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ABSTRACT

The first of three sections in this booklet reviews ways in which printed and duplicated materials can be used within the context of the three basic instructional strategies, i.e., mass instruction, individualized learning, and group learning. The second section examines in detail the planning and designing of such materials for specific purposes, including discussions of the basic principles underlying the design of printed and duplicated materials, and the design of specific types of materials such as handouts, worksheets, individualized learning materials, and group learning materials. In the third section, the advantages and disadvantages of five processes by which materials can be mass produced are identified, and guidance is offered on which method to use in any particular situation: (1) photocopying; (2) hectographic duplication; (3) stencil duplication; (4) offset-lithographic printing; and (5) computer-aided printing. Copyright restrictions on multiple copying of documents are briefly noted, and an annotated list of six references recommended for further reading is included. (MES)

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How to Produce Printed and Duplicated Materials

Introduction

As is shown in booklet number 10 in this series ("A review of the different types of instructional materials available to teachers and lecturers"), the various paper-based materials that can be prepared 'in-house' in a school or college and run off in large numbers on a duplicator or printing machine constitute one of the most versatile tools at the disposal of today's teachers and lecturers. In this booklet, we will therefore take a detailed look at the production of such materials.

First, we will take a general look at how printed and duplicated materials can be used within the context of the three basic instructional strategies that are identified in "A guide to the selection of instructional methods" – mass instruction, individualised learning and group learning. Then, we will carry out a detailed examination of how one should set about the task of planning and designing printed and duplicated materials, looking first at the basic principles that should underlie such design and then at the design of specific types of materials – handouts, worksheets, individualised learning materials, and so on. Finally, we will turn our attention to the various processes by which the materials can be mass produced, identifying the advantages and disadvantages of each process and offering guidance on which method to use in any particular situation.

How printed and duplicated materials can be used in different teaching/learning situations.

In "A review of the different types of instructional materials available to teachers and lecturers", it is shown that printed and duplicated materials can play a key (albeit different) role in each of the three basic classes of instructional methods (*mass instruction, individualised learning and group learning*).

Mass instruction

In the case of mass instruction, the role of printed and duplicated materials is essentially a *supportive* one, providing the teacher, instructor or trainer who is carrying out the instruction with tools that help him to achieve specific objectives or subsets thereof. Among the most important of these tools are all the various forms of information – providing *handouts* that can be given to the members of a class – sets of notes, tables of data, copies of important diagrams, maps, and so on. Appropriate use of such handouts can

not only improve the effectiveness of the mass instruction process (by, for example. ensuring that *every* member of the class – and not just those that are accomplished note-takers or good graphic artists – ends the lesson with a decent set of notes or a clear copy of a key diagram) but can also greatly increase its efficiency (by, for example, reducing face-to-face contact time or enabling a greater proportion of such time to be devoted to educationally-useful activities such as exercises and discussions).

The other main class of printed and duplicated materials that can be used in mass instruction contains *assignment sheets* of one form and another – problem sheets, worksheets, lab sheets, and so on. As in the case of handouts, appropriate use of such materials can greatly increase the effectiveness of mass instruction of all types. Use of a well-designed worksheet at an appropriate point in a taught lesson, for example, can introduce a welcome participative element into what may otherwise be a completely passive experience for the students, thus helping to maintain their concentration and interest.

Individualised learning

As is shown in "A review of the different types of instructional materials available to teachers and lecturers", the role of instructional materials in individualised learning is much more crucial to the learning process than is the case in mass instruction, since it is these materials that have to constitute the actual vehicle whereby the instruction process is carried out. In other words, self-instructional materials not only have to convey information to the learner, they also have to structure and control the process by which this information is presented to and assimilated by the learner. Such materials therefore require to be much more carefully designed than materials that are simply to be used to support mass instruction. Indeed, experience has shown that they can take up to 10 times longer to produce.

Printed and duplicated materials can play three basic roles in individualised learning. First, they can be used as the actual medium of instruction, e.g. in the form of *structured notes, worksheets* or *programmed texts*. If they are well designed, such materials can constitute an extremely effective method of enabling pupils, students or trainees to master the basic facts and principles of a subject or topic at their own natural pace. Also, there is a considerable amount of evidence to suggest that the resulting degree of mastery is generally greater than that attained in the course of a conventional expository lesson, where the pace is dictated by the instructor.

Second, printed and duplicated materials can be used as a vehicle for structuring and controlling the process by which learners acquire information rather than as a means of conveying the information

itself. Good examples of such materials are the various forms of *study guide*, which can be used to direct learners to relevant chapters (or parts thereof) in text books or instruct them on how to make optimum use of other individualised learning media such as tape-slide programmes, multi-media packages and home experiment kits.

Third, printed and duplicated materials can be used to support other individualised learning media. They can, for example, provide worksheets or diagnostic instruments for use in conjunction with audiovisual programmes or computer-based learning systems, provide illustrative or extension material, or give learners their own personal copies of key material for subsequent study or revision.

Group learning

Unlike mass and individualised learning, group learning is essentially a *process-centred* activity, with the emphasis being on the interactions that take place between the people taking part rather than on the teaching or learning of facts, principles, etc. Thus, the role of any instructional materials that may be used in conjunction with a particular group-learning exercise is usually mainly supportive, although such materials can play a key part in making the exercise function smoothly.

Of the various media that can be used to support group learning exercises, printed and duplicated materials are almost certainly the most versatile and most important. They can, for example, be used to provide the basic resource materials on which the exercise is centred, provide the participants with instructions or guidance on how to carry out the exercise, and provide ancillary or illustrative material of various types. In most exercises that involve simulation or role play, for example, printed or duplicated materials are used to establish the basic scenario and brief the participants on their respective roles. They can also be used to provide things like worksheets, data sheets and background reading material, all of which are commonly used in group learning exercises.

How to plan and design the materials

Now that we have seen how printed and duplicated materials can be used in different types of teaching/learning situations, let us turn our attention to the way in which such materials should be planned and designed for specific purposes. We will begin by looking at some of the general principles that should underlie all such work of this type, then at how to tackle the design of particular types of printed and duplicated materials, looking in turn at *handouts, worksheets, individualised study materials* and *resource materials for group learning exercises.*

Basic principles underlying the design of printed and duplicated materials

Although printed and duplicated teaching materials come in a wide range of types, and vary greatly in format, content, layout, level and so on, it is possible to adopt a standard basic approach to their planning and design. This has the following three stages:

(i) Identifying the specific instructional role that you want the materials to play;

(ii) Formulating a basic plan for the materials;

(iii) Writing and designing the materials.

The full production process has, of course, a rather crucial fourth stage, namely, producing the materials in whatever form and quantity are needed, but this will be considered separately in the final section. Let us now look at the three planning and design stages in greater detail.

(i) *Identifying the instructional role.* This is, of course, the starting point in the planning and design of *all* teaching or training materials. It involves taking a detailed look at the learning objectives that you are trying to achieve, and identifying the specific areas where printed or duplicated materials could help you do this within the overall context of the basic instructional strategy that you have decided to use.

(ii) *Formulating a basic plan for the materials.* Identification of the role that you want the materials to play should be of considerable assistance in the next stage of the design process – formulating a basic plan for the materials. Indeed, in many cases, you will find that the process is virtually automatic, with the basic design parameters for the materials (their *format, content* and *structure)* following logically from this role. It is usually advisable to consider these three design parameters in turn, beginning by deciding what sort of materials you want to use (a handout? a worksheet? a set of role sheets? and so on), then deciding on the basic content, and finally drawing up an outline structure. At each stage, it is useful to sketch your ideas out on scrap paper, a process that can be extremely helpful in clarifying your thinking and eventually coming up with a workable scheme. Needless to say, this may well take several attempts, with a number of seemingly promising ideas being considered, found wanting and discarded *en route*.

(iii) *Writing the materials.* With some types of printed and duplicated materials, most of the creative work is done at the basic design stage, with the actual writing of the material

merely involving filling out these ideas and finalising the lay-out. With others, the writing stage is where the hard work really starts, involving many hours, days or even weeks of concentrated effort. This is especially so in the case of lengthy materials such as linked series of hand-out notes, suites of individualised learning documents or integrated sets of resource materials for exercises of the game/simulation/participative case study type. Obviously, it is vitally important to adopt a systematic, disciplined approach to such work, and readers should find the following guidelines helpful in achieving this.

Matching the content to the design objectives and target population

This is one of the most obvious things that a writer of instructional materials has to get right if the materials are to achieve their design objectives properly. Thus, it is worthwhile spending some time thinking about detailed content before embarking on the writing task. One way of doing this is to ask yourself the following three questions:

(a) What *must* the readers know after using the material?

(b) What, over and above (a), *should* the readers know after using the material?

(c) What, over and above (a) and (b) *would it be useful* if the readers knew after using the material.

Clearly, it is absolutely essential to include everything contained in category (a), highly desirable to include everything in category (b) and desirable to include as much of (c) as possible. Conversely, there is absolutely no point in including anything that falls into none of the three categories, unless it fulfils some other essential function.

Using an appropriate writing style

Adopting a writing style that is appropriate both to the type of materials and the ability of the users is one of the most difficult tasks facing every author. If one is only used to writing formal reports or research papers for learned journals, for example, it is never easy to change to the radically different style that is required for educational writing, particularly if the material is to be used with younger or less-able learners. A number of authors offer hints on how this can be done, however, among the most useful of which are the 'twelve hints for effective writing' given by Derek Rowntree:

1. Write like you talk
2. Use the first person
3. Use contradictions

4. Talk directly to the reader
5. Write about people, things and facts
6. Use active verbs and personal subjects
7. Use verbs rather that nouns and adjectives
8. Use short sentences
9. Use short paragraphs
10. Use rhetorical questions
11. Dramatise wherever possible
12. Use illustrations, examples, case studies.

There are also a number of useful tests – both subjective and objective – that you can use to see whether your style needs to be improved in any way. The first involves reading something that you have written recently and asking yourself the following questions:

- Is my style pompous? formal? friendly? slapdash?
- Do I use too many cliches?
- Do I use more words than I need?
- Do I have favourite words and phrases that I overuse?
- Do I make frequent use of passive constructions? impersonal constructions? negatives?
- Are my sentences generally long or short?
- Do I use too many long words? abstract words? technical words?

If this self-evaluation process highlights any obvious faults in your writing style, you should make a deliberate effort to eliminate or mitigate them. If, for example, you find that you make too much use of the passive, check each paragraph that you write for a while and eliminate every passive verb; you will soon find that you make much less frequent use of such verbs.

A rather more objective test that can be used to determine whether the style of written educational material is suitable for the people who are to use it is the *Cloze Text*. This involves selecting a typical passage roughly 250 words long, and, after a 30–40 word run-in, blanking out the next word and every sixth or seventh word thereafter. This blanking should be done by covering the words in question with suitable opaque material (eg plastic tape) that makes it impossible to read them. Once this has been done, select one (or, preferably, several) of the people in your target population and ask them to read the material. If they fail to provide the *correct* word or a *totally acceptable alternative* in at least 60–70% of the cases, then

the text is too difficult. If this is so, modify the passage by simplifying the language and shortening the sentences.

Another objective method of determining whether the style of a text is appropriate to the people for whom it is intended is to calculate its *Modified Fog Index*, which gives a direct measure of the *reading age* of the material (ie the lowest age group by which the material is likely to be fully understood). This can be calculated as follows:

1. Choose a typical sample of the text, and work through a particular section, counting the words and sentences as you do so; stop at the end of the first sentence that takes you past 100 words. Calculate the average sentence length (asl) by dividing the total number of words by the number of sentences.
2. Work through the same sample again, counting the number of words with three or more syllables. Do not count words that are (a) capitalised, (b) combinations of short, easy words (like 'over-worked' or 'underground') or (c) verbs that only have three syllables because of endings like 'ed' and 'es' (eg 'deflated' and 'dismisses'). Calculate the percentage of hard words (%hw) in the passage by dividing the number of remaining words of three or more syllables by the total number of words and multiplying by 100.
3. Calculate the reading age of the passage using the formula:

   Modified Fog Index = reading age (in years)
   $$= 0.4 \text{ (as l + \%hw)} + 5$$

If the average reading age of several typical passages in a given text turns out to be significantly greater than the age of the group for which it is intended, it again obviously requires modification by simplifying the language and shortening the sentences. Indeed, the reading level of educational material should, ideally, be well *below* the maximum level of difficulty with which the group can cope if they are not to find that the struggle simply to read the material inhibits mastery of the content. For this reason, any instructional material with a Modified Fog Index of over 20 is probably too difficult for *any* group – even highly-literate degree students – to cope with easily.

Two further points should be made regarding the Cloze Text and Modified Fog Index. First, both tests can only be used on passages of continuous prose, and are therefore unsuitable for checking the level of instructional material that consists of short sections (eg programmed texts) or is broken up with equations, tables, etc. Second, both tests tend to give an over-high indication of the reading age of material that contains a high percentage of scientific, technical or other specialized terms, and due allowance should therefore be made for this if necessary. Despite these limitations,

however, the two tests constitute a reasonably accurate and extremely useful method of checking the appropriateness of the level of textual material.

Adopting an efficient method of composing text

At this point, it would probably be useful to mention some of the different methods of working that it is possible for writers to adopt, and, in particular, to make readers aware of the way in which recent developments in microelectronics have made the task of composing textual materials very much easier than has ever been the case in the past.

There are four basic ways in which it is possible to compose textual material, three of which have been in use for many years. The first of these traditional methods is to write the material out in longhand – a somewhat slow and laborious method, but still the one that many authors prefer. The second is to dictate the material into a tape recorder of some sort – a very efficient method indeed if you have the ability to 'think in paragraphs' and if the material that you are developing lends itself to this type of composition. The third is to work directly at a typewriter – a method that is used by many professional authors, since it is considerably quicker than the longhand method if you posses the necessary typing skills.

During the last few years, however, a totally new method of composing text has become available, namely, use of an electronic *word processor*. Such a device enables text to be created on the screen of a computer video display unit using a keyboard terminal and subsequently stored in the computer's memory system, from where it can be recalled or printed out in hard-copy form at any time. The main advantage of such a system over a conventional typewriter is that corrections and changes can be made to the text being worked on virtually instantaneously, thus enabling an author to produce perfect final copy *as he or she works*, without the need to type the same page over and over again if changes are required. Furthermore, the development of progressively cheaper word processing equipment and software packages than enable inexpensive microcomputers to be converted into word processors means that more and more people are finding that they have access to such systems. Indeed, some commentators believe that virtually all instructional writing will be done on word processors within a comparatively few years. Such machines (they claim) will soon be just as common in schools, colleges and training establishments as typewriters are today, and, once teachers and trainers find out how easy and convenient they are to use, they will (it is argued) abandon more traditional methods of composition for evermore. Such an argument is difficult to refute.

The Importance of layout

Whatever type of material you are producing, the *layout* can be just as important as the content in determining whether it does its job effectively. Thus, it is essential that you give a considerable amount of thought to how this content is to be presented to the reader. In the case of lengthy textual materials, for example, it is always an advantage to divide the content into clearly-defined sections, and to use a systematic and logical labelling system to tell the reader what these sections are, indicate material of different types or degrees of importance, and so on. Appropriate use of things like different sizes, types and weights of print, underlining, boxing in of certain material, blank spaces, and illustrations can also help to produce a clear, visually-attractive and interesting layout. Detailed guidance on all aspects of layout can be found in the book by Hartley that is described in the 'Further Reading' section at the end of this booklet.

How to design specific types of materials

Having dealt with some of the basic principles that should underlie the design of all types of printed and duplicated materials, let us now turn our attention to specific types of materials.

Handouts

These can be used for an extremely wide range of purposes, and the detailed design of any particular handout will, of course, depend to a large extent on the exact role that is to be required to play. Some commonly-used types are listed below:

- Complete sets of notes on specific areas or topics, designed to be given to learners to save them from having to take notes themselves during lectures, training sessions, etc.
- Skeleton sets of notes, containing blank spaces that learners have to fill in themselves during a lesson of some sort; these can have educational advantages over complete notes in some situations, since they involve some participation on the part of the learner.
- Shorter documents (often only a single sheet) that are given out during a lesson to save the students from having to copy a complicated diagram, map, set of data, etc or to illustrate some specific point(s).

Worksheets

These come in almost as many forms as handouts, and can be used in just as wide a range of instructional situations. Again, the detailed design will depend to a very great extent on the purpose for which the worksheet is intended. We can, however, distinguish between at least two basic types:

- Highly-structured, 'convergent' worksheets, where the answers or other material that the learner has to fill in are largely (or completely) predetermined by the writer.
- More open-ended worksheets, where the responses are not nearly so circumscribed and allow the learner scope for divergent thinking or the exercise of creativity.

Both types can be used in all three of the basic classes of instructional situation (mass instruction, individualised learning and group learning), although the former is probably the one that is best suited for individualised learning, where the learning experience generally requires to be fairly tightly structured.

Individualised learning materials

As we saw earlier, materials that are intended for use in individualised learning have to be much more carefully designed than most other types of instructional materials, because they have to control or manage the actual instruction process as well as supply the content. We also saw that printed and duplicated materials can play three basic roles in self-instructional systems:

- They can constitute the actual vehicle by which the instruction takes place.
- They can be used to structure and/or control or manage the instruction process, with the main instruction being carried out via other media (e.g. books or tape-slide programmes).
- They can be used to support other individualised learning media, by, for example, providing worksheets.

The design of self-instructional materials is discussed at much greater length in a separate booklet in this series - "How to design programmed learning materials". Further information can also be found in the booklet by Lewis and the book by Rowntree and Connors described in the 'Further Reading' section at the end of this booklet.

Group learning materials

As in the case of mass instruction and individualised learning, printed and duplicated materials are capable of playing a wide variety of roles in group learning situations. Again, the detailed design of the materials depends to a large extent on the exact nature of this role.

Some of the most commonly-used types are listed below:

- Materials providing instructions or guidance on how to carry out or run an exercise (instruction sheets for participants, organiser's guides, and so on).
- Basic resource materials for use in the exercise (role sheets, background information documents, data sheets, worksheets and so on).
- Ancillary, illustrative and extension materials of various types.

When designing the resource materials for a group learning exercise, it is important to ensure that each item is capable of fulfilling its own specific function, fits into the general context of the exercise and is consistent with all the other materials in the package. This will almost certainly require a certain amount of 'tuning', i.e. revising or amending particular items as the work progresses in order to produce a self-consistent, balanced package. Readers who are interested in making use of group learning techniques in their work, and who wish to receive further guidance on how to design the necessary resource materials, are referred to the two books on game design that are listed in the 'Further Reading' section at the end of this booklet – "A Handbook of Game Design" and "Case Studies in Game Design". These cover the design of virtually all the different types of printed and duplicated materials that can be used in group learning exercises, with the latter containing large numbers of illustrative examples of such materials.

How to produce multiple copies of the materials

Having dealt at some length with the planning and design of printed and duplicated instructional materials, let us now turn our attention to the various ways in which it is possible to produce multiple copies of such materials for use by a class, group or set of individual learners. Basically, there are five practical methods by which this can be done within a college – *photocopying, hectographic duplication, stencil duplicating, offset-lithographic printing and computer-aided printing*. We will therefore look at each of these in turn, explaining how they work and identifying their main strengths and weaknesses, after which we will discuss how to set about choosing which method to use in a particular situation.

Photocopying

The generic term 'photocopying' covers a wide range of different processes, but they all make use of light of some sort to produce a copy (or multiple copies) of an original document. Possibly the

greatest advantage of the method is that this original requires no special preparation, since virtually any type of document (a typed or handwritten sheet carrying graphic information, a page in a magazine or book, or even a photograph) can be copied on most modern machines.

The principle on which photocopiers operate involves making use of electrostatic forces to transfer pigmented powder of some sort to the parts of the copy paper on which an image is to be produced and then using heat to fuse this powder to the surface of the paper in order to make the image permanent. Two main processes are used, namely, *direct electrostatic* (where the pigment is deposited directly onto the surface of the copy paper) and *transfer electrostatic* (where the pigment is first deposited onto the photosensitive surface of a rotating drum and then transferred onto the copy paper). Transfer electrostatic photocopiers have two considerable advantages over direct electrostatic machines. First, they use ordinary paper as copy paper as opposed to the special (and more expensive) zinc oxide-coated paper that is needed for direct electrostatic machines. Second, they can be made to operate much faster than direct machines, a considerable advantage when it comes to producing multiple copies. For these reasons, most multiple photocopying is now done on transfer electrostatic machines, which are becoming increasingly versatile and sophisticated every year. One slight disadvantage of the use of photocopiers to run off copies of hand-prepared materials is that certain colours of ink do not copy well (or at all) on some machines. Thus, when preparing the masters of such materials, care should be taken to employ colours that will reproduce on the machine to be used.

Hectographic duplicating

This method, which is also known as *spirit duplicating* or *Banda* (from the trade name of one of the leading manufacturers), is one of the simplest non-photographic methods of producing multiple copies of single-sheet material. It is also by far the easiest method of producing multi-colour copies.

Preparing the master

Unlike photocopying, hectographic duplication involves preparing a special master copy (known as a *hectographic master)* of the material to be duplicated. This is done by typing, writing or drawing on a special sheet of plain glossy paper which is in contact with the dye side of a *hectograph transfer sheet* of the required colour. This is coated with a special type of aniline dye, some of which is transferred onto the underside of the master, where a reversed image of the original material is produced. Multi-colour masters can

be produced by using different coloured master sheets, one after the other.

Hints on hectograph master preparation

If the master is being typed:

- Use a standard-sized typewriter rather than a light, portable machine;
- Set the typewriter to *stencil* or remove the ribbon;
- Use the special backing sheet supplied in the box of transfer sheets.

If the master is being prepared by hand:

- Lightly sketch out the material on the matt side of the master sheet *before* inserting the transfer sheet;
- Place the master sheet and transfer sheet on a sheet of glass or similar hard, smooth surface during the actual preparation, using a fine ball-point pen or stylus to write or draw on the material;
- Fill in any blocks of colour required by rubbing hard with a soft (B) pencil.

In both cases; leave a margin of at least 1cm all round.

To correct mistakes, first

cover over with special paint or eraser,

or cover the mistake with a small piece of clean master paper,

or *carefully* scrape off the dye with a scalpel or razor blade.

Then insert the correction using a fresh corner of transfer sheet.

Running off multiple copies

This is done using a machine of the type shown in figure 1.

The completed master is fixed to the *master drum* of the duplicating machine, dye side outwards. A carefully-aligned stack of copy paper is placed in the input tray, and sheets are then pulled through the machine one by one by turning the handle (or, in the case of some machines, switching on the motor). As it passes through the machine, each sheet is first lightly moistened with spirit by means of a felt pad (hence the name *spirit duplication),* and is then pressed against the rotating master drum by a pressure roller. As the paper is pressed against the master, the moistened paper picks up a small amount of dye, thus producing a permanent image on its surface.

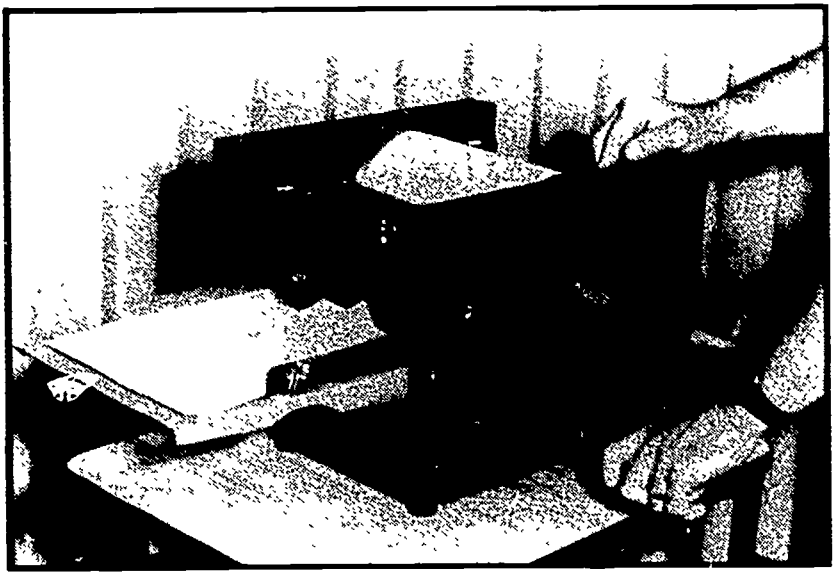


Figure 1: - a hectograph duplicator

Since some of the dye on the master is used up every time a copy is made, each master can only be used to produce a limited number of copies - possibly as many as 200 when the purple dye is used and considerably fewer (perhaps only 100 or so) with other colours. Also, the method does not give high-quality high-definition copies (since the nature of the dye transfer process gives rise to some spreading and smudging) and can be messy for the user. Nevertheless, it is a quick, cheap and extremely handy method that will probably remain in use for a long time to come.

Stencil duplication

Like hectograph duplication, stencil duplication is also commonly referred to by the names of leading equipment manufacturers. Thus, in the UK, the name *roneo* is used, while in the USA, the corresponding name is *mimeograph*.

Preparing the master

Again, as in the case of hectograph duplication, stencil duplication involves preparing a special master - the *stencil* from which the process gets its name. This is made from a thin sheet of special porous paper coated with a waxy substance that is imperious to ink, the stencil being prepared by typing or otherwise breaking through the coating (e.g. by drawing or writing) in order to produce the required image.

Hints on stencil preparation

If the stencil is being typed (the easiest and most effective method):

- Use a standard-sized typewriter rather than a light portable machine;
- Set the typewriter to *stencil* or remove the ribbon;
- Insert a sheet of carbon paper between the stencil paper and the backing sheet in order to make the image clearly legible;

If the stencil is being prepared by hand:

- Lay the stencil (with backing sheet still attached) on a suitable hard surface – preferably a special stencil preparation board;
- *Carefully* write or draw on the material using a suitable stylus (or, if not available, a fine ball-point pen), taking great care not to tear the stencil (this takes practice!).

In both cases, keep within the lines shown on the stencil that correspond to the size of copy paper that is to be used.

Electronic stencil cutters, which make stencils from original documents in the form of single sheets, are also available, but these are both slow and expensive to use.

To correct mistakes, cover the error with a *thin* layer of stencil correction fluid, and, once this has dried, *carefully* re-type, re-write or re-draw the relevant materials, making sure that the layer of dried correction fluid has been penetrated.

Running off multiple copies

Stencil duplication involves squeezing ink through the holes in the impervious waxy coating of the stencil onto porous copy paper, where it is absorbed into the surface to produce a permanent image once the ink has been allowed to dry. This is done using a machine of the type shown in figure 2 – a machine that is in many ways similar to a hectograph duplicator.

To run off copies using a particular stencil, the thick paper backing sheet is removed and the stencil attached to the ink-drum, which is made of porous metal that allows the ink to ooze through from the inside to the outer surface, onto which the stencil is (literally) stuck. Copies are then run off by turning the handle (or switching on the motor in the case of an electrically powered machine). This pulls sheets of copy paper through the machine one at a time, the sheets again being pressed against the rotating drum by means of a pressure roller. Since the ink on the completed copies may take a little time to dry, it is advisable to stack them in a dry, warm place for time before use (a few hours is usually sufficient).

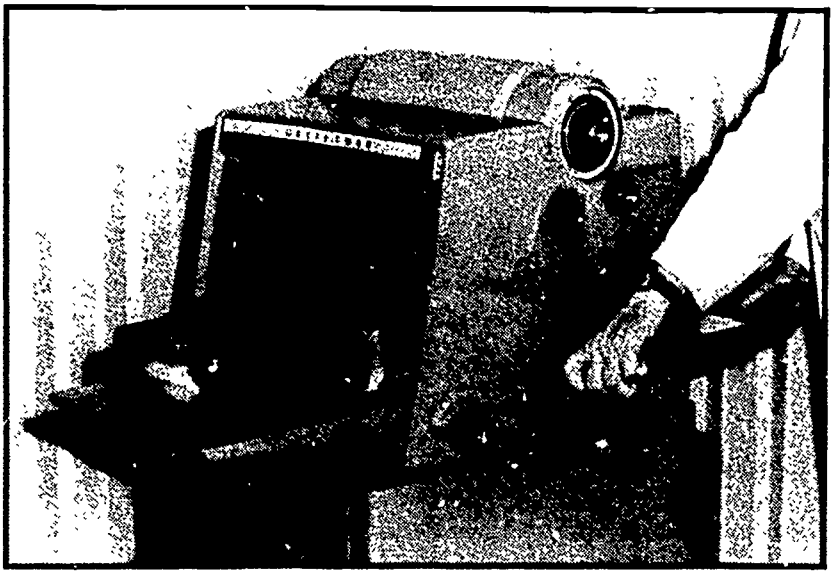


Figure 2: a stencil duplicator

Stencil duplication has two advantages over hectograph duplication. First, it can be used to produce many more copies – several ousand, if the stencil is carefully handled and is cleaned and properly stored between print runs. (Special stencil storage boxes, in which the stencils are hung vertically by the cardboard tops to which they are attached, are used for this purpose). Second, they can, if well prepared, produce a much sharper, better-quality image. On the debit side, stencils are extremely messy to use, and the ink is rather difficult to remove from hands and clothing. Thus, stencil duplication is a job that is best delegated to clerical support staff, if at all possible.

Small offset-litho printing

The term 'small offset-litho' is used to describe the small-scale offset-lithographic machines that are now becoming increasingly widely used in situations where large numbers of high-quality copies of documents have to be made. Such machines are available in a wide range of types, sizes and prices, ranging from basic table-top machines that cost little more than a stencil duplicator to highly-sophisticated presses that are comparable to those found in commercial printing firms.

Preparing the master

Like the previous two duplication processes described, small offset printing requires the prepratation of a suitable master. These come

in a wide range of types, catering for a variety of purposes – and budgets. The cheapest paper plates can cost less than the stencils used in stencil duplication, and can be used to produce similar numbers of copies – up to several thousand. More expensive metal plates produce better quality prints, and can be used to produce much larger number of copies – tens of thousands, if need be. Both types of plates can be given their image either directly or via some plate making process. Direct methods include typing (using a special greasy *lithographic ribbon* in the typewriter), writing or drawing with a special ballpoint pen, or painting. Provided that greasy finger marks are kept off the surface, such direct preparation can be almost as easy and trouble-free as the preparation of hectograph masters. At the other end of the scale, plates for the highest quality work – including full three-colour printing – can be made using conventional photo-litho methods similar to those used by commercial printing organisations. Basically, this involves first making a film negative of the material to be printed, and then transferring the image to a light-sensitive lithographic plate, which is then developed. Such a process is slow and expensive, however, and unless exceptionally high quality is essential, a number of quicker and cheaper photocopy methods can be used.

Printing the copies

Small offset-lithographic printing is based on the same principle as ordinary offset-lithographic printing, and is carried out using machines like the one shown in figure 3.

The lithographic process involves producing a master plate on which the image area is greasy (so that it repels water but attracts ink) whereas the remainder is kept clear of grease (so that it attracts water). Thus, if the plate is first coated with water and then with ink, the water will adhere to the non-image areas only, preventing the ink from adhering to these areas when it is applied; the ink will thus only adhere to the image area. In the offset lithographic process, the ink that adheres to the image area of the master is first transferred to a rubber offset cylinder and hence to the copy paper, so that the paper and master never actually come into contact. This prevents the surface of the plate from being damaged by the hard, rough paper.

Advantages of small offset-litho include its great versatility (it can reproduce images of virtually all types – including photographic images), the high quality of the material produced, and its low running costs, which can make it economical for print runs as low as 30 copies in some cases.

The main disadvantages of such a system are its high capital cost (for all but the most basic machines) and the fact that it normally has

to be run by specialist staff. Thus, most organisations who install small offset-litho have to centralise the service via a central reprographic unit or similar set-up. This inevitably causes delays when staff require materials, since, unlike (say) a local photocopier or hectograph duplicator, the system is not directly available to them.

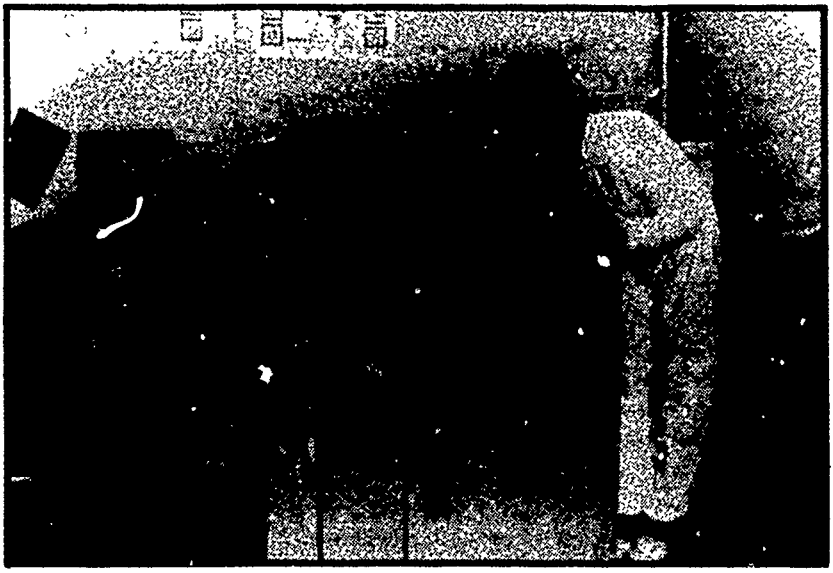


Figure 3: a small offset litho printing press

Computer-aided printing (CAP)

This final method involves using a computer printer of some sort to produce multiple hard-copy printouts of material stored in the computer. Such multiple printing can be done using all types of computer printer, but, unless the printer has a really high printing speed, it is much slower than the other methods described in this section.

Until recently, most of the computer printers available in educational and training establishments have been of the dot matrix or daisy wheel type, neither of which is really suitable for producing large numbers of copies, especially of long documents. The former generally also produce comparatively poor quality material that many people find difficult to read. Now, however, high-speed laser printers capable of producing material of extremely high print quality are becoming increasingly widely available, thus making CAP much more attractive as a multiple-printing method. If, as seems likely, the facilities available using such machines continue to improve and the costs continue to come down, CAP is certain to become more and more widely used in schools, colleges and training establishments.

Choosing which method to use

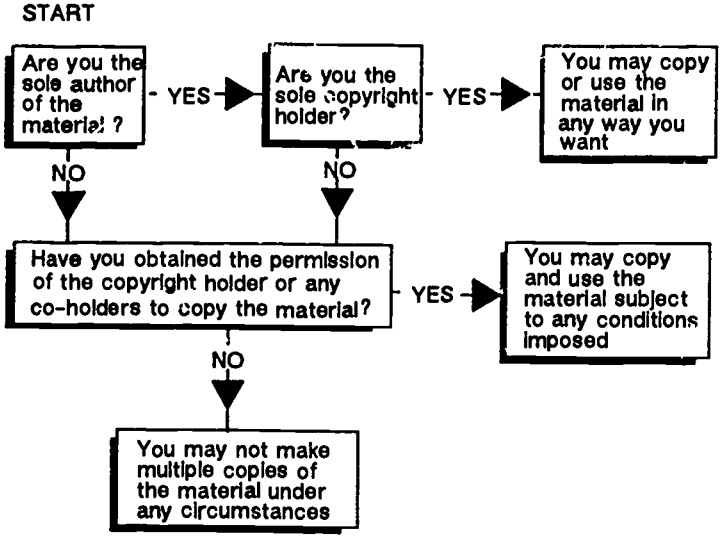
In some cases, a lecturer who wants to produce multiple copies of handouts or similar materials will have very little choice as to how this can be done, being restricted to whatever reprographic system happens to be available in his or her institution. In other cases, a variety of systems may well be available, in which case it will be necessary to decide which system is most suitable for the particular job he or she has in mind. Obviously, this choice will depend on a number of factors, including such things as the nature of the material to be copied, the number of copies required, the quality required, whether colour is needed, the urgency with which the material is required, cost constraints, and so on. Thus, anyone who wanted to produce (say) 30 copies of a single-sheet handout for use in a lesson due to take place later in the same morning or afternoon would probably have to use either a photocopier, a hectograph duplicator or a computer-aided printing system of some sort, with the final choice depending on availability, personal preference and whether more than one colour was required. Someone wanting to produce 300 copies of a 50-page set of lecture notes for distribution to students at the start of the following term, on the other hand, would probably either have the material typed on stencils and have the sets run off by a technician or member of the clerical staff, or make use of the high-speed photocopying or small offset-litho facilities available in a central reprographic unit. He would not, in this case, try to do the job himself on (say) a small local photocopier, because this would not only be highly expensive, but would take an inordinately long time and probably burn out the machine in the process.

A summary of the respective advantages and disadvantages of the five reprographic methods described in this booklet is given in the following table, and it is hoped that this will be of help to readers faced with making such decisions.

Method	Advantages	Disadvantages
Photocopying	• Simple and convenient to use. • Generally directly available to staff. • No special master required – can copy any material. • Produces high-quality copies. • No restriction on print run. • Collation facilities often available.	• Machines expensive. • Machines require careful handling and regular maintenance if they are not to break down or produce inferior copies. • Unit costs can be relatively high. • Certain colours do not reproduce on some machines.
Hectograph duplication	• Simple and convenient to use. • Generally directly available to staff. • Machines and materials relatively inexpensive. • Can produce multi-colour copies.	• Special master required. • Quality of copies comparatively poor. • Limited to small print runs (not more than 200 or so). • Can be messy.
Stencil duplication	• Can produce fairly high-quality copies. • Can produce large numbers of copies – up to several thousand. • Stencils can be stored for subsequent re-use. • Low unit cost per copy.	• Special master required • Only suitable for certain types of material. • Extremely messy to use • Time may be needed for copies to dry after printing.
Small offset litho	• Extremely versatile – can produce virtually all types of material. • Can produce extremely high quality copies. • Can produce large numbers of copies (tens of thousands, if necessary) • Unit costs extremely low on long print runs.	• Special master required • Equipment expensive, and normally involves centralised operation.
Computer-aided printing (using a laser printer)	• Very versatile – can produce virtually any type of material. • Can produce material in wide range of customised formats. • Produces high-quality copy with multiple fonts. • Clean to use. • Collation facilities available on some large machines.	• Not yet cost effective for long runs of large documents. • Print engine of laser has finite life – replacement costs involved. • Requires specialist maintenance. • Equipment easily damaged if misused. • Cannot yet handle colour. • Setting up and interfacing requires some specialist knowledge.

Note on copyright restrictions regarding multiple copying of documents

In the above, it is, of course, assumed that the person carrying out or instigating the production of multiple copies has the legal right to do so. If you produced the original material yourself, there is generally no problem, since the author of a document automatically holds copyright in respect thereof unless this copyright is vested in or shared with some other person or body under the terms of a contractual or other agreement (e.g. if the author was paid to write the material for someone else). If you did *not* produce the material yourself, on the other hand, the law of copyright *strictly forbids* you from making multiple copies – even for educational purposes – *without the prior consent of the copyright holder* (normally the author or his agent, but sometimes the organisation for which he or she works. Thus, before making multiple copies of *any* material, you should make sure that you are legally entitled to do so. This can be done using the following algorithm.



Further Reading

1. *Producing Teaching Materials*,by H I Ellington; Kogan Page, London; 1985. (Chapter 2 of this book – which was written as a handbook for practising teachers and lecturers – deals with the production of printed and duplicated materials in greater detail; it also contains examples of materials of different types).
2. *Designing Instructional Text* by J Hartley; Kogan Page, London; 1985 (A comprehensive guide to typography and to the design

of paper-based instructional materials of all types; extremely useful.)

3. *How to Write Self-study Materials*, by R Lewis; Council for Educational Technology, London; 1981 (An inexpensive booklet that provides an excellent introduction to the subject.)

4. *How to Develop Self-Instructional Teaching - A Self-instructional Guide to the Writing of Self-Instructional Materials*, edited by D Rowntree and B Conners; The Open University, Milton Keynes; 1980 (An extremely useful guide for anyone wishing to write such materials.

5. *A Handbook of Game Design*, by H I Ellington, E Addinall and F Percival; Kogan Page, London; 1982 (An introductory text that includes detailed guidance on how to produce the various items of courseware needed to run a game, simulation or case study).

6. *Case Studies in Game Design*, by H I Ellington, E Addinall and F Percival; Kogan Page, London; 1984 (A book that looks in detail at how 12 different group-learning exercises were designed; it includes numerous examples of the different types of print-based materials that are used in such exercises.)