases. I see no reason why the deletion of justification and line splitting, and the elimination of potential mistakes which go with this at the keyboard stage, should not pretty nearly double keyboard output. I may be rather reckless here. I would think it would be a minimum of 50 per cent. This does depend very much on the language and the kind of work you are doing.

Mr. B. R. HATVANY (Burroughs Machines Ltd): It has been reported that clock typists can perforate tape without justification at a speed of 500 to 780 lines an hour, while the same operators could produce only an average of 350 lines an hour if these additional decisions must be made.

Mr. HOLLAND: Perhaps, in answer to that, I should comment that the sort of speed increase which will be demonstrated by deletion of all justification and hyphenation routines depends very much on the measure of the job. In other words, if you are commonly setting newspaper measure of 11 ems and you come up with a line-end decision of some kind or another every 25 or 30 characters—maybe even less, depending on the type size—obviously you will show marked benefit. If, on the other hand, you are setting a book measure with an average of 60 to 70 characters in the line and you delete the pauses after every 60 or 70 characters, you will not demonstrate such significant gains. Therefore, it just goes back to the fact that we do not have a lot of accurate information on this kind of thing, and history will answer these questions.

Mr. A. H. PHILLIPS (HMSO): When can we have a Monotype keyboard with automatic justification?

Mr. HOLLAND: I will get the sack if I answer that!

Mr. H. O. SMITH (Crosfield Electronics Ltd): I would like to follow up Mr. De Witt. It does seem to me that the major economies in the computer typesetting field are achieved by this saving in keyboard operation. There are certain fringe benefits obviously, but I think this percentage saving in keyboard operation is a very important economic factor. Claims are made which appear to be quite wild. To go from 10,000 an hour to 20,000 an hour seems to be quite ridiculous, based upon my experience in the typesetting field. The Los Angeles Times claim somewhere between 30 per cent and 40 per cent saving in a very narrow measure. What would be the saving in average book-work

measures? Half of that? This is the thing about which we ought to get more information.

The other thing which worries me is not this easy field of straight typesetting. As Mr. De Witt said in the paper which was presented to the Institute of Printing last year, until there is an up-dating of the output of the end-product machine there is little future in making small savings in this primary keyboarding operation.

My other point—and I would be grateful if any speaker could help me—is this: whereas one can begin to see good sound sense in computerized book-work typesetting, I cannot personally see how it would apply to other fields of composition.

Mr. BARBER: In the first part of your question you asked what the savings were in book-work. The only savings which are available are those that take the logical decision from the perforator. Therefore, from your own experience in justifying conventionally, you know what the saving would mean in terms of a percentage.

Mr. G. LANGDON (NGA): I am curious about this question of re-training. From that point of view I have some interest in this matter. Could any of the speakers tell us about the Brewer keyboard which I understand is in use in America? It is based on the Linotype standard keyboard rather than the typewriter keyboard. Have any of our speakers any information about this?

Mr. H. P. WHITTAKER (M. H. Whittaker & Son Ltd): I believe Mr. Duncan begged the question in his talk about the value of hard copy. I think I would be right in saying that the people who have controlled hot metal typesetting machines by tape for many years will agree that hard copy is not essential to the attendant and, in fact, of little value to the keyboard operator. What is important is that hard copy is now almost vital for controlling phototypesetting machines because, with phototypesetting machines—and there is no system yet available commercially which has a correction system as efficient as a hot metal correction system—hard copy is becoming more essential in order to produce a clean tape to put into a phototypesetting unit. What I would like to ask is this: having got our hard copy and prepared our correction tape—there are I know tape-merging systems—are there any existing computers which will do the tape merging automatically in themselves without having to have a separate unit?

Mr. BARBER: If I understood your question correctly, this is the way we do, in fact, apply corrections. Mr. Archer showed you a print-out this morning. This is the entire concept of the

system. The fact that this correction has involved the de-justification and re-justification of the content of that tape is all part of the scheme.

Mr. WHITTAKER: I have a supplementary question. Can you put your correction tape into the computer at the same time? In other words, in the system as you have described it you have to go through the computer to get a print-out, whereas with a hard copy keyboard it is possible to get a hard copy and do the correction and produce the corrected tape before you go to the computer. Can you put those two through computers?

Mr. BARBER: We want to proof-read at the computer print-out level. As such we are not interested in the hard copy. Since we are not generating a hard copy we have no terms of reference by means of which we could access in any way the paper tape which is going in initially. In answer to your question, in the Rocappi system, it is 'no'. The LA system is the only one I know of which could do this, and there are certain limitations within that correction system. On the question of how many lines you can access at one time, I think the limit is 99. If you want to correct on line one, you have got to write 01 and for line ninety-nine, 99. We are willing to go to—and do go to—99,999, so what we have lost one way we have tried to gain in another.

Mr. E. G. CLUFF (ICT): I am here with Mr. Chadwick. I have not been present at earlier sessions of this conference. I have come to hear what people have to say who are interested in this question of keyboards and codes. Although I do work for one of the leading computer manufacturers in this country, my main interest is in standardization and this is why I work very closely with Mr. Chadwick.

One speaker mentioned the button pressure of two or three ounces which was regarded as being the optimum for keyboards. One of the things which has come out of our work in the BSI is that force is very strongly linked with length of keystroke.

Dr. Conrad, of Cambridge University, has produced for us some results on this subject. These show a correct correlation between a keystroke of $\frac{1}{4}$ " and a force of two to three ounces.

Secondly, our international work on codes, which has not reached a very advanced stage, had to take into account the keyboard considerations in the pairing of characters inside the code table. Likewise, we are now going back to keyboards because we are having to look at our code to see where the characters should go on the keyboard.

On the question of the size of the keyboard, there was one illustration of extending the keyboard upwards to a fifth row. This is a very important point of principle, because the question

of the operator's span with the least movement is important. So far we have worked from a different angle, whereby we want to keep the operator's hands as close together as possible in the centre of the keyboard and not extend movement upwards. We have expanded our keyboard in the case of a 65 keyboard by putting some of the less used functions at the sides, so the operator's fingers only need to move to the outside very infrequently.

On the question of multi-alphabets, some of the fundamental principles of our work in coding have been concerned with catering for multi-alphabets, particularly with those languages requiring accents. We have been concerned for some time now with international communications and we have had to include in this international code a proper repertoire of accents, certainly catering for German, French, Spanish and Scandinavian; the latter requires three extra letters.

I want to add one further point. It is possible, with conventions we have discussed but not standardized, to cater for a different number of alphabets by a convention within the English alphabet itself. We have a double code in conjunction, so that a number which follows a certain character shows you are now in alphabet 7 or 10. This is possibly a point which may be of interest to the conference.

CHAIRMAN: We have had a very interesting session on keyboarding problems. I would like to take this opportunity on your behalf of thanking the three speakers, Mr. Boyd, Mr. Barber and Mr. Holland, for the way in which they have presented their papers and dealt with your questions.

Further Reports on Technical Progress

CHAPTER 6

Further Reports on Technical Progress

Chairman

Mr R F Fullick

Speakers

Mr E Hanson

Mr F S Angell

Dr H Brandt Corstius

Mr F De Witt

Mr Milton Schwartz

Mr A H Beaven

Mr G Bafour

CHAIRMAN: Before I introduce the speakers, I would like to mention at this point that the conference is honoured to have with it two pioneers of computer typesetting who probably started to think, talk and work on it before any of us here were ready to listen to them; they are Mr. Bafour from France and Mr. De Witt from the United States. They will both be speaking for a few minutes this evening.

I would like to introduce to you the people who are going to speak. First we have Mr. Hanson, computer-graphic inventor and developer of the Linasec. He will be followed by Mr. Angell, who has spent the last 24 years working on teletypesetting, first with the Teletype Company and then with Fairchild; he will describe to you, in company with Dr. Truscott, the Thompson Ramo Wooldridge computer Fairchild are introducing for computer typesetting. The next speaker will be Dr. Corstius from the Mathematical Centre in Amsterdam; he will talk on the programme which has been written over there for computer typesetting. Next we shall hear from Mr. De Witt who is with Friden; he will talk about their approach to the problems of tape perforation and tape processing. We shall then hear from Mr. Schwartz of Alphanumeric; Alphanumeric is a data-processing company which is concerned with systems analysis in the graphic arts; he will talk about their project of computer typesetting and also give us some details of the high-speed photocomposing machine they are developing. He will be followed by Mr. Beaven

of NCR who will speak briefly on their plans for computer typesetting. Finally Mr. Bafour will read a short paper on the work which the BBR system (these initials will be explained) is going to proceed with in France.

I will now call upon Mr. Hanson.

Linasec

Mr. E. HANSON (Compugraphic Corporation, USA): There are two things I would like to do very much. First, I would like to tell you something about Linasec. I am going to make this very, very brief because the second thing I would like to deal with is probably of much more general interest.

Linasec is a special-purpose computer. There are two versions of Linasec each of which does one job only; they convert unjustified tape to justified tape. Linasec I sells for about £10,000 in this country; Linasec II sells for about £14,000. They will operate at speeds of about 5,000 lines an hour on almost any measure. They are special-purpose machines. They are machines in which the machine does the major part of the computation but the machine is not capable of doing hyphenation. When hyphenation is necessary it calls for help. This displays on a screen the word which needs to be divided and calls on a monitor to make the decision as to how the word is to be divided or, perhaps, a decision that the word must be carried to the next line, recognizing that this is going to create a line on which the spacing between words is somewhat larger than you would wish it to be. You have no choice; if the word is 'straight' it cannot be divided.

Let us consider the differences between the Linasec I and the Linasec II. The Linasec I is intended primarily for the composition of fairly long measure. Most book-work can be done satisfactorily on a Linasec I. Linasec I is capable of working only with the expansion of the space bands to justify the line. Linasec II is capable of adding to a line whatever spacing is necessary to make the line justify. Hence Linasec II is necessarily the machine for use in a newspaper plant or in book plants which do a lot of fairly narrow measure work.

I think that is really all I would like to say about the Linasec machine as it stands.

The second thing I want to talk about is the general question of special-purpose computers as opposed to general-purpose computers. The point I would like to come back to on this is a question Mr. Smith asked this afternoon which was, basically, 'if you are going into computer typesetting, how are you going to pay for the computer? Where is the saving going to come from

which will pay for this additional equipment which you are putting into your plant?' The other thing we have to look at is this question of how much potential saving there is here to pay for a piece of equipment. My feeling is that a special-purpose computer like Linasec is, at least at the moment, a better answer to the problem of making justified from unjustified tape than a general purpose machine which would cost significantly more.

I would like to turn over the rest of my time to an open discussion. Since Mr. Smith asked the question this afternoon I have done a little pencil-pushing. I have some figures with which you may or may not agree. I would be interested in your views on these. First of all, it seemed to me that the average cost of composition might reasonably be taken to be something like 1s. od. per 1,000 ens. This is not total composition. This is just paying the salary of a man who actually does the keyboarding. This seemed to be a reasonable figure for, say, a teletypesetter keyboard producing 10,000 ens an hour. By 'reasonable' I mean that it is not going to be four times that much. Taking 1s. od. per 1,000 ens, the most you can hope to do by converting unjustified tape is to save a portion of that 1s. od. on each 1,000 ens. This is all the money you have to spend on your computer. You cannot spend 1s. od. processing those 1,000 ens: maybe you can spend a quarter of it. Let us suppose that you can get a 25 per cent increase in your keyboard productivity which I think reasonable; this leaves you so little to pay for the additional equipment that it must be moderately priced.

I took a case where you might have four keyboards and where you are casting type at a rate of $4\frac{1}{2}$ lines a minute—this is for a full day's operation—and I tried to figure out what sort of keyboard production you would have to get at your perforating keyboards to make this break even. With a £10,000 computer you are going to have to get about 13,000 ens an hour at your perforating keyboard in order to pay for this piece of equipment. I think this is a perfectly reasonable thing to expect. With proper operator selection and training you can do better than this. However, if you then go from a computer which costs you £10,000 to a computer which costs you £20,000, the keyboard rate in the same situation, to break even, goes from 13,000 ens an hour to 16,000 ens an hour. If you go to a £30,000 computer, it goes to 19,000 ens an hour. If you go to a £40,000 computer, it goes to 22,000 ens an hour. I honestly do not see how you are going to justify paying £40,000, £50,000 or £60,000 for a computer, even if you have this amount of money available to pay for the equipment.

I would be interested at this point to hear other opinions on this subject.

Mr. E. R. LANNON (Washington Dept. of Health, Education & Welfare, U.S.A.): How are you amortizing?

Mr. HANSON: I figure on the basis of charging the sales price of the computer over the period of five years.

Mr. C. J. DUNCAN (Newcastle University): No maintenance on the computer?

Mr. HANSON: I felt that the computer would have a life of somewhat more than five years, and that spreading the cost over five years would take care of this. If you were to shorten the period, I think my question would become even more pointed.

Mr. DUNCAN: What if you doubled the number of keyboards?

Mr. HANSON: If you do that, you improve the situation considerably. However, you have to put a tremendous amount through the computer in order to be able to justify anything like a £20,000 or £30,000 investment.

Mr. F. C. HOLLAND (Monotype Corporation Ltd): These figures you have been mentioning are more or less break-even figures. When you say you have to pay for the computer, this is a break-even point; you would not make a profit on it?

Mr. HANSON: No.

Mr. F. SIMMONS (NGA): I would like to say to Mr. Hanson that, if you are expecting a higher productivity from the keyboard operators as a contribution towards the cost of the computers, please bear in mind that they will expect to share in the increased productivity.

Mr. HANSON: I think the sharing should begin only after you have reached the break-even point.

Mr. A. MacNAGHTEN (Short Brothers & Harland Ltd): When it comes to justifying the purchase of a general purpose computer, surely you should allow for the fact that it will do other jobs as well.

Mr. HANSON: You should, but I have never seen it done.

Mr. MacNAGHTEN: It is capable of doing it.

Mr. HANSON: Yes, it is capable of doing it. There are about sixteen general purpose computers being used for typesetting in the United States and none of these is being used for anything except typesetting.

Mr. DUNCAN: Is that absolutely true of Perry? Are they using two separate computer installations at Perry? There is a bulletin out this month which gives details of non-typesetting computer usage. Is that on a separate computer?

CHAIRMAN: We were there in December. They certainly have two computers. They are using one as a buffer. However, a

great deal of administration is being done at Perry Press; wages, accounting, income tax, invoicing and all sorts of things, through the same computer room.

Mr. HANSON: What sort of an investment do these two machines represent?

CHAIRMAN: From my knowledge the investment might be about \$500,000.

I would now like to call on Mr. Angell.

Fairchild's general purpose computer

Mr. F. S. ANGELL (Fairchild Graphic Equipment (U.K.) Ltd): I am going to do as Mr. Hanson has done and be as brief as I can, throwing this open to questions afterwards.

I do want to show you what we have to offer in the way of a computer. This is in the form of an announcement. This particular computer is manufactured by Thompson, Ramo & Wooldridge who are quite well known for their computers. Fairchild have been looking through the computer field for a computer which they feel would be suitable for graphic arts use. They are not a computer organization which is attempting to see how it can fit into the graphic arts. They are primarily graphic arts people looking for a computer which might fit. The Thompson Ramo Wooldridge computer was the one which fitted the picture best in size and in capacity. The capacity and abilities of this computer are slightly larger than those of the RCA 301.

It is a general purpose computer, 16" by 20" at the base and 59" high. It is a problem-orientated computer, which simplifies the handling of many of the keyboarding problems which arise in instructing a computer as to what has been done. It is not a wired-logic computer but a stored-logic computer. Our programme is stored in this computer. The advantage of this is the facility and ease with which the computer storage or programming can be changed. It is also equipped with two inputs and outputs and can simultaneously process two different type faces and two different line lengths, which is a thing that has been needed. As regards the speed, this will run 9,000 newspaper lines per hour with standard equipment. With special equipment this can go up to as high as 27,000 newspaper lines per hour. It requires fewer key strokes for instruction. Right now, we are running at 95 per cent accuracy on our hyphenation and, when I speak of 95 per cent accuracy, I am not taking the total lineage as a base figure; I am taking the hyphenated lines as a base figure. We feel the reliability of this computer is better than anything

else on the market to-day, due to the fact that the mean time between failures is in excess of 1,300 hours. The reason for this is that this computer was originally designed for military applications, according to military specifications, and they required extra heavy duty components throughout. This includes the printed circuit and all other facilities in the computer.

The computer is being used in Santa Monica on a pilot programme; we are debugging a programme which will be available here very shortly.

The control available to the composing room personnel is at the top of the computer. There is no way that they can perform any mischief by trying to make changes of their own. It is a simple on/off device, a matter of pushing a button, and the computer runs to completion.

Below this is the control used for test purposes and for running diagnostic tests, which can be done periodically to check that all the printed circuits are in good condition. The printed circuit board is of the plug-in type. It is about 50 per cent thicker than the average board, which will save a lot of maintenance problems.

Behind are the power supplies with all the power packs in order, set up in unit construction so they can easily be maintained. No air conditioning is required with this computer, nor is there a dust problem to worry about because the unit is completely enclosed. The fact that no special air conditioning is required is quite important. The unit will operate up to 122° F. with no interference. We will be coming out very shortly with an improved unit giving 30 inputs and 20 outputs, which should enable a user to keep up with the flow of copy at deadline time and not fall behind.

Dr. Truscott and Mr. Roberts will be happy to join me in answering any question of a technical nature.

Mr. A. C. McINTOSH (Unwin Brothers Ltd): Price?

Mr. F. S. ANGELL: I would say in the neighbourhood of £45,000.

Mr. HOLLAND: Is the new model with an allotter attached to it a sequential system?

Mr. ANGELL: It will be sequential.

Mr. G. B. TAYLOR (Computaprint Ltd): When Mr. Angell says that the capacity of this device is slightly greater than the RCA 301, would he like to tell us which configuration of the RCA 301 he has in mind?

Dr. D. N. TRUSCOTT (International Systems Control Ltd): This is one of those questions which admits a great many answers. In terms of output of lines justified for the normal

assembly, which we understand is used for the 301, the capacity is slightly greater.

Mr. G. P. COOKE (Brown, Knight & Truscott Ltd): When you say that the programme is built into the equipment, do you mean that, if for any reason the programme has to be changed, you have to change the hardware physically?

Mr. ANGELL: I am sorry if I gave you that impression. The programme is not built into the computer. It is not a wired-in programme; it is a stored logic programme. This can be changed very readily by merely running one out and running another programme in by tape.

Mr. PHILLIPS: Could you tell us the name of this computer?

Mr. ANGELL: It is Thompson-Ramo-Wooldridge, TRW.

Mr. R. BOYD (Richard Clay & Co. Ltd): We had a figure of 9,000 lines an hour. Could you give this to us in bits or characters per second? If so, what output punch are you using?

Dr. TRUSCOTT: All the figures I have are in terms of output lines of the Santa Monica output. It is a regular news paper line. The actual speed of the machine can rise to 300 characters per second. The limitation is normally in the output devices. The two channels, which were on the slide that Mr. Angell showed, were Royal McBee punches. The machine is not saturated with two; it can handle more than two.

Mr. E. FORBES (U.S. Government Printing Office): Are those punches 100 characters per second?

Dr. TRUSCOTT: They are 60 characters per second.

Mr. A. J. MAYNE (Consultant Research Scientist): Who writes the programmes for this computer? If the computer supplier writes them, how much do they cost?

Dr. TRUSCOTT: The computer comes with a standard programme which is based on an analysis of the hyphenations in Webster's Dictionary. It produces this ninety-five per cent of correct hyphenations and carries also a list of 4,000 standard exceptions. If you have a particular house style which you require, then this will take a small amount of additional programming. However, this will not cost much. The main programme comes with a machine in the main price. It is used by all the inputs and outputs which run into it.

Mr. MAYNE: I understand you have to change the programme to change the type face or the size.

Dr. TRUSCOTT: When you wish to feed in the perforated tape for a particular piece of type for setting, you start off with a code which is set on the teletypesetter keyboard, which tells the machine the size of type, the particular fount and the column

width. The hyphenation programmes apply to all faces whatever they are. However, this particular key goes on to the front of your tape and if the next tape going in is of a different column width it carries this identification and the machine handles it.

A Dutch programme

CHAIRMAN: Dr. Corstius from the Mathematical Centre in Amsterdam is going to talk about typesetting programmes which have been developed by them in Holland.

Dr. H. BRANDT CORSTIUS (Mathematical Centre, Amsterdam): We are a Research Institute; we do not sell computers, nor do we print anything besides our own research reports. However, we do have a computer, and we want to use it for any problem we encounter.

One problem we saw about six months ago was the hyphenating of Dutch words. I am quite sure you are not interested in Dutch, so I will not go into this deeply. We have heard many things about splitting English words. I have even heard it said that English words are the hardest to hyphenate, that they are harder to hyphenate than words in any other language in the world. As I do not know all the languages in the world I do not know if this is true! However, I am quite sure of one thing: at least in English it is a finite problem; you can solve it with a dictionary. We have seen that this will probably be too expensive. However, the problem as regards the Dutch language is not finite, because we make any compound word we want; we string words together without spaces, as is the case in certain other languages such as German.

This is not a finite problem and we have to do it by a logical process. We solved that problem and we tried our solution on 50,000 running words in normal Dutch text. We achieved 99.5 per cent accuracy. This means that 0.5 per cent had one wrong hyphenation. Most mistakes were made in words which were not Dutch but English or French. They often occur in Dutch text. The computer cannot see which language it is.

We use this hyphenating procedure in a justification programme. I will not go into the details because it must be similar to other programmes about which you have already heard. We can do pretty well anything we want. The programme is independent of the input codes and the output devices. We use a proportional-spaced typewriter. The typed text is then printed in offset. I have here a book which was produced in that way in a rather short time. It was an anniversary publication of the Dutch Computer Society. We did not make any corrections in it at all.

If you are really going to produce something like this, you have to make corrections afterwards. We counted 320 broken lines—words broken at the end of the line—and, of these, three were wrong. That is about 1 per cent. You get more mistakes this way than you do if you just take all the running words in the text, which as I said had a success percentage of 99.5, because you have to split the longer words, and those are the words in which mistakes are made more frequently.

We are going to use the same programme for a TTS machine. For a Braille printer, which is being installed in Delft, (Braille characters are rather large; there are only about 30 on a line, so you have to hyphenate frequently), the same programme will be used.

I do not want to say anything more about these programmes and how they work. You can read them if you wish because they are written in Algol 60.

This is a rather important point about which we feel very strongly. There was some controversy this morning as to whether you should use a general programme language or machine code. The advantages of a general programming language like Algol are clear. The programme can be written and read by the specialist in the field and not just by the man who knows the computer. The programme can be very easily changed. If you want to make any change, you can do so in a few minutes. The programme can work on any machine, provided it has a compiler for that language of course.

What are the advantages of the machine code? One could say that one advantage was for the computer-making industry, in that you have to stay with them. This is not an advantage for the users. Another advantage is one which Mr. Barber mentioned when he made a bet that any good machine code programme would work faster than a compiled general language programme. I think he would lose his bet! In regard to Algol, if you read the definition of it you will see somewhere that in an Algol text any machine code is permitted. The point I want to emphasize is that if you have a programme written in Algol and one procedure keeps coming back, like an output procedure, you can always write that procedure in your machine code. I do not think that it is really a question of having either symbolic language or a specific machine code language. You can use both of them and have the advantages of both of them. If you have a good Algol compiler, it should be able to compile Algol into the machine code, leaving the machine code parts of the programme undisturbed.

I would just like to add one further point about a programme

designed to lessen the work of the keyboard operator. This afternoon we talked about keyboarding problems. It seemed to me that it was generally assumed that each character needed one stroke. I do not think this is true. If you have a word like 'the' and a spacing, which occurs very often, you could replace this by 't' and a spacing. This would result in a gain of 50 per cent from four characters to two characters. The computer would very easily convert this again into 'the'. In other words, you could have a shorthand convention.

You might say that it is hard on the operator to have to learn this. If you pay her for the amount of characters which come out of the machine rather than the amount of characters she punches, I think she will feel it is worthwhile for her to learn this system!

Another possibility for this kind of system might be where you have difficult words to spell, like the name of the Russian Prime Minister, which is often mis-spelt, in our newspapers at least. In fact, I have seen two different spellings of 'Khrushchev' in your newspapers. If you used the letter 'K', the computer could expand this into the full name which, of course, would be spelt in the same way every time, so you will not have any mis-spellings.

Mr. J. T. HARRISON (Stephen Austin and Sons Ltd): I would like to ask Dr. Corstius whether he thinks there might be a danger in using the redundancy in a language which, in English, I believe, is 75 per cent. By using the significant part of this, you introduce the possibility of one error completely altering the sense of the whole text.

Dr. CORSTIUS: That is probably true. We would have to see whether it was too dangerous for our system. I do not know.

Mr. W. P. JASPERT (Print in Britain): On that particular problem I would say that most newspaper reporters write their copy and have their standard abbreviations in any case. Most compositors are used to it, so the computers could get used to it.

CHAIRMAN: I would now like to call on Mr. De Witt.

Friden's range of equipment

Mr. F. De WITT (Friden Inc. USA): I would like to tell you first a little bit about what Friden makes. The name Friden is associated traditionally with calculators and adding machines, but we do make other equipment. These are principally keyboards and tape-processing equipment.

The basic features of the keyboards are these: a heavy duty writing machine producing hard copy; an electric powered keyboard; one or more tape punches, punching up to eight channels (and these can, of course, be the advance sprocket hole or the in-

line sprocket hole, and they can be either a tape punch or an edge card punch); one or more tape readers, with the above features, and also a tab card reader. An add-punch 10-key keyboard is used by the New York Times to set the numerical part of the stock market. This numerical part is automatically merged with the names of the stocks on a Friden tape merger.

We get requests for many combinations of these pieces of equipment. We have the Flexowriter which is a writing machine controlled from tape and producing tape. We have a Justowriter which is a typesetting machine with a small justification computer built into it. We have the linecasting control Justowriter which punches tape for controlling Linotypes and Intertypes, and also some of the Photon models and the Intertype Fotomatic. We are just about to announce a new model of the linecasting control Justowriter which will handle the non-unit founts which are used in Europe and America. We have previously been limited to the unit founts which are used primarily by the American newspapers.

The use of separate punches and separate readers gives us various machines such as code converters, tape mergers and the tape editor. The tape editor is a device which will automatically add the thin space codes to linecasting control tape and it will also automatically delete lines which the operator wants deleted.

Although there seems to be some doubt as to how much time is saved by punching non-justified tape for computer use, we know that by punching tape, which is to be put through the tape editor—that is by punching tape in which the operator does not have to worry about thin spaces being added and does not have to worry about turning back the tape and rubbing out errors—we can save at least 25 per cent of the operator's time. This also results in a saving of possibly 10 per cent on the slug casting machine. This depends entirely on the number of rub-out codes which would have been in the tape if it had been set in the conventional manner.

We also combine an edge card punch and a printing punch with the Justowriter to produce a classified ad. system, so the classified ads. for offset newspapers can be manually sorted during the day, kept up to date and then at press time can be fed into the system, producing a tape which will operate our Justowriter reproducer.

I would also like to say that we have a linecasting control computer-input keyboard. This is a Justowriter which has been modified so that it does not put in any end-of-line codes, even though you do return the carriage at the end of the line. We

have also modified this machine so you do not even have to punch a key to return the carriage. When you reach a word space at the end of the carriage travel, the carriage automatically returns and the word space is punched in the tape. This is a separate non-justifying perforator. However, this same feature can be supplied in any of our linecasting control Justowriters. If customers have any doubt about whether their computer is always going to work, they can go back to the normal form of conventional typesetting.

I would like to emphasize again the tape editor, the savings in operator time and the increased production. A maximum increase in production is obtained through a minimum investment in extra equipment.

Mr. BOYD: I would like to ask Mr. De Witt, with regard to the automatic carriage return on the last word space, whether there is any possibility that the operator will beat this by getting another key down before it is back ready for him.

Mr. De WITT: I believe we would lock the keyboard out during the return.

Mr. DUNCAN: I would like to ask a supplementary, if I may. Has Mr. De Witt considered something like a two, three or four key store while the carriage is returning?

Mr. De WITT: No, we have not.

CHAIRMAN: Thank you very much, Mr. De Witt.

From data processing into print

Mr. M. SCHWARTZ (Alphanumeric Inc., USA): The sessions during the last two days created a great deal of discussion about proof reading; whether it could be accomplished by using computer output or whether graphic arts output was necessary. When high-speed photocomposition equipment is available, this argument will be purely academic. There have been differing opinions on this subject and my opinion is that proof reading is best accomplished when the output is in graphic arts form.

The state of the art in photocomposition to-day can be equated to the state the computer industry was in ten years ago where Flexowriters were the prime output devices. While the central processors operated at very high speeds, the entire electronic data processing system came to a screeching halt when information was fed out. To-day, central processors are in the order of one thousand times faster and output printers are over one hundred times faster. However, when applied to the graphic arts industry, the equivalent of Flexowriters as output devices is still being used because all the photocomposition equipment discussed to

date have been slow devices with speeds of only five to ten characters a second.

Alphanumeric is essentially a data-processing company presently doing systems analysis and programming in many varied areas. Computer operated typesetting services for the graphic arts industry happen to be one of the areas we are in, and which we hope will some day become our prime business. In this industry at present, we are still a service company without a service to sell, the main reason being that we do not have available to us suitable high-speed photocomposition equipment. Facing the problem of not being able to obtain equipment in the foreseeable future, we initiated a programme for the development of the type of equipment we considered ideal for the graphic arts industry. Most computer applications to-day are really simulations of manual operations. Our approach in intruding into the graphic arts industry was not to devise or develop new standards but to simulate the operation of both the typesetter and his typesetting equipment. Using the specifications of a Linotype machine, we investigated whether a digital computer with proper display equipment could simulate both the operation of the human being and the machine, and generate the kind of output at high speed which the machine was capable of doing. This investigation indicated positive results and from this we evolved a photocomposing system.

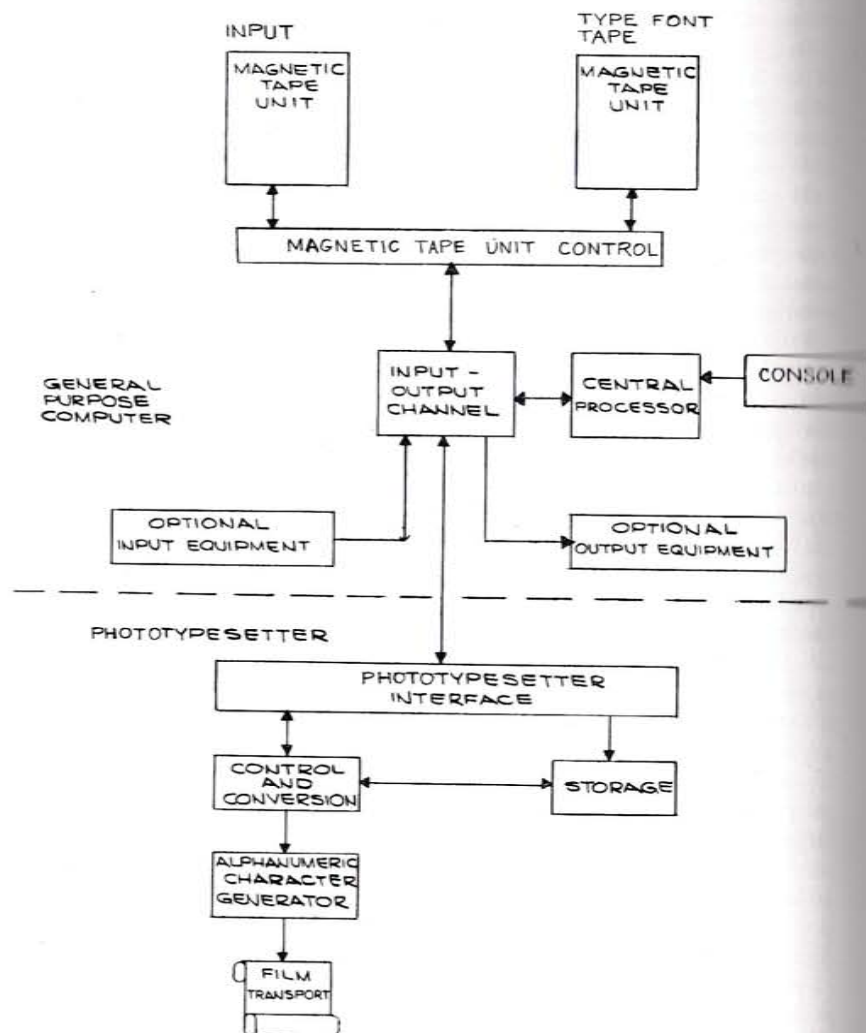
Our system is intended primarily to record alphanumeric data of high quality and of numerous formats on both film suitable for the making of photo offset plates and light sensitive paper suitable for the making of proof copy. Input information necessary to produce the recorded alphanumeric data can be supplied at high speeds by magnetic tape or by any other machine-readable means. Output copy is produced at speeds compatible with existing computer output speeds. An integral part of our system is a general purpose computer. Such a computer can be adapted easily and operates most economically when producing publications requiring the sorting and merging and editing of information. The computer is also used in the production of output in graphic arts quality and format when provided with a suitable output device to take the place of its normally available high-speed printer.

The phototypesetter we have designed requires an interface with the computer. With slight modifications to this interface unit it can be adapted to operate on line with many general purpose computers that have available input/output channels for the attachment of external devices. Type fount characters to be printed are previously coded and stored on magnetic tape

which acts as a slow access bulk storage medium. The handling of characters in this manner allows the user the capability of designing, coding, storing, copying, and generating type fount characters of any design or size without dependence upon the manufacturer.

In other words, our system does not use type of the kind printers have been accustomed to seeing or working with in the past. We do not have a photographic matrix. We take patterns or characters and subdivide them into many segments or little sections, separately coding each section. They are then stored as bulk storage on magnetic tape. When desired, they are recalled from their bulk storage media and used for the generation of type. In previous development, several display devices were considered. The one we are presently working with is a high resolution cathode ray tube.

Figure 1 is a simplified system block diagram of the photocomposer. The section above the dashed line is the general purpose computer with standard peripheral gear. Shown with the computer are only two magnetic tape units, although four might be more appropriate. One of the units shown is used to input the raw data to be typeset. The other tape unit (type fount tape) holds the coded information necessary for the making of the actual characters. One reel of high-density IBM magnetic tape can be used to store the equivalent of 700—90 character type founts. Once created, the cost of duplicating these 700 founts is \$50, including the price of the magnetic tape. The boxes labelled Optional Input/Output Equipment could be paper tape or punched card reading or writing units. Below the dashed line is the phototypesetter. It consists of an interface which behaves as a buffer allowing communication to and from the computer. The control and conversion unit controls the phototypesetter using information received from the computer. The storage unit is large enough to hold both the coded character which is being printed plus the next character to be printed. There is never any wait from the computer for accepting a character to be printed (i.e. printing is continuous). Character information is then directed to the character generator which produces a line of characters at a time. The maximum line length the system can accommodate is eight inches or 48 pica. Printed type can vary in size from six to fourteen points. The only movable element in the entire system is the film transport which moves the film at constant speed past the character generator. When film is in the proper position for printing, an entire line of information is scanned across the cathode ray tube and is directed to the film via an appropriate lens.



SIMPLIFIED SYSTEM BLOCK DIAGRAM
FIGURE 1

Figure 2 is a typical character slug representing a 12 point uppercase 'G'. A coding scheme is applied to this pattern, thereby digitizing it. The coding is quite efficient, needing less than 10 per cent of the information, as you see in the figure, to display this pattern.

In conclusion, I would like to mention some other specifications of our system. The computer itself can hold in rapid access storage over three type founts of 90 characters each. Any of these 270 characters can be intermixed on a line. A larger storage would make available more than three type founts. Composition speed can be measured by a character rate but it is best for us to measure it by page rate because the speed varies inversely with the character size. One 8" by 10" page with one character will take as long to produce as a page with 20,000 characters. When composing with six point characters, the output speed will be approximately 4,000 characters per second. It will be reduced to approximately 850 characters per second when printing fourteen point type. Substitution of a 90 character fount will take half a second.

The Alphanumeric Photocomposer is not a saleable item since we are not manufacturers. Our entire development budget is £50,000. We expect to have a system on line with the general purpose computer available to us by mid-1965. At that time we hope to transform our company into a photocomposition service company with services to sell to the printing and publishing industry.

CHAIRMAN: I will now ask Mr. Beaven to make a short statement on the NCR programme.

Mr. A. H. BEAVEN (National Cash Register Co. Ltd): I am attending this conference primarily as a member of Mr. Chadwick's team on coding and standardization, but one of my interests is programme research. Like Mr. Duncan, I hover over the battlefield in a helicopter. It occurred to me that you might forgive the intrusion of one more three-letter manufacturer into the conference. I suspect that manufacturers of computers have three-letter systems for reference because they can be justified but not hyphenated!

First of all, what I want to talk about very briefly is the computer system which we have installed in the United States in a newspaper office. I would then like to look at the picture in relation to Great Britain.

The Orlando project

We have an NCR 315 in Orlando, Florida. The people at

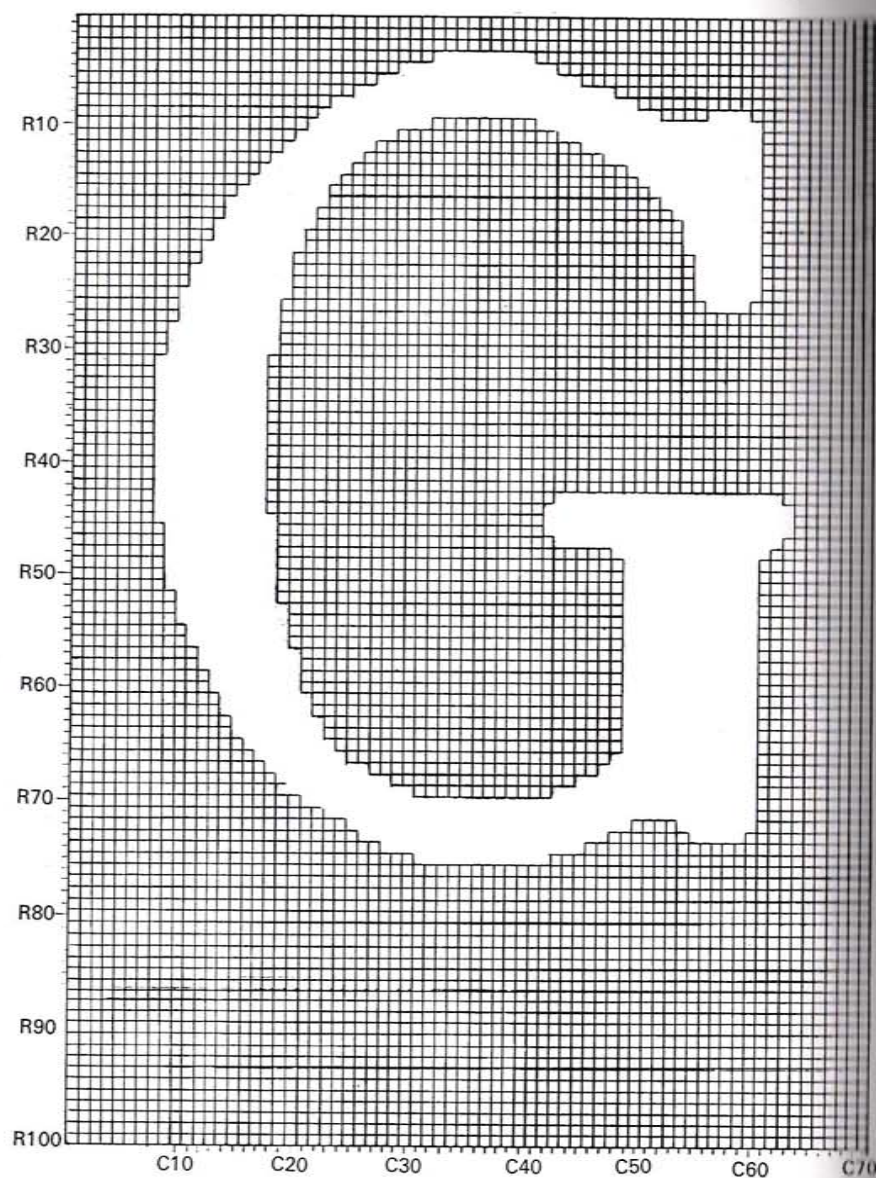


FIG. 2.

Orlando Sentinel Star claim to be setting more editorial copy by computer, as distinct from classified ads, than any other newspaper. I am not in a position to comment on the accuracy of this. At present the only job being done on the 315 is editorial copy. They are also running a pilot scheme for doing general accounting and payroll. In the light of what was said earlier in the conference, my own feeling is that a general purpose computer, which is suitable for the bread-and-butter accountancy of any company, will be more than adequate for what is needed for typesetting. The reason for this is that the 315 programme as it exists at present does hyphenation and justification by logical means only with 94-95 per cent success—that is, of hyphenating which takes place. The actual part of the computer which does this is the memory only, the paper tape reader and the paper tape punch; the correct copy comes out on a high-speed line printer.

The accounting side of the operation needs magnetic backing store, and we are looking into systems of dictionary look-up using the device, which I referred to earlier on, called the CRAM magnetic storage unit. This is a random access device which treats strips of magnetic card as temporary drum surfaces. We can, if we are pushed, store the whole of the big Webster in one CRAM deck with the hyphenation points; in practice one would use two. Even so, the accounting department need two, three or possibly four CRAM handlers for their sort of work; so there is plenty of capacity in the system.

Very briefly, I would like to turn to general programming languages. It is very important that people should recognize the value of these programming languages. Manufacturers generally, and NCR in particular, are committed to such languages. Our present range of computers, and those we market in association with Elliott-Automation in this country, cover a fair number of recognized programming languages such as Algol, Fortran, and so on. These languages have their merits and they have their demerits. However, the main thing about them is that they do allow the non-computer expert to get some practice in writing programmes. It may well be that certain parts of them are less efficient. They are useful as a start. My own feeling is that, with regard to the shortage of programming talent, manufacturers will be grateful if we can find suitable material in redundant compositors as programmers.

There have been a number of conferences proving that over the next 20 years we shall be very short of computer programmers. If we can make some use of people who would not otherwise have turned into programmers, we shall have achieved a

great advantage. However, there is one point: general purpose languages are no more fixed in their design than the design of computers. All languages are constantly being improved, added to, altered and modified. The intention, however, is that they should be modified in such a way that they are compatible upwards. If you write in Algol 60, by the time Algol 65 or 66 comes out, the Algol 60 programmes will continue to be compilable on the new system, though obviously not in reverse; otherwise there would be no progress. This is a very important point to the user. Do not have an auto-code which is not compatible upwards, otherwise you will be as stuck with the general purpose programme as you would be with a special purpose one. However, special purpose programmes are useful, since there are other fields in which a lot of work is being done with machine-orientated languages, or special purpose assemblers.

On the point about general purpose versus special purpose computers, I am relieved to find that a special purpose computer may well cost you more than a small general purpose computer which will do exactly the same sort of job as well as doing other things. The general purpose manufacturer has a place here just as much as the special purpose manufacturer.

CHAIRMAN: Last, but not least, Mr. Bafour has a short paper to present.

Pioneering in France

Mr. G. BAFOUR (L'Imprimerie Nationale, France): Mr. Duncan had the courtesy to suggest to Mr. Grunberger and myself that I might say a few words to you.

I thank him very much for that suggestion. It gives me the opportunity to recall that, in 1954, a French team—Messrs. Raymond, Blanchard and myself (the initials B.B.R.)—patented a system for using computers in the field of automatic typesetting of text.

In 1958, experiments, the results of which were published at the time and which have been recalled by Mr. Duncan in the Penrose Annual, were carried out using a computer of the *Société d'Electronique et d'Automatisme*. The output tapes were fed into the Intertype casters of the *Imprimerie Nationale*, equipped with Fairchild readers and control units.

The computer received two tapes, one of them for the unjustified and unhyphenated text, and the other for corrections and also for general instructions on layout and location and size of illustrations to be inserted in the text. It produced a six-level perforated tape in the TTS code. This tape was used, as I have

already said, to feed an Intertype model, F.4., with double distribution, including italic and bold faces.

Since then our work has continued and now the *Compagnie Européenne d'Automatisme Electronique (CAE)* represented here by Mr. Grunberger, has taken up this work in which my contribution continues.

This firm, which is an affiliate both of the *Compagnie Générale de Télégraphie Sans Fil* and the Thompson-Ramo-Wooldridge Inc. for the common market countries, is now ready to supply a computer typesetting equipment, based on the CAE 510 computer.

The programming method of the CAE is to use logical rules to hyphenate words without any dictionary. The accuracy obtained for the French language is better than 99 per cent.

A double input and output will allow the computer, whenever necessary, to accomplish simultaneously two different tasks on independent texts.

The speed of each output is one hundred characters per second.

Studies are now being carried out to develop hyphenation programmes for the German and Italian languages.

As regards the English language, programmes have been developed by the Bunker-Ramo Corporation (part of Thompson-Ramo-Wooldridge).

CHAIRMAN: We have had an extremely full hour-and-a-half. I would like to thank, first of all, the speakers for their co-operation in packing so much into that time. I would also like to thank you as an audience for accepting so well the limitation of your sacred right to answer the speakers back!

Coding Standardization

CHAPTER 7

Coding Standardization

Chairman
Mr F Simmons

Speakers
Mr G Chadwick
Mr E G Cluff
Mr B Summerton
Mr A H Beaven

CHAIRMAN: I have very great pleasure this morning in introducing to you Mr. Chadwick of the BSI, who is going to talk to us on the standardization of codes. I am sure from what was said last night by one of his colleagues during the last few minutes of the session that we are in for a very interesting talk once again this morning. Mr. Chadwick has with him Mr. Cluff of ICT, Mr. Summerton of IBM, and Mr. Beaven of NCR. I have no doubt that the four of them will give us a good account of this particular subject.

Groundwork by BSI

Mr. G. CHADWICK (BSI): In case delegates are wondering why some Standards representatives are present at the conference, it is because Mr. Duncan had written to me late in April telling me of the development of computer typesetting processes and suggesting it would be an advantage to establish some standards fairly quickly. Throughout May, international technical meetings in New York discussed coding, among other things, and Mr. Duncan had asked if the Standards representatives would give some kind of report on the situation on their return to this country.

Work on data processing subjects began in BSI late in 1956 and the first committee was set up early in 1957. Late in 1959 the first Coding Standard was published. This was for the codes used on punched cards. Discussions on the coding on punched tape began late in 1957 and, after some 20 meetings and 4½ years' hard

work, B.S. 3480, dealing with the codes on punched tape, was published early in 1962, being the first in the world actually published on this subject. In June 1963, a Standard (B.S. 3635) dealing with the codes on punched tape for the numerical control of machine tools, was published. The codes in this later Standard were directly related to international work currently proceeding.

International deliberations began in Geneva in May 1961, and various technical committees were set up which have had several meetings since and have now produced a draft ISO (International Standards Organization) proposal for coding in 6 and 7 bit character sets. This looks like being generally accepted by all countries which embrace major data processing interests. When the international work started there were two main documents, one being the draft British Standard which was subsequently published, and the other, a proposed American Standard which became known as ASCII.

The data processing coding experts in this country, as in the other countries, were anxious that any agreement made should be international, yet at the same time they have realized that it is not possible for delegates to sit around an international table and speak in the name of their country unless national work has properly developed so that they can be briefed. As a consequence, national and international deliberations have proceeded side by side with many amendments to original documents. When the international 6 and 7 bit character sets have been promulgated, and if the United Kingdom is a party to the agreed document, it is intended to make the necessary amendments to the two existing British Coding Specifications.

It seems from what we have heard at this conference that the new technique of computer typesetting is likely to develop and catch on in this industry and we are of the opinion that you could use as a basis the BSI/ISO 6 and 7 bit codes. It appears that you do require more alphabets or rather more sets of alphabetical type faces than we have covered and you may require a larger repertoire of punctuation and diacritical signs, but these will not present insurmountable difficulties and all your requirements may well be covered by certain conventions which the colleagues who follow me will no doubt mention. Internationally, the committee which was called 'Numerical Control of Machine Tools' will in future deal with the Numerical Control of Industrial Processes and this is likely to happen nationally in the U.K. As I have already mentioned, we have done a separate specification giving the codes for the numerical control of machine tools which is one form of industrial process,

and it seems to me that typesetting by computer is another form. If we can get together to deal with this problem we in our BSI committee should, if necessary, be prepared to consider another coding specification dealing specifically with your requirements, but still allied to the basic 6 and 7 bit codes.

I have with me Messrs. Beaven of NCR, Cluff of ICT, and Summerton of IBM. All three companies are directly associated with our work and two of these gentlemen are active members of our coding committee and were with the United Kingdom delegation in New York. Their intention is to speak to you about the standardization problems from the point of view of committee members and I am now going to ask Mr. Cluff to take over from me for this purpose.

Mr. E. G. CLUFF (ICT): I believe you have already had more than one speaker from ICT this week. Therefore, I would like to make it clear at the beginning that I am not representing an ICT point of view on this subject; I am speaking here on behalf of the industry. I would like to explain what we are trying to do in standards work. You might find some small anomalies between what my ICT colleague said and what I will tell you this morning. In standards work we are looking to the future. My colleagues were talking about existing equipment.

Mr. Chadwick has already mentioned how we started this work in 1957. I recall that one of the first jobs I did in that committee was to prepare a list of all the different codes used by the computers in the United Kingdom at that time. We were rather thicker on the ground in 1957 than we are now. For every computer there was a different code and a different character set. It is true that in those days we were working only on a five-track paper tape code, five bits, which has limitations, some of which you already know, but this created considerable difficulties for the industry and for the users, particularly if a user wanted to take some information from one area and send it to another. We had to handle these difficulties and we were forced to handle each problem as unique. However, it was clearly a very inefficient way of working, and we tried to establish what the needs were for the industry. Through the years we have gradually led up to what is now a fairly firmly-established international code.

I know nothing about your industry, but I believe that you have some special requirements of which we in the computer industry, or in the standards side of the computer industry, may be unaware and have not taken into account. However, the important thing which we wish to convey to you to-day—Mr. Chadwick has already mentioned it—is that this code and character set on which we are working has gained international

acceptance. It is on this line and this theme that I want to develop my talk.

The five-track paper tape codes which were in use (even before 1957) for a great number of years, were those used by the British Post Office and by the international telegraphic system. Some of you may know about this type of code. It has limitations for the computer industry but was, in its time, perfectly adequate for telegraphic communications. It has, in particular, a limited repertoire.

As this work has developed, not only is it true to say that every participating country has accepted these new ideas, but the most important thing to my mind is that so far it has been found acceptable by the CCITT which is the international organization responsible for telecommunications. This means that in a few years—and we are starting now because some equipment is already becoming available which is working to this code—you will find all computers able to accept this code, and communications will be possible between different computers of different manufacture. Even across boundaries using the same code and character set, we hope and believe the international telegraphic system will be using this code where an expanded alphabet is required. I make that qualification because we do not want anybody to be led to assume that the CCITT is about to give up its existing No. 2 Alphabet. Although there are still many years life left in this, the expanded code will undoubtedly be used in a great number of areas.

One of the things which has led to the ready acceptance of this code is the fact that the American Government placed a very large order with an American company for equipment—teleprinter class equipment—working to this code with this character set, and such equipment is already being installed in the States. This will have a very significant effect upon world usage.

When we in the United Kingdom began to consider this coding question, most of the manufacturers were convinced that we ought to concentrate on what we call a six-bit code. Although I see some here who will be clear what I mean by a 'six-bit code', perhaps I ought to spend a moment or two explaining what we mean by this. A 'bit' is an abbreviation for a binary digit. There are 8 tracks across paper tape upon which we could put 8 bits, so that a bit could be likened to a representation of the presence or the absence of a signal. The CCITT or the international alphabet could be said to be a 5-bit code. We were talking in terms of 6-bits there, and here is the current 7-bit code. (Figure 1.)

One of the reasons why we were all concentrating at the time on a 6-bit code which, incidentally, gives you 64 combinations,

was that we felt that this was an economic question; we had to keep the cost down to the absolute minimum. However, the result of our co-operation with the Americans was that it became apparent that there was a great need to have 64 graphics in the code. This meant that if you wanted to take 64 graphics and send them to another place you must have more than 64 combinations, because you need controls in order to determine certain factors about the information you are sending. It was this viewpoint which led to the development of what is now the 7-bit code.

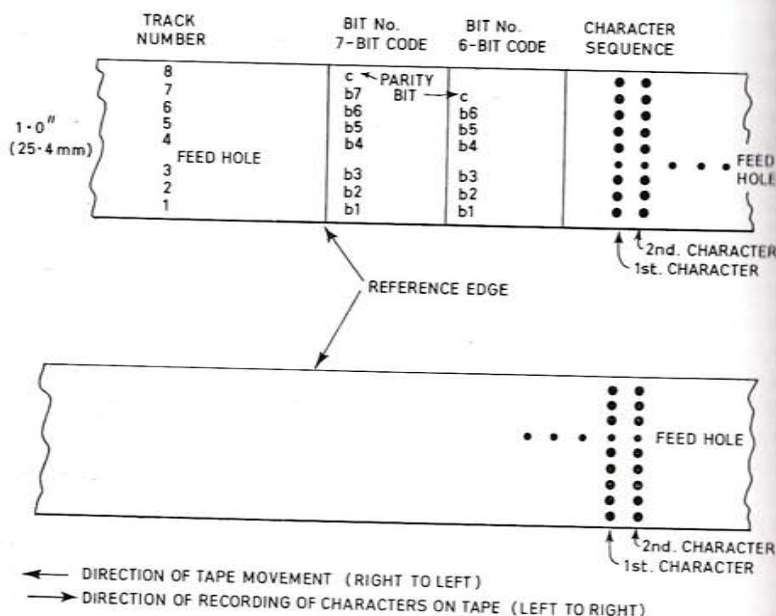


FIG. 1.

I would like to refer to our 7-bit code, as it arose from the New York meeting which took place in May this year. I did not have time to illustrate the 6-bit code, but it is very similar as far as the centre four columns are concerned and was intended to be compatible. It is not as compatible to-day as it was. It is my personal belief that it is this 7-bit code which we will be living with for the next 20 years. Although there will still be some interest clinging to the 6-bit code, I do not think this is going to have such a significant effect upon the work as the 7-bit code.

I think it would be a waste of your time for me to go through the whole of this code and explain what it is all about. I will point to some of the salient features of the table and then invite

questions if some of you have queries on points with which I have not dealt.

You will notice that we have the graphics in the four centre columns, upper case alphabet, numerals and the most important symbols which we have all agreed are necessary. In the closing minutes of yesterday afternoon I spoke about taking into account keyboard requirements. It is that which determines the positions of some of these because, when you try and place these graphics on a keyboard, it is common practice to pair certain characters together. Many of these symbols have been commonly paired in many devices with associated numerals. That is one of the things we had to take into account. I have included 10d. and 11d. to show that sterling is catered for, but with the advent of decimal currency I think we can forget about it and we shall be left with the colon and the semi-colon.

International problems

One important aspect is that we have reserved certain positions for national usage. Where national characters such as those used in the Scandinavian countries are not required, the preferred symbols are shown in parentheses; we have left-hand square bracket, right-hand square bracket, and a currency sign No. 2.

In order to have an international code, we in the United Kingdom have to recognize that people on the Continent do use accents. This was referred to on more than one occasion yesterday. What we will be doing for international communications is to have a convention whereby a lower case 'e' with an accent will be provided by the following convention of 'e' 'backspace' 'accent'. That will produce the accented 'e'. This is for international communications across boundaries. Within a particular country, in order to avoid this type of convention of non-productive key strokes, to which reference has been made, there will be the possibility in the national usage areas of 'e' with an accent already associated with it by a single key stroke, but we cannot standardize these internationally; though France may want accented 'e', Germany may not; they may want 'o' with an 'umlaut'. Although I am not saying what particular national graphics will go in there, I want to indicate that we have catered for two classes of work: first, the international communications where you will use this convention so that France may communicate with Portugal, Germany and various other countries who want accented letters; secondly, within the country where you can avoid this convention ('e backspace accent') and short-cut to accented letters.

I will run down the controls before I finish and invite questions. These controls here (indicating Column 0 in Figure 2) are what we call 'Format Effectors'. They are of interest to you in connection with the laying out of information in printed form; BS—backspace, HT—horizontal tabulate, LF—line feed, VT—vertical tabulate, FF—form feed. Vertical tabulate is different from form feed inasmuch as it goes to a predetermined point on the same page, whereas form feed goes to the first position on the next page. CR is carriage return, SO is shift out and SI shift in.

One of the most important aspects of this code is that it does avoid the non-productive key strokes which were spoken of yesterday. As distinct from the international telegraphic alphabet No. 2 where you have to have shift operations between numerals and letters, this not only has numerals and letters in the one shift but it also has the lower case too. This does not mean to say that you can avoid an additional key stroke on typewriters which are in any case limited to 44 printing keys, but appearing in paper tape there would be only a single character. These controls are important, and in view of what was said yesterday I realize that they appear to fit your industry very well. However, I think it would be dangerous to use these purely for your industry because these are transmission controls which have been developed so as to allow communication throughout the world. SOH is start of heading, STX is start of text, ETX is end of text, EOT is end of transmission, ENQ is enquiry. Nack is negative acknowledge and Ack is acknowledge. However, if you tried to use these inside your industry for your own purposes and then, in addition, tried to communicate via a transmission system you would, of course, run into a number of problems.

In conclusion, I would just like to make passing reference to the implementation of the abstract code to show you how we have agreed so far to lay this out in paper tape. This represents 1" paper tape, which is in common use, with 8 possible tracks. In Fig. 2 the first 4 tracks are shown as bit 1 to bit 4, which gives a binary representation of 0-15 for the vertical axis of the code table, whilst bits 5, 6 and 7 laid out on tracks 5, 6 and 7 provide 8 combinations for the 8 columns horizontally. Parity would be placed in track 8, punching a hole where necessary to make the total number of holes in any row even.

Mr. B. SUMMERTON (IBM): First of all, I would like to reiterate Mr. Cluff's remark, in that I am not here as a company representative but as a representative of the BSI committee.

I would like to say that concurrent with the meetings in New York there were further meetings on the numerical control of

machine tools and they, in fact, looked at this type of code. I would imagine that their problems are similar to yours; they are trying to fit a data-processing, data-communication code into their own particular environment—that is, machine tool control. I consider typesetting as another of these requirements. It was agreed—Mr. Chadwick can correct me on this if I am wrong

	0	1	2	3	4	5	6	7
0	(TC ₀) Null	(TC ₇) DLE	Space	0	—	P	(a) ③	p
1	(TC ₁) SOH	DC ₁	!	1	A	Q	a	q
2	(TC ₂) STX	DC ₂	" ⑥	2	B	R	b	r
3	(TC ₃) ETX	DC ₃	# ⑥	3	C	S	c	s
4	(TC ₄) EOT	DC ₄ (Stop)	CS ₁ ⑤	4	D	T	d	t
5	(TC ₅) ENQ	(TC ₈) NACK	%	5	E	U	e	u
6	(TC ₆) Ack	(TC ₉) Sync	&	6	F	V	f	v
7	Bell	(TC ₁₀) ETB	' ⑥	7	G	W	g	w
8	FE ₀ (BS)	CNCL	(	8	H	X	h	x
9	FE ₁ (HT)	EM	)	9	I	Y	i	y
10	FE ₂ (LF) ①	SS	* : ②	J	Z	j	z	③
11	FE ₃ (VT)	ESC	+ ; ②	K	(L) ③	k	l	③
12	FE ₄ (FF)	IS ₄ (FS)	, <	L	(CS ₂) ③	l	③	③
13	FE ₅ (CR) ①	IS ₃ (GS)	=	M	(J) ③	m	③	③
14	SO	IS ₂ (RS)	.	>	N	^ ⑦ ⑧	n	③
15	SI	IS ₁ (US)	/	?	O	`	o	De.

FIG. 2.

because I was not at these meetings—that the numerical control people would take this code, look at it and try to fit their requirements into it as far as possible. In other words, they would take the alphas and the numerics. Maybe they do not need all the controls which the data transmission people need. They would modify the code in these areas only.

I would appeal to all those interested in typesetting to make

their requirements known as soon as possible in order that you may have at least the same opportunity as the numeric control people of arranging your code.

Mr. CHADWICK: I would like to add a comment on this question of the numerical control of machine tools. It is important from your point of view. The numerical control of machine tool coding started life as an offshoot of the normal international coding committee. When we met in New York this time it suddenly changed its substance, and in future it is going to deal with the numerical control of industrial processes, which is a much wider field. When we decided to do a separate coding exercise for the numerical control of machine tools, we in this country produced a new and separate British Standard. We anticipated the international work, saying to ourselves, 'This is what will probably be in the international document.' However, it was not, and the subject is still under review. It is pretty certain, however, that it will be based on the 7-bit character set which Mr. Cluff has shown you and, when it is completed, we shall make the necessary amendments to the British Standard.

What I am indicating is that we are quite prepared in our British Standards committee to deal with the coding problems of any industry on the basis of the numerical control of industrial processes; yours will be an industrial process.

Questions on codes

Mr. C. T. ROSS (Computaprint Ltd): Is this code published?

Mr. CHADWICK: It is only in draft form at present, as used at the New York meetings. We are waiting for the international secretariat to prepare a draft for voting purposes. There are two existing British Standards—B.S. 3480 and 3635, but they do not give the code as shown and will be amended later. Internationally speaking, it may be some eighteen months before it is published. The moment we are certain what the final form is going to be, we shall amend our standards without waiting for the international document to be published.

Mr. A. H. PHILLIPS (HMSO): Could you tell us what the second row of controls are on the 7-bit code? (Column 1 of 7-bit code.) They do not mean anything to me.

Mr. CLUFF: These are device controls for controlling such things as remote punches and readers. This one (TC7 DLE) is a transmission control, data link escape, and will be used for extending transmission controls generally. 'Nack' is a negative acknowledge, another transmission control. 'Sync' is synchronous

idle, which is in connection with data transmission again. 'ETB' is end of transmission block. 'CNCL' is cancel. This was referred to yesterday by someone who called it 'delete'. 'Delete' is 'Del' and is used in paper tape for the over-punching of a character in error. However, 'Del' is not the same as 'CNCL'. 'CNCL' means cancelling all the information back to a certain point. It might be that line, that sentence, or anything you like to define. 'EM' is end of medium. I do not think I want to say too much about that or 'SS' which is start of special sequence. 'ESC' is escape. It is the means of escape out of one code into some other code or it might be escape into some other character repertoire. One of the things we have discussed but not formalized is that you might use this if you wanted some new strange alphabet. 'Escape' could be used, for instance, on its own or in conjunction with a number so that you could escape into Alphabet N. 7 which you might have invented. This will be for private usage and not part of the standard. 'FS', 'GS', 'RS' and 'US' are information separators; file separator, group separator, record separator and unit separator. These are used frequently within data processing but do have possibly some significance in your area.

Mr. E. FORBES (U.S. Government Printing Office): I would like to comment on the character 'Escape'. I think that it has a special significance for the printer because we are thinking in terms of 256. You can arrange them according to the probability that you have, within the first 64 or 88 or 120, the ones which are going to be used most frequently. The use of the code 'Escape' would mean you could repeat the entire block of 128.

Mr. CHADWICK: This 'Escape' is a vital and very interesting character in this set. It originally arose because agreement on the characters, both controls and graphics, was difficult to reach. One trouble was the limited number of positions available in a 7-bit set. Many people required certain characters or controls for which there was no room. So 'Escape' was brought in to solve the problem. You use the normal code up to the point where you really require to introduce your own special characters—you encode 'Escape' and from then on you can use your private characters. It is a character which allows you to say you are using the standard code when in fact (maybe only temporarily) you really are not. It is the sort of trickery which the state of the art forces us to use occasionally.

Mr. R. A. FREIMAN (Random House, Inc): Let us pretend you had about 450 characters to represent. What trickery would you use to give that?

Mr. CHADWICK: For 450 different characters you might have to devise a code and use 'Escape' to introduce it.

Mr. FREIMAN: Is there no possibility of using a double or triple one? By using 8 twice you get 16, do you not? Am I right in assuming that 3 times 8 would give you 24? Or would you follow a simpler procedure? With the Lumitype you say that 9 times 8 equals 16. Could we do this four times and six times in order to produce as many as 450 variations?

Mr. SUMMERTON: There are facilities in this code for escaping here with the 'Escape' and there are facilities for shifting. The difference between the escape and the shift is that the shifting certainly applies to a sequence of characters where it is known by which character you return. In other words, all the time you are in the shift-out mode you are always looking for this code shift-in to return to this code. The escape is a much more powerful thing and, therefore, a much more dangerous function to use. However, once you have escaped there is no reason why you cannot escape, and escape, and escape again. Mr. Cluff has mentioned that possibly the code for escape on one track of the tape followed by a number of the next track would indicate the code to which you are escaping. On 8-track tape, depending on whether you use parity or not, you have 128 or 256 and the possibility of getting 400. A couple of escapes, an escape to an escape, would be sufficient.

While I am on my feet I would like to explain more closely, from an international point of view, the special international symbols which are not really required all that much by us in the United Kingdom. There is a symbol on this code which has a dual meaning—diaeresis and double quote sign. There is a symbol which has a double meaning—acute accent and apostrophe. There are symbols which normally carry the meaning of circumflex, but it is felt that certain countries may want to call that *tilde*, like the Spanish and Portuguese countries in Europe and South America. This other symbol is the *grave* accent. There we have five main diacritical signs, as we call them. There are certain areas, as Mr. Cluff has mentioned, which are referred to as national use areas and where the French, for instance, can put five lower case accented characters. I know they have more than that; I believe they have about a dozen. If one looks at a French typewriter it has about five accented characters and a couple of diacritical signs, and these allow them to present their full lower case repertoire.

With these comments from an international point of view, I think we are catering for the Roman-based alphabets.

With regard to the Japanese alphabets—the Katakana Kanji—and some of the Middle Eastern languages, they have to adopt an escape or a shift philosophy. They have a completely different

alphabet. The Japanese Katakana consists of 40-50 characters, so they have to escape into these other alphabets.

CHAIRMAN: I would now like to ask Mr. Beaven to say a few words.

Mr. A. BEAVEN (National Cash Register Co. Ltd): First of all, I would like to say that I have in the past been rather cynical about codes. Meetings to standardize codes have usually resulted in one more code for the manufacturer to consider. However, the important part of this—and the most important part from my point of view—is the necessity for standardization for data interchange. In the European Computer Manufacturers' Association we have done quite a lot of work on this, and this 7-bit code is going to be valuable for interchange of information, whether data or programmes. The important point here is that if you are going to interchange you must be very careful about these 'Escape' things. If you define with your correspondent what you mean by 'Escape', and that is what he wants, then you are all right. You can have your specials and you are communicating completely. If, however, you have someone who is using it for a different purpose and his characters which follow the escape are different, you will not be able to communicate in that part of the message which follows this, but you will be able to communicate, and quite well, over the rest of it.

The other thing—and Mr. Cluff has touched on this—is that the implementation of this is a very hefty problem. The important part for the printing industry is implementing in paper tape, but work is being done on implementing this for punched cards and magnetic tape. Therefore, in fact, you will have a consistent implementation, we hope, through all the media in which you can represent this code.

Mr. FREIMAN: We have heard 8-bit and 7-bit mentioned. What do you think it will be?

Mr. SUMMERTON: From the point of view of through-put time, one wants to have an acceptable character-set with a minimum number of bits. From the communication point of view, certainly the United States are going this way; they have gone to 7-bits. Certain European countries have gone to 6-bits. I think this could well change.

CHAIRMAN: Thank you very much. Before we close this session, I would like to express, on your behalf, our appreciation to Mr. Chadwick and his colleagues for a very interesting session.

High Speed Photo Composing Systems

CHAPTER 8

High Speed Photo Composing Systems

Chairman
Mr G S Allen

Speakers
Mr V M Corrado
Mr R Higonnet

CHAIRMAN: We are now approaching the end of the conference and we have reached the stage where we have the last two papers. These papers are both on very high-speed photo-composing systems. Mr. Corrado is going to talk first and he will be followed by Mr. Higonnet after we have had a discussion on the first paper.

Mr. Corrado has been responsible for the initiation and development of the Linotron equipment, and he has come over from America especially to tell us about it this morning.

The Linotron system

Mr. V. M. CORRADO (Mergenthaler Linotype Company): Before we go into the details of how Linotron works and what it looks like, I would like to spend a few moments briefly going over the history that led to the development of the Linotron. Mergenthaler's interest in electronic typesetting really goes back to 1946, when they built a closed-loop television system to do typesetting. When I joined the Company in 1949, as a junior engineer, part of my responsibility was to help evaluate what we had on the laboratory benches. The conclusion of our evaluation was that photo-typesetting using video techniques was not practical at that time, principally because the resolution and illumination capabilities of cathode-ray tubes were such that characters of acceptable quality could not be produced on standard photographic material. So we shelved that development programme and said, 'Let's see what else we can do to get photo-typesetting on the road.' Now at that time neither we nor the rest of the industry were thinking about very high-speed phototype-

setting; we were looking for phototypesetting at the more usual speeds. We went to the optical-mechanical approach; and, to make this part of the story short, you all know that we came up with Linofilm which reached the public about 1956. Its speed (twelve characters per second), although adequate for the applications for which it was designed, is slow compared with the speeds we are designing into Linotron.

Around the middle of the 1950s, everybody started using electronic data-processing machines, and a tremendous amount of useful data in both the scientific and industrial fields was produced. The United States Air Force, which had several problems in the data-processing field, asked that somebody carry out a study and produce a design specification for what they called a lexical-graphical composer-printer. By this they meant a device that would set justified text, not only by line but by page, and also insert illustrations.

The contract also called for a study of techniques that were not being used by the graphic arts industry but that might have application. One of these was what we have come to call the video approach. We talked to several companies, amongst which was Columbia Broadcasting System Laboratories in Stamford, Connecticut. We were delighted to find that the resolution capabilities and illumination intensities of one of their cathode-ray tubes were such that the tube could be used in the development of a graphic arts machine.

As we thought more about this cathode-ray tube and its graphic arts capabilities, we began to think more in terms of a systems concept. One of the first things we thought about was area composition. If we had a machine that could not only justify and hyphenate a line but could also justify the column and leave space for the insertion of illustrations, we would be automating many of the tasks of this whole system. This led us to insist on an area-composition approach.

In our discussion with the CBS we said, 'What are the basic machine requirements?' The output, as I have just said, must be in the form of area composition and obviously you must use standard photographic material. As regards the input, I have said enough about data-processing machines to indicate that the equipment must be compatible with the output of electronic data-processing machines. This means that we are talking about a machine capable of 1,000 characters per second. I have heard during the week of throughput speeds for computers from 100 to 225 and possibly 300 characters per second. This is true for the smaller computers. However, our studies of the larger systems—the 1410, 7080, and the new IBM360—show that throughput

speeds for area composition and complete make-up of the pages can be 1,000 to 2,000 characters per second.

Then, of course, there is the question of quality. If Mergenthaler is going to build a machine it has to have graphic arts quality. The type founts must be readily replaceable. Because of the high speed of the machine, we should have job set availability—it should not be necessary to change the character grid frequently during a job.

In laying out the specification for the Linotron, we tried to incorporate all these requirements.

The output should be on photographic film or paper.

The composition size would be 8" by 10½". We should also be able to do continuous listing of 10½" wide material.

The input should be magnetic tape because of the speed. The quality of the machine must be between that of Linotype and Linofilm. When I say this, I am referring to the comparison of the photographic film output of Linofilm with a reproduction proof copy of Linotype.

The type fount will be a 3" by 3" character grid. There will be 256 characters for the job set. This is about the maximum number that is practical from the technical viewpoint.

The type sizes will run from 5 to 18 points. I have chosen 5, 6, 7, 8, 10, 12, 14, and 18. Actually they can be any whole-number point sizes in that range.

As regards the speed, 5 point type will be set at 1,100 characters per second and 18 point type will be set at 250 characters per second. The variation is due to the variation in the number of scanning lines you need to do your logic. A significant point is that effectively you get the same number of pages per minute regardless of the point size. On a normal page, this would be between 8 and 10 pages a minute, 8" by 10½" area.

Figure 1 is a schematic view of the system. There is the character generator section, the display and the control. There is a grating system, which is used both as counting device and as a servo system to permit exact character alignment. I will go into that in a little more detail later. The display has a film magazine. It is very simply shown in Fig. 1 and is a relatively simple device, because we place film in front of the display tube and it stays there until we have composed the whole page. Therefore, all you need is a mechanism that can advance the film at the rate of 8½" in half a second. You have to have a vacuum platen to hold the film flat, and input and output cassettes that will hold 500' of film material up to 11" or 12" wide. The input magnetic tape unit and conventional magnetic tape are purchased from an outside supplier. The purpose of the magnetic tape is to supply

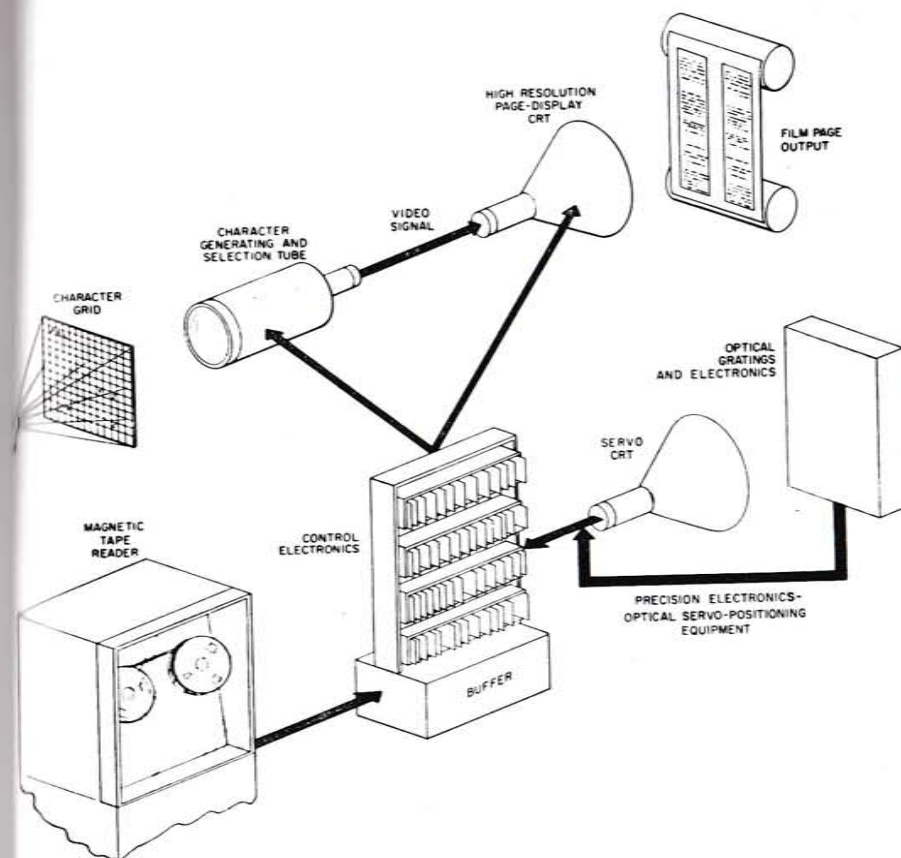


FIG. 1.

the information for the system. What it does is to read blocks of information into the buffer. The buffer will hold approximately 2,000 characters and the machine control codes. The control electronics selects a character, converts it into a video signal, and then transmits it over to the display tube and simultaneously scans out that character in its right position in relation to the other characters which fall on that page.

Figure 2 shows the character grid for the Linotron. You may recognize the metal frame on the outside. It is the same frame that we use in a Linofilm. The frame is about 4½" on the side. The useful area of the characters, as I mentioned before, is approximately 3" by 3". We have placed on that grid not 88 characters, as in Linofilm, but 256 characters. We have also put

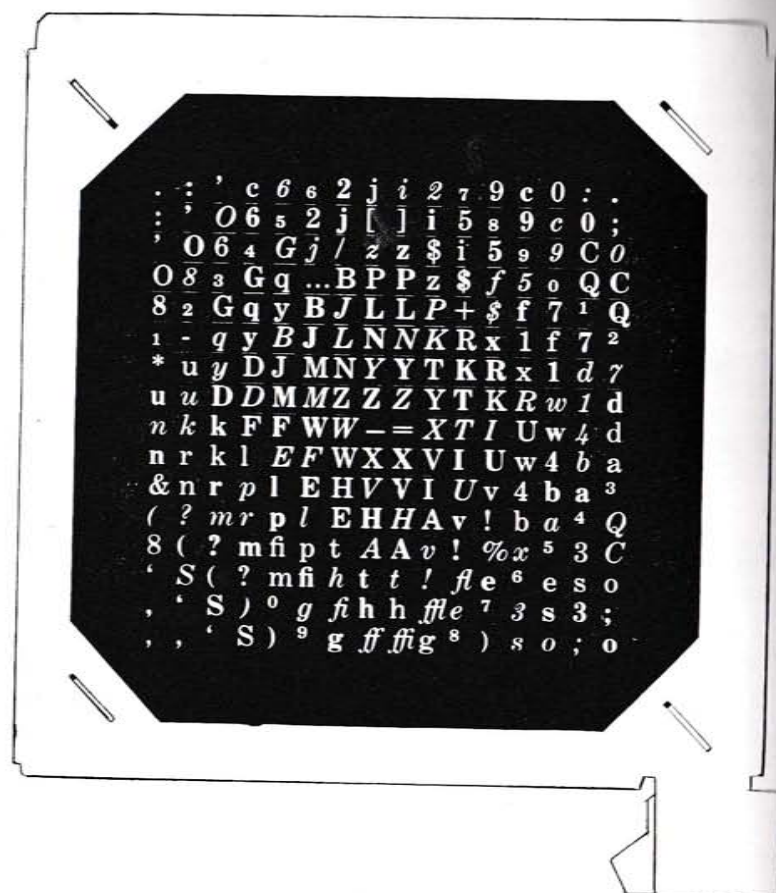


FIG. 2.

the width information underneath each character in the form of a row of dots that can represent any character width between 4 and 18 units, as in Monotype or Linofilm. The size of the character on the grid is 12 points; the other character sizes are obtained by minifying or magnifying electronically in the control system. These character grids are interchangeable, and the problem of getting new type faces is no greater than getting new type faces on Linofilm.

Figure 3 gives a more detailed picture of the character generator. This has been the most significant part of the development of the Linotron system: a character generator that would truly reproduce in graphic arts form any character from a reasonable grid source. The light source passes through the condensing

optics to gather as much light as possible to illuminate the back surface of the character grid. All the characters are then imaged optically on the photo cathode, which is the first element of the Linotron tube. The purpose of the photo cathode is to convert the light energy that impinges upon it into electrons. It emits electrons. Consequently you get an electron image or the makings of an electron image. These electrons are then accelerated down the tube and are imaged on the back surface of an aperture plate. This plate consists of 256 holes, each one thousandth of an inch

CHARACTER GENERATOR

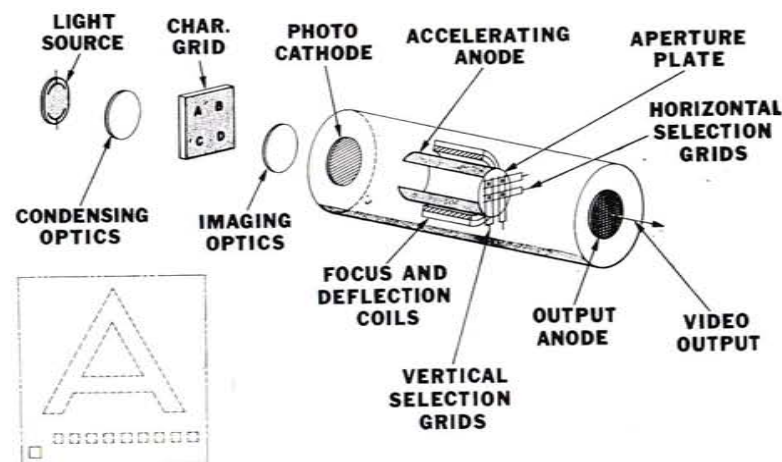


FIG. 3.

square. Immediately in front of the aperture plate we have a series of horizontal and vertical selection grids. Their purpose is to apply the appropriate voltage to one horizontal grid and one vertical grid to allow the stream of electrons from that character and only that character to pass through the output anode into the remainder of the system. The 'A' at the side of Figure 3 helps to show what is going on here. The dotted character and the dotted squares represent the electron image that is hitting the back surface of the aperture plate. The solid line square is the aperture in the plate. Visualize this square travelling from right to left, and at each pass it moves down approximately one-thousandth of an inch. You can see then that, as the character passes that hole, it is being dissected and converted into a video signal. What we are doing is converting this optical image into an electron image. We are taking all these 256 characters and

subjecting them to this dissection. Then, disregarding all the other 255, we are selecting one of them and passing it as a video signal.

Figure 4 shows a schematic diagram of the display and servo end of the machine. The top portion is the cathode-ray tube and its associated film magazine, where we actually display the characters and photograph them on the output material. The lower system is an identical system with an identical cathode-ray tube. However, at the other end we have a grating. This grating

LINOTRON DISPLAY AND SERVO SYSTEM

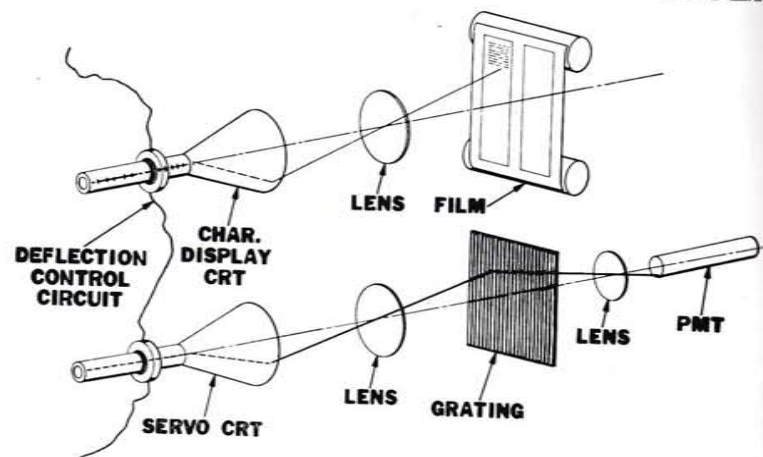


FIG. 4.

assembly consists of transparent and opaque lines with a photo multiplier tube in the back. There is also a vertical grating, which is not shown. The purpose of these gratings is to eliminate any character misalignment. You are all familiar with your own television sets, where sometimes things look fuzzy and out of place over in the corners of the tube; this system eliminates that.

The best way to describe the machine is to describe how we would operate it. Here is essentially what we do. The magnetic tape has a signal which says it wants the first character to be scanned out—so many units from the left hand side of the page and so many units down from the top. This number is entered in a register, and the register then waits for a number of pulses to be generated by the photomultiplier tube. The current that operates this deflection coil will start moving the beam, and that

beam then is imaged on the grating that has the horizontal lines.

As the spot crosses the grating lines, the light is interrupted. A photomultiplier counts the number of times that it is interrupted. When the number of interruptions equals the number that was put in by the magnetic tape, you know that you are in the right horizontal position and the right vertical position. This method ensures squareness over the entire page area.

Now, where does all of this go? The control current, which passes through the servo tube deflection coil, also passes through the deflection coil of the character display tube. Consequently, the one beam is going to follow the other precisely.

We have talked about the basic machine. There are some additional features that can be added to the machine, for instance a 10-level code to make it possible to use the Honeywell 800 Computer system. A second possibility is an optical overlay format feature. By that, we mean a slide-projector device arranged so that the slides can be projected directly on to the film. We can also provide horizontal and vertical line rule generation. The tape would specify an 'X' and 'Y' co-ordinate, and the beam would draw a line from there to a stopping point. We can provide an automatic error check, whereby at the end of each page the machine automatically cycles itself to check its maximum horizontal and vertical deflection. It takes a character, moves it as far to the right as possible, and moves it down as far as possible. It is projected through a go and no-go gauge, and the light transmission measured. This checks illumination level as well as vertical and horizontal deflection.

It is also interesting to note that you can get a 5,000 or 10,000 character-per-second speed out of this machine if you uncouple the servo. This does not reduce character quality. However, you do not get the alignment which most typographers and printers want. This feature could be used for rapid production of a proof copy. It is also possible to add a mechanical grid changer to the device. This will provide four grids on a ring, and will rotate any of them into position upon receipt of the proper control signal from the tape.

Last, but not least, is the turn-page function. This allows us not only to set 8" by 10½" but 10½" by 8". This is also done by simple control. It is merely necessary to switch the horizontal and vertical deflection circuits.

Let me point out another advantage of area composition at this point. Here are two different type faces—Roman and Bold face. This could be a dictionary page, where you have several fount changes on a line, maybe three or four. With existing

machines, it is rather difficult to do this effectively because of the time needed for the frequent grid changes that are necessary. However, with area composition the number of fount changes on a page is reduced to the number of founts that you have on a page minus one. Therefore you can first set all the Roman on a page, then perform a single grid change and set all the Bold. I am sure

PAGE FORMATS

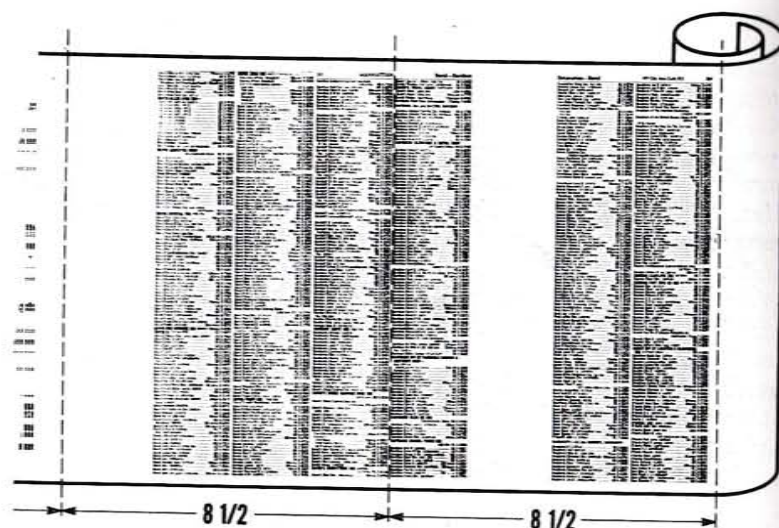


FIG. 5.

the computer people here will agree that this is not too difficult a task for a computer sub-routine.

Figure 5 shows a page from a Manhattan telephone directory. You can see that even though the format is greater than 8" by 10 $\frac{1}{2}$ ", it can be handled in several pieces. We can do the first three columns, advance the film, do the fourth column, and then do the first two columns of the next page. Let me also point out that this method simplifies the task of the computer. You will notice that we can still follow the natural order of alphabetic listing. We do not have to follow the first listing of the first column by the first of the second column and the latter by the first of the third column and so forth—a prodigious problem for the computer.

I have listed here some of the limitations of existing typesetting systems and the way Linotron can solve some of these problems. A major disadvantage of computer print-out is its poor legibility, and its low information density. Let me cite an example. The U.S. Air Force prints something like a billion and a half pages from computer print-out just in the one area of its stock list catalogues. (I refer here to American billions—10⁹, not 10¹².) We have found that we can pack three times as much information on a page if we use Linotron typography, which gives quite a saving: more than the cost of the machine!

The next area is book printing. Proof copy make-up is, apparently, very expensive and time consuming, and everyone gets angry if it is in line printer form. Linotron composition at 5,000 characters per second on a very inexpensive dry process output paper could supply the output proof in the final form. This would make everyone happy.

The next item concerns display advertising. We at Mergenthaler have had some experience with this. The basic problem in doing display advertising on a phototypesetter is that existing phototypesetters set type line-by-line. This makes it hard to set copy properly on the page. It would be much better if we could set copy in block form, as can be done with an area composition device like the Linotron.

In the composition of newspaper text, photocomposition has never been widely employed because of the page revision problem. Part of this problem results from the fact that it takes so long to phototypeset corrections and get them into new plates for printing. Here again, high-speed area composition would help.

The last item I have listed here is directory composition. With hot metal there is a huge storage problem; in photocomposition, as in news text, the problem is page revision. With Linotron, the storing of the information on magnetic tape solves the storage problem and the high speed of the equipment takes care of the page revision problem.

I do not think we can really talk about Linotron alone; we must talk a little about how it fits into the system. It has to take all its instructions, what characters to set, where to set them, what space to leave for photographs, and so forth, from a more intelligent machine than itself. Therefore, we have a computer programmed with what we call an autaset programme. We have written an autaset programme for Linofilm and are writing an autaset programme for Linotron. In other words, we use a master typography programme that is based completely on formats. The information that comes out of this computer will then tell the Linotron exactly where to place each and every character to pro-

duce a 'formatted' page. The input to this typography programme can be from existing files of magnetic tape. For instance, you may have magnetic tapes to-day that are formatted to run a 1403 printer. These tapes can be passed through a simple insertion programme to provide the necessary instructions at the beginning of each block of information. Thus edited, the tape will go through the autaset programme to give you all the information needed for Linotron.

Input information may also be unformatted but edited. This can go directly to the autaset programme, or it can be used to run the 1403 printer.

A third source of information would be paper tape that would then be converted into magnetic tape. The paper tape can be keyboarded by an operator. Corrections to stored tapes could be handled in this fashion.

In summary, I would like to emphasize that Mergenthaler is building this machine to fill an existing need of large organizations. I also want to point out that we are trying to build a machine that will be used by smaller companies in time to come. This is a relatively expensive machine; the machine itself will cost about \$500,000, and, when all is said and done, you are going to spend \$1,000,000 to get one system going. However, I want you to realize here that we will not merely build this machine, sell it, forget about it. We hope to use the techniques being developed here to produce a less expensive machine in the years to come.

CHAIRMAN: When I asked Mr. Corrado if he would tell us all about it, I used a slightly more poetic turn of phrase and asked if he was going to remove the seventh veil. He said, 'Anything but the seventh veil!' I hate to think what else there is he has not told us this morning. I think he has given us a very clear and comprehensive description of the system.

I am going to open the discussion for just a few minutes. This will be followed by the second paper, after which you will have an opportunity for further discussion of both systems.

Mr. C. T. ROSS (Computaprint Ltd): If we ordered a machine to-day, when could you deliver it?

Mr. CORRADO: Approximately two years.

Mr. G. B. TAYLOR (Computaprint Ltd): Would Mr. Corrado tell us something about the configuration of the tape input? He mentioned IBM equipment. Could he dispel any fears on the part of some of those present that one will need an IBM computer to drive this Linotron?

Mr. CORRADO: I should have mentioned this before. At the input stage of the machine—the tape input—any format and

any coding system can be used provided that you have a reader to accept it. Immediately beyond the tape reader we have what we call a programmable de-coding matrix. To put this in its simplest terms, this will convert any coding configuration into the signals that the Linotron will read.

Mr. J. FORREST (Westminster Press Provincial Newspapers Ltd): I would like to ask Mr. Corrado what size and what quality of maintenance staff one has to visualize in a project of this nature, even allowing for plug-in panel replacement.

Mr. CORRADO: I would say one man on each shift, a man of the quality of a Linofilm service man.

Mr. R. PRESCOTT (Dun & Bradstreet Ltd): Could the speaker give us some idea of the error rate? I am thinking of the possibility of reading a wrong character. Is there any check on this?

Mr. CORRADO: There is a parity check throughout the digital portion of the system. I think the best way to answer that question is to say that the error rate compares with existing digital computer rates. We are using the same techniques in developing these circuits.

CHAIRMAN: You will have an opportunity to put more questions to Mr. Corrado later on.

I am now going to call on Mr. Higonnet to give the second paper. He needs no introduction, I am sure. He is one of the pioneers of phototypesetting. I think we can call him the father of the Lumitype-Photon family; it is quite a large family now. He has done a tremendous amount of work in the formative stages of phototypesetting, and he is now going to give us a fairly brief paper on the Lumizip 900.

The Lumizip 900

Mr. RENE A. HIGONNET (International Photon Corp, U.S.A.): Photon in America, known as Lumitype in this country, has produced two machines so far to be used with computers. One, which has been mentioned before, is known as the 513 and is used in Florida. The other one, called the 560, has been used at MIT in Cambridge, Massachusetts, by Dr. Barnett. These two machines differ, first of all in that the 513 accepts a 6-level code without information as to widths of the characters. Therefore, the width has to be re-generated in the machine and justification has to be re-calculated. So this machine is more complicated than the 560. The 560 machine will accept a tape produced by a computer but with what we call a double code;

that is, a code giving the identification of the character and its width. Both machines are slow.

The machine I want to describe now is a high-speed machine based on entirely different principles. It is called the Lumizip 900 and is now in commercial operation. I suppose you know the Lumitype machine in which we have a revolving disc and a flash light to photograph it when it is in the correct position. You have to have a complete sweep of the alphabet in front of the lens to get a single character. Therefore, the cycle of this machine is character by character. It is essentially a start-and-stop machine. There is an advantage in this. Since after every flash you start to move the film or an optical mechanism, you have the possibility of stopping the machine entirely and making any kind of lens change or size change. That is why we are able to mix in the same line as many different characters of different sizes and styles as we like. It is impossible to use any method of this kind—that of a movable matrix—in a high-speed machine of the order of several hundred characters per second.

The approach we have used in the Lumizip has been the use of photographic matrices which are inexpensive and can be photographed directly. It is possible with this device to obtain extremely high quality, because we operate in this machine at a lower speed of the image on the film than we do on the Lumitype.

Editor's Note: The talk from this point took the form of a commentary on slides and film. It has therefore been paraphrased.

High-speed photographic composition is accomplished by the Lumizip 900 in the following manner:

The images of all of the characters are contained in a stationary matrix (a glass negative). Each of the characters of the stationary matrix is provided with individual means of flash illumination. Character images are reproduced on film by a lens travelling alternatively between two fixed positions in such a manner that the entire film width is swept. A memory storage system and controlling circuits produce timing for the illumination of individual characters. The position of the character in the glass matrix and its relative position in the line being composed are taken into account by calculation. A complete line is photographed in a single traverse of the lens, that is a single sweep of the alphabet across the line. To the observer, characters appear to be photographed at random as the lens moves. After each line has been composed the sensitive film is indexed to a new position so that the next line may be similarly composed.

The Lumizip 900 system is divided into three units: Photo

Unit, Control Unit and Tape Handler. The upper section of the Photo Unit contains all the optical and mechanical parts for photographing. The lower section of the Photo Unit contains the electronic assemblies required to control the photography.

The Control Unit, as its name implies, houses the control panel, as well as tape format translator, memory, arithmetic section, logic control section, and confidence check section. The control panel is mounted in the top of the Control Unit to facilitate operation of the equipment. The rest of the section is mounted below the counter.

Optical geometry

The optical system is schematically shown in Figure 6. The matrix is shown at 10. It consists of a glass plate with transparent characters on opaque background. To facilitate this description, it has been assumed that all the characters of the alphabet are arranged in consecutive order as shown. Associated with each character is an individual light source, 21, which consists of a flash lamp which is operated by the discharge of a condenser. The condenser discharge is triggered by a pulse generated at the appropriate instant by the solid-state electronics. The film is shown at 8, in a plane parallel to the plane of matrix 10. A lens, 44, is positioned between the matrix (object plane) and the film (image plane) so that it can make an image in the film plane of the whole alphabet. The lens is mounted on a carriage which can reciprocate between two extreme positions, corresponding to positions 44 and 46 of the lens, along line SS parallel to the matrix plane. When the projection lens is at position 44 (shown in solid lines), it makes a potential image of all the characters of the matrix on a screen 3, at position 1. As the lens moves towards position 46 along line SS, it carries the potential image of the alphabet with it. The image reaches position 2 when the lens reaches position 46, shown in dotted lines. During the translation of the lens, the potential image of each character of the matrix sweeps the whole width of the film. Hence, any character can be projected at any location along the projection line on the film by flashing the appropriate flash lamp at the precise instant when the character to be projected makes a potential image at the correct point on the film. A full line is created by firing the appropriate combination of lamps during each sweep of the lens from position 44 to position 46, and another line when it moves back from position 46 to position 44. To the observer, characters appear to be flashed at random as the lens moves. However, each

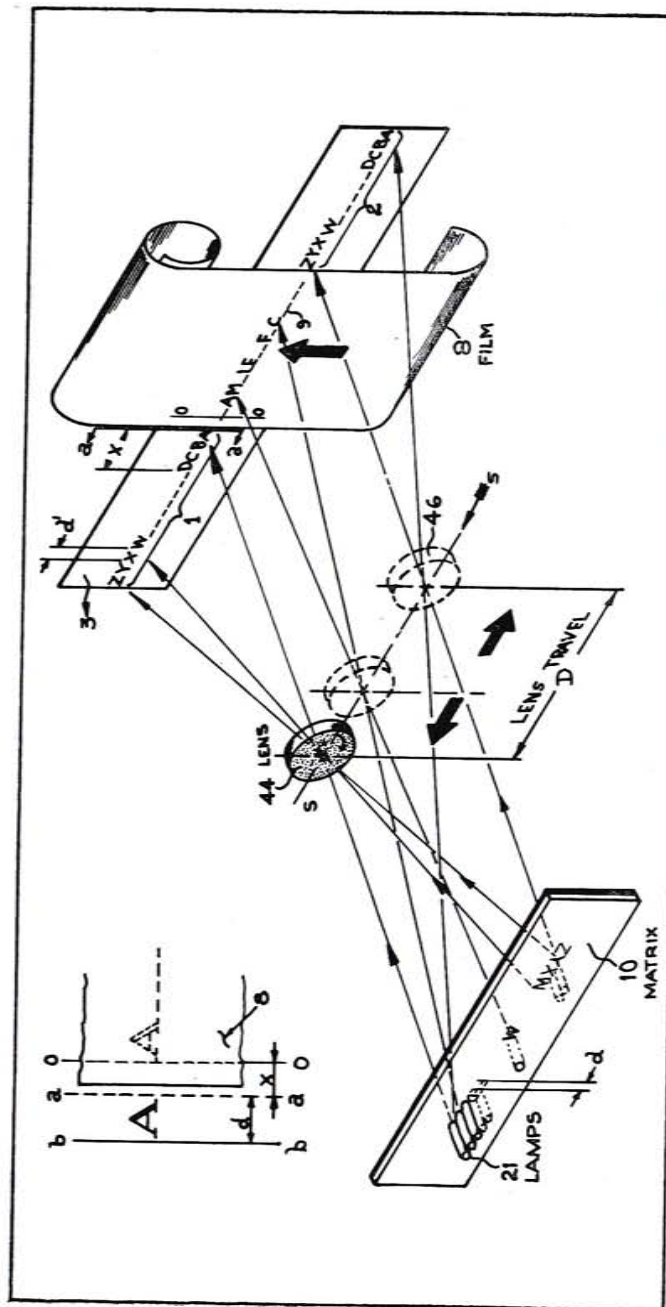


FIG. 6.

character must be flashed according to its position in the line and to its position in the matrix.

The displacement of the film for line spacing occurs during the reversing of the lens. It is accomplished in less than 90 milliseconds. A grid attached to the lens carriage, an optical system, and a photocell generate a timing pulse for each unit displacement of the carriage.

The distance 'X' from a left-hand reference line of a character to the line a-a is referred to as rank distance or rank value. As the projection of the alphabet moves from position 1 to position 2, there is a time at which line a-a coincides with line o-o, the latter line representing the left-hand margin of the line to be composed. Timing pulses are generated as soon as line a-a coincides with line o-o. One impulse is generated each time the alphabet projection moves by a distance equal to one-eighteenth of a 6 point em. As the left-hand reference line b-b of the first character A of the alphabet is located at a distance from a-a equal to K units, it is clear that when line a-a has moved K units to the right from o-o, the character A is in position to be projected flush with the left-hand margin of the text, represented by line o-o. The same applies to any letter of the alphabet. For example, the character E will be in the right position for projection at the same location, that is flush with the left-hand margin, 5K pulses after line a-a has crossed line o-o.

The location of the characters in the line to be composed depends not only on the location of the characters in the alphabet, but also on the space occupied by all the preceding characters in the line, or the preceding characters and justifying spaces. Consequently, in order to determine the time at which any character should be projected on to the film, it is necessary to add the character's rank value (expressed in units) to the sum of all preceding character widths and justifying spaces, if any (also expressed in units).

The sum of these values, called flash position number, or index number, determines the time at which a character must be flashed. It is evident that characters are not flashed in the sequence in which they are read. For example, the line 'SAMPLE OF COMPOSITION' is formed in the following flash sequence: A, E, C, F, M, L, P, S, O, I, I, M, O, O, P, N, O, S, T. The flash timing is computed by a solid-state electronic circuit of the machine.

There is a diffuser, a condenser lens, and a filter associated with each flash lamp. All the flash lamp units are aimed at a common point located at the centre of the film. The lens reciprocates in the area illuminated by each lamp. The purpose of the condenser lens assembly is to increase the light input to

the lens and equalize the illumination in the plane of the lens.

A pair of reflecting surfaces is located between the travelling lens and the film. The purpose of this system is to shorten the sweep of the lens. If all the 264 characters of the matrix were on the same horizontal line of the matrix, as shown in Figure 6, it is evident that, unless a considerably smaller matrix be used, the whole system would be impracticable. There is no available flash lamp to-day which would have an acceptable life, intensity and size, to run a small matrix. On the other hand, tests made with other light sources, such as cathode ray tubes, have been found to be unsatisfactory because they necessitate the use of high-speed films which do not provide a sufficient degree of contrast between exposed and unexposed portions. The problem has been solved by using several horizontal rows of master characters on the matrix. There are eleven such rows, each comprising twenty-four characters, which gives a total of 264 characters. The optical system, described above, has been thoroughly tested; it is made possible by the use of large, perfectly formed, undistorted master characters, straight optics and extremely short-duration flashes.

It is possible to use either film or paper. Line spacing, or leading, is achieved by a motor-driven mechanism. This mechanism comprises a series of rollers to drive the film (or paper). The portion of the film receiving the image of the line is held against a presser by proper formation of the film loop.

There are two basic check points in this system. One is a parity check on the input codes, and the other is a system self-check capability. In order to provide information on the performance of flash lamps, the equipment contains twenty-four light pipes, each of which looks at eleven flash tubes and transfers the light energy to a photodiode detector. When a command is given to flash a lamp, it will be compared to the output of the detector to see if any lamp has been flashed. If no flash occurs, an error will be indicated. Also, if a flash should occur at any time without the command having been given, an error signal will be operated.

Questions on high speed systems

CHAIRMAN: Thank you very much, Mr. Higonnet, for showing us the slides and film and telling us about the Lumizip.

I would now like to open the discussion on both papers. These papers have shown us, very clearly, systems which have used a considerable amount of ingenuity to solve the problems of getting characters on to film in the shortest possible time. The

approaches are widely different, but they are both extremely interesting.

I would like to put a question to Mr. Corrado. Would it be true to say that you have, in fact, incorporated a very large number of the problems in the Linotron equipment in the image conversion tube? It seems that electron optics play a most important part in the character generation and positioning system. This is quite obviously a very advanced use of the techniques of electron optics. It does seem to me that the character generating tube itself is quite a remarkable achievement. Is it true to say that you have, in fact, packed a high percentage of your problems into that part of the equipment?

Mr. CORRADO: The answer to your question is 'yes'; we have packed a lot into this part.

Mr. C. J. DUNCAN (Newcastle University): Could I ask Mr. Corrado a number of short questions which are all related to the same thing?

1. I take it that it is a sequential machine.

2. The next question concerns positional accuracy.

(i). You are using the same current through these tubes. The bottom one is doing the geometrical scan which gives you positional accuracy. How do you match the tubes so they have the same sort of characteristics?

(ii). How do you take care of things like thermal drift on the tubes?

3. May I ask about something which you skipped over pretty quickly. How can you go back within one frame? If you want to go back within two frames, you have got to get your film back into position within a ten-thousandth of an inch. Do you never expect to do that?

Mr. CORRADO: The answer to number 1 is 'Yes, sequential'.

2(i). This question concerned the tubes and the matching of them. The tubes and their respective coils can be manufactured to close enough tolerances so that they can be effectively exact.

2(ii). Thermal drift on the tube is all in the same area; it is all in the same compartment. You can control temperature so that the effect of temperature is minimized if not eliminated completely.

3. We do not expect to go back to the previous page.

CHAIRMAN: You are, in fact, answering the question a stage further: you not only do not go back a third time but you do not go back a second time either. Is that right?

Mr. CORRADO: Correct. On any given page, we will fill in, shall we say, the roman, and leave space for the italic or what have you. After we have finished using all the characters on one

particular grid, we then switch grids and go back and fill in the other words. Consequently, the number of fount changes you make on the page is equal to the number of different type styles on that page. This one aspect is going to make dictionary composition tremendously easy, because there are so many fount changes. This applies equally to mathematical composition. However, another problem is involved here, in that your computers have to generate the programme to do the mathematics.

Mr. G. CROUCHER (William Clowes & Sons Ltd): On the Linofilm the 'ennage' per hour falls sharply with the number of grid changes, particularly if you are setting mathematics. Will the same thing apply on the Linotron?

Mr. CORRADO: No. What I have been trying to make clear here is that the number of fount changes will be equal to the number of grids which you require for a given composition. It is aided in both ways going from Linofilm to Linotron. First of all, you only have 88 characters on a Linofilm grid, but on Linotron you have 256. Secondly, it can do all the characters on one particular grid first and then go back and fill in the other characters from the next grid.

Mr. CROUCHER: Although you have answered the question, I still cannot take it in. My interest is mathematics. We found the Linofilm difficult because of the fact that we had to bring in practically all the 18 grids even on one page of mathematics. Unless you have in your 256 matrix grids, as I see it, interchangeable matrices in order to avoid more grid changes than are necessary, you are still up against the same problem that you are going to have grid changes when you want a superior 2 or an alpha or a script or something of that nature. They will all have to come off separate grids and you will not want the other 255.

Mr. CORRADO: That is true, but you have 88 characters on the Linofilm grid compared with 256 on the Linotron. There is an advantage there of about 3:1.

Secondly, if you had, for the sake of argument, 'X' and 'Y' on one grid and the power was on another grid, in Linofilm you have to set the 'X', change the fount, set the superior figure, change the fount, set the 'Y' and change the fount again. On Linotron you would first set 'XY' and change the fount and then come back and set the 2 and 2.

Mr. R. A. FREIMAN (Random House Inc): Could I add to that? We made an analysis of the use of a Linofilm on a particular job. On the Linofilm, using the normal set-up with conventional ready-made grids, we discovered that we would have to average about 10 grid changes per line. This made the Linofilm

absolutely out of the question because of the slowness thus engendered. With the Linotron's capacity of 256 and its four grids, this is no longer a problem, to us anyway.

Mr. CROUCHER: We found that we averaged 200 grid changes per page, on Maths, on the old 88 matrix grid.

Mr. FREIMAN: Our alternative was to go through a computer to find out the frequency of the occurrence of various characters and then have a special set of grids made. If you follow that principle, you may have to have a special repertoire of grids for every different complex job, and this would be awkward.

Mr. ROSS: Could I ask Mr. Higonnet if he could give us some idea of the cost and delivery time?

Mr. HIGONNET: £100,000 and, I suppose, one to three years.

Mr. A. H. PHILLIPS (HMSO): If, Mr. Corrado, you are taking all the characters off one grid and putting them anywhere on the page or on another page and filling them in, there is a chance, if you are doing dictionary or mathematical work, that there will be a delay as regards information. Is this delay engendered by your machine or will this have to be on the tape which you feed into your machine?

Mr. CORRADO: I do not know if I have understood your question. Let us say that the computer goes through the routine of setting the whole page, putting down the roman and the italic all the way across the line. After it has completed that, the computer will then pick out all the roman characters through another routine first and then the italics will follow in their proper correlated position, described by the 'X' and 'Y' co-ordinates. In my opinion, this is relatively simple for the computer to do, because the computer has the information already that a fount change is required. It has to provide fount change information to the Linotron. If the information is there, then you programme your computer to say, 'Any time I see fount 4 come up, I throw it out on the scratch tape and any time I see fount 5 come up, I throw it out on another scratch tape. After I have thrown all the information out on scratch tapes, I put them back and join them up again in the sequence of all the roman, all the italic and all the bold.'

Mr. PHILLIPS: This synchronization of grids is done on the tape before it is put on to your reader?

Mr. CORRADO: Right.

Mr. A. BEAVEN (National Cash Register Co. Ltd): Just following up on that point, how big is the buffer in your system? If I understood Mr. Corrado correctly, he has a magnetic tape presented by the computer which has been edited, so that if he

had four founts on a page he would have four sets of records on the magnetic tape in sequence.

Mr. CORRADO: The size of the buffer is such that it will hold 2,048 characters in construction.

Mr. BEAVEN: What do you expect from magnetic tape? Do you expect one record which consists of all the roman and another record which consists of all the italic?

Mr. CORRADO: It is a series of records in sequence on the tape.

Mr. F. SIMMONS (NGA): In view of what we have heard this morning, it strikes me that a lot of people will be wondering whether it is worth while to enter into the computer typesetting field with existing forms of hot metal or filmsetting equipment when, in fact, they now know there are other forms of filmsetting coming along within the next two or three years which will tend to change the picture considerably. My question therefore is this: Bearing in mind what Mr. Ross said yesterday with regard to the desirability of choosing the right form of computer and the right form of programming, in the initial stages, if people are, in fact, programming at this stage with existing forms of computers and with existing forms of filmsetting and hot metal composing equipment, will those programmes be adaptable to the type of machines which have been described to us this morning, if and when they come in? Or are people going to have to mark time for the next two or three years in order to wait for these more up-to-date developments which obviously will give us greater progress?

Mr. CORRADO: First of all, I would say that 80 per cent of the programming which is being done for current photocomposition will be most useful in the programming for Linotron. We are still trying ultimately to do the same work. Most of the work is involved in writing flow diagrams. True, there is a great deal of laborious work involved in writing the details either for the compiler or for the machine language programme, but what you are really doing in preparing a flow diagram is putting down a logical system for line justification, hyphenation, column justification, graphics placement, and so forth.

Mr. C. BARBER (Rocappi Inc., U.S.A.): I would say that without previous experience on machines—both the computers and the typesetting machines—which are not quite so advanced as the ones we are discussing at the moment, you would not stand a chance with regard to defining logic. In particular, the idea of presenting your text in the founts which are required on a particular page is a very new one. There is no programme like that available right now, as far as I know. It sounds to me as if it would be a very difficult programme, and one which could only

be written by people who had had previous experience in justifying to get one line out.

Mr. CORRADO: Are you referring to filling in? I do not see that as a problem. When you write a programme for Rocappi and when you change a fount, there is a bit of information on your own line which says that the character which follows or the word which follows is in bold; the information is there. How much more difficult would it be for you to write an extension of that programme? In other words, after you have set your page, how much more difficult would it be for you to go back and pick out all the words which are in italic and throw them on the scratch tape, pick out the bold, or any other type faces you have, and throw them out on another scratch tape and then bring them back and re-arrange them in that fashion?

Mr. BARBER: Within our system, outputting for hot metal machines which are not mixers and wanting 8 point, 9 point and 10 point, we now write all the 8 point together, all the 9 point together and all the 10 point together. The paper tape comes off in three separate packages and goes to three separate line-casters. You might be introducing leading and indent, and this is something which has to be generated within the computer, where previously leading and indent had been input variables rather than output variables from the computer.

Mr. ROSS: I think Mr. Simmons has brought up a very important point because there is always the problem of whether you should wait until tomorrow because tomorrow things are going to be more interesting. I would agree with Mr. Corrado that a great deal of the programming which we do for computers now will be very useful, irrespective of what output unit we use. There is a great deal of organizational work to be done, getting the information in correctly, arranging information, and so on. The part which has got to be re-written is the output end for whatever output device exists, and that piece, of course, would have to be re-written, not only for a Linotron but for a Lumizip or whatever comes along. However, this yet again emphasizes the point that one must look ahead to the possibility of these developments taking place and write one's programmes accordingly now.

Mr. E. FORBES (U.S. Government Printing Office): I would like to speak to Mr. Simmons's question. You will realize that in the Government Printing Office we, in under two years, will have to utilize this tremendous photocomposition capacity. We obviously have a great deal of work to do in selecting the jobs which are most feasible from the ones which are not going on computers, and new information handling systems will generate

a variety of different publications from the same data base. Many of these publications are bulky. Reduction in the book bulk is achieved by getting two pages of information on to one page. Higher readability will generate sufficient savings to pay for the major portion of the initial programming.

I think it is vitally important that we should all recognize that there is much work to be done in the organization and preparation of information and in the original keyboarding ability, all of which requires proof reading and correction. The only way to do this is to carry out these human systems development tests. When the hard work comes, a tremendous amount of problems arise if the work has not been done before and as a result is just going to sit there. The question of the final output driving either a 5-character per second photocomposer or a 500-character per second machine is a fairly trivial one, either in terms of running costs on the computer or the transfer from one to the other. This is a task you do at one time. For example, in about three or four months you will have a simulator which will actually allow you to test a tape which is properly prepared for the Linotron and use the Linofilm photocomposer as an output printer which will display what you get. Things like this are going to have to be operational and you are going to need these to solve the same problems.

Mr. A. B. TYRELL (Ministry of Labour): This procedure of waiting for techniques which may be an improvement on ones currently being developed is a very dangerous one. This has been shown to be true in some of our older print industries. While you are waiting for something which may or may not materialize, you tend to fall behind, and the productivity of other countries which are adopting new techniques tends to rise *vis-à-vis* your own. You then find yourself in an embarrassing position later on in trying to catch up. The experience of old printers has shown that the catching-up process is extremely difficult. I feel it is necessary to apply the modern techniques as quickly as you can, and that you should not wait for something which may or may not come about in the future.

Mr. R. BENNETT (Butler & Tanner Ltd): On reliability, I would say that your Linotron tube seems to have a great deal packed into it. Therefore, a great many things might go wrong inside it. Mr. Higonnet's machine, on the other hand, seems to have a great many smaller parts, each one of which might go wrong separately. I wondered if both of you could give us your views on which system you think would give the better reliability in practice.

CHAIRMAN: I think we will modify that question slightly

and ask both Mr. Corrado and Mr. Higonnet to comment about reliability.

Mr. CORRADO: I think the one thing I can say about the Linotron tube is that, although we have compressed many functions into it, there are few techniques which take care of all these requirements. You saw a photograph of a tube. What does it use? It uses a photo cathode, a couple of accelerating anodes, an aperture plate, control grids and an electron multiplier. These are all existing techniques. These are all existing systems which are put together to perform the function of selecting the character, dissecting it, converting from an optical image to an electron image, then dissecting all of those and selecting one. When you study it, it is a relatively simple device.

As far as reliability is concerned, if you mean in terms of life, I would say that you can expect a tube of that sort to last from 1,500 to 5,000 working hours.

Mr. BENNETT: What proportion of the cost of the machine does the tube represent? Is it a high proportion of the cost?

Mr. CORRADO: The price of the machine is pretty high; the cost of the tube is low in proportion to the total cost.

Mr. HIGONNET: There are 264 flash tubes, and we have few failures. We can always detect a failure. If there is a failure in one line, we just re-set the line for the missing character. I think the rate of reliability in the solid state electronic part is the same as that for computers.

Mr. F. C. HOLLAND (Monotype Corporation Ltd): I would like to make a comment in relation to the Linotron. In your medium speed range of something like 1,000 characters per second, if average keyboard speeds are going to be around 3 per second, the feeding and the keeping of your animal in a healthy state will require 300 keyboard operators, assuming it is simple copy. As soon as they get on to more complex material, the keyboard speeds will drop and you could need 500 keyboard operators. Would you care to comment on the proposition that the use of your machine might mean the setting up of two or three national typesetting agencies to handle all the work?

Mr. CORRADO: I think your comment is based on the fact that you think all the information which goes through a Linotron is only used once and never used again. Let us take the simple task of telephone directory composition. We are talking about photocomposition now. You have several hundred listings on a page. If you want to re-set that page and add three names and take one out, the keyboarding which has to be done involves only three lines, but the new machine has to be fast enough to set

the other 300 or 400 lines which are on the page. As I tried to bring out in my talk, the fact that this machine is being built for computer usage at the moment, where there is a tremendous amount of updating of information, means that you are going to re-digest material over and over and over again.

Mr. TAYLOR: Could I put the same question to both gentlemen: is there any possibility of on-line operation, that is to say, without the buffering magnetic tape?

Mr. CORRADO: This is absolutely feasible because, from our studies into complete typographical area composition looking at throughput through a computer, we found that some of the larger machines—like the 1410, the 70/80 and the IBM 360—will do anything from 1,000 to 2,000 characters per second. If Linotron goes at 1,000 per second I think it can keep up.

Mr. HIGONNET: There should be some kind of buffer stage. In the case of the Photon Zip it would not work on line.

Mr. F. C. HALE (Monotype Corporation Ltd): In Mr. Higonnet's machine there seems to be a variation in the length of the light path according to the position of the characters in the grid. Could Mr. Higonnet comment on this?

Mr. HIGONNET: You have an adjustment of intensity for every flash tube.

Mr. FORBES: I would like to make a point which I think is important, particularly with regard to the small businessmen who are trying to visualize how these high-speed photocomposers may affect their present business. I sensed from Mr. Holland's question that many of the men in the audience are much concerned about this. I would like to make the point that the reason the Government Printing Office got into this business was because we had a great many millions of dollars of composition copy, essentially computer listings, which we were putting on the camera. They are very bulky and they are very wasteful. We had to have some means of compressing the information on a tape so we need print only half as many pages. This is a growing business which we have never seen before. It is something totally new. There is going to be a new class of work coming from these new computer handling systems. It creates an opportunity for the people who have the typographical keyboarding skills and the skills to organize and prepare information to learn how economically to sell a new service, because they understand the preparation of information for printing. This is an exciting opportunity. For those people who want to experiment a little, it is an opportunity for them to do some very interesting development work in search of new business.

There is one other point which is important too. Although the

machines will operate at a very high output speed, much of the information presented is information which could have been prepared in element form far earlier, so that any change could be done at the last minute before going through the computer and the phototypesetting equipment. It is not necessary to have 500 keyboards to play a part in one of these high-speed operations.

Mr. C. NASH (International Printers Ltd): I would like to ask a question of Mr. Higonnet. I am not sure whether he made clear the type size range on the Zip or the method of changing type size.

Mr. HIGONNET: On the machine I have shown, if you want different sizes they must be on the matrix. You can have them of any size up to 12 or more, but they have to be on the matrix. You have an alphabet which will give you 12 point on the film and another one which will give you 8 points. It is a photographic process. Therefore, the relationship between the size of the character on the film and on the matrix is fixed. There is the possibility of using a movable matrix in which you can change the style by losing one line. Therefore, you could reach a capacity of about 800 characters, or you can mix in the same line. Whenever you make a change you lose one line because you have a mechanical movement which you have to take care of.

CHAIRMAN: I would like to thank both Mr. Corrado and Mr. Higonnet for answering your questions and for giving us such a valuable session this morning.

Before we close the conference I would like briefly to say a few things to you. Over the last few days we have been watching various aspects of computer typesetting unfold, and you have had an opportunity of looking at systems, principles, problems and advantages, and from time to time there has even been a little bit of sales creeping into the speeches! This conference has been valuable because this subject of computer typesetting is very obviously in a state of formative ferment. There is a great deal of pioneering work to be done.

You have seen, from the various talks which have been given, the different approaches which people are working on, and you will see that there is a tremendous amount of enthusiasm and money going into the different methods.

This conference has fulfilled its purpose. Many people have told me that they consider it has been very successful. We hope those who have come so far will have found it worth while to have done so.

Before I finish I would like to thank all the speakers and the chairmen of the sessions for the valuable work they have done in

this relatively short period of two-and-a-half days. We have got through a tremendous amount of information.

I would also like to thank the members of the Computer Typesetting Committee who have all done quite a lot of work to make this possible. However, the most important person, the person who has taken the biggest load of the whole conference, is Mr. Jefferies, the Assistant Secretary of the Institute of Printing. He has organized the conference. Although he is a human being he has done it with computer-like efficiency.

I am sure you will like to know that the proceedings of this conference will be published. There will be a charge for the proceedings because we budgeted this conference to break even.

Finally, I should mention the Institute of Printing; most people here from this country are probably members. People who have come from abroad may like to contact the Secretary and find out more about the Institute of Printing because we are most anxious to have more members abroad; we think it is good and healthy for our organization to keep in touch with people all over the world. We would like to encourage membership. If you are not members, we hope you will join.

The conference is closed.

Biographical notes

Gordon S. Allen is President of the Institute of Printing, Development Director of International Printers Ltd and Technical Director of Odhams (Watford) Ltd. Prior to joining I.P.C. he was Chief Research Engineer of Crosfield Electronics Ltd and was responsible for creating their research department. He is the author of a number of technical papers and started the Association of Printing Technologists which eventually merged with the Institute of Printing upon its formation in 1961. Mr. Allen is a Fellow of the Institute, Fellow of the Royal Photographic Society, and an Associate Member of the Institution of Electrical Engineers.

G. P. Bafour, a graduate in engineering, has been head of the development department of *L'Imprimerie Nationale* since 1944 and has made significant contributions to the progress of teletypesetter applications in France. His special interest in automatic typesetting led to the introduction of a number of patents for the application of computers to these problems and, in 1958, to a practical demonstration of the possibilities of the B.B.R. system.

Colin R. Barber was employed as a mathematical physicist in the Turbine Research Department of Plessey Company Ltd, after a period of six years in the Merchant Navy. Subsequently, he was a Stress Analyst with Avro Aircraft (Canada) and Senior Research Engineer for S.K.F. Laboratory in Philadelphia. He was then appointed Physical Science Project Leader with the Radio Corporation of America and, in 1963, joined Perry Publications in Florida as Manager of Computer Typesetting Applications. Mr. Barber is now Director of Research for Rocappi Incorporated.

A. H. Beaven, a mathematics graduate of University College, London, joined the new Business Computing Section of Elliott Brothers (London) Ltd in 1956 and subsequently transferred to NCR when the association between NCR and Elliott's was started. He has been concerned with setting up NCR Computing Centres in London and Dundee and has also been responsible for programming research and development, including investigations into the ways in which computers could help the printing industry.

R. Boyd began his career in printing with a three-year trainee course at Oxford University Press. Deciding to specialize in technical development, he spent a further year's training with H. Wolff Book Mfg. Co. in New York, and then visited all the major book producers in the United States. From 1957 he has been working for Richard Clay & Co. Ltd and is now in charge of technical development and research for the Richard Clay group of companies.

G. Chadwick, as a senior technical officer, is responsible for all the work on data processing subjects at B.S.I., and is Secretary of all the data processing committees of the Institution. He recently led a large British delegation to a series of computer and information processing meetings in New York.

Edward G. Cluff joined Powers-Samas in 1951, having gained previous experience in data processing in New Zealand at the Reserve Bank. His early experience in tape-to-card conversion and transmission of data resulted in his presence at the early meetings at B.S.I. in 1957 which prepared BS 3480:1962 'Data Processing Codes for Punched Tape'. As the work on data processing standards has extended, he has co-ordinated all the standards activities of I.C.T. Ltd.

E. J. Coates, who is a Fellow of the Library Association, entered bibliographical index publishing after initial experience in the public library service. He worked on the editorial side of the *British National Bibliography* from 1950 to 1961 and was appointed Editor of the newly established *British Technology Index* in 1962. Both publications use non-conventional printing. Mr. Coates has written extensively on document indexing and classification for information retrieval.

Victor M. Corrado, a graduate in electrical engineering of Duke University, North Carolina, USA, has been with Mergenthaler Linotype Company for fifteen years. He has been closely involved in the design and development of his company's products, particularly the Linofilm system. For the past three years Mr. Corrado has been Manager of Mergenthaler Graphic Systems Engineering Department and is responsible for providing the industry with information on electronic data processing and automated systems. His latest endeavour is Linotron—a high speed photo-typesetting machine.

H. Brandt Corstius studied mathematics at the University of Amsterdam, worked at the University of California, and is now a research worker at the Mathematical Centre in Amsterdam, with special responsibilities for the development of computer applications in the field of linguistics.

Frank De Witt, an Associate Member of the Institute of Printing, graduated from Middlebury College (Vermont) in 1929. His printing experience includes hand and machine composition, estimating, and management in commercial printing plants; teaching and research at Rochester Institute of Technology; writing for British and American printing magazines; and consulting for state and federal governments. He was active in the early development of the Justowriter and is now Graphic Arts Specialist in the Product Planning Department of Friden, Inc.

C. J. Duncan, a Fellow of the Institute of Printing, joined Kodak in 1938 and, during the war-time years, worked on air photography at the Royal Aircraft Establishment at Farnborough. In 1947 he was appointed Director of the Photographic Department at Newcastle University and his interest in the graphic arts prompted him to create a photolitho section in 1953, in order to attempt short-run colour reproduction. The need for producing economic text led him to suggest the use of computers and, in 1961, he received a DSIR grant to help demonstrate the possibilities.

Dr. D. G. B. Edwards is a graduate in physics of Manchester University and has also been awarded the degrees of MSc in Electrical Engineering and Doctor

of Philosophy. In 1950 he joined the staff of the Computing Machine Laboratory, Electrical Engineering Department, University of Manchester, and in October 1964 was appointed Reader in Electrical Engineering. He has been closely associated with the design and development of the various Manchester University computers and has travelled extensively abroad, giving lectures in the USA, Portugal, France, Italy, and USSR.

R. F. Fullick joined Hazell Watson & Viney Ltd in 1958, after retirement from the Regular Army. He was associated with web-offset from the erection of the *Readers Digest* drum-type press at Taylowe, Maidenhead, in the summer of 1958. From 1960 until the end of 1962 he was in charge, as general manager, of the Hazell Sun web-offset plant at Slough. Mr. Fullick began research into computer typesetting with Mr. R. Atterbury, of the Westerham Press, in 1963. He is now a director of Rocappi Inc. of Philadelphia, USA, and of the associated British company, Rocappi Ltd.

Rene A. Higonnet invented and developed the Photon-Lumitype photographic typesetting machine, with Louis M. Moyroud. He obtained an Electrical Engineering degree from the University of Grenoble in 1922, and was an exchange student to Carleton College and Harvard University in the USA from 1922 to 1924. In 1925 he joined the telephone company, Le Matériel Téléphonique, a subsidiary of International Telephone and Telegraph, of New York. A telephone engineer by profession, he had no knowledge of the printing art and it was by accident that, in 1944, whilst visiting a printing plant in occupied France, he had the idea of inventing a photographic typesetting machine.

F. C. Holland became interested in the graphic arts in 1950 when he was appointed to the sales staff of the Monotype Corporation Ltd. From 1954 to 1958 he managed the West African Sales and Service operations from Nigeria and, until 1962, worked on a special research and sales support assignment in Canada and the USA. He then became interested in operational research and has continued to specialize in this field, particularly with reference to filmsetting techniques and the computer processing of keyboard tapes. Mr. Holland is Operational Research Manager of the Monotype Corporation Ltd.

J. M. Johnston, a graduate of London University, was at one time Assistant Editor of the *ABC Railway Guide* and has been Editor of the *ABC World Airways Guide* since its initial publication in June, 1946. His work has brought him into close touch with computer typesetting as an aid to the efficient production of timetables. Mr. Johnston is also Editor of the *ABC Air Cargo Guide* and the *ABC Shipping Guide*.

Duncan Macintyre trained originally as an electro-mechanical engineer and became interested in printing techniques when he left the Services. After working with several small lithographic printers, he joined Westerham Press in 1959 and set up full processing departments for an electronic colour separation, photosetting, and four-colour pilot printing plant for a future new

factory. Mr. Macintyre started a research project in 1963 into computer typesetting and subsequently worked for a period with Rocappi Inc. in the United States.

Adam Maitland has been managing director successively of Eyre and Spottiswoode Ltd, Her Majesty's Printers, and of St Clements Press Ltd, printers of *The Financial Times*. He became interested in computer typesetting as a means towards swift and economical reproduction of computer-calculated financial statistics. Mr. Maitland is a member of the Council of the Institute of Printing and of its Computer Typesetting Committee.

H. G. Milner, after early training in the commercial side of the printing industry and part-time lecturing in typography, entered the newspaper industry in the late 1930s. During his employment with *The Manchester Guardian and Evening News* he has held several senior posts on the production and technical side of the business and is now Controller of Technical Development. After spending some time on problems connected with the facsimile reproduction of newspapers he was closely concerned with the successful venture of printing *The Guardian* in London as well as in Manchester, which included the introduction of the first large-scale two-way teletypesetting transmission in Europe.

C. T. Ross became involved in the printing industry four years ago by developing a system of high speed, high accuracy, high quality reproduction of the output of a computer. As manager of the N.C.R. Financial Computing Centre he initiated research into the computer control of TTS line-casting machines for newspapers, a computer production system for directories and a number of other developments. He is now a director of Computaprint Ltd.

Fred Simmons, J.P., after serving an apprenticeship in hand and mechanical composing and studying at Stafford Technical College and Birmingham School of Printing, joined the staff of the Typographical Association in 1937. He was elected Secretary of the TA Manchester Branch in 1947, and held the position for ten years prior to his election as General President of the Association. As NGA General President, Mr. Simmons is responsible for all apprenticeship matters on behalf of the Association and represents the Association on the National JIC Apprenticeship Authority. He is a Governor of the Manchester Regional College of Art and is a Moderator for the City and Guilds of London Institute. Mr. Simmons is a founder member of the Institute of Printing and serves on its Computer Typesetting Committee.

Glossary

THIS BRIEF GLOSSARY IS INTENDED TO COVER ELECTRONIC COMPUTER TERMS USED DURING THE CONFERENCE TO ASSIST THOSE NOT FAMILIAR WITH THIS SPECIALIZED TERMINOLOGY.

ACCESS TIME: The time interval between the call for the transfer of data to or from a computer store and the instant the operation is completed. The call is made by the Control Unit. The Access Time is the sum of the Transfer Time and the Waiting Time. The access speeds have an important bearing on the efficiency of a computer installation.

ADDRESS: There are quite a number of variations of the term 'address' but, as a general definition, we can say it is an expression, usually numerical, that designates a particular location in a store, or some other data source or destination.

ALGOL: A programming language for scientific use. The Algorithmic Language.

ANALOGUE COMPUTER: A computer that operates by translating numbers into measurable quantities such as voltages, resistances or rotations: in other words a computer in which Analogue representation is used.

ASSEMBLY PROGRAMME: This term should be 'Assembly Routine'. A translating routine which accepts or selects required sub-routines, assembles parts of a programme and makes the necessary adjustments to cross-references.

AUTOMATIC PROGRAMME INTERRUPT: The ability of computers to abandon one operation, temporarily, when a priority operation arises, complete another operation and return to the first operation.

BINARY DIGITS: Counting system used by computers internally. There are only two binary digits, 1 and 0, that is, current 'on' or 'off'. These two digits must be organized into a code to represent numbers larger than two; hence 4 is represented by 100 where the '1' in the first position represents '4', the middle '0' represents '2' and is zero to indicate that this column has no value, and last column is zero to indicate that no '1' is present. The number five becomes 101 and six 110. Eight will require another column, hence, 1,000. In other words a binary digit, or Bit, is a digit in the representation of a number in binary notation, i.e. 0 or 1 as distinct from denary notation, i.e. 0, 1, 2, 3, 4, 5, 6, 7, 8 or 9.

BUFFER: This refers to buffer 'stores' which are used to compensate for a difference in the rate of flow of data or in the time of occurrence of events when transferring data from one device to another. The information is sent to and called from the buffer store by the computer programme.

CHANNEL: One of a number of parallel paths across and along which signals representing data are encoded, normally by punched holes (or their absence) or by magnetic pulses (or their absence).

COBOL: A programming language for general business use (Common Business Oriented Language). Used by banks, accountants, etc.

CODING: A system of symbols representing data, functions and instructions in a form in which they can be dealt with by computers and their associated equipment.

COMPILER: A complete translating routine including code conversion, and the assembly and adaptation of parts of a programme. A programme in any one of the programming languages has to go into a compiler for use on a computer.

CONCURRENT PROCESSING: The ability to work on more than one programme at the same time.

DICTIONARY APPROACH: A system where the hyphenation point of a word is obtained from a stored list of pre-hyphenated words.

DIGITAL COMPUTER: A computer which operates by using numbers to express all the quantities and variables of a problem. In digital computers, the numbers, in turn are expressed by electrical impulses. Thus, a computer in which digital representation, as opposed to analogue representation, is used.

DUMP: To transfer all or part of the contents of one section of computer memory into another section or some output device.

ERASE: To obliterate information from a magnetic surface or some other memory unit.

FIELD: A group of related characters treated as a unit in computer operations, generally used in connection with punched cards or recording on magnetic tape.

FORTRAN: A programming language for scientific use.

HARDWARE: The various devices which make up the computer system. For example, the central processor and the high-speed printer are both computer hardware (colloquial).

INSTRUCTION: A coded programme step that tells the computer what to do for a single elementary operation in a programme.

LINE PRINTER: An output device for printing the computer results on continuous stationery at speeds of up to 1,000 lines per minute. These printers are often restricted to the use of capitals and a total of 64 characters. The term should be 'Line-at-a-time-printer'.

LOOP: The repeated execution of a series of instructions for a fixed number of times.

MAGNETIC CORE STORAGE: A type of computer storage which employs a number of tiny doughnut shaped cores of magnetic material, interlaced with wire in such a way that each core can be selectively magnetized to represent a binary 1 or 0.

MAGNETIC DRUM STORAGE: A metal cylinder, with a sensitized surface which spins inside a jacket with reading-writing heads. The address of all data on the drum is known and the data can be placed or removed by the reading-writing head. Data can be placed into or called from storage without sorting input data or searching the entire memory as is necessary with tape reels.

MAGNETIC TAPE STORAGE: Reels of metallic or plastic tape with sensitized surface which is magnetized to hold data. Data can be read, erased, entered or replaced by recording heads. Data is usually entered in sequence. Magnetic tape storage provides large capacity in a small space and provides unlimited ability to expand.

MEMORY STORAGE: This is an information file accessible to the computer. It holds information such as rate tables, current inventories, balances

etc., and programming instructions. Internal memory storage is a part of the computer itself such as drums, cores, or thin-film. External memory is separate from the computer such as paper tape, magnetic tape or punched cards. In other words a Store is a device in which data can be inserted and retained and from which it can be obtained when required.

MICROSECOND: A millionth of a second.

MILLISECOND: A thousandth of a second.

NANOSECOND: A billionth of a second (a thousand-millionth).

OPTICAL CHARACTER SCANNER: A device that can recognize a type-written or printed character and translate it into a form suitable for computer input.

OUTPUT DEVICE: The unit that translates computer results into usable or final form.

PRINT OUT: The printed result off either a computer line printer or a tape operated direct printing device.

PROCESSING SECTION: This unit does the actual changing of input into output, including the arithmetic section and intermediate storage. This is usually referred to as the central processor, which is based on the arithmetic unit.

PROGRAMME (noun): A set of instructions or steps that tells the computer how to handle a complete problem such as type justification, payroll, production scheduling, or other application. Most programmes include alternate steps or routines to take care of variations. Generally, programme steps form a complete cycle. Each incoming unit of information sets off the complete cycle from beginning to end.

PROGRAMME (verb): To plan the whole operation from input to output and set the control section to handle it.

RANDOM ACCESS: Access to storage under conditions in which the next position from which information is obtained, or delivered, is in no way dependent on the previous one.

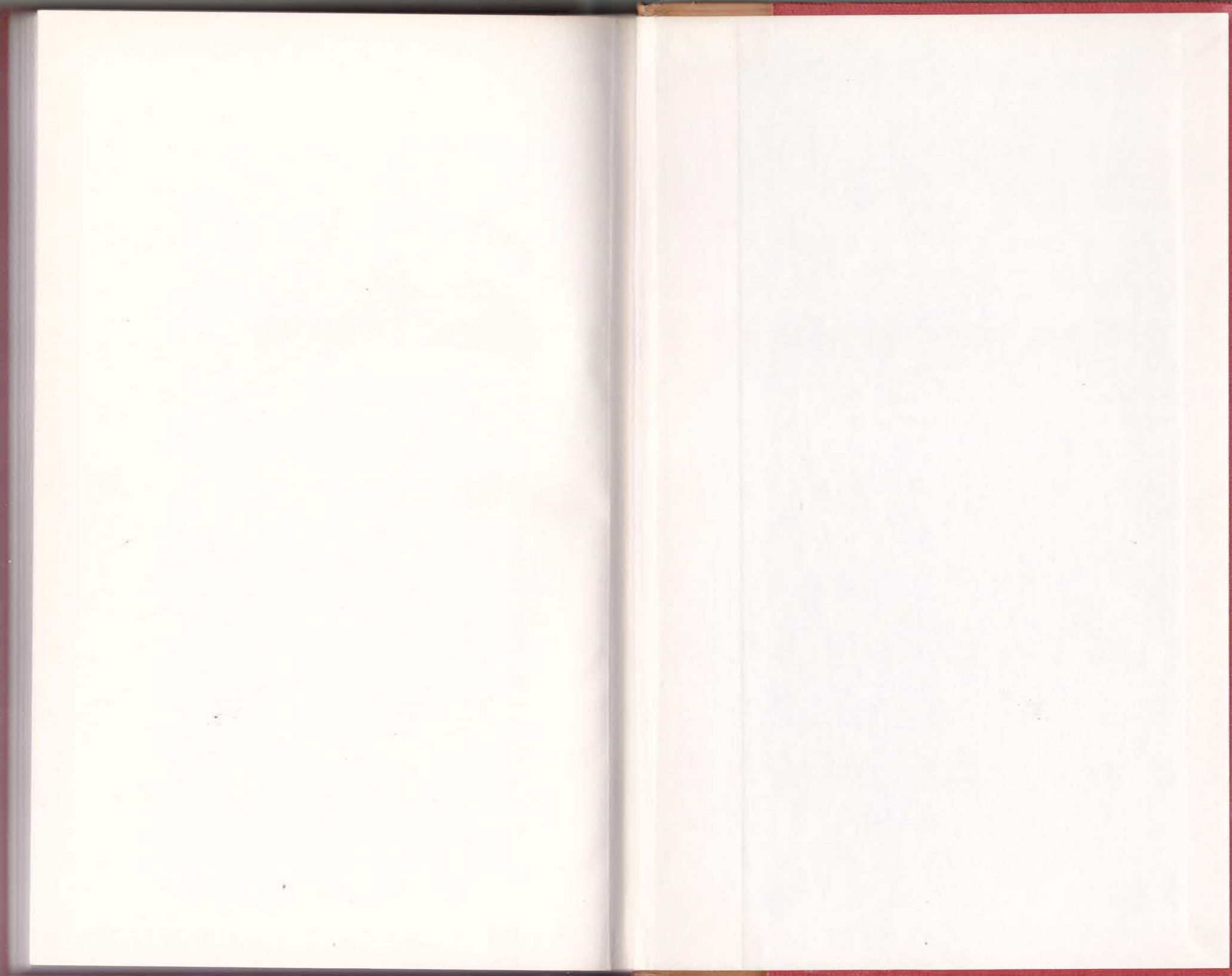
REGISTER: A device in which information is temporarily placed for storage or other purposes. This store is usually of a 'one-word' capacity.

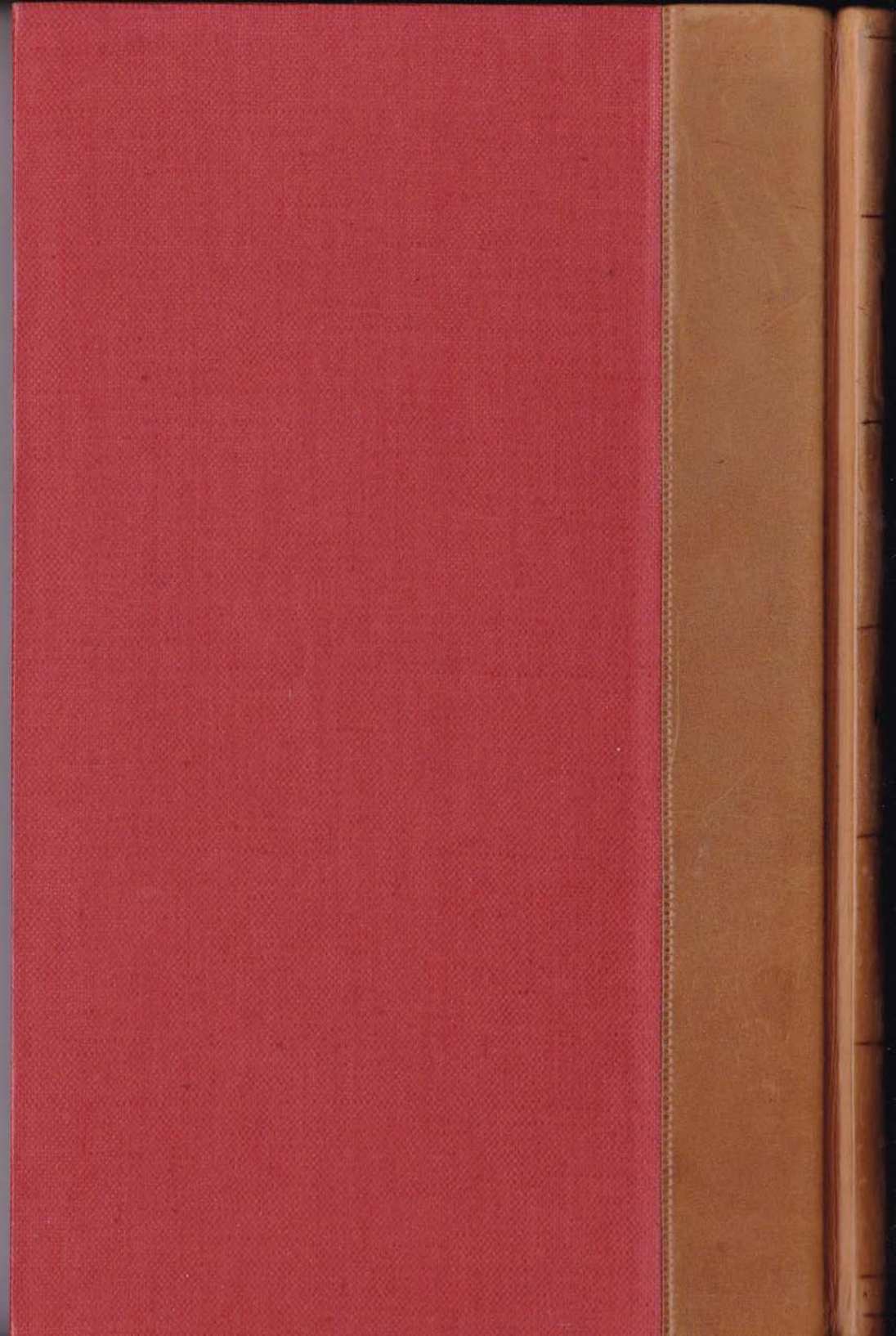
SOFTWARE: A term used to describe programmes available for a computer system. It differentiates programmes or codes from Hardware, i.e. equipment.

SOLID STATE ELEMENTS: Components that depend on electric or magnetic phenomena in solids, e.g. in semiconductors and ferrites. They perform the same functions as vacuum tubes (valves).

STORED PROGRAMME: A set of instructions in the memory section that can run the computer or be cut in to take over from a normal programme when the occasion arises.

SUB-ROUTINE: A part of a programme which can be used or interpolated at more than one point in a particular programme or which is available for use and inclusion in other programmes.





COMPUTER
TYPESETTING
CONFERENCE

1964

PROCEEDINGS