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ABSTRACT

This paper provides a review of computer typesetting in the United Kingdom with an emphasis on the use of data originating from a computer rather than from a printing environment. It explains the need for an alternative to the computer line-printer when large amounts of data are being processed, and the effect of new techniques on the printing industry. A selection of current and potential applications is reported under sectional headings to illustrate the range and volume of possible development. The use of data banks to provide a source of copy for the production of varied publications is dealt with, and an estimate of future trends is offered. (Author)

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COMPUTER TYPESETTING in the U.K. - a review

H.J. Davis

Report No. 1 on DPC Information Display Project.

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Office for Scientific and Technical Information,
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Key words

composition
computer
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data banks
document handling
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information
keyboarding
legibility
letterpress
libraries
line casters
line printer
manuscript
modular routines
photo-composing
printing
process control
rationalisation
special purpose
text processing
typesetting
typography

CONTENTS

1. INTRODUCTION

In the context of this report, 'computer typesetting' refers to all applications in which a computer is used as an interface to prepare tapes to drive a typesetting machine, whether the output of the device is metal or film. Developments in the field of text processing have, however, advanced to a level where a distinction might be made of systems that generate an expanded representation of the input data and provide for the formatting of text embracing the wider aspects of composition practice.

Initially, the development of research into the possibility of computer typesetting began in the United States. It arose out of the necessity to provide a more sophisticated and legible medium for the presentation of the increasing volume of information that was being processed by computers.

The conventional line-printer output requires a square inch of paper to display sixty characters. The same area of paper - for example in a telephone directory - can hold in excess of 600 typeset characters, using both sides of the paper. The economy of paper will be apparent, but far more important to the recipient is the convenience and accessibility of information processed in a typeset page format.

It was probably as a by-product of this research into text-processing that the potentialities of using computers in the newspaper industry were realised. The essence of newspaper production is speed, and there is a high level of capital expenditure in the industry, so it is not surprising that computer manufacturers turned their attention to developing systems for this market and that major progress has been made in this field.

The system that evolved was a form of process control; it was designed specifically to relieve a keyboard operator from making end-of-line decisions. The operator is required to produce a primary tape on which the manuscript is coded as a continuous string of words and spaces. This tape is then used as input to a computer and the typesetting program undertakes a 'sausage machine'-like function of measuring the aggregate character-widths in a word against the residual line length to divide the text into lines of equal length.

Most systems provide a form of hyphenation routine, but the higher the degree of sophistication of these routines, the slower the production. For this reason, some systems provide for human intervention by displaying each 'unacceptable' line-end word on a cathode ray screen for the monitor operator to decide the location of the hyphen. Another method requires the keyboard operator to insert a discretionary hyphen in long words when producing the primary tape.

Printers and publishers have also taken an interest in computer typesetting systems although in this field the economic justification for such systems is more difficult than in the case of the newspaper industry. Outside the sphere of newspapers and general printing installations, some notable progress has been made in this country in the typesetting of text processed and generated in a data processing environment. It is with the typesetting of this kind of data, previously output on a computer line printer, that the remainder of this report will be largely concerned.

2. WORLD STATISTICS

Before proceeding to examine the different areas of development in Britain, it is worth noting the continued rapid growth rate that was revealed by the annual survey carried out by Composition Information Services (1) at the end of 1968. This report showed an increase of 54 per cent over the previous year in the use of computers in typesetting, bringing the total to 821 with a further 74 on order. The 1964 total was 80.

Outside the United States, the United Kingdom has the most installations with 53, against 39 in Canada and 26 in Germany.

General-purpose computers are used in 51 per cent of all installations. The IBM 1130 was still the most popular model, followed closely by the Digital Equipment Corporation Typeset-8 Series which have more than doubled their sales in this field. Compugraphic, who market the special-purpose computers Justape and Justape Junior, have benefitted most in the twelve month period with sales of 136 of their machines. The world survey shows the service bureaux, with only 4 per cent of the installations, to be the fastest growing group of computer typesetting users, although newspapers still account for nearly two-thirds of the total. The printers' share has decreased since the last survey from 20.5 to 16.8 per cent. The increasing trend towards

photo-composing machines is emphasised by the fact that they are now in use in nearly one-third of all computer typesetting installations. The most popular machine for this purpose is the Photon 713 'Textmaster', followed by the Mergenthaler 'Linofilm'.

3. UNITED KINGDOM SURVEY

In the summer of 1964, the Institute of Printing organised its first conference on computer typesetting at the University of London. It was arranged in order to provide an opportunity for printers and computer specialists to meet and discuss problems involved in the application of computers to conventional methods of typesetting. All sections of the printing industry were represented, and for many this was the beginning of any real understanding of the potentialities of computers in the printing industry. From this time, the printing colleges, together with the unions, master printers, the Institute of Printing and others, have co-operated in providing lectures and appreciation and retraining courses that have enabled printing personnel to become more informed and play a more active role in the development of the new techniques.

The British printing industry was already in a stage of transition from hot metal to film before this event. The phasing-in had been gradual, because of the very considerable capital that was invested in metal, machinery and other equipment associated with the letterpress process.

This evolution was accelerated by a few of the larger printing groups, who, already undertaking some rationalisation as a result of take-overs and mergers, invested vast capital in new buildings and installations fully equipped with the latest photo-composing and offset machinery, and at the same time sponsored research and development programmes in computer typesetting.

As a result of this awareness, two computer bureaux (Computaprint and Rocappi) were established about this time, both wholly dedicated to computer typesetting, and both have accumulated considerable experience from a wide variety of applications. Of these Rocappi now operates through another bureau rather than maintaining its own installation.

In 1965, the Ministry of Technology sponsored the Computer Typesetting Research Project at Newcastle University to prepare a suite of text handling and processing programs which would be of practical use to the printing industry. A team under the leadership of

Mr. John Duncan has conducted experiments on most aspects of computer typesetting during the past four years and has published a comprehensive set of papers (2) fully documenting their applications. It is expected that the project will be completed towards the end of 1969.

A few independent research establishments have also participated in the development of systems, but the bulk of the operational computer typesetting systems in this country has been provided by the computer manufacturers, either directly or through the agency of the suppliers listed in Appendix I. The largest number of installations is claimed by Digital Equipment for its Typeset-8 series, closely followed by the ICL 1900 series.

ICL has developed a typesetting 'software package' which is a composite program of modular routines. A user's system can consist of a selection of the modules and can be increased to provide wider applications. It is claimed that when the 'package' is complete it will be capable of most typesetting functions. Other manufacturers supplying general purpose machines have preferred to write or adapt their software to suit individual installations unless the user develops his own program.

The Government has, through the agency of the Office for Scientific and Technical Information, made a considerable contribution to the research being undertaken into the development of text processing. In 1967 the Documentation Processing Centre was set up as part of the OSTI organisation to provide centralised facilities for sponsored experimental projects being conducted mainly in Universities and similar institutions. These facilities include computing capacity, peripheral equipment and software as well as expertise in both document handling and computer processing. The Centre will acquire a working knowledge of existing operational systems and collect information about other current and potential areas of research. It will also advise, or assist where requested, within its terms of reference, (see Appendix III), those organisations anxious to achieve graphic output from computer processed data.

4. AREAS OF RESEARCH AND DEVELOPMENT

The following sections are intended to illustrate rather than to catalogue the developments known to have been undertaken in the field of computer typesetting in this country.

4.1 Newspapers and periodicals

The newspaper industry uses both special and general-purpose machines to process tapes to drive hot metal line-casting or photo-composing machines.

The special purpose devices are basically process control machines designed solely for the function of typesetting. They can be modified by plug-in hardware or paper-tape to provide a variety of formatting styles, a justification routine and a form of hyphenation.

Some general-purpose machines are used purely in a typesetting mode, but 'packages' are available for classified advertising (covering both production and accounting procedures), newsagents' accounting, circulation statistics, wages, purchase ledger and budget control.

Southwark Offset, a subsidiary of the International Printing Corporation, is the most up-to-date plant for magazine production in London. They are using an ICL 1900 series machine and with the aid of ICL have trained a number of printing personnel as programmers for the purpose of writing their own modular typesetting software routines.

4.2 Book Production

A growing number of printers and publishers are using, or considering the introduction of, computer typesetting for book production. While the economy of a once-off production would be minimal, it should be understood that, from the one initial keyboarding, subsequent editions could be produced in any desired format from the manuscript held on magnetic tape.

The occurrence of hyphenation is much less frequent in the wider line lengths associated with book production, and, since the introduction of computer typesetting, the importance of 'justified' text in book production has again been strongly questioned. If text is only aligned to the left margin it further reduces the occurrence of hyphenation and considerably increases processing speeds.

The Royal National Institute of the Blind, using an IBM 1130 computer, are working on a process that, it is hoped, will lead to quicker and cheaper production of braille books. Using their own systems analyst, who has been working on analysing US programs for the translation of braille, the RNIB aim to use the computer to translate directly into braille and provide punched card output for production of master printing plates.

A new machine being developed by the RNIB will accept these punched cards and will produce a perforated zinc plate for use on the RNIB solid dot braille printing machine.

Technical books and scientific publications have always been a specialist field in conventional printing. While there is little doubt that they will remain so, the development of photo-composing machines using cathode ray tubes to generate any character shape and the facility of mixing type sizes provide greater scope for the presentation of complex mathematical display formulae.

In the field of mathematical publications, research is currently being undertaken by Marconi-Elliott Computer Systems Limited into methods of encoding formulae for computer input in such a way that a mathematical typesetting program could then output a tape to drive a photo-composing machine. They have also made some progress in the development of a programming language known as MATHSET which is being designed for the purpose of writing mathematical typesetting programs.

Comprite Limited, who are the UK agents for Composition Systems Incorporated, specialise in typesetting systems. They claim to have developed keyboarding methods and computer programs which will successfully produce typographically correct mathematical equations from non-justifying keyboards.

4.3 Directories and other listings

An Elliott 903 computer has been installed at the Stationery Office Printing Press in Edinburgh to assist the typesetting of telephone directory entries and other work. The system accepts copy from up to ten operators' keyboards and produces the paper-tape output which is fed to Intertype hot metal line-casting machines. Entries in the GPO telephone directories conform to a number of standard formats and the programs written for the application simplify the keyboard operators' task by performing various automatic functions including justifying and breaking entries, leadering, capitalisation, repeated surnames and control of a number of different formats.

A system for the production of telephone directories on the Linotron 505 photo-composing machine has been developed by the HMSO staff at Norwich with assistance from the consultant, Mr. Roy Gift. The installation is now sited at HMSO Gateshead.

Thomson Directories Limited are the official advertisement contractors for the GPO telephone directories. The company was formed in 1965 as a subsidiary of the Thomson Organisation Limited and has embarked on a ten-year plan of rapid expansion employing computer typesetting and associated techniques. The plan involves the development of a network of new Yellow Page directories and other interesting extensions into the fields of proprietary information.

For many years Butler and Tanner Limited have produced the annual Medical Register for the General Medical Council. The alterations to thousands of quarto pages of standing type necessitated by the annual revision of the register were becoming a major problem, and the Council has now turned to computer photo-typesetting. In order at the same time to cover the complex operations involved in the registration of practitioners, the Council has installed its own tape-generating equipment, periodically supplying amendment input for a standing file held on magnetic tape by a computer bureau. In addition to providing at intervals throughout the year a series of different data retrieval and processing operations, the computer systems permit a final updating run on the press date, followed shortly by the production of made-up film pages comprising the entire Medical Register.

There are many other varieties of data in the form of listings that might be considered in this section, and among these is the annual production of Electoral Registers, in which a number of local authorities are known to be interested.

4.4 Reference publications

Butler and Tanner Limited are associating with Computaprint for the production of the 1970 edition of 'Who's Who' (3,500 pages). Entries are quite long, each miniature biography averaging 1,500 characters, and the system being devised might be suitable for other reference works with long entries. Each entry is given a discrete code number under a system designed so that an almost unlimited number of new entries can be inserted between two existing entries without upsetting the numbering sequence. The computer input is by GSA perforator, which is basically a typewriter (IBM 73 with golf ball action) mounted on a desk housed in the drawer of which is a punch complete with tape rewinder. Output is a magnetic tape to drive the Lumizip 901 photocomposing machine.

The Research Department of the Association of Special Libraries and Information Bureaux have developed a system for the production of their publication 'Index to Theses'. A suite of twelve programs has been written, in which three programs are concerned with the typesetting process and one is used to translate the assembled codes to those required by the particular output device. The other programs undertake the input, validation, sorting, cross-referencing and re-formatting of the data.

A program to produce the Gazeteer of Great Britain for the quarter-inch Ordnance Survey map has been completed by HMSO. The system is designed to produce a tape to drive a hot-metal line-casting machine.

The earthquake bulletin published monthly by the Seismological Centre in Edinburgh is now being photo-composed by Computaprint from data supplied by the Centre on magnetic tape. It is claimed that the composition and make-up time are reduced by 75 per cent.

4.5 Library applications

Librarians with their understanding of hierarchial classification of subjects and indexing methods are playing a leading part in the mechanisation of library systems. Difficulties arise when attempts are made to adapt the time-proven and established manual systems of classification into a machine-readable code. A recent innovation in the U.K. has been the creation of a Standard Book Number Scheme (3) which ensures that in future every new book published is assigned a unique nine digit number which both appears in the book and is associated with its pre-publication documents.

Two important development projects are being conducted by the British National Bibliography and the Bodleian Library at Oxford. The BNB MARC (Machine Readable Catalogue) (4) is part of an international system designed for the purpose of supplying and interchanging bibliographical records at a national and international level. In due course the weekly 'British National Bibliography' is likely to be typeset from current MARC records.

The entire pre-1920 catalogue of the Bodleian Libiary (5) at Oxford, estimated at a total of 1.5 million entries, is being transcribed to magnetic tape using an optical character reader. Pages of entries are prepared on ordinary typewriters modified to type an optical font, and are then scanned with a Farrington 3030 page

reader. The pre-1920 catalogue contains a total of 150 million characters. Alphabets of all European languages curret over 300 years are represented, both classical and modern. About 200 different characters have been identified in the entries, most having both upper- and lower-case forms. Currently the total catalogue contains about 3.5 million entries, of which the post-1920 part is growing at the rate of about 60,000 entries a year.

4.6 Information systems

In the field of information processing a considerable amount of study has been undertaken into methods of organising input that are calculated to make the maximum use of all information held in the system. This requires the system record of new information to be structured in such a way that any specific element of information can be readily located and retrieved. The success of such a system also depends on an error-free input system which must be based on a routine of efficient copy preparation, highly skilled keyboarding and careful record checking.

The most significant original development in this country is probably that part of the OSTI-sponsored INSPEC (6) system that deals with the production of computer typeset abstract publications. This application developed by the team situated at the Institution of Electrical Engineers is now operational and data is processed on an ICL 1900 series computer. The fundamental concept of the system is that a single intellectual effort of classification and indexing, and a single keyboarding operation, will combine to create one unique record in the magnetic store. Each record contains everything that the system needs to 'know' about a given scientific paper. From this store the computer can select, compile, sort, index, and compose each individual publication. The typesetting service produces three abstract journals and three current-awareness papers, together with a series of monthly and cumulative indexes. The publications are produced by Unwin Brothers on a Photon 713 'Textmaster' machine using a matrix with a unique mathematical and scientific character set. There is no doubt that this highly successful and important application will serve as a model for other abstracting and typesetting services.

Weatherby and Sons, who are agents for the Jockey Club and National Hunt Committee, are currently engaged in the design and programming of a large data collection

and retrieval system based upon an IBM 360/30. This system will effectively control the day-to-day administration of horse-racing in Great Britain and will use computer-controlled typesetting techniques to produce official racing publications.

The Stationery Office (H.M.S.O.) is investigating the possibility of putting the Statutes on to a computer system for typesetting purposes with a view to its possible use eventually for the retrieval of legal information.

4.7 Statistical data

Perhaps the most natural application for computer typesetting is that of numeric data, in that, because the numeral digits in type are not of variable width as are alphabetic characters, the time-consuming process of determining the width of each character is not necessary. The greater ease with which font changes can be handled in computer typesetting is of particular value with statistical data, where font differences can help to imply distinctions and associations within sets of printed values. When, further, the numeric data has been engendered by a programmed calculation in the computer, the need for keyboarding will be minimal and the possibility of errors extremely remote.

One such application is the 'Taylors Tax Tables' undertaken by the Estates Gazette in association with Marconi-Elliott Computer Ssytems Limited. Fifty sets of figures were input to an ICL 4100 which produced 179,700 six-figure entries by calculation. The data was then translated to Photon 713 code and the resultant tape was fed to the 'Textmaster' photo-composing machine to produce 800 pages of error-free tables.

Another example of processing numeric data might be the daily updating of Stock Exchange lists, where only the quotation price, together with a unique company code, needs to be keyboarded for each business transaction. A program would then automatically calculate the plus or minus fluctuation value, amend, if necessary, the highest or lowest quotation value for the current period, and insert the closing price.

Preparatory work is being undertaken by HMSO for processing the results of the next national census. The work involves complex routines for the presentation of the tabulated statistical data under boxed rule headings.

A time-table setting system based on punched card input to an IBM 1401 computer to produce a magnetic tape to drive a Lumizip 901 photo-composing machine has been developed by Computaprint Limited and Index Publishers. Computaprint are also producing the Rootes Motors Parts List on a Univac 418. Rootes provide a magnetic-tape output from the ICL 1500 which is converted to drive the Lumizip 901 photo-composing machine.

After two years planning and co-operation between International Data Highways and British Rail, a system to mechanise the production of railway time-tables is being considered. This will entail the setting up of a data base containing at least 50,000 unique passenger journeys on the train services of all regions. From this data base the individual time-tables will be produced, including, where necessary, optimised interconnections.

5. ECONOMICS

There is no easy answer to the question 'Is computer typesetting an economic proposition.' Many factors have to be considered before a computer is purchased.

Arthur Phillips, in his book 'Computer peripherals and typesetting', lists eighteen questions that should be considered in appraising the economics of a computer typesetting system. This list of questions has been reproduced by permission of the author as Appendix II to this report.

Special-purpose computers are generally expected to be written off over three years and general-purpose machines over a 5-10 year period, so that unless speed is of paramount importance or, alternatively, the volume of typesetting is very considerable, the advantages of using a computer to process data that would not otherwise enter a computer system are unlikely to justify the high capital costs. Basically, it is a matter of evaluating whether the marginal production increase in typesetting would cover the cost of the computer installation, bearing in mind the short estimated life of the installation.

A general-purpose computer can of course help to pay for itself through its capabilities to generate special indexes and bulletins from the same data base and to undertake accountancy, wages and other general administration services.

A fairly competitive market now exists for the use of bureau computers, and time is also readily available from installations having the faster photo-composing machines. These facilities could prove for some a worthwhile alternative to the heavy capital expenditure involved in the purchase of such equipment.

The output of film provides a very considerable economic advantage over metal in most respects, speed of production, convenience of handling and the limited space for storage. The ability to produce, under program control, fully made-up page output in any specified format, using variable type sizes, extends the economy over the whole field of composition practice.

6. FUTURE DEVELOPMENTS

The introduction of the third generation computers provided a considerable advance in both speed and store capacity. It is said that the next generation of computers will be at least ten times faster in basic operations.

As the capacity of computers increases, so also does the potential size of systems. Vast data banks are currently being created and planned to provide library, bibliographical and information services covering every aspect of the life of the community.

The knowledge acquired from many man years of study into methods of structuring input records will be used to obtain the maximum flexibility in data manipulation from a single keyboarding entry. These calculated entries will allow for the smallest element of data in a record hierarchy to be located. It will in this way be possible to collate like elements or fields of information to provide for selective retrieval or the compilation of indexes.

The ability to produce magnetic tape direct from a keyboard may largely eliminate paper tape as an intermediate computer-input medium. The techniques for reading printed characters in differing type founts and sizes are being improved and the emphasis is on cheaper equipment rather than higher document-reading speeds. A great deal of data will enter systems already verified on a visual display unit attached to an on-line terminal keyboard unit.

The skills that will be required to ensure error-free input to a system will demand personnel of a special ability. These 'documentalists' on whom the efficiency of a system largely depends will require a knowledge of copy preparation, data processing, keyboarding and typography. This need should influence the development of training and retraining courses.

The ability to digitise and hold line illustrations in store is not far removed from the very effective technique of CRT generated characters used in the latest photo-composing and microfilm recording devices. Further development will enable on-line creation of text illustrations immediately available for page composition.

Retrieval systems will require various levels and qualities of output from such systems. The lowest levels will be used for small quantities of output on console typewriters, line-printers and video-display units. The higher levels will be used for vast quantities of film output in complete page format from photo-composing and microfilm recording machines, although developments in interactive systems will tend to limit the quantity required to be printed. The typesetting programs will be capable of any format and will undertake the insertion of folios and running-heads, justification, hyphenation, column adjustment, fount and type size changes and page-depth control. It will also be possible to provide text separation for two colour publications.

High level programming languages will continue towards the goal of a straight-forward user language; a text-processing command language is being investigated as part of the DPC information display project, with the aim of encoding data to provide for the maximum character, formulae and diagrammatic representation within the limits imposed by a chosen output device.

News and information services will be on-line to centres throughout the country and the world, and the 'national' newspapers as we now know them could become 'local' daily papers with a mixture of national and local news. It is unclear at this stage how far down the line this process could be continued and whether, ultimately, the problem of typesetting data received on a domestic terminal will need to be considered.

7. CONCLUSIONS

The revolutionary techniques being developed in the processing and generating of 'manuscript' will require the printing industry to deal with a considerable increase in the volume of production, of which much of the typesetting would not have been considered practicable by conventional methods. The anticipated demands on the industry make more urgent the need for a new approach to the training of apprentices, and, also, for

the re-training of adult personnel. It was for these reasons that The Minister of Employment and Productivity authorised the establishment of an Industrial Training Board for the Printing and Publishing Industry. The Bogrd, under the chairmanship of Mr. Norman Fisher, will consider, report and make recommendations on the training needs of the industry.

Fundamentally, the art of typesetting is very much the same, whether performed by hand, keyboard or computer, and, ideally, programs should be written by those with a knowledge of the conventional operation. If the craftsmanship of presentation and legibility can be harnessed to the power of the computer and the scope of, say, the photo-composing machine, we shall not only have the capability of producing enormous quantities of printed matter, we shall ensure that it can be effectively used.

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Appendix I

List of manufacturers and suppliers of computers used in known typesetting installations in the United Kingdom.

General purpose (manufacturers):

Digital Equipment Corporation
Marconi-Elliott Computer Systems Limited
Honeywell Controls Limited
IBM
ICL
Univac

Special purpose (manufacturer):

Muirhead Limited

Special purpose (suppliers):

Fairchild Graphic Equipment (UK) Limited
Harris-Intertype Company
Linotype and Machinery Limited
Monotype Corporation Limited

Appendix II

Economic Considerations of Computer Typesetting
(reproduced from Computer peripherals and typesetting, HMSO, 1968)

A great deal of research is necessary before the full potential of computer typesetting can be realized and effort can easily be wasted by experimenting with unsuitable work or endeavouring to write comprehensive programs for a variety of input and output media. For some work it may be convenient to make the typesetting work the final output; for other requirements it may be desirable to start with the typesetting tape and use this data for computer input and subsequent processing.

If speed and complexity of operation is the vital factor then it is not a question of whether to use a computer, but how to use it. If the computer is to replace existing systems the first consideration should be 'what series of operations is it going to replace.' This defines the economic margin within which the computer must operate.

The economic margin is interpreted as the difference between the cheapest effective way of doing the work without the computer and the cost of doing the work with a computer, assuming that the computer programming and running time costs nothing. If a system is designed to make this margin as big as possible, then consideration can be given to the recovery of programming costs and the reduction of processing time in order to obtain an estimate of the true economics.

The problem of the application of the computer to typesetting can be summarised in the following questions which must be answered satisfactorily before a successful system can be evolved.

1. Can the proposed application be considered a research project from which there is not expected to be any direct financial gain.

2. If not a research project, is the data which will be typeset going into the computer in any event because of other processing requirements. If so, can modular programs be written that will provide all the typesetting controls without complicating the programs required for the main processing.

3. If the data are not otherwise going into the computer, is an ADP system needed solely to provide maximum processing speed independently of cost.

4. If speed is not paramount, is there a sufficient economic margin in the use of the computer to make it a worthwhile proposition.

5. What is the maximum use that can be made of the information once it is in a machine readable form. Can this use be extended to increase the economic margin of the project by the output of additional information. Can typeset output be generated to exceed the data input and are any library routines available for this processing.

6. What quality of finished print is expected. What is the upper limit to the range of characters. Would facsimile reproduction of computer print-out be adequate and economic.

7. What peripheral equipment is available and will it work at an adequate speed for the project. Is there any requirement for data-links or CRT remote displays.

8. If graphic arts quality is required does the typographic style of the text need to be modified to give the best appearance within a logical framework so that as much as possible of the typographic control coding can be in the program and not in the input.

9. Is there any need for display setting under computer control. If so is this practicable, or should it be left to manual composition.

10. What typesetting or filmsetting equipment is available for graphic arts print-out. Is this adequate for the proposed setting. Are type or filmsetting routines already available for the selected equipment.

11. What is the minimum amount of data that need be included in the input tape in order to provide the maximum information output.

12. What is the best form of input, tabulator cards with fixed fields, punched tape with variable fields or on-line keyboards.

13. Which input keyboard arrangement will give the best scope to meet the output requirements with the minimum of keystrokes. Is hard-copy desirable with the primary data generation.

14. What are the advantages and disadvantages of keyboard verification compared with reading computer print-out and the use of correction routines.

15. What is the best method of primary and subsequent correction. What are the economies of a fast filmsetter proof run compared with computer line-printer output. If it is planned to use successive computer runs for corrections has the cost of checking the print-out been considered.

16. Does the advantage of using a machine oriented language for the program outweigh the use of a machine independent language which would enable the program to be used on different computers. Would it be best to write the programs in a problem oriented language to reduce program writing and debugging time and then to translate the program into a symbolic machine code when the programs have been proven.

17. How can modular programs be written to make them available for other work with the minimum of amendment.

18. Will the cost of programming be recovered on the initial job or can it be recovered if spread over other work for which it will be needed.

The answer to these questions should provide an adequate framework for the study of a successful typesetting system. It should also make it clear that what is called the 'systems analysis' of computer application is of prime importance in typesetting. The difficulty in studying a system for computer typesetting is in the imponderables which depend on meeting the changing needs of the many people involved in the process before a text is printed. It is the technical author, editor and compiler of the text who really stands to gain the most from the use of the computer once the facility of textual analysis and compilation is pefected.

Appendix III

The Documentation Processing Centre

1. The Documentation Processing Centre (DPC) is an official research and experimental organisation, set up in Manchester in 1967 after a recommendation from the Advisory Commitee for Scientific and Technical Information. Its main objective is to enable computers to play a more effective part in the scientific and technical information systems of this country. DPC is a section of the Office for Scientific and Technical Information (OSTI), which is in turn a division of Libraries and Information Systems Branch of the Department of Education and Science.

2. The main roles of OSTI are to promote research, development of new techniques and systems, improvement of existing library and other information services and experiments with new ones. It also helps to co-ordinate the information activities of the Government and private organisations in order to blend UK effort with work being done in other countries; and it encourages all forms of research that can influence the effectiveness of (i) scientific communications, (ii) classification, storage, retrieval and translation of information, and (iii) operation of information services for scientists and engineers.

3. The assistance which the DPC is to give OSTI in fulfilling these roles includes the provision of access for those engaged on experimental information projects to a wide range of computing and allied facilities, which can be supplied more economically and efficiently by (or through) a specialised centre than by general service bureaux or by the Institutions responsible for the projects. It also conducts research on computing aspects of the handling of scientific and technical information - particularly on the design, development and evaluation of computer programs, on the special processing problems associated with non-numerical data operations, and on graphical input and visual display of such data.