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Technical and economic criteria for media selection and planning in educational institutions

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Preface

Since 1974 Unesco has carried out research on the economics of the new educational methods and the cost effectiveness of educational radio and television systems and has given rise to the publication of *The Economics of New Educational Media*[1] . This work covers the practical application of the Unesco study, with particular regard to equipment selection and media system planning in educational institutions.

Until now, the use of media in educational institutions seems to have been more a matter of empirical decision than of reasoned choice. Photography, sound tapes, films or video were often introduced in educational or training institutions by strongly motivated practitioners, without the education system as a whole taking them seriously into account.

The modernization of teaching methods is incompatible with such empiricism ; on the contrary, systematic application is required so that the results are controlled. Consideration of the cost and pedagogical effects of the various media is one of the main criteria for the acknowledgement of their credibility by decision-makers and for rational planning of their use.

This work is aimed at teachers and educators, archivists, principals, inspectors and administrative or managerial staff who, at some time or other, are required to decide which media to use in the education process at the level of a single institution or of a given area, or in their particular field of activity. It is intended to provide useful information on the technical and economic criteria to be considered in order to evaluate the organizational and financial consequences of their choice. For instance, relatively small expenses such as those involved in running a language laboratory, if multiplied by the number of establishments to be equipped, represent very high costs for the education system as a whole. Any decision-maker should therefore, in all awareness, make the best possible choice and be in a position to answer questions such as the following : What are the effective possibilities of such and such equipment or media system ? What are its technical characteristics ? How easy is it to implement? What pedagogical situations is it best suited to ? What are the selection criteria ? What is its approximate cost ? How are the financial effects of its use evaluated? What educational and material resources does it require in terms of staff, time and premises?

The present guide has been written to help agents of the education system answer such questions. It is divided into two complementary sections of equal importance. Part one describes a number of media utilization situations either within a single school or establishment (document reproduction, back projection, photography, language laboratory and closed-circuit television) or at the level of a group of institutions (radio, video, film or video library). The situations presented are likely examples of media use. They were generated after studying the results of various investigations concerning a great number of institutions. They are, so to speak, "theoretical cases" based on average close-to-real-life situations[1].

From the study of concrete examples, the reader will derive a method of investigation. The examination of the organizational conditions that govern the use of a medium is an essential element of economic analysis, since cost variations are sometimes greater between two different uses of the same medium than between two different media.

After defining the criteria which apply to the analysis of the various theoretical cases, a method of unit cost calculation is proposed in Part two[2] (per document, student or student/hour) in order to optimize the use of media in the education system.

The procedure followed derives from the systematic approach which takes into account objectives, resources and constraints in order to determine, in the light of all these variables and from the various possible outcomes, the wisest course of action.

Certain economic concepts, such as fixed costs, variable costs, depreciation and annualization, prove

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1 Unesco. *The Economics of New Educational Media.* Vol. 1 : *Present Status of Research and Trends*, Paris, Unesco, 1977 ; vol. 2 : *Cost and Effectiveness*, Paris, Unesco, 1980 ; vol. 3 : *Cost and Effectiveness : Overview and Synthesis*, Paris, Unesco, 1982. (Educational Methods and Techniques 1.)

2 Part one was written by Maurice Guillin, the author of several technical and economic studies carried out in France under the sponsorship of BETEA (Bureau d'Etudes Technico-économiques relatives à l'Enseignement Audiovisuel), a research unit run jointly by the French Ministry of Education and the television companies. Part two was undertaken by François Orivel, a specialist working for the Institute of Research on the Economics of Education (IREDU, based in Dijon) which is part of the French Centre nationale de recherche scientifique (CNRS). Jean Valérien, Inspecteur d'Académie and Advisor for New Educational Technologies at the French Ministry of Education, was editor of the present version.

3 The prices quoted are those pertaining in France in 1980. Changes will therefore have to be made to adapt costs to the current situation of individual countries.

to be essential for a comprehensive analysis of the use of educational media. They should therefore neither be rejected out of hand nor even less under-rated, since in the field of education, as in fact in all other areas, it is essential to rationalize choices and attempt to optimize services. We hope the present study will contribute to achieving this goal with greater ease.

PART ONE

Media Selection and Planning for Educational Purposes

1. METHODS AVAILABLE FOR THE REPRODUCTION OF DOCUMENTS

I - EQUIPMENT CONCERNED

All equipment which can reproduce a text, a drawing or a diagram more or less automatically, to provide any number of copies from one to several thousand, is included in this study and referred to as reproduction equipment.

We will, however, limit outselves to office equipment, which involves a relatively small investment and can be operated by the usual administrative staff, provided existing staff members can be given a few days' specialized training in how to use the more sophisticated systems. Standard printer's equipment, which is often resorted to when a very large number of copies is required, will not be dealt with.

There are two main categories of reproduction equipment : *duplicating systems and reprography or copying systems.* The former require inking a matrix or master which has to be prepared beforehand ; they are particularly suitable for printing several hundred or even several thousand copies. In the latter, each copy is obtained by means of a radiation ; such systems are suited to the printing of a relatively small number of copies.

II - PROPOSED METHOD FOR SELECTING EQUIPMENT

The method proposed to facilitate the choice of a reproduction system involves three steps :

1. Assessment of needs. It is essential to begin by making an inventory of the type of documents required for reproduction, together with an assessment of the number of copies for each type over a given period. It is advisable to choose a sufficiently long period of time, preferably a year. Problems concerning time limits, which may cause bottlenecks, should be carefully studied. This preliminary job of identifying yearly requirements in terms of the type of document needed is often a difficult one, but it is essential that it should be carried out with the greatest possible accuracy.

2. Preliminary selection of possible systems. Comparing the features of the various types of equipment available and the assessment of needs as outlined above, will allow a preliminary selection of duplicating and/or reprography systems. The basic features of the main systems are given in tables 1 and 2. At this stage, it is advisable to allow for a relatively wide range of choice and to rule out only those systems that appear to be clearly unsuitable.

3. Assessment of cost. In order to reach an estimate for the unit cost of printing or duplication, the following items should be taken into consideration.

a) Staff costs

Let S be the annual cost of staff, including wages, social security contributions, fringe benefits, etc. If the number of effective working days per annum is estimated at 225 and the effective daily working time at 7.5 hours, the cost of staff per minute is :

$$\frac{S}{225 \times 7.5 \times 60} = Sm$$

(to be rounded up to the nearest hundredth).

Only the working time actually spent on printing should be taken into account when calculating staff costs. We will assume that this time is of standard length, i.e. 15 seconds for reprography and 2 minutes for duplication for every change of text. This gives us an estimated cost of 0.25 Sm for reprography and 2 Sm for duplication.

Sm can be evaluated at FF. 0.50 per minute (basis 1980).

b) Cost of equipment

The prices considered are always normal retail prices, excluding discounts and tax. These are the current prices at the end of 1980.

For a given category of machines, prices can vary considerably. The equipment selected, while offering suitable quality guarantees, is within the lower price range of the category considered. Naturally the efficiency grading presented in this study takes account of this choice concerning price.

Maintenance costs were estimated on a yearly basis at an all-inclusive 5 per cent of the purchase price of the equipment, with the exception, however, of direct or indirect electrostatic-copying equipment, for which the rate was estimated at 10 per cent to take account of current prices.

As a rule, depreciation is calculated on the basis of a 10,000-hour life span of the equipment, i.e. 5 years. This depreciation does not take into account interest on invested capital. Given the price of the machine, its depreciation time and maintenance cost, an hourly cost may be established which, if compared with the output for the same period, yields a cost/machine of the unit produced. In order to ascertain the level of output, both the efficiency and the effective life-span of the equipment must be considered. In the best circumstances, a machine with an output of 1,000 copies per hour could produce 1,000 x 10,000 hours = 10,000,000 copies.

Apart from immobilization of the equipment for maintenance and repair, the reproduction systems may be temporarily out of use for many reasons, especially

TABLE 1

Features of the different duplication processes

CASES CONSIDERED	HECTOGRAPHY	STENCIL	OFFSET
A. GENERAL APPEARANCE OF THE MASTER (Reproduction medium)			
Reproduction medium	Art paper (kaolin coated)	Japanese or English tissue coated with a generally whitish film, inkproof	Medium with a porous or grainy surface : paper, cardboard, aluminium, plastic, depending on the number of copies required
Writing : hand or machine	Transferring media : hectographic carbon in sheet or tape form, transferring surface on back of master	Perforating media : cutting wheel, stylus, dry-point, typewriter faces and other perforating material	Lithographic media : pencil, ink, ball-point, paint brush ink for drawing
Black or monochrome hand or machine-written text or drawing	Fairly good	Good	Very good
Polychrome hand or machine-written text or drawing	One master and one run for all colours	One master and one run per colour	One master and one run per colour
B. TRANSFER OF ORIGINAL TO MASTER (duplication copy)			
Transferring process	Indirect thermocopy	Electronic stencil cutting. Thermic stencil	Reversal-transfer, electrocopy, electrostatic copying, other special processes
Text or line drawing	Fairly good	Good	Very good (depending on the transferring process used)
Half tones without screens (colour gradation)	Not advisable	Possible with appropriate material	Possible with appropriate material
C. COPIES ON PAPER			
Opaque	Yes	Yes	Yes
White	Yes	Yes	Yes
Transparent, translucent	With caution	Watch for smudging	Yes
Coloured	Yes	Yes	Yes
Stiff	Yes	Yes	Yes
Two sides	With caution	One run-on rotary machine for two-side copying	Yes
D. PRESERVATION			
Master	Possible according to dye used, residual transferring material	Subsequent de-inking	Subsequent de-inking and reasure
Copy	Deteriorates slightly in the light	Good preservation	Good preservation
E. MISCELLANEOUS			
Speed	According to automation of equipment		
Reduction	No	No	On appropriate material
Maximum size	A3	A3	A3

TABLE 2

Possibilities offered by reprographic processes

Cases considered			PROCESSES: Reversal-transfer	High-speed emulsion development	Direct and indirect thermocopy	Dual spectrum	Diazoprint	Electrocopy on ordinary paper	Electrocopy on processed paper	Electronic stencil cutting	
Originals for reproduction	medium	Opaque, one side only	○	○	○	○	◐	○	○	○	
		opaque, two sides	○	○	○	○	●	○	○	○	
		transparent, translucent	○	○	○	○	○	○	○	○	
		colour	◐	◐	◐	◐	●	◐	◐	◐	
		page of book	○	○	●	○	●	○	○		
	image	line	○	○	○	○	○	○	○	○	
		colour gradation without screens	●	○	●	◐	●	●	●	◐	
		colour gradation with screens	○	○	●	○	●	◐	◐	○	
		colour	○	○	◐	○	◐	◐	◐	○	
Copies requested	medium	opaque	○	○	○	○	○	○	○	●	
		double-sided	●	●	◐	●	○	○	●	●	
		colour	○	○	○	○	○	○	○	●	
		transparent, translucent	○	◐	○	○	○	○	●	●	
		processed	○	○	◐	○	○	●	○	●	
		unprocessed	●	●	◐	●	●	○	●	●	
	image	black	○	○	○	○	○	○	○	●	
		colour	●	●	●	●	◐	◐[1]	●	●	1 on request at RANK
		size reduction	●	●	●	●	●	○	○	●	
	masters for duplication	hectographie	●	●	○	●	●	●	●	●	
		stencil	●	●	○	●	●	●	●	○	
		offset	○	●	●	●	●	○	○	○	
	transparencies for projection		○	●	○	●	◐	○	●	●	

Key : ○ suitable.
◐ suitable under certain conditions.
● Unsuitable.

as they were not designed to be used continuously. This is why we have considered average levels of output. The various assumptions made in order to carry out this study were decided after consulting users and professionals. Although they may be debatable, their influence on the final cost remains within reasonable limits.

c) Cost of supplies

The supplies considered are of standard quality, excluding discounts and tax (although substantial discounts may often be obtained for large orders). Spoilt copies have not been taken into account, despite their frequency, because their effect on the final cost is usually very small.

In the case of offset, the prices of supplies and miscellaneous products used (ink, cloths, plate preconditioning products, cleaning products, etc.) have been estimated at a fixed 10 per cent of the price of the paper. This estimate is based on the experience of users.

The cost of electricity has not been taken into account because it is normally low. One may, however, wish to assess the impact of such a cost in certain cases where it can add up to a considerable sum, when for instance a machine requires pre-heating and must therefore be left on throughout the working day even if it is not used at all or used only for a small number of copies.

None of the overhead capital costs have been taken into consideration. This is because their influence is negligible when comparing the cost of duplicating by the various methods available. This would not be the case, however, if our purpose was to compare the cost of reproduction in an in-house printing department to that of an outside commercial printer. It would then be essential to include all relevant expenses in the prices to be compared.

III - UNIT COST OF PRINTING OR DUPLICATION

The unit considered will be the production of a text of A4 size (21 x 29.7cm) which must be prepared on a typewriter. It is estimated that a page contains approximately 30 lines and requires 20 minutes for typing and any associated work.

For duplicating equipment, the costs of making the master or original matrix should be taken into account (depreciation, maintenance, supplies and staff). To make a stencil for instance, an electronic cutter is used. This machine costs P francs and is to be written

off on the basis of 20,000 prints over a 5-year period. The cutting of a 21 x 29.5cm stencil requires 5 minutes. The following elements should be taken into consideration.

- Depreciation of the machine, i.e. $\frac{P}{20,000}$
- Maintenance of the machine, 5 per cent per annum, i.e. $\frac{0.05 \times P \times 5}{20,000}$
- Supplies, i.e. the stencil which costs f
- Wages, i.e. 5 Sm

The following sum should then be added to the cost of printing : $\frac{1.25}{20,000}$ + f + 5 Sm

In the following paragraphs, we will calculate a number of unit costs by means of a similar method in order to refine the first selection which was made after comparing requirements and the possibilities of the various types of equipment.

IV - DUPLICATION

As shown in table 1, there are three main types of duplicating equipment covering almost the whole market: spirit duplicators (Hectography), stencil duplicators and small offset machines.

1. Spirit Duplicators (Hectography)

a) Price, excluding tax, of equipment and supplies

Prices range from FF. 600 to FF. 20,000 according to whether :

- feed and drive are manual, with damping done by felt pad (basic equipment, size 25 x 35cm, relatively light : 7 to 10kg)
- paper feed is automatic
- damping is done by roller with automatic paper feed
- controls are electric, with automatic paper feed and damping of the rollers
- size is standard or A3 (large).

The price of hectographic carbons (FF. 0.30 to 0.40 each) and reams (FF. 0.60 to 1.30 each) should be added to the cost of this basic equipment.

b) Cost of duplication

Cost varies considerably according to whether the master has been handwritten or typed or prepared by an automatic thermocopying process. We will examine each in turn.

. Manual process (written or typed)

We will consider that the text has approximately 30 lines (each containing on average 62 signs and spaces) in Pica characters, and is to be printed on 21 x 29.7cm size paper.
Time spent, including re-reading and correction is estimated at 20 minutes.

. Supplies

1 sheet of coated paper (112g)	FF. 0.06
1 hectographic carbon (protected purple carbon of standard quality)	0.36

Depreciation and maintenance of typewriter (standard electric) on the basis of a cost of FF. 4,000 :

- depreciation : FF. 4,000/10,000 hours = FF.0.40
- maintenance : 5 per cent per annum over 5 years : FF. 1,000/10,000 hours = $\frac{\text{FF. } 0.10}{1 \text{ hour}}$ $\frac{}{0.50}$

That is, for 20 minutes 0.17

. Remuneration of staff, on the basis of FF. 0.50 a minute : 0.50 x 20 10.00

That is, for making the master FF. 10.59

. Thermic process

Ream of hectographic carbon	0.60
Depreciation and maintenance of thermocopying equipment on the basis of a price of FF. 2,000 and assuming that it will be uased for 10,000 reproductions :	
- depreciation : FF. 2,000/10,000 copies = 0.20	
- maintenance : 5 per cent over 5 years, 500/10,000 = 0.05	
Per copy	0.25
Remuneration of staff : as already mentioned, starting-up time was estimated at 15 seconds, plus 5 seconds for the actual duplication, i.e. 20 seconds altogether.	
$\frac{50 \times 20}{60}$ =	0.17
Cost of making the master	1.02

. Cost of the actual printing

Depreciation and maintenance of the duplicator : considering the small number of copies (100 - 150) that can be printed on this type of equipment from one master, we have selected a machine with a manually operated cylinder and automatic paper feed. Damping is done by felt pad or by roller. Price of the equipment is estimated at FF. 2,000. Theoretical output may be estimated at 1,000 copies per hour, but in fact 100,000 copies a year, i.e. 500,000 copies over 5 years, seems to be a suitable basis for depreciation. Therefore :	
- purchasing price	FF. 2,000
- maintenance (5 per cent per annum)	500
- unit cost : FF. 2,500/500,000 copies	5
The cost of printing paper is estimated at FF. 0.03 per 21 x 29.7cm size sheet. The cost of printing liquid is estimated at FF. 12 per litre for 3,000 to 5,000 copies, i.e. $\frac{12}{4000}$ =	0.003
Remuneration of staff : as mentioned earlier, it is estimated that printing by means of the duplicator requires a 2-minute starting-up time, i.e. FF. 0.50 x 2 = FF. 1.00 20 copies can thereafter be printed per minute.	

c) Conclusions concerning spirit duplicators

TABLE 3

Cost of hectographic duplication (in centimes, basis France, 1980)

Number of copies	10		20		50		100		150	
Items	Typed master	Thermic master	Typed master	Thermic master	Typed master	Thermic master	Typed master	Thermic master	Typed master	Thermic master
1 - Master	1 059	102	1 059	102	1 059	102	1 059	102	1 059	102
2 - Duplicator	5	5	10	10	25	25	50	50	75	75
3 - Supplies :										
. Paper	30	30	60	60	150	150	300	300	450	450
. Liquid	3	3	6	6	15	15	30	30	45	45
4 - Salary :										
. Starting-up	100	100	100	100	100	100	100	100	100	100
. Printing	25	25	50	50	125	125	250	250	375	375
Total	1 222	265	1 285	328	1 474	517	1 789	832	2 104	1 147
Unit cost	122.2	26.5	64.2	16.4	29.5	10.3	17.9	8.3	14.3	7.6

To simplify matters, it is estimated that hectographic duplication in standard working conditions and with standard supplies and equipment allow for the printing of about a hundred copies, 150 if purple is used.

2. Stencil duplicators

Cost of equipment

Leaving aside flat-bed machines which are entirely manual and whose prices range from FF. 270 to 520, the price of stencil duplicators varies between FF.600 and FF. 40,000.

The basic equipment consists of single cylinder, manually operated machines. Rotation is effected by a handle ; the paper is fed manually, one sheet at a time ; and an inking button is operated to ensure an even distribution of ink after it has been poured onto the cylinder.

One stage further on come machines which are still operated by means of a handle, but with automatic paper feed (the rotation of the cylinder causes an arm to move forward and this slides a sheet of paper under the cylinder). Some machines offer certain improvements : printing height control, counter, automatic disengagement of the pressure roller when a sheet fails to go through, ink intensity control, etc. Some machines are portable. Most have a single cylinder. Prices range from FF.700 to FF. 2,400.

Next, there is a category of hand-operated machines, either single or dual cylinder, whose prices range between about FF. 2,000 and FF. 5,500.

Differences in price are mainly due to the degree of sophistication of the device, such as slant correction, inking control, ink feed by cartridge or tube, copy counters which can be reset, adjustment of the pressure roller. Accuracy in the operation of the printing paper feeding device is also a factor to be taken into account. A manual duplicator is available for double-size printing. This is a dual cylinder machine and its price is approximately FF.11,000. The cost of electric duplicators for size 21 x 29.7cm printing with sheet paper feed, varies between FF. 3,700 and FF. 12,000.

Differences in price may be justified by the provision of the same improvements as for manual duplicators, plus the production speed offered, which ranges from the figures mentioned above to 160 copies per minute. Another factor to be considered is the possibility of varying the production speed : either the speed is fixed, or there are two or three different speeds, or the speed can be varied continuously between two extremes - giving a rate of 30 to 160 copies per minute for instance.

Other devices are designed to facilitate the use of types of paper other than the porous kind which is the type recommended for this type of duplicator. Two such systems are spraying of anti-smearing powder or automatic interleaving of sheets of cardboard or blotting paper.

The price of electric duplicators for double-size printing (42 x 29.7cm) ranges from FF. 13,600 to 17,000.

Finally, the most expensive machines are duplicators with continuous paper feed and several cylinders which allow for simultaneous double-sided printing. Their price ranges from FF. 30,000 to FF. 40,000, but their output is exceptionally high, up to 18,000 pages per hour.

Cost of supplies and accessories

The price of stencils, if they are of the ordinary type, ranges from FF. 0.50 to FF. 1.50 a unit. Some companies sell a stencil specially designed for writing and drawing by hand. It is blue in colour with a superimposed grid in order to facilitate the cutting of plans, maps, drawings and charts. It is used for freehand writing and engraving : the material appears in white as the blue, inkproof surface is pierced by the cutting. The price of this stencil is approximately FF. 1.20. The price of stencils for thermic cutters ranges from FF. 1.50 to FF. 4.00 each.

The price of thermic cutters ranges from roughly FF. 1,800 to FF. 4,000 (this latter figure being exceptional). Most are priced between FF. 2,200 and FF.3,000.

Stencils for electronic cutters are either made of paper, allowing the printing of an advertised number of copies ranging from 3,000 to 5,000 and costing an average FF. 1.50 to FF. 2.00, or of plastic, making possible the printing of larger numbers of copies (from 10,000 up), costing between FF. 3 and FF. 5.50 each. Within this range of stencils, special mention should be made of a stencil incorporating a transparent film which, in addition to the stencil, provides a high quality transparency suitable for back-projection (price FF.4). A stencillograph currently costs FF. 205.

The better quality of reproduction obtained by the electronic process involves higher prices. The prices of the fifteen or so existing machines range from about FF. 6,000 to FF. 16,000 for 21 x 29.7cm size printing. A machine able to print 42 x 29.7cm size copies costs about FF. 25,000. The lowest prices, around FF. 6,000 are for equipment with poor definition. The more expensive machines, on the other hand, have two speeds and a choice of definition.

The paper used for printing must have neither a silk nor a glazed finish, but a slightly porous surface which will facilitate absorption and drying of the ink. AFNOR, the French Association for Standardization, has determined a category of paper suitable for stencil duplicators, which includes :

. paper subject to infrequent use (for notices and circulars)
  - brightness : 53 to 60 per cent
  - weight : 60g
. paper subject to frequent use
  - brightness : 69 to 75 per cent
  - weight : 60 to 80g
. high quality paper (for official letterheads)
  - brightness : 76 to 83 per cent
  - weight : 70 to 90g

For double-sided printing, 80 to 90g weight paper is to be used. An 80g weight, 21 x 29.7cm size sheet of laid paper suivable for double-sized printing costs 3.5 centimes.

Ink is usually sold in cartridges or in tubes at an average price of FF. 15.

Colour ink is 20 to 50 per cent more expensive than black ink.

Cost of printing

The cost of preparing the master must first be calculated, taking into consideration the various possible methods : manual (typewriter), thermic cutter and electronic cutter.

As for the hectographic process, it is assumed that the text has about 30 lines of 62 signs or spaces, in Pica characters, and is to be printed on 21 x 29.7cm size paper.

. Manual process (typewriter)

We will assume that the preparation of a typed master takes 20 minutes (including re-reading and corrections) :

- supplies : 1 stencil	FF. 0.75
- depreciation and maintenance of typewriter (see under hectography)	FF. 0.17
- remuneration of staff : 0.50 x 20 minutes	FF. 10.00
	FF. 10.92

. Thermic process

- supplies : 1 stencil	FF. 2.50
- the device used is the same as for hectographic masters, i.e.	FF. 0.25
- remuneration of staff during starting-up time (15 seconds) and printing (5 seconds)	FF. 0.17
	FF. 2.92

. Electronic process

- supplies : masters are of varying quality. The cost of a paper master is	FF. 2.00
- cutters vary in speed and precision. The price of a machine suitable for line cutting and requiring approximately 5 minutes to cut a 21 x 29.7cm size text is FF. 9,000. This type of machine is seldom put to intensive use. Depreciation is calculated on the basis of 20,000 cuttings, i.e. 9,000/20,000 =	FF. 0.45
- maintenance (5 per cent per annum)	FF. 0.113
	FF. 0.563
The machine uses needles which must be replaced from time to time. On the basis of a price of FF. 87 per box of twenty-five needles and one needle for twenty stencils, we have $\frac{87}{25 \times 20}$ =	FF. 0.174
That is, for total supplies	FF. 0.737
- remuneration of staff : with this type of equipment, the cutting of a 21 x 29.7cm size document lasts about 5 minutes, hence : 0.50 x 5 minutes	FF. 2.50
Total	FF. 5.237
Rounded up to	FF. 5.25

. Cost of the actual printing, which includes :

- depreciation of the cost of preparing the master
- depreciation and maintenance of the duplicator : because of the number of copies which can normally be printed on this type of equipment, one usually selects electrically operated machines (single size), which cost approximately FF. 6,000.

Average output is estimated at 3,000 prints an hour. Realistically speaking, 600,000 copies a year represents a high average for many users.

- purchasing price	FF. 6,000
- maintenance (5 per cent per annum)	FF. 1,500
Total	FF. 7,500

	Price per page
That is : unit cost = 7,500/300,000 = 0.25 centime	0.25 centime
- supplies, including :	
. paper : FF. 0.03 per 21 x 29.7cm size sheet (weight 72g for single-sided printing)	0.03 centime
. ink : FF. 15 per tube, i.e. for 7,000 to 8,000 copies, that is, 15/7,000 = FF. 0.002 per page	FF. 0.002

- time spent on printing, estimated at 2 minutes for preparation (FF. 1) and 1 minute for 50 prints (FF. 0.50) FF. 0.50

Note : If the document has several pages, it is worthwhile, because of the high price of paper, to use double-sided printing, choosing slightly heavier paper costing FF. 0.035 per sheet. To illustrate the resulting saving, let us take the example of printing 500 copies of a twenty-page circular : for single-sided printing, we have (assuming the master is typed) 6.8 centimes per sheet x 500 sheets and 20 pages = FF. 680, of which FF. 300 is spent on paper (10,000 sheets at FF. 0.03); for double-sided printing, all other items remaining unchanged, we have : 5,000 sheets at FF. 0.035 = FF.175, that is, a saving of FF. 125 (18 per cent of the total expense).

Conclusions concerning stencil duplicators

Stencil duplication has many advantages compared with hectography, of which two are particularly important. First, it allows for a far greater number of copies. In standard working conditions and with standard equipment and supplies, 1,500 copies may be made. Stencils for electronic cutters, when they are chosen from top quality material, enable this figure to be considerably exceeded. Some users have succeeded in obtaining more than 20,000 copies. It should be noted that this capacity of stencil duplicators to print large numbers of copies inclines users to choose electrically operated machines whenever possible (whereas hectographic duplicators, operated by means of a handle, can only turn out 100 to 150 copies).

The second major advantage is the elimination of the problem of faded copies : each print receives the same quantity of ink, the text is well-contrasted on a white background and the colour withstands light. Unit cost is estimated in table 4.

3. Small Offset Machines

Cost of equipment

The price range of small offset machines is extremely wide. A summary of the types of equipment available is as follows :

Simple duplicators, which are small and can be placed on a table. Their weight ranges from 60 to 140kg. They sometimes have a variable speed control, for speeds ranging between 2,000 and 7,000 sheets per hour. These machines are suitable for the printing of circulars, preferably on homogeneous paper.

Classical offset machines, which are larger than the simple duplicators and mounted on a stand. Most of them weigh between 250 and 700kg, and, more exceptionally, between 900 and 1000kg. They require certain technical skills on the part of the operator but offer high-quality printing and a wide range of capabilities. Many of these machines are able to produce A3 size prints (420 x 297mm). Their theoretical speed goes up to 9,000 sheets per hour, but the time required for adjustment may bring their real output down to 1,500 sheets per hour.

System machines : these highly automated machines are suitable for high speed printing where quality of framing is less important than ease of operation. The highest degree of automation is obtained by plate-makers/duplicators. Collating equipment can be connected to the machine. According to the type of equipment selected, the price varies between FF. 16,000 and FF. 250,000.

Cost of supplies

The plates, depending on whether they are made of metal, cardboard or plastic, and also on the process

TABLE 4

Cost of stencil duplication, one side only (in French centimes)

Number of copies	10 copies			20 copies			50 copies			100 copies			150 copies			500 copies			1 000 copies		
	Master			Master			Master			Master			Master			Master			Master		
Items	typed	ther-mic	élect-ronic	typed	ther-mic	élect-ronic	typed	ther-mic	élect-ronic	typed	ther-mic	élect-ronic	typed	ther-mic	élect-ronic	typed	ther-mic	élect-ronic	typed	ther-mic	élect-ronic
1 - Master	1 092	292	525	1 092	292	525	1 092	292	525	1 092	292	525	1 092	292	525	1 092	292	525	1 092	292	525
2 - Duplicator	2,5	2,5	2,5	5	5	5	12,5	12,5	12,5	25	25	25	37,5	37,5	37,5	125	125	125	250	250	250
3 - Supplies :																					
• paper	30	30	30	60	60	60	150	150	150	300	300	300	450	450	450	1 500	1 500	1 500	3 000	3 000	3 000
• ink	2	2	2	4	4	4	10	10	10	20	20	20	30	30	30	100	100	100	200	200	200
4 - Salary :																					
• starting-up	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
• printing	10	10	10	20	20	20	50	50	50	100	100	100	150	150	150	500	500	500	1 000	1 000	1 000
Total	1 236,5	436,5	669,5	1 281	481	714	1 414,5	614,5	847,5	1 637	837	1 070	1 859,5	1 059,5	1 292,5	3 417	2 617	2 850	5 642	4 842	5 075
Unit price	123,6	43,6	66,9	64	24	35,7	28,3	12,3	16,9	16,4	8,4	10,7	12,4	7,1	8,6	6,8	5,2	5,7	5,6	4,8	5,1

used, range between FF. 0.30 and FF. 4.00. The price of other supplies, excluding paper, are as follows :

- Damping products : approx. FF. 10 per litre
- Ink : approx. FF. 28.00 per 1kg box (i.e. per 20,000 prints)
- Plate preconditioning products : approx. FF. 28.00 per litre (i.e. per 200 to 300 plates)
- Cloths : approx. FF. 120 per 10kg
- Metal plate protective gum : approx. FF. 35 per 5 litres (300 to 400 plates per litre).

The aggregate cost of these various supplies represents approximately 10 per cent of the price of the paper. The average cost of paper is FF. 0.03 for the 21 x 29.7cm size sheet, but prices vary considerably according to quality and weight.

Cost of printing

The wide variety of existing equipment and operations possible with small offset machines make it very difficult to assess costs. For this reason the following prices are to be considered as an approximation, adopting the same basis for calculation as already mentioned, and assuming that the plates are made of cardboard (which is the most popular material). The cost of preparing the master depends on which of three techniques is utilized :

Manual process (typewriter)

Time is the same as for hectographic or stencil duplication, i.e. 20 minutes (including re-reading and corrections), so that we have :

- Supplies : 1 cardboard plate — FF. 1.00
- Depreciation and maintenance of the typewriter — FF. 0.17
- Remuneration of staff 0.50 x 20 minutes — F.F. 10.00

FF. 11.17

Zinc oxide electrocopying

- Supplies : cardboard plate coated with zinc oxide suitable for offset — FF. 1.00
- Depreciation and maintenance of the electrocopying equipment. On the basis of a machine costing FF. 6,000, which produces 2,000 copies per month and can be written off over a 5-year period, we have : 6,000/120,000 copies = — FF. 0.05
  Maintenance or replacement of parts (10 per cent per annum): 3,000/120,000 copies FF. 0.02 — FF. 0.025
- Payment of staff : the operation only lasts a few seconds. Allow 15 seconds for starting-up and 5 seconds for printing, i.e. 20 seconds at FF. 0.50 a minute — FF. 0.17

FF. 1.24

Cassette process

- Supplies :
  Cardboard plate for several thousand copies — FF. 3.80
  Processing products (estimate) — FF. 0.20
- Depreciation and maintenance : Cost of the machine can be estimated at FF. 12,500 and maintenance at 5 per cent per annum of the purchasing price, i.e. FF. 3,125 for 5 years. It can easily produce 100 plates per day, that is 100,000 plates in 5 years, hence 15,625/100,000 = — FF. 0.16
- Remuneration of staff : preparing and processing the plate takes approximately 3 minutes, hence FF. 0.50 x 3 = — FF. 1.50

FF. 5.66

Apart from writing off the cost of making the master, the following items should also be priced :

- Depreciation and maintenance of the duplicator. Cost of the machine can be estimated at FF. 20,000, output at 3,000 prints per hour and life span at 5 years (i.e. 10,000 hours), but in fact not more than 1,000,000 copies are printed a year, that is, 5,000,000 copies altogether.
  Unit cost is therefore as follows :
  purchasing price — FF. 20,000.00
  maintenance (5 per cent per annum) — FF. 5,000.00
  that is 25,000/5,000,000 — FF. 0.5

- Supplies include :
  paper, costing FF. 0.03 per 21 x 29.7cm size sheet; miscellaneous products (ink, cloths), the cost of which is estimated at 10 per cent of the price of the paper.

- Time spent on printing, estimated at 2 minutes for starting up, that is FF. 0.50 x 2 = FF. 1.00 and at 1 minute, that is FF. 0.50 for 50 prints.

Conclusions concerning small offset machines

On the basis of the above assumptions, Table 5 can be drawn up .

Conclusions drawn concerning small offset machines differ widely depending on whether one considers simple duplicators or classical offset machines.

Offset duplicators have similar characteristics to stencil (electric) duplicators, both at the level of possibilities and from the point of view of cost. They are well suited to the printing of a few hundred or a few thousand copies ; copy quality is homogeneous; they are fast in operation ; and the higher cost of purchasing this equipment is compensated for by a lower cost and greater ease of master preparation, for which electrostatic machines can be used.

As far as differences between the two systems are concerned, it should be noted that offset gives the user greater freedom in choosing the paper : silk or glazed finish paper, which is commonly used in offices, does not raise the same problems as for stencil duplication. Lightweight paper (Bible, 45g) can also be used under certain conditions (with lower machine speed, suction grippers, chain delivery device).

On the other hand, operating an offset machine, even of the simplest kind, requires greater technical skill on the operator's part. The temperature of the premises and the relative humidity require constant attention ; cleaning and maintenance of the equipment must be carried out with care. In this respect, offset is a more delicate process than stencil.

Offset duplicators seem less suited to changes in the type of master. A change from a typed master to one prepared by reprography may require changes in the damping agent or new machine adjustments, which is not the case with stencil.

Plate-makers/duplicators are an excellent way to print circulars. They allow for the printing of a small or very small number of copies (ten to twenty). However, they require a large investment, the writing off of which can only be justified when very large numbers of copies are produced.

The main advantage of offset is that it produces high quality prints which could not be obtained by other processes - half-tones, solids, four-colour process

TABLE 5

Cost of offset printing (one sided only) in French centimes

Number of copies	10 copies			20 copies			50 copies			100 copies			150 copies			500 copies			1 000 copies		
Items	manual	élec-tro-copy	cas-sette	manual	élec-tro-copy	cas-sette	manual	élec-tro-copy	cas-sette	manual	élec-tro-copy	cas-sette	manual	élec-tro-copy	cas-sette	manual	élec-tro-copy	cas-sette	manual	élec-tro-copy	cas-sette
1 - Master	1 117	124	566	1 117	124	566	1 117	124	566	1 117	124	566	1 117	124	566	1 117	124	566	1 117	124	566
2 - Duplicator	5	5	5	10	10	10	25	25	25	50	50	50	75	75	75	250	250	250	500	500	500
3 - Supplies																					
• paper	30	30	30	60	60	60	150	150	150	300	300	300	450	450	450	1 500	1 500	1 500	3 000	3 000	3 000
• ink and products	3	3	3	6	6	6	15	15	15	30	30	30	45	45	45	150	150	150	300	300	300
4 - Wages																					
• starting-up	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
• printing	10	10	10	20	20	20	50	50	50	100	100	100	150	150	150	500	500	500	1 000	1 000	1 000
Total	1 265	272	714	1 313	320	762	1 457	464	906	1 697	704	1 146	1 937	944	1 386	3 617	2 624	3 066	6 017	5 024	5 466
Unit price	126	27,2	71,4	65,6	16	38,1	29,1	9,3	18,1	17	7	11,5	12,9	6,3	9,2	7,2	5,2	6,1	6	5	5,5

- on a wide range of paper types. One might be inclined, therefore, to set up an in-house printing department, but the cost of this should be carefully assessed, taking into account : the need to have qualified operators, paid higher wages than the staff normally used for duplicating work ; and the need to complement the offset machine with a whole collection of accessory equipment: for type-setting : type-setting machines (varityper, IMB composphere, photo-composing machine, titler), process camera (calling on the services of a finisher), plate printer, etc.; at the finishing stage : cutting machine, assembling machine, stitcher, thermic binder, etc.). The investment in complementary equipment may well be twice or three times as costly as the price of the actual offset machine.

An offset machine of the duplicator type is suited to simple printing work, such as circulars, which only involves text or line drawings. In this case, preparation of the master is done by a direct process (writing or reprography).

V - REPROGRAPHY

1. General

Reprographic equipment (copiers) should be distinguished from duplicators. They differ in a number of respects. **Technique used** : copiers always use a radiation to form the new image. **Field of application** : photocopiers are normally used for making a single copy or a small number of copies (although recent improvements have made them suitable for printing larger quantities at reasonable cost ; this is especially true for a category of machines called "photocopiers-duplicators"). The radiation used can be either infra-red, of the visible spectrum, or ultraviolet. In the case of infra-red or ultra-violet radiation, the copies may be handled in the daylight (direct sunlight should however be avoided with ultra-violet radiation). Photocopiers are based on photochemical or photoelectric processes and they produce copies of perfect fidelity that do not require checking.

Generally, one of the following processes us used:

Contact printing : The paper is placed in direct contact with the document to be reproduced and the image is therefore always the same size as the original. Reproduction is done either by reflection or by transparency.

Optical printing : The image to be reproduced is picked up through a lens which inverts it and may modify its dimensions. On some machines, the image is then rectified through a prism or a mirror so as to be directly readable.

The actual processes can be divided into five groups, four of which relate to contact printing : traditional photocopy, thermocopy, dual spectrum and diazoprint. The fifth process is optical : electrocopy.

Because it is modern, with easy-to-use equipment (even without the assistance of an operator) and produces high-quality copies, electrocopy deserves to be dealt with in greater detail.

2. Price of the equipment and supplies

. Indirect electrocopying machines (ordinary paper)

Because their operating principle is relatively complex, these machines are costly. Their price ranges from about FF. 14,000 to 460,000.

The paper feed system is usually for paper in sheet form, although some machines provide for paper feed in rolls. Most of this equipment is designed for A4 size prints. Printing speeds (starting with the second

copy) range between 8 and 120 copies per minute. Prices rise proportionately with the printing speed offered :

8 to 12 copies per minute: FF. 14,000 to 30,000
13 to 20 copies per minute: FF. 20,000 to 60,000
more than 20 copies per minute : FF. 80,000 to 460,000.

There are about twenty machines that can produce double-size (A3) prints. Printing speed varies between 15 and 30 copies a minute, and prices range from FF.25,000 to 55,000.

Because electrocopying involves an optical reproduction process (the printing paper does not touch the original), size reduction of the copy as compared with the original is possible. Machines offering this device cost between FF. 35,000 and 140,000.

. Direct electrocopying machines (processed paper)

Generally, the price of this type of equipment is much lower than that of machines operating with ordinary paper. Many machines cost about FF. 4,000. Paper is fed either in sheets or in a roll. Some machines are adapted to both types of paper feed.

The great majority of equipment is designed for A4 size prints. For this size, with a printing speed between 5 and 10 copies per minute, prices range from FF. 4,000 to about 8,000. For higher printing speeds (up to 15 copies per minute), the cost varies between FF. 6,000 and 14,000.

For double size, prices range between about FF.5,200 and 8,000, and printing speed varies between 12 and 15 copies per minute. A few machines are also available which are adapted to A2 size printing. Size reduction is possible with equipment costing between FF. 14,000 and 26,000. A 21 x 29.7cm size sheet of processed paper costs between FF. 0.15 and 0.30.

3. Cost of printing

There is of course no charge at the stage of preparing the original. Any document of suitable size, written or printed in black or in standard colours (it is advisable to avoid orange, red and yellow) may be copied.

a) Indirect electrocopy (ordinary paper)

Costs include depreciation, maintenance, paper and time. For the purpose of cost assessment, we have selected a machine for 21 x 29.7cm size printing, costing FF. 25,000 and with a printing speed of one copy every five seconds. When the cost of maintenance is billed separately, it generally equals at least 10 per cent of the price of the machine. But there are many arrangements, some of which are complex, which require payment of a set price for maintenance and supplies irrespective of the number of copies. This may result in a prohibitive price per copy when the number of copies required is low. Generally, an increase in the number of copies causes a substantial decrease in cost.

For the machine selected, maintenance is provided for in the form of a charge covering periodic inspection, replacement of the photo-conductive substrate and supply of the liquid toner but excluding the paper. This charge amounts to 17 centimes per copy up to the 2,500th and then drops to 7.5 centimes.

This leads us to formulate three situations, each of which will give rise to a separate cost calculation.

1st case : 2,000 copies per month
2nd case : 4,000 copies per month
3rd case : 20,000 copies per month

Depreciation per copy will then be :

1st case : 25,000/120,000 = 20.8 centimes
2nd case : 25,000/240,000 = 10.4 centimes
3rd case : 25,000/1,200,000 = 2.1 centimes

The charge will drop to 7.5 centimes as from the 2,501st copy each month.

Supplies (toner, substrate) are included in the maintenance charge ; paper remains to be provided for : ordinary paper at FF. 0.03 per sheet.

Finally, time spent on copying : starting-up time, 15 seconds, costs FF. 0.125 and printing, 5 seconds, costs FF. 0.042.

Three tables (6, 7 and 8) may thus be drawn up.

b) Direct electrocopy (zinc oxide paper)

The cost of printing includes :

- depreciation and maintenance of the machine. The price of the machine selected is FF. 6,800 ; it produces a copy every 5 seconds. A fixed yearly sum is paid for maintenance ; it is usually about 10 per cent of the price of the machine.

We assume that 2,000 copies are printed each month, that is 120,000 copies in 5 years.

We have a cost per copy of FF. 6,800 + 3,400 = 10,200/120,000 : FF. 0.085.

- cost of a sheet of processed paper : FF. 0.24 (21 x 29.7cm)
- time spent, evaluated as follows :
  . starting-up : 15 seconds, i.e. FF. 0.125
  . printing : 5 seconds per copy, i.e. FF.0.42.

We can draw up table 9.

4. A special type of copier : copier-duplicators

When dealing with the printing speed of copiers, we mentioned speeds of 75, or even 120 copies per minute. At this speed, photocopiers offer similar possibilities to those of electric duplicators, hence the name of copier-duplicators is given to them. Their main advantage lies in the fact that they produce copies as rapidly as duplicators and do not, on the other hand, require the preparing of a plate and then setting it up on the machine.

There are, therefore, two competing categories of equipment : plate-maker/duplicators and copier-duplicators. Both offer a high degree of automation, which may be extended to the collating stage by fitting collating machines onto them. Prices range between FF. 40,000 and 150,000.

Because they are easy to use and work fast, copier-duplicators are very attractive machines. However, they can obviously only interest users whose needs are very great ; their maximum cost effectiveness seems to be for a small number of copies (up to about 50) since in this case writing off the cost of plate making is uneconomic with duplicators ; and finally, the quality of printing restricts their use to standard administrative work, since half-tones and solids (hence photographs) are poorly reproduced. Offset gives better results. It should be noted, however, that the quality of text reproduction may be excellent.

5. Colour electrocopy

Reprographic equipment can usually reproduce all colours, but the text of the copy, whatever the original colour, is always black. However, since 1968 new machines have appeared, which allow for a reasonable fidelity in the reproduction of original colours. These machines are based on the principle of indirect electrocopy, with the exception of the Mita which uses processed paper.

This technique is used for making scale models,

TABLE 6

Cost of printing by indirect electrocopy (ordinary paper)
on the basis of 2,000 copies per month (in centimes)

Number of copies Expense account	1	2	3	5	10	20
1 - Copier (depreciation)	20.8	41.6	62.4	104.0	208.0	416.0
2 - Maintenance	17.0	34.0	51.0	85.0	170.0	340.0
3 - Supplies (paper)	3.0	6.0	9.0	15.0	30.0	60.0
4 - Wages						
. Starting-up	12.5	12.5	12.5	12.5	12.5	12.5
. Printing	4.2	8.4	12.8	21.0	42.0	84.0
Total	57.5	102.5	147.7	237.5	462.5	912.5
Unit cost	57.5	51.2	49.2	47.5	46.2	45.6

TABLE 7

Cost of printing by indirect electrocopy (ordinary paper)
on the basis of 4,000 copies per month (in centimes)

Number of copies Expense account	1	2	3	5	10	20
1 - Copier (depreciation)	10.4	20.8	31.2	52.0	104.0	208.0
2 - Maintenance (2,500 prints at 17 centimes and 1,500 prints at 7.5 centimes)	13.4	26.8	40.2	67.0	134.0	268.0
3 - Supplies (paper)	3.0	6.0	9.0	15.0	30.0	60.0
4 - Wages						
. Starting-up	12.5	12.5	12.5	12.5	12.5	12.5
. Printing	4.2	8.4	12.8	21.0	42.0	84.0
Total	43.5	74.5	105.7	167.5	322.5	632.5
Unit cost	43.5	37.2	35.2	33.5	32.2	31.6

TABLE 8

Cost of printing by indirect electrocopy (ordinary paper)
on the basis of 20,000 copies per month (in centimes)

Number of copies Expense account	1	2	3	5	10	20
1 - Copier (depreciation)	2.1	4.2	6.3	10.5	21.0	42.0
2 - Maintenance (2,500 prints at 17 centimes and 17,500 prints at 7.5 centimes)	8.7	17.4	26.1	43.5	87.0	174.0
3 - Supplies (paper)	3.0	6.0	9.0	15.0	30.0	60.0
4 - Wages						
. Starting-up	12.5	12.5	12.5	12.5	12.5	12.5
. Printing	4.2	8.4	12.8	21.0	42.0	84.0
Total	30.5	48.5	66.7	102.5	192.5	372.5
Unit cost	30.5	24.2	22.2	20.5	19.2	18.6

TABLE 9

Cost of printing by direct electrocopy (zinc oxide processed paper) in French centimes

Number of copies Expense account	1	2	3	5	10	20
1 - Copier	8.5	17.0	25.5	42.5	85.0	170.0
2 - Supplies	24.0	48.0	72.0	120.0	240.0	480.0
3 - Wages						
. Starting-up	12.5	12.5	12.5	12.5	12.5	12.5
. Printing	4.2	8.4	12.6	21.0	42.0	84.0
Total	49.2	85.9	122.6	196.0	379.5	746.5
Unit cost	49.2	42.9	41.0	39.2	37.9	37.3

commercial catalogues and educational material : geographical maps, mechanical diagrams, anatomical drawings, etc. Prices range from FF. 150,000 to 200,000 for machines using ordinary paper. For custom work, one company charges the following prices :

TABLE 10

Number of copies	Unit price (size 21 x 29.7 cm)
1	FF. 7.00
2	FF. 6.00
3 to 9	FF. 5.50
50	FF. 4.15
100	FF. 3.50
200	FF. 3.30
500 and above	FF. 3.00

The use of transparent or tracing paper or cardboard entails an extra unit cost of FF. 2.00.

Colour electrocopy is much more expensive and less widely-used than black and white.

VI - CONCLUSIONS

The unit cost analysis which we have carried out, on the basis of prices prevailing in France in 1980 and excluding tax, confirms the importance of working out one's **exact reproduction needs by type of document.** It is this cost analysis which will enable the definite choice of a system to be made. Table 11 below recapitulates this analysis.

TABLE 11

Cost of printing by duplication (in French centimes)

Number of copies	10	20	50	100	150	500	1000
Hectographic duplication	122.2 to 26.5	64.2 to 16.4	29.5 to 10.3	17.9 to 8.3	14.3 to 7.6		
Stencil duplicator	123.6 to 66.9	64.0 to 35.7	28.3 to 16.9	16.4 to 10.7	12.4 to 8.6	6.8 to 5.7	5.6 to 5.1
Small offset	126.0 to 71.4	65.6 to 38.1	29.1 to 18.1	17.0 to 11.5	12.9 to 9.2	7.2 to 6.1	6.0 to 5.5

TABLE 11 (continued)

Cost of printing by reprography (in French centimes

Number of copies	1	2	3	5	10	20
Indirect electrocopy 2,000 copies per month	57.5	51.2	49.2	47.5	46.2	45.6
4,000 copies per month	43.5	37.2	35.2	33.5	33.2	31.6
20,000 copies per month	30.5	24.2	22.2	20.5	19.2	18.6
Direct electrocopy 2,000 copies per month	49.2	42.9	41.0	39.2	37.9	37.3

2. BACK PROJECTION AND TRANSPARENCIES

I - GENERAL

Projection in full daylight by means of an overhead projector is undoubtedly a privileged teaching medium.

1. An overhead projector (OHP) may be used in two different ways as an aid to teaching : (1) drawings produced for immediate use, on a roll of acetate, using simple writing instruments (pencil, markers), which are subsequently erased (in this way the OHP is simply being used as an ordinary writing board) ; and (2) drawings prepared in advance on transparencies which can be stored as part of a collection of vufoils specific to the educational establishment concerned (transparencies can be bought ready-made from commercial producers or produced by the teachers themselves using a variety of techniques).

It is very important to emphasize the production of transparencies, by encouraging research in the design, execution and exploitation of the vufoil (overlays, gradual disclosure, animation, etc.).

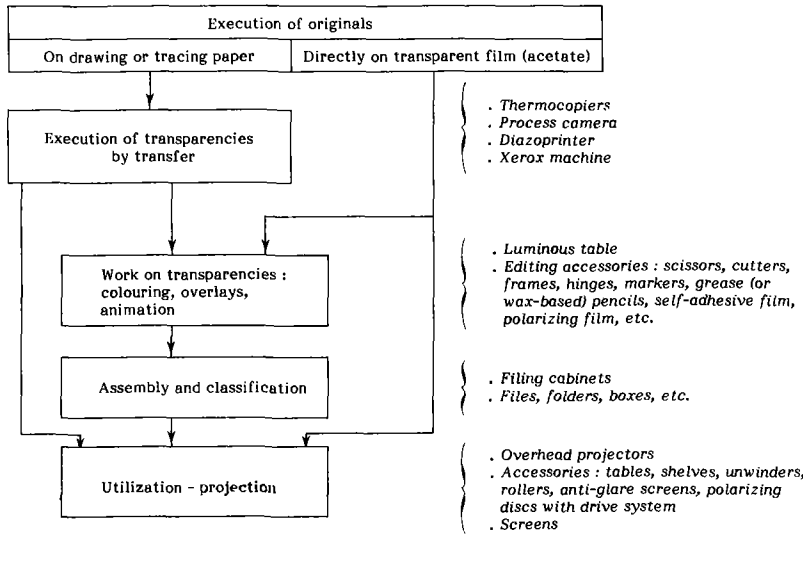
However large the scale of production of transparencies by the teachers themselves (often limited, it appears, by the time required for preparation and execution, and by the freedom left to teachers for design and production), it seems necessary to have a graphic workroom at one's disposal with the drawing materials and instruments required for making transparencies.

2. Two situations should be considered in the context of the scale of production . First, where the volume of production is small (as is often the case in educational institutions) and the workshop functions without permanent staff : in these circumstances, the availability of premises and the motivation of the teachers are the only reasons that keep it going. Second, where the volume of production is large (as in some training centres or some large vocationally-oriented schools) and the uses to which the OHP is put are extremely varied : in these circumstances, the workshop operates with full or part-time graphic designers.

3. Two methods can be used for small scale execution of transparencies : transferring originals from paper or tracing paper (indirect) ; and drawing directly on the transparent film. The indirect method allows for more precise graphic work and duplication of as many copies as required. It is however more expensive, all the more so if colour is used (as in this case expensive photographic transferring processes have to be applied). The transfer method, because it substantially increases capital costs, is reserved for establishments producing large quantities of transparencies. The direct method, where the transparency is made by the teacher, is usually quicker and involves relatively simple and inexpensive facilities. However, the quality of artwork may be less than professional. Table 12 gives details of the different stages of production of transparencies together with the necessary equipment.

TABLE 12

Stages in the execution of transparencies and corresponding equipment



II - ASSESSMENT OF NEEDS

1. Educational establishment

We will take as an example a school with 600 pupils, 30 in each class. This school is for children aged 11 to 15 and does not have a specialized technical section.

The school has twenty classes divided among four different levels. Pupils receive 900 hours of tuition per year, which for all twenty classes represents 18,000 hours yearly. Thirty teachers work full-time, each teaching 600 hours per year (30 x 600 = 18,000). We will assume that these thirty teachers are responsible for ten different subjects.

Assuming that a class lasts one-and-a-half hours, each teacher gives 400 lessons per year, and throughout the whole school, 12,000 lessons are taught by all thirty teachers. Utilization of the overhead projector can be estimated at 2 per cent of class time, which represents for the whole school a utilization time of 240 hours a year. The relative share of writing board type utilization, where the documents are not retained for further use, and utilization of transparencies prepared in advance and used year after year (the life span of a transparency being three to five years) should be assessed.

According to the above assumptions, it may be estimated that 100 original vufoils will have to be produced each year. It is on this basis that our assessment of cost will be made.

2. Case of a similar establishment with a technical orientation

For a school of the same size which is technically or vocationally orientated, it is estimated that utilization of the overhead projector is multiplied by four, i.e. 400 original vufoils are produced each year.

3. Training centres

A number of institutions (large schools or training centres) can justify the permanent employment of a graphic artist and more complete equipment.

4. Basic equipment

Back projection equipment includes, per unit :

- a portable overhead projector, costing FF. 3,300
- accessories : a telescopic table : FF. 700 ; a shelf: FF. 150 ; a detachable unwinder : FF. 150 ; and a screen : FF. 400 ; i.e. for total accessories, FF. 1,400.

Total cost per unit : FF. 4,700.

Supplies are estimated at FF. 2,120 a year, with the following breakdown :

- for 'writing board' type utilization	
250 acetate films	FF. 270
writing materials (markers, pencils)	FF. 330
	FF. 600
- for making 100 transparencies	
250 acetate films	FF. 270
writing material	FF. 300
100 A4 size frames	FF. 300
2 rolls of metallized hinges	FF. 50
20 Letraset-type sheets of letters	FF. 600
	FF. 1,520

III - COST ASSESSMENT

1. In the minimal-use situation

For a school with 600 pupils divided into twenty classes, one back projection unit should be provided for every four forms, that is five units for the whole establishment. The back projection equipment will represent a cost of FF. 4,700 x 5, i.e. FF. 23,500. In this instance, each unit must be shared by six teachers. Utilization time of each of these units, on the basis of one hour a week on average, at each level and for each subject, is :

4 (30 x 10) = 1,200 hours for all five units,
i.e. 240 hours for each.

The cost of supplies of acetate scroll required for writing-board type utilization and for making 100 transparencies per year should be added to the price of the basic equipment. This cost is estimated at FF. 2,120 per year.

Such a small scale of production does not justify employing a permanent graphic artist.

The workshop used for producing the 100 documents per year must therefore be fitted with very simple equipment, the price of which may be estimated at FF. 6,000, and including :

- 1 drawing board, 1 T-square, 2 squares	FF. 500
- 1 desk comprising a working table and a light box	FF. 800
- 1 stool	FF. 500
- drawing material, including a box of pens	FF. 400
- compasses, lettering guides, spray guns	FF. 400
- 1 thermocopier for transferring	FF. 3,400

We have selected a thermocopier for transferring on account of the cost of this machine and its ease and speed of operation. All the above equipment will be written off over ten years, which represents a cost of FF. 340 per year. Cost of maintenance and replacement of parts may be estimated at 5 per cent per year of the investment, i.e. FF. 170. No special room is required to store and use the equipment.

2. In the case of a 'training institution' type of situation

Production of transparencies by such institutions may be large enough to justify the permanent use of a graphic artist. This implies : higher quality drawing materials; more comprehensive transferring equipment (a thermocopier plus a transferring machine by diazoprint or by film) ; and specialized premises. The cost analysis runs as follows.

a) Back projection material

Each back projection unit is identical to that used in the example of the school as described earlier. Polarizing discs may however be added to the overhead projectors for the purpose of animation. In this case, the cost of each unit will be FF 6,000, that is FF.24,000 for all four units.

b) Production equipment

1 luminous table with drawing instruments	FF. 9,000
1 height-adjustable stool	600
1 horizontal drawing table	1,000
1 cabinet and 2 storage units with 5 drawers each	2,600
1 thermocopier	3,400
1 ultra-violet insolating machine	3,000
1 ammoniac printer	2,000
developing and rinsing tank	400
	F.F. 22,000

Depreciation can be calculated over ten years and maintenance costs estimated at 5 per cent.

c) Premises

The surface required for utilization of the production equipment is approximately 20 square metres.

d) Supplies

In 'training institution' or 'vocational training centre' type situations, we envisage intensive use of the overhead projector (four times more than in the basic educational institution, with a production of 400 originals each year).

400 boxes of 25 diazochrome films	FF. 38,000
4 sets of adhesive film (6 colours)	500
4 adhesive films for animation (rotation)	1,200
4 adhesive films for animation (transfer-type)	1,200
simple drawing instruments	100
400 size A4 frames and hinges	1,200
40 special letter-sheets	1,200
	FF. 43,400

These costs are given merely as an indication, as the cost of making transparencies in terms of the supplies required varies according to how sophisticated the transparencies are.

e) Staff costs

The time required for design should be differenciated from that needed for production. Design time varies from virtually nothing in the case of 'writing board' type utilization to long periods in the case of a very elaborate transparency, for instance, one whose aim is to explain, in several stages, some operating principle of a machine or of equipment which involves complex technology. The cost of design may be estimated in designer/hours, with salaries and social security contributions of varying amounts depending on the employee's qualifications. This cost can vary in the ratio of 1 to 10.

Production costs corresponding to the actual making and duplicating should also be estimated according to qualifications and associated wage rates.

Employment of a specialist graphic artist (level of qualification : French *baccalauréat* + 2 years' experience) on a full-time basis (i.e. 1,600 hours per year) makes possible the production of 400 original transparencies a year.

3. PHOTOGRAPHY IN AN EDUCATIONAL CONTEXT

I - GENERAL

Many studies have shown that it is wholly worthwhile to provide facilities for pupils to take up photography at school or in an educational environment, a photography club for instance. This can be brought about in a variety of ways, and, in each instance, economic considerations and organizational constraints vary substantially. We will, therefore, examine in turn the different techniques involved, ranging from the simplest to those requiring greater know-how.

1. Objectives

Several stages can be identified in the use of photography in an educational context, according to the objectives to be achieved. We will consider three.

a) Learning how to see with a camera

Learning about composition, i.e. isolating a certain portion of space and time, is possible when using simple or instant cameras which allow the picture to be seen and evaluated immediately. This skill can be acquired even without a camera : a device can be constructed out of cardboard, with a mirror and a lens to observe an image ; or photograms can be produced involving various artistic and creative activities.

b) Having pupils produce photographic work

The purpose of this second stage is to enable pupils to develop a disciplined approach to photography so that ultimately they will be competent to produce quite elaborate work.

Besides being an educational activity, photography can also become a cultural and social one by virtue of the value of the work produced as social testimony. It can also have a poetic function since it enables pupils to communicate their own way of seeing the world and expressing themselves[1].

These different stages obviously require a more sophisticated and extensive range of equipment, suitably adapted for group work.

[1] Pupils can also learn how to tell a story using a succession of illustrations, and by such an introduction to the art of narration in pictures, discover that the photographic image behaves quite differently when it is part of a text and when it is placed alongside other pictures. Such parameters as composition, strength of lines and balancing of values, which so far have been read without conscious awareness, now begin to carry meaning.

c) Producing teaching material for the school

It should be possible to produce additional copies of photographs, selected for their value as examples, for use as teaching aids during classes.

In this way, collections of photographs can be put together in sufficient quantity to supply the whole school's requirements.

2. Constraints

The selection of materials and equipment is not simply a function of the objectives sought. There are a number of additional constraints inherent in the provision of instruction in photography.

In order for photography to be taught, the following factors have to be considered : availability of staff; availability of time (involving coordination of time-tables in order to form groups) ; and availability of suitable premises, including storage rooms.

Training personnel. Photographic processes are both numerous and time-consuming. If it is intended to provide for laboratory processing of film, a great deal of time is involved. The same applies to shooting, an activity which usually requires careful preparation. Since the time needed for these operations cannot be shortened, the sessions allocated to photography must take this factor into account. It is usually preferable to give over a whole day or a half-day to photographic activities rather than to attempt to concentrate them into one-hour periods as is appropriate for other subjects. This involves training personnel being available for several hours at a time and precise planning is therefore necessary.

Time available : work groups. The problem is further complicated by the requirement to form small work groups. For certain activities, the number of groups will obviously be determined by the availability of training personnel as well as suitable premises.

Premises. Shooting, developing and printing require adequate premises for the provision of a mini-studio and laboratory. Running water and a dark room are essential facilities.

3. Selection of equipment

Table 13 allows for an initial analysis of equipment in the light of desired objectives ; precise requirements can be determined following an in-depth economic study, including the operating budget, an aspect which will be considered later.

TABLE 13

Table of photographic equipment

EQUIPMENT / OBJECTIVE	Instant cameras	Miniature reflex camera with interchangeable lenses + normal lens	Additional lenses	Various accessories	Reproduction device	Mini-studio	Laboratory accessories
Introduction to shooting	+++	-	-	-	-	-	-
Acquiring basic technical knowledge	+	+	-	-	-	-	-
Acquiring in-depth technical knowledge	+	+	+	+	-	-	-
Routine production	-	+++	+++	+++	+++	+++	+++
Production and reproduction in large quantities	-	+++	+++	+++	+++	+++	+++

Note : the signs + or - indicate the degree of suitability of the different types of equipment according to the objective pursued. Instant cameras, for example, are very useful for an introduction to shooting but are of no assistance for the learning of processing skills.

II - EXAMPLE OF APPLICATION

Let us consider a school with 600 pupils divided into twenty classes with thirty-five pupils as a maximum in any class. The pupils are given thirty hours of classes weekly for thirty weeks, i.e. 900 hours over the year. Availability of training personnel is estimated at 600 hours a year for a secondary school teacher, 900 hours a year for a primary school teacher or specialist instructor, and 1600 hours a year for a specialist laboratory technician.

We will examine the different objectives described above in turn.

1. Introduction to picture-taking

Taken as a whole, this activity requires twenty hours. For all the pupils in the school to be trained, fifty groups each of twelve pupils should be formed, which amounts to 50 x 20 = 1,000 hours of training in a year (i.e. the equivalent of two teaching schedules at secondary level, or a little more than one schedule for a primary school teacher, or a little less than a full working year for a technician).

a) Equipment

Each group of twenty pupils requires at least three cameras (six would be ideal). Instant cameras will be selected because they are the most convenient. The cost will be FF. 200 x 3 = FF. 600 per group. The theoretical cost would be FF. 600 per group, i.e. 600 x 50 = FF. 30,000 . But the same cameras can be used for several groups, and, from experience, it is realistic to provide for just one set of cameras for five groups, which brings the cost down to FF. 3,000 (ten times lower than the previous estimate).

Depreciation of this equipment will be calculated over five years. Maintenance costs should be provided for and estimated at 5 per cent a year, i.e. 3,000 x 0.05 = FF. 150.

b) Operation

A minimum of three photographs should be taken by each pupil during the initial stage. Since each class lasts three hours and total training time is twenty hours, the time available allows for approximately seven classes. With twelve pupils in each class, the total number of photographs taken will be 252 (i.e. 3 x 7 x 12) which, for convenience, is rounded up to 260. Instant 8 x 8cm colour photographs are obtained by using ten-exposure cartridges costing FF. 45 ; it follows that for each group twenty-six cartridges are needed, representing an annual cost of FF. 1,170. This budget should be increased by 10 per cent to take account of any handling errors, as well as for the supply of products such as batteries, and this brings the annual cost for each group to some FF. 1,300.

c) Storage

The three cameras available for each group can be stored after use in standard school cupboards which should be locked to prevent theft. The photographs will be placed in transparent plastic suspended folders, protected from humidity and excessive heat. In extreme conditions of humidity, air-conditioned filing cabinets or air-tight cupboards must be used, but this is an exceptional occurrence. Cartridges should be stored in pre-determined conditions of temperature (5° - 10°C) and humidity (50 to 60 per cent), which means that access to a refrigerator is necessary.

Hence the following cost :

- 1 50 litre capacity refrigerator for storage of cartridges	FF. 500
- 1 storage cabinet	500
- 1 cupboard suitable for storage of suspended plastic folders (capacity 500 photographs)	500
	FF. 1,500

The refrigerator can be written off over five years and the storage cabinet over ten years. The plastic folders must be replaced from time to time.

2. Routine production work

In order to reach a satisfactory level of technical skill, thirty hours of training should be allocated to acquire the basic technical knowledge necessary for out-of-doors shooting, and a further thirty to forty-five hours to achieve competence in developing and printing operations, depending on whether black-and-white or colour is being used.

Based on groups each comprising twelve pupils, the requirements for training personnel for a total of fifty groups are as follows :

- 1,500 hours for camera work (thirty hours x fifty groups) will involve a staffing requirement of 2.5 secondary school teacher posts, or two primary school teacher posts or one specialist technician post ;
- 1,500 to 2,250 hours for developing and printing, depending on whether black-and-white or colour film is involved. At the most - that is, to allow for camera work, developing and colour printing - the total staff requirement amounts to six secondary school teachers, or five primary school teachers along with 2.5 specialist technicians.

a) Shooting equipment

A minimum of two cameras is needed for each group of twelve pupils (four would be ideal).

A manual miniature reflex is the most suitable camera. This is a basic camera with a standard lens. The camera is sold at a price of FF. 600, but it does not include a meter (the indications given by the meter must be transferred to the aperture and shutter speed settings on the camera.

If a semi-automatic or automatic camera is selected, it is advisable to choose one which can also be operated with manual settings. Such cameras, with a standard lens, cost FF. 1,200.

Each group also needs :

- a 35mm wide-angle lens) or a 35-105mm
- an 80 or 105mm telephoto lens) zoom lens
- a tripod
- a flash facility
- filters (ultra-violet, green, red)
- two tungsten lamps, 300 or 500 W
- two lamp holders

This additional equipment costs approximately FF.3,000.

For a school with 600 pupils and fifty groups, the financial outlay would be very heavy. In practice, however, it is possible to get by with only the amount of equipment required for ten groups, which represents a total cost of :

basic equipment : 1,200 x 2 x 10 = FF. 24,000
complementary equipment: 3,000 x 10 = FF.30,000
total : FF. 54,000

Depreciation can be calculated over five years. Maintenance costs are estimated at 10 per cent of the initial price.

b) Laboratory equipment

Processing photographic film involves the following stages :

- developing in a developer bath which brings out the image (two or three baths are required for colour film);
- fixing bath to ensure that the image is retained;
- blow-up and exposure to a source of light by means of an enlarger ;
- washing and drying.

The specific equipment required is described below.

Black and white laboratory equipment

1 Kindermann-type 3-reel tank
1 film cartridge opener
1 thin-ended thermometer for tank
2 ordinary film clips
2 heavy-duty film clips
1 shammy (chamois) leather or squeegee
1 pair of scissors, minimum blade length 10cm
1 transparent polystyrene beaker (capacity 1 litre)
2 plastic 1-litre flasks and one 500cc flask
1 transparent polystyrene 300ml test-tube
1 polystyrene funnel
1 column-type enlarger with manual focusing lens holder, all-purpose negative holder
anti-newton glass, light box
good-quality enlarger (5 or 6 lenses)
Masking frame 18cm x 24cm x 30 cm
Paterson-type 35mm contact printer
Special laboratory stop watch
Scoponet type focusing magnifier
Airbrush
Small cutting machine
Laboratory lamphouse with filters
3 plastic 31cm3 or 51cm3 carboys
2 deep plastic basins 18cm x 24cm
5 deep plastic basins 30cm x 40cm
5 paper-handling clips
1 spirit thermometer
1 plastic paper dryer

Total cost FF. 3,000

Colour laboratory equipment

Replace the 3-reel tank by :
1 drum processor for colour processing (small fresh bath)
Replace the thin-ended thermometer by a precision thermometer (1/2C) 10°-50°C
1 enlarger fitted with colour head

Add :
1 voltage regulator
1 colour analyser
1 water jacket device with temperature control 18° to 45°C
1 processing time exposure control
1 exposure time indicator
1 automatic tank agitation device

Total cost FF. 4,500

Depreciation of this equipment (black-and-white or colour) must be calculated over five years.

Maintenance costs should be estimated at 10 per cent per annum.

c) Accommodation

A room is required with facilities for four people to work individually at all stages of processing: developing, rinsing, fixing, washing, enlarging and printing. This will allow for twelve pupils to operate in groups of two at a time. The room must have a minimum surface area of 50 square meters divided into two sections. For the premises to be operational, the following conditions must be fulfilled : access to the two separate sections must be easy and must be kept clear to allow for evacuation ; one of the two sections must be capable of being turned into a darkroom ; the light room should be fitted with fluorescent light, and the darkroom with inactinic (tungsten) light; power supply (ground connections) and water supply must be provided for, as well as the disposal of liquid waste. Large quantities of water are used ; it may have to be filtered for the processing of colour emulsions. Temperature of the baths must be constant to within 1/2°C ; temperature requirements vary between 20°C and 38°C according to the film. Airing and ventilation, thermal regulation and, if necessary, air conditioning must be provided for ; and there should be storage cabinets with locks to store the equipment (chemicals should be separated from all other material), files to store negatives and boxes for slides.

Cost of building processing laboratory. A building providing 50 square metres of floor surface at FF.3,000 per square metre (technical premises) will cost FF.150,000. Depreciation should be calculated over twenty years (including maintenance costs).

Furniture. FF. 2,000 for cabinets and files ; depreciation over ten years.

Supplies. Some materials are affected by environmental factors.

It will cost FF. 300 a year to store photographs, paper, films and negatives. Three isothermal cupboards are required for longer-term storage and for protection from climatic influences. The cost will be FF.3,000 x 3 = FF. 9,000. Depreciation should be calculated over ten years ; maintenance and electricity costs will run at 15 per cent of the initial capital cost a year.

d) Operation

Table 14 summarizes requirements for film and paper.

TABLE 14

Basis for calculation : School with a maximum of 600 pupils

Skill to be acquired	Length of classes	Number of classes each year	Number of groups, with 12 members in each
Basic technical knowledge of shooting (30 hours)	3 hours	10	50
Basic technical knowledge of laboratory processing (black and white) 30 hours	3 hours	10	50
Laboratory processing : colour (45 hours)	3 hours	15	50

Note : Reversal slide film is gradually replacing negative film for this type of use : the cost per photograph is half that of a 9 x 13cm colour print, the range of emulsions is wider, image definition is usually superior, and the original allows for immediate readaptability and, of course, large size projection. If prints on paper are subsequently required, selection and printing corrections are made easier by the fact that the print can be compared with the original. Twenty-exposure films can also be used, which allows for easier selection at the developing stage and shorter immobilization time of the film inside the camera.

Black and white processing

. 42 36-exposure films (size 135), various emulsion speeds FF. 15 x 42 =	FF. 630
. Film processing chemicals 5 litres of developer and 5 litres of fixer	125
. Printing paper	500
. Chemicals	125
Total	FF. 1,380

Colour processing

. Film	FF. 750
. Chemicals	750
. Development of 750 shots and printing of 50	440
Total	FF. 1,940

e) Acquiring more advanced technical knowledge enabling the pupils to produce high quality photographs

Further to the basic skills cycle described in the previous section, which requires sixty to seventy-five hours for colour and black and white, a scheme for the development of higher proficiency should be included. The more proficient one becomes, the harder it becomes to assess needs with precision, since individual factors come into play : pupils possess varying degrees of aesthetic motivation, and this affects the allocation of time to shooting or processing. Some 100 to 200 hours should be allowed to reach the level of competence of a good amateur photographer.

For this stage, requirements are as follows :

(1) - at least one qualified technician holding a *Brevet de Technicien Supérieur* or having equivalent professional experience ;

(2) - additional equipment required to furnish a photographic studio :

2 lamp stands	FF. 150 x 2 =	FF. 300
2 lamp holders	50 x 2 =	100
2 reflector lamps	60 x 2 =	120
2 tungsten lamps	40 x 2 =	80
Sundry items		100
Total		FF. 700

Depreciation can be calculated over five years and maintenance costs are estimated at 5 per cent a year.

(3) - additional shooting equipment for special purposes (micro- and macrophotography)

1 macro lens, focus 100mm	FF. 600
1 microscope adapter	150
1 flexible releaser	20
1 copy stand	700
Total	FF. 1,470

Depreciation is again calculated over five years and maintenance costs will be at the rate of 5 per cent per year.

(4) - substantial increase in operating costs:
+ 15 per cent for black-and-white film (because of the wide variety of emulsions used)
+ 10 per cent for black-and-white processing chemicals (special products for high-quality prints)
+ 500 per cent for black-and-white paper (wide range of paper types and sizes)
+ 100 per cent for colour processing.

III - LARGE-SCALE PRODUCTION AND MULTI-COPYING

Producing and copying photographs on a large scale requires professional equipment. Qualified personnel are needed for the operation of such equipment. As a guide, let us look at two examples.

1. Example A : reproducing up to fifty copies from an original slide

The investment is as follows :

- 1 repro bellows	FF. 1,000
- a protection framing device	60
- 1,000 protecting masks	220
Total	FF. 1,280

2. Example B : reproducing up to 200 slides

The investment required is larger :

- a slide duplicator with accessories	FF. 5,000
- a protection framing device	60
- 4,000 protecting masks	440
Total	FF. 5,500

Depreciation : ten years
Maintenance : 10 per cent per year.

3. *Large-scale production and multi-copying*

This requires processing machines and semi-industrial printers which are beyond the scope of this study. The purchase of such equipment can only be justified when 200 to 300 copies of a single slide are required daily. Furthermore, special premises offering twenty-five square metres and including electrical fittings, a water filtering system and thermal control are necessary. The following prices may be given as an indication:
- duplicating printer : FF. 6,000
- processing machine : FF. 6,000.

4. LANGUAGE LABORATORY

I - GENERAL

Installing a language laboratory in a school, university, technical training college or further education institute raises a number of practical problems which must be taken into account if the fullest use is to be made of such equipment.

Over the past few years, considerable technical progress has been made in this field and, as a consequence, many of the earlier constraints affecting the use of language laboratories have been removed. Objectives are now clearer, and, as a result, it has become easier to determine the relevant technical and economic parameters. Administrators and teachers can now be given reliable information.

1. Utilization situations

The type of laboratory work that we are concerned with goes beyond the use of a language-teaching or stereo tape recorder in the classroom. Laboratory exercises allow for : training in oral comprehension, training in pronunciation and reading, training in spontaneous expression, training in doing commentaries and structural exercises (drawn either from textbooks or made up by the teacher).

The very nature of these exercises requires all the pupils to work at their own individual speed. For this reason, the 'light' version of a language laboratory, i.e. one which is audio-active but which requires **all students to work at the same pace** can be replaced by a set of individual language-teaching tape recorders, sound-insulated and used on a 'self-service' basis. The cost of each unit, comprising a tape recorder, table and combined headset, is approximately FF.5,900.

Language laboratories available on the market take account of the need for students to work at their own pace ; the technical possibilities offered also allow for individual tuition.

II - BASIC DATA

The following estimates are based on information obtained following enquiries carried out among users[1].

Let us take as an example a secondary school which also trains qualified technicians. It has between 1,200 and 1,500 pupils, thirty-five pupils per class and five different class levels. Frequency of utilization of the laboratory is one hour every two weeks for groups of eighteen students, whatever the language studied.

The academic year is estimated at 900 teaching hours (thirty weeks and thirty hours per week and per pupil).

Potential occupation of the school's language laboratory may be estimated as follows :

- Calculation of the number of groups (eighteen pupils per group, average number of students 1,200 to 1,500) works out at seventy-six groups. Considering the frequency of utilization as one hour every two weeks over thirty weeks, whatever the language studied, we have :
- Calculation of potential occupation time :
  $76 \times 1 \text{ hour} \times \frac{30}{2} = 1{,}140 \text{ hours per year}$

Statistically, on the basis of a specific study of a real situation, utilization time is estimated at 750 to 900 hours for such a school with five levels of tuition.

III - COST ASSESSMENT

Costs will be broken down as follows :

. Costs related to the use of the laboratory
. Costs related to the production of exercises
. Costs related to management

1. Utilization of the language laboratory

a) Accommodation costs

The premises must contain all the booths and the teacher console (the latter is sometimes in a separate studio-type room, separated from the main room by a large window). A surface area of two square metres for each booth and ten square metres for the console must be available. In the present case, twenty booths will be built to allow for failure and repair. Hence the floor surface required will be (20 x 2) + 10 = 50 square metres.

For the premises requiring modification for acoustic purposes, the cost can be estimated at FF. 3,000 per square metre floor surface, i.e. FF. 3,000 x 50 = FF.150,000, plus FF. 3,000 for sound insulation and miscellaneous expenses, i.e. a total of FF. 153,000.

Depreciation is calculated over thirty years ; maintenance costs per square metre will be considered part of depreciation costs, along with other expenses such as electricity.

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[1] Investigation carried out by the Paris based *Centre Régional de Documentation Pédagogique*, under sponsorship of the *Centre National de Documentation Pédagogique*, in all types of teaching establishments, and by Mr. Michel Marceau, English teacher (1981).

b) Equipment

- One teacher console	FF. 6,500
- One connecting panel (linking student consoles to the teacher console	1,500
- One command panel	6,000
- Power supply	3,500
- One microprocessor unit	12,300
- 20 student consoles including legs, plate glass, side panels	16,000
- 20 headsets (FF. 300 each)	6,000
- 1 teacher tape recorder	6,500
- 1 teacher cassette recorder	4,500
- 20 student cassette recorders (FF. 4,500 each)	90,000
Total	FF. 152,800

The cost of fittings (wiring, etc.) is approximately FF. 300 per booth, i.e. 300 x 20 = 6,000.

Total cost : 152,800 + 6,000 = 158,000 rounded up to FF. 159,000.

Depreciation of this equipment is calculated over 10,000 hours of operation, i.e. about ten years.

Maintenance costs amount to 5 per cent a year, i.e. 152,800 x 0.05 = FF. 7,640 (this percentage is determined according to the statistical average of prices charged for repairs and of the number of breakdowns over a given year).

c) Furniture and miscellaneous items

- 1 cupboard, 1 table, 4 chairs, and sundry items	FF. 4,000
- 1 fire extinguisher	4,500
	FF. 8,500

Depreciation is calculated over ten years, all costs included.

d) Programmes and cassette duplication

The programmes used in the laboratory serve as a support to the audio-lingual methods employed in the classroom.

We will base our estimate on twenty original one-hour tapes per language and at each level. At present market prices the total cost will amount to FF. 2,000 excluding tax for all twenty tapes. We assume that there are five different levels and four languages taught, which involves an initial investment of FF. 2,000 x 5 = FF. 40,000.

These original tapes will be duplicated in cassette form for use in the laboratory. All duplicating operations are carried out in the laboratory itself, as all modern types of laboratories allow for automatic programme transfer and high speed cassette duplication (four times the nominal speed). We will therefore estimate only the cost of cassettes required for duplication purposes : 20 x 5 x 4 x 20 booths = 8,000 x C.60 cassettes.

Since the average unit cost of a cassette is FF.5, we have : FF. 5 x 8,000 = FF. 40,000. Cassettes should be replaced every year.

e) Maintenance

The frequency of regular maintenance operations keeps a laboratory in good working order and reduces the number of repairs. Time spent on maintenance is estimated as follows :

Cleaning of the heads and dust removal : once a week, one hour/week ;

Cleaning of the tape decks : one a month, three hours/month ; i.e. about sixty hours a year by a technician appointed by the school.

Supplies cost FF. 50 a year for items such as cotton wool, spirit and wooden swabs. The investment required includes the purchase of dust covers, estimated at FF.30 for student consoles and at FF. 50 for the teacher console, i.e. (30 x 20) + 50 = FF. 650. Life span : five years.

Wages of the school technician can be calculated on the basis of 1,600 hours per year, for an average cost excluding employer contributions, of FF. 30,000 per year. Since employer contributions are estimated at 40% of the wages, the total cost to the employer will be :

$$\frac{60}{1,600} \times \text{FF. } 38,000 = 1,425$$

$$\frac{1,425 \times 40}{100} = \text{FF. } 570$$

i.e. 1,425 + 570 = FF. 1,995.

f) Training personnel

The staff requirement is two teachers - a senior teacher and an assistant teacher - working as a team, each one being in charge of half the teaching - one in the laboratory, the other in the classroom.

The hourly wages of these teachers must be taken into account. For a highly-qualified language teacher, the average salary, excluding employer contributions, is FF. 200 an hour. For an assistant teacher the average salary, excluding employer contributions, is FF. 100 an hour. Employer contributions amount to 40 per cent of salary. If we base our calculations on 1,140 hours per year (see section II), we have : (FF. 200 x 1,140) + (FF. 100 x 1,140) = 228,000 + 114,000 = FF. 342.000 for basic salaries ;

$\frac{342,000 \times 40}{100}$ = FF. 136,800 for employer contributions

The total staffing cost is, therefore, FF. 324,000 + FF. 136,800 = FF. 478,800.

2. Production of exercises

We will consider two different cases : 1) an audio-lingual course used in the classroom and adapted for use in the laboratory and 2) the production of original exercises.

a) Adaptation of classroom exercises

As already mentioned, this is done using the console tape-recorder and microphone. Wage costs are based on one hour of recording on tape ready for transferring which will involve two hours' work on the teacher's part as well as one hour of final recording by the assistant.

b) Production of original exercises

Premises : In this case, it is advisable to have a small self-contained recording studio for which the acoustic modification is easy and inexpensive ; a surface area of four square metres is sufficient for recordings with two or three people, as the equipment takes up very little room[1]. On the basis of FF. 3,000 per square

[1] One may be surprised at the small size of these premises. In fact, the space used is often taken from an adjoining room and adequately sound-insulated. Premises built specially for the purpose may take the form of a small studio of twelve square metres, but the only advantage of this will be to offer greater comfort.

metre, we have : 3,000 x 4 = FF. 12,000 plus 5,000 for acoustic modification, i.e. a total of FF. 17,000. Buildings will be written off over thirty years, all costs included.

Equipment

2 cardioid dynamic microphones	FF. 1,600
2 semi-professional tape recorders (type REVOX)	10,000
1 turntable	1,500
1 mixing console	1,000
1 amplifier	1,500
1 loudspeaker	500
1 headphone	500
Total	FF. 16,600

Assessment of production costs. One hour of finished recording requires :

Preparation time : 4 teacher hours
+ 1 assistant hour = 5 hours
Recording time : 3 hours (teacher + assistant)
Editing time : 3 hours (assistant only)

1,000 metres of tape will be needed (speed 19cm/s), estimated average cost FF. 0.15 per metre.

Wage costs are calculated on the basis of the figures stated above, i.e. for a one-hour programme:

Teacher's fees : 7 hours x FF. 200 = FF. 1,400
Employer contributions : $\frac{1,400 \times 40}{100} = \frac{560}{1,960}$
Assistant's fees : 7 hours x FF. 100 = FF. 700
Employer's contributions : $\frac{700 \times 40}{100} = \frac{280}{980}$
Cost of tape : FF. 0.15 x 1,000 = FF. 150
Total : 1,960 + 980 + 150 = FF. 3,090

3. Management costs

Planning the occupation schedule of the laboratory, passing on information from articles or books written on the subject of language laboratories and organizing at least one meeting each year on the use of the laboratory, are responsibilities which should be entrusted to a co-ordinating teacher.

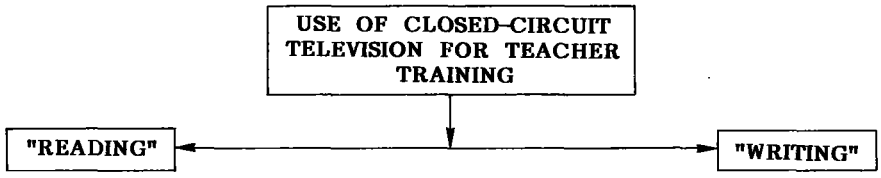
The time required can be estimated at sixty teacher hours a year if this work is to be carried out in the best possible way.

5. CLOSED CIRCUIT TELEVISION FOR TRAINING EDUCATIONAL STAFF

I - GENERAL

The use of closed-circuit television for staff training and, more specifically, for teacher training can be summarized as shown in Figure 1.

Figure 1

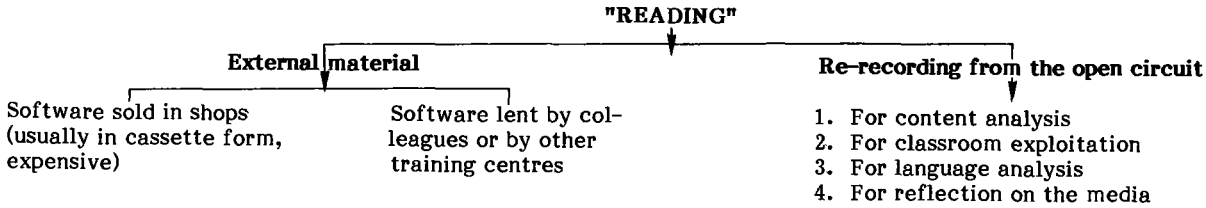


Within the context of a training course, it is impossible to separate "reading" from "writint". Both functions are linked and they complement and enrich one another.

However, "reading" and "writing" refer to types of equipment that can be technically isolated.

1. Use as a broadcasting or "reading" medium

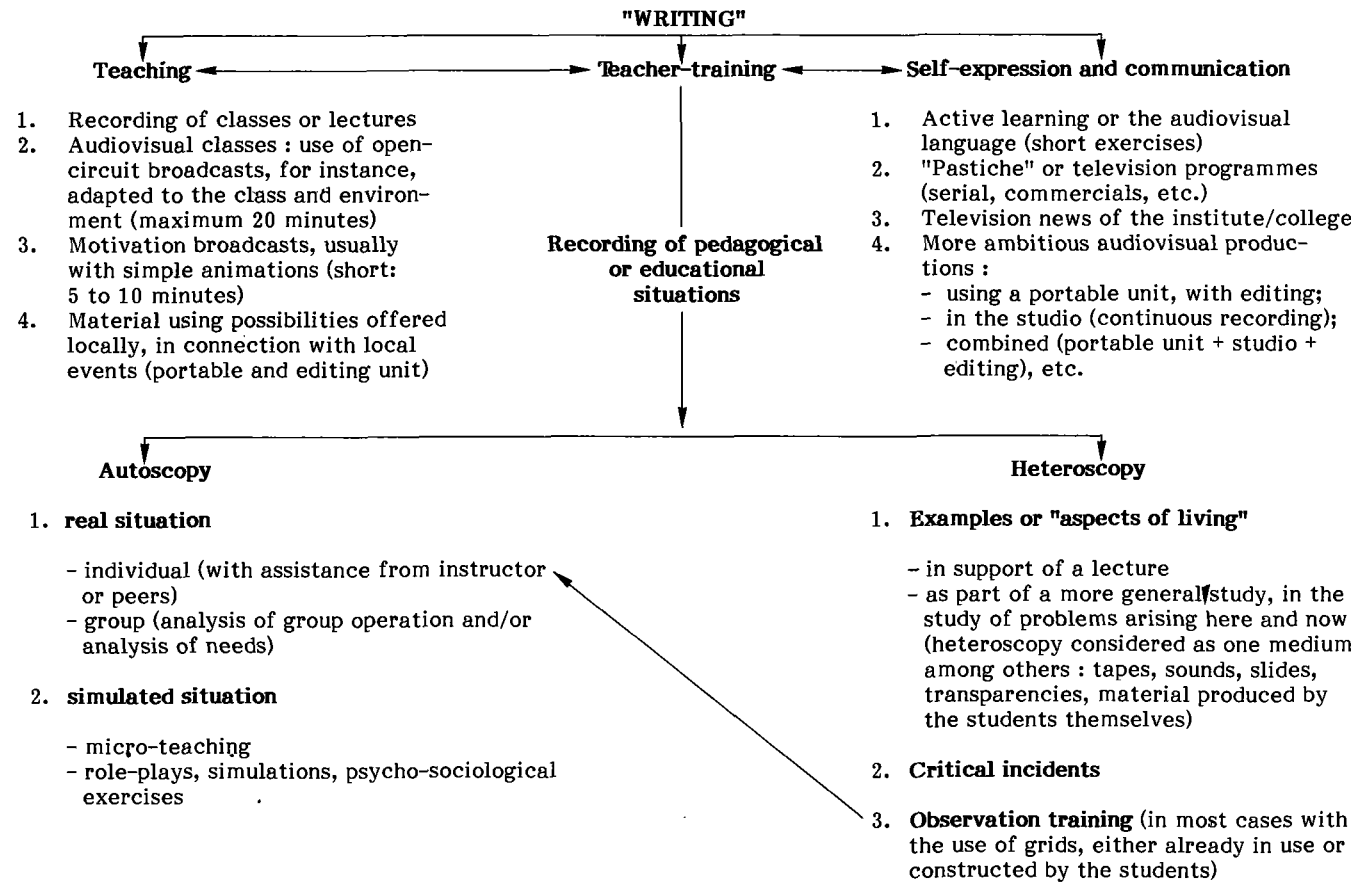
Figure 2



The equipment required for this function is described below under the heading "recording and broadcasting unit".

2. Use as a "writing" medium

Figure 3



According to the degree of sophistication of the equipment used, either more or less ambitious audio-visual material will be produced. Furthermore, autoscopy and micro-teaching require specialized premises.

3. Parameters considered in this study

The following parameters will be considered : equipment investment costs, operating costs, cost of the premises and staff costs. The following estimates are based on a model teacher-training college with 300 students divided into three levels (100 students at each level). Students' available time is estimated at 30 hours a week, i.e. 900 hours a year.

The available time of the training personnel is estimated at 500 hours a year for tutors and 1,600 hours a year for technical staff.

II - RECORDING AND BROADCASTING UNIT

Recording equipment

- 1 colour monitor receiver with a 44 cm screen, video inlet and outlet, audio inlet and outlet
- 1 VHS video recorder, programmable, ½ inch tape width
- 1 supporting table

Total FF. 10,000

Playback equipment

For the whole college, five identical playback units will be provided, including :

- 1 colour television set, 56cm screen, separate standardized video and audio inlets
- 1 VHS video recorder with quick motion/slow motion/freeze frame
- 1 supporting unit

Total per unit	FF. 10,000
for five units	50,000

Serviceable life and maintenance

Depreciation of the fixed equipment will be determined on the basis of 3,000 hours of operation ; maintenance and servicing costs will be calculated over the same period at half the purchasing price of the equipment.

The serviceable life of portable equipment will be reduced by a third (2,000 hours instead of 3,000). Maintenance and servicing costs will be estimated in the same way but over a shorter period.

Cost of the videotape

Utilization time of the equipment is estimated at ten hours a week, i.e. 10 hours x 30 weeks = 300 hours a year. The recordings made during that time must be stored for future use and re-use by the whole college. Cost of videotape is calculated on the basis of FF.80

per hour, i.e. per year : FF. 80 x 300 = 24,000, plus storage for 300 one-hour cassettes. It is estimated that each cassette is viewed on average 50 times during the year (and can be played up to 200 times).

One-third of the stock will be erased for re-use, but these erased tapes, because of re-recording and re-viewing, can only be played up to 100 times.

Storage

The floor volume required for storage is estimated at 3.5 cubic metres. The cost of buildings is estimated at FF. 2,500 per square metre of floor surface, written off over twenty years, and the cost of furniture at FF. 800, written off over ten years.

III - "WRITING" UNIT

We will describe two sets of equipment, one allowing for simple applications, the other allowing for the production of more elaborate material. However, intermediate solutions may be found according to the financial means at the college's disposal.

1. Colour ½ inch autonomous portable set

Equipment

- 1 monitor 31cm	
- 1 VHS video recorder	
- 1 camera with electronic viewfinder, microphone, power supply, small accessories	FF. 20,000
- 1 editing video recorder	14,000
- 2 storage cabinets	800
Total	FF. 34,800

Serviceable life and maintenance

Serviceable life is estimated at 2,000 hours, which corresponds to fifteen hours' use per week for five years. Small accessories costing FF. 2,000 should be replaced every three years. Maintenance does not normally require specialized staff and only the cost of servicing, estimated at 15 per cent per year of the purchasing price, should be taken into account.

Cost of videotape

The amount of tape to be provided is three times longer than the actual timing of the finished programme (i.e., a one-hour tape is required to produce a twenty-minute programme). The cost of videotape is estimated at FF. 80 per hour.

Storage

The basis for calculation will be identical to that mentioned above for the "Recording and Broadcasting" unit.

Staff costs

Use of this equipment does not require specialized staff. The teacher will use the students as operators after a period of gradual and controlled familiarization.

The time required for producing a programme is estimated at ten times the length of the finished programme, or two-and-a-half hours for a fifteen-minute programme.

2. Colour 3/4 inch production set

Equipment

- 3 colour cameras + power supply 30,000 x 3	FF. 90,000
- 3/4 inch video recorder, microphone, headphone	20,000
- Control monitor	10,000
- Lighting pack, accessories	5,000
i.e. subtotal of FF. 125,000 for exterior and interior shooting	
- 1 light video camera, electronic viewfinder, triopd	30,000
- 2 3/4-inch video recorders (one of these fitted for editing)	120,000
- 1 automated editing console 1 time base corrector, synchronizing regenerator	25,000
- 1 control room for mixing and special effects	40,000
- 1 camera for reading material	30,000
- 1 film scanner	40,000
- Lighting and accessories	5,000
i.e. subtotal of FF. 290,000 for editing and inserts	
- 1 sound mixer	10,000
- 2 record turntables	10,000
- 2 tape recorders	25,000
i.e. subtotal of FF. 45,000 for sound mixing.	

Serviceable life

Depreciation can be calculated over 2,000 hours of use.

Maintenance

Some machines (commutable oscilloscope, all-purpose controller, test pattern generator, optical test chart, set of components and tool kit), costing FF. 15,000, can only be used by a specialized technician. In this case, maintenance costs are estimated at 5 per cent a year.

Videotape

Prices of V-size cassettes are as follows :

10 minutes :	FF. 100
20 minutes :	FF. 120
30 minutes :	FF. 130
1 hour :	FF. 180

For the portable video recorder : twenty-minute tapes at FF. 130. In addition, the cost of transferring documents to ½ inch VHS cassettes for playback purposes must be taken into account.

Operating conditions

Didactic productions intended specifically for teaching purposes represent about 3 per cent of the total amount of programmes viewed each year. This type of production, which represents a total of about nine hours, corresponds to thirty-six fifteen-minute programmes for which production time is estimated at two-and-a-half hours (namely, ten times the actual duration of the programme,

i.e. a total of ninety hours per year). This represents three hours a week for thirty weeks for groups of fifteen students. For each training session, a one-hour tape will be made available and it will subsequently be erased.

Transportation costs

The need to transport the equipment damage-free requires the purchase of padded boxes and of a station wagon type vehicle, at a total cost estimated at FF.60,000. Depreciation of the vehicle and maintenance costs, taking all items into account (depreciation of the vehicle, repair and servicing costs, purchase of tyres, fuel consumption, insurance, garaging) will be added up and entered in the budget in the ratio of twice the value of the vehicle every five years or after every 100,000 km.

Management costs and small items

Management costs and the cost of manufacturing small production equipment (sketches, models, etc.) are estimated at 10 per cent of the cost of production of the programmes.

Cost of premises

A room with a floor surface of 48 square metres is required as a studio ; it should be made suitable for technical use (including sound insulation, acoustical treatment, and power supply). This represents a cost of FF. 3,000 per square metre, to be written off over twenty years. Also, a storage room of 20 square metres is necessary ; it should be fitted with locking cabinets. Cost : FF. 2,500 per square metre x 20 = FF.50,000, plus FF. 2,000 for four cabinets.

Electricity

It is estimated at 2 per cent of the cost of production of the programmes (in the case of studio filming).

Wage costs

These costs vary considerably if one takes into account the time required for programme design. Because a technician is indispensable, his wages must be taken into account on a yearly basis of 1,600 hours (level of qualifications : *baccalauréat* + two years). The work performed by all other operators is considered to be part of their jobs.

IV - RECORDING OF MEDAGOGICAL SITUATIONS (AUTOSCOPY, MICRO-TEACHING)

The two sets of equipment described above in sections III.1 and III.2 may be used for recording teaching situations. The ½ inch portable set is appropriate to micro-teaching, whereas the 3/4 inch set is more adapted to whole class recording. To be beneficial, these activities require about three hours a week per student, i.e. ninety hours a year. They are usually performed by groups of 15 students, which for a college with 300 students represents 20 groups, i.e. 20 x 90 hours = 1,800 hours of equipment utilization a year. In this case, it may be necessary to have two recording sets.

When recording pedagogical situations, it is estimated that a one-hour cassette is used for every three-hour session and for each group of fifteen students. These tapes will be kept and erased at the end of the year for re-use. Cassettes are meant to be used fifty times on average.

Two cabinets can be used for storage. Their cost is estimated at FF. 400 x 2 = 800 (depreciation being calculated over ten years).

Sound recording in a room with several speakers is a delicate operation ; it can only be done in a mini-studio fitted with power outlets, and allowing for possible suspension of microphones and projectors, acoustic correction and occultation. The technical room can be turned into a studio-classroom simply by adding furniture, the cost of which is estimated at FF. 1,000 (depreciation over twenty years for the premises, ten years for the furniture).

It is advisable, in the college, to provide for small (12 square metres) screening rooms for group work, i.e. five such rooms for the whole establishment. Cost per square metre : FF. 2,500. Depreciation over twenty years.

For the purpose of feedback on performance, the tutor will be in charge of the filming and will subsequently lead a group discussion in one of the screening rooms with one of the playback sets.

When the studio-classroom is used, the tutor must be assisted by the technician for two hours (preparation, filming and editing) for each three-hour session. However, a highly-sophisticated unit must be considered as a teaching laboratory and run by a full-time tutor to deal with the administrative work, pedagogical meeting, planning, preparing the shots, etc.). Such responsibilities cannot possibly be imposed upon a tutor already giving classes elsewhere. The annual wages of the additional teacher will be added to total wage costs.

V - OPTIMAL OPERATING CONDITIONS

In order to ensure maximum effectiveness of expensive equipment it is advisable for the educational establishment to consider the whole range of activities as described in order to make a selection according to table 14.

Table 14

	Unit III.1 Reporting	Unit III.2 Reporting	Unit III.2 Studio-classroom
Production of educational programmes (90 hours/year	90 hours/year	45 hours	45 hours
Production of expression-communication type programmes (90 hours/year)	90 hours/year	45 hours	45 hours
Recording of observations (autoscopy, heteroscopy) (1800 hours/year)	1,800 hours/year	120 hours	600 hours

The reporting version of unit III.2 includes a camera, a video recorder, a monitor and accessories ; the studio or studio-classroom version includes the whole range of equipment.

6. PRODUCING RADIO PROGRAMMES FOR EDUCATIONAL PURPOSES

I - GENERAL

The purpose of this chapter is to provide comparative information on the cost of production of educational radio programmes. The word production should be understood as the sequence of operations from the creation work on a given subject to the completion of the actual tape ready for broadcasting. The following points will be dealt with :

- Determination of the structure of costs and types of broadcasts ;
- Determination of production budgets for various types of programmes, on the basis of estimates made by organizations producing educational radio programmes intended to be broadcast nationwide.

II - COST STRUCTURE

Only the cost of obtaining the tape ready for broadcasting is taken into account (we assume that the content of the programme has been previously defined). This cost can be divided into two parts :

1. Non-technical production costs

These are non-technical expenses incurred for producing the programme ; they consist only of staff costs for a sound engineer and recording technician. The cost of teacher hours is not included. The actors are also supposed to work voluntarily since they are not professional (students, theatre clubs, school children, etc.).

2. Manufacturing costs

These are technical expenses incurred recording the programme and editing the tape to make it suitable for broadcasting.

Recording. Sound recording involves the cost of equipment as well as the cost of using a recording studio.

Editing. This includes mixing, re-recording and editing operations. It requires equipment (an editing console) and a technician.

To the cost of recording and editing should be added the cost of supplies, mainly tapes.

3. Management costs

To summarize, the cost structure covers the three following headings : production, manufacture and management.

III - DIFFERENT TYPES OF RADIO PROGRAMMES

This classification has been established after consulting professionals specialized in the production of such programmes.

1. Types of broadcasts

Category A : Spoken programme : talk, lecture, reading of a text in one or two voices.

Category B : Dialogue-type programme : interview, questions and answers prepared in advance, dialogue including other voices providing additional comment or illustration.

Category C : Sketch-type programme : Dramatization (two or three characters) and sound effects. Simple radiovision broadcasts.

Category D : Round-table discussion, interview without answers prepared in advance.

Category E : E1. Theatre programme or excerpts from a play.

E2. 'Mood'-type programme with many different sound planes and dramatization, musical illustrations and sound effects.

2. Studio manufacturing time

If we call :

E : recording time
M : editing time
d : broadcasting time

we can estimate manufacturing time as follows for the different categories of programmes.

Category A : E : 2 to 3 d
M : 2 to 3 d

Category B : E : 3 to 4 d
M : 3 to 4 d

Category C : E : 8 d
M : 6 d

Category D : E : 8 d
M : 12 d

Category E : E1 E : 8 d
M : 8 d

E2 E : 12 d
M : 10 d

3. Manufacturing time with field broadcast

If we call R the time spent on reporting, manufacturing times may be estimated as above.

Category A : R : 2 to 3 d
M : 2 to 3 d

Category B : R : 3 to 4 d
M : 3 to 4 d

The other categories (C, D, E) need no reporting time.

IV - CALCULATING MANUFACTURING COSTS

The above ratios are however not sufficient for calculating manufacturing costs. Such ratios vary not only according to the category, but also according to the quality of the programme, the experience of the teachers who have recorded it and the subject matter of the broadcast. This is also true for non-technical production costs. For this reason the ratios given should be considered as averages serving as a base for more accurate calculations.

1. Bases for calculation

Utilization time of the equipment is estimated at 200 days a year and seven hours a day. Personnel working time is estimated at 230 days a year and seven hours' work a day.

2. Hourly costs

Field broadcast :

Hourly wage of a sound recording technician (including social security employer contributions)	FF 90
Depreciation of maintenance equipment (Investment FF 20,000 - 10 per cent maintenance per year - Depreciation over 5 years)	FF 3
Total	FF 93 per hour

Studio broadcast :

Hourly wage of a sound engineer (including social security employer contributions)	FF 120
Depreciation of equipment and premises (Investment : Premises FF 180,000, depreciation over twenty years ; Equipment FF 436,000, depreciation over ten years, 10 per cent of maintenance per year)	FF 41
Total	FF 161 per hour

Editing unit

Hourly wage of a technician (including social security employer contributions)	FF 90
Depreciation of equipment and premises (Investment : Premises FF 36,000, depreciation over twenty years ; Equipment FF 10,000, depreciation over ten years, 10 per cent maintenance per year	FF 1
Total	FF 91 per hour

3. Management costs

These will be estimated on an inclusive basis at FF20 per hour.

4. Cost of magnetic tape

In order to assess the cost of tape, it is estimated that the various categories require the following lengths of tape (speed : 19 cm/s) :

A : 1,000m
B : 1,500m
C and D : 2,200m
E : 4,000m

The average cost of tape is estimated at FF 0.15 per metre.

5. Evaluation of the hourly cost of production of different types of programmes [1]

a) Category A

Estimating formula : E : 2 to 3 d
M : 2 to 3 d

Production costs :

(i) **Field broadcast**
Value of E : between FF 93 x 2 = FF 186
and FF 93 x 3 = FF 279
Value of M : as for E
Management : FF 20
Cost of tape : FF 0.15 x 1,000 = FF 150
Estimate of hourly production cost H^F :
(FF 186 x 2) + FF 20 + FF 150 < $H^F \leqslant$ (279 x 2) + FF 20 + FF 150
Hence FF 542 < $H^F \leqslant$ FF 728

(ii) **Studio broadcast**
Value of E : FF 161 x 2 = FF 322
FF 161 x 3 = FF 483
Value of M : as for E
Management : FF 20
Cost of tape : FF 150
Estimate of hourly cost of production H^F :
FF 814 < $H^F \leqslant$ FF 1,136

b) Category B

Estimating formula : E : 3 to 4 d
M : 3 to 4 d

(i) **Field broadcast**
Value of E : FF 93 x 3 = FF 279
FF 93 x 4 = FF 372
Value of M : as for E
Management : FF 20
Cost of tape : FF 0.15 x 1,500 = FF 225
Estimate of hourly production cost H^F :
(FF 279 x 2) + FF 20 + FF 225 < $H^F \leqslant$ (FF 372 x 2) + FF 20 + FF 225
Hence FF 803 < $H^F \leqslant$ 989

[1] In the calculations given in this section, the mathematical symbol < means 'is less than' and the symbol $\leqslant$ means 'is less than or equal to'.

(ii) **Studio broadcast**
Value of E : FF 161 x 3 = FF 483
FF 161 x 4 = FF 644
Value of M : as for E
Management : FF 20
Cost of tape : FF 0.15 x 1,500 = FF 225
Estimated hourly cost of production H^F
FF 1,211 < H^F ⩽ FF 1,532

c) **Category C**

Estimating formula E : 8 d
M : 6 d

Studio broadcast
Value of E : FF 161 x 8 = FF 1,288
Value of M : FF 91 x 6 = FF 546
Management : FF 20
Cost of tape : FF 0.15 x 2,200 = FF 330
Estimated hourly cost of production H^F :
FF 1,288 + FF 546 + FF 20 + FF 330 = FF 2,184

d) **Category D**

Estimating formula E : 8 d
M : 12 d

Studio broadcast
Value of E : FF 161 x 8 = FF 1,288
Value of M : FF 91 x 12 = FF 1,092
Management : FF 20
Cost of tape : FF 0.15 x 2,200 = FF 330
Estimated hourly cost of production H^F :
FF 1,288 + 1,092 + FF 20 + FF 330 = FF 2,730

e) **Category E**

This type of studio broadcast requires the presence of a sound engineer and an audio technician at the same time.

(i) **E1 estimating formula :** E : 8 d
M : 8 d
Evaluation of production costs
Value of E : (FF 120 + FF 90 + FF 41) x 8
= FF 2,008
Value of M : FF 91 x 8 = FF 728
Management : FF 20
Estimated hourly cost of production H^F :
FF 2,008 + FF 728 + FF 20 + FF 600 = FF 3,356

(ii) **E2 estimating formula :** E : 12 d
M : 10 d
Evaluation of production costs
Value of E : (FF 120 + FF 90 + FF 41) x 12
= FF 3,012
Value of M : FF 91 x 10 = FF 910
Management : FF 20
Cost of tape : FF 0.15 x 4,000 = FF 600
Estimated hourly cost of production H^F :
FF 3,012 + FF 910 + FF 20 + FF 600 = FF 4,542

V - COST OF BROADCASTING

In the present context, the hourly cost of broadcasting charged by the broadcasting organization for all transmitting stations on French territory is as follows:

FF 8,302.5 network charge
FF 304.91 speaker's announcement

FF 8,607.41

Note : In a different context (if broadcasting was undertaken free of charge by a national broadcasting organization), the cost of broadcasting would not be taken into account.

7. PRODUCING EDUCATIONAL MATERIAL USING BASIC VIDEO EQUIPMENT

I - GENERAL

1. Utilization situations

The various applications of basic colour video equipment in an educational environment may be classified as follows :

Recording and broadcasting. The expanding domestic market for videotape recorders and the increased use of videocassettes by the general public have made videotape accessible for educational and training purposes. It is convenient for packaging information in the form of moving pictures and sound which must be distributed to many locations and viewed by small groups. Material recorded on videotape is available both for repeat broadcasting and information processing. In this mode, the audio-visual equipment simply serves as a vehicle for the recording and transmission of information.

Feedback. The simplest application of basic video can be found in the study of behaviour. It offers opportunities for demonstrating professional standards of performance, individual training and feedback on performance measured against the standards or models communicated.

Simple productions. From experience gained in the uses mentioned above, competence is acquired in handling the medium and the quality of production improves. Video also provides an outlet for group expression by the persons concerned. Simple documentary programmes can be produced.

Elaborate productions. More sophisticated and expensive productions involve broadcasting-quality equipment, including automated editing equipment, a colour studio and so on. It is only justified for professional training, corporate information or a few educational sectors which require elaborate educational programmes compiled from a wide range of sources. It involves the delivery of videocassettes to reception points equipped with compatible recorders.

II - PARAMETERS CONSIDERED FOR THE ECONOMIC STUDY

For each individual case, the following technical and economic parameters must be taken into account : equipment costs ; operating expenses including maintenance and servicing, cost of videotapes, direct production costs and management costs (secretarial work and related expenses) ; cost of premises, if specific; and salaries and wages of the technical and production staff (estimated from data indicated in the text).

III - LIGHT RECORDING AND BROADCASTING STRUCTURE

1. Equipment

a) Recording

1 colour monitor receiver with a 44cm screen, video inlet, video outlet, audio inlet, audio outlet
1 VHS videotape recorder, programmable, ½" (12.7cm) tape width
1 supporting unit

TOTAL FF 10,000

b) Playback

1 colour television set, 56cm screen, separate standardized video and audio inlets
1 VHS videotape recorder with quick motion/slow motion/freeze-frame
1 supporting unit

TOTAL FF 10,000

c) Duplication unit

1 VHS videotape reproducer
1 VHS videotape recorder
1 duplication cord
1 supporting unit

TOTAL FF 11,000

2. Operating expenses

a) Service life and maintenance

Depreciation of fixed electronic equipment will be determined on the basis of 3,000 hours, at half its purchase price. Maintenance expenses will be calculated over the same period at half its purchase price.

b) Cost of the videotape

There are half-inch, high-density cassettes

with different recording times at the following prices:

0H30 : FF 70
1H00 : FF 80
2H00 : FF 100
3H00 : FF 120
4H00 : FF 150

It is generally estimated that a cassette may be used from 100 to 200 times, taking into account all possible mechanical incidents.

3. Wage costs

The basic data are established on the assumption that recording and copying will be performed in real time. Thus, for recording fifty hours of programmes broadcast during the year, one has to plan on fifty hours for the recording and on as many times fifty hours as identical copies are desired, in the absence of duplication benches which use many so-called "slave" video recorders and require complex and costly facilities of the industrial type. Recordings and duplications are performed without any other handling than programming, loading and unloading the instruments. Thus, salaries and wages are almost insignificant ; they will account for 5 per cent of the price of recording.

4. Premises

It is estimated that for 1 square metre of storage, only one-quarter of the surface is useful (corridors must be taken into account). Given the volume of a cassette, it is assumed that 1 square metre of floor is needed to store 1,000 one-hour cassettes. In addition, an identical total surface must be provided for packing, plating, collecting, etc. Therefore, 500 cassettes may be stored per square metre.

In the present case, it is only possible to plan on 1,600 hours a year for the operator, i.e. the following number of copies :

$\frac{(1{,}600 - 50)}{50}$ = 31 one-hour copies, plus 50 originals

i.e. eighty-one one-hour cassettes or about 0.10 sq.m. of floor surface. Therefore, only one cabinet is required.

IV - OVERALL COST ESTIMATE

1. Equipment

Colour, half-inch tape width (VHS videotape recorders)
i.e. 1 monitor (31 cm)
1 portable set including :
. portable video recorder
. power supply, camera, microphone and small accessories, torch, small boom, headset, cables, transport cases — FF 20,000

or

1 monitor (44 cm)
1 home video recorder with :
. camera on tripod, microphones and small accessories for indoor exercises always performed in the same place — FF 21,000

If necessary, in both cases :
1 editing video recorder for editing sequences and obtaining a finished document suitable for public broadcasting — FF 14,000
2 storage cabinets at FF400 each — FF 800

2. Operating expenses

Service life. Portable instruments and cameras may be used at the approximate rate of fifteen hours a week for five years, i.e. 2,000 hours. The fixed video recorder has an estimated service life of 3,000 hours. The accessories (microphone, etc.) must be replaced every three years.

Maintenance. The presence of a qualified technician is not required. The cost of maintenance may account for up to 15 per cent of the purchasing price on a yearly basis.

Videotape. Estimates are the same as in Chapter III. One has to plan on three times the length of tape of the produced document, on the basis of 30mn of finished document per training course. It is estimated that only a quarter of the recordings will be retained, the remaining tapes being erased for subsequent reuse.

3. Premises

The instruments and tapes will be stored separately in two special cabinets provided for the purpose.

4. Wage costs

The use of the equipment does not require any specific technical expertise. (The teacher or the group leader will use the participants as operators after a progressive introduction to the technique, under the teacher's supervision.)

V - LIGHT COLOUR VIDEO PRODUCTION

1. Equipment

The following suggestions take into consideration the desired mobility of the equipment and its adaptability to different situations. It should be possible to use "one-tube" cameras either on a tripod or on the shoulder, in a studio or on location.

With the production methods used, most of the job is done upon editing the product. The weak point of this type of production is its impracticality in the processing of sound. The video production unit should be suitable for location or studio work according to the production diagram below. Estimates of the equipment investments are given in table 15.

2. Operating expenses

Service life. Portable electronic equipment will be written off over 2,000 hours. Small accessories (microphones, etc.) are replaced every 3 years.

Maintenance equipment. Commutable oscilloscope (line frame). All-purpose controller, test pattern generator, optical test chart, standard small-tool kit, etc., set of components, etc.
TOTAL — FF 15,000

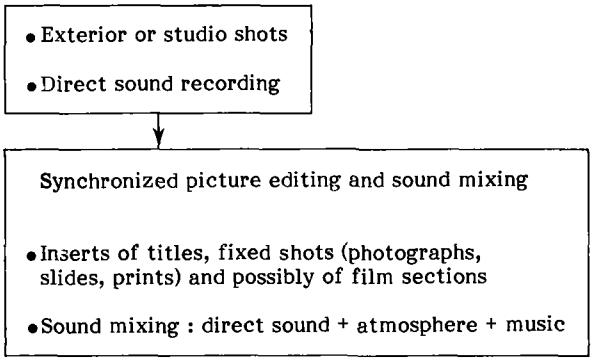
Maintenance. The presence of a widely-competent qualified technician is required (level of knowledge: technical *Baccalauréat*). Thus, maintenance expenses will be brought down to about 5 per cent of the purchasing price of the equipment each year. Otherwise, faulty settings and more frequent technical failures will make the operation of the equipment more costly.

Videotape. Prices of the videotape are those indicated in 7.III ; on average, the estimated length

Table 15

Video production - portable half-inch colour equipment (institutional type)

Simultaneous picture editing and sound mixing



I.	Portable set : camera, tripod Portable half-inch video recorder microphone, headset control monitor Lighting pack, accessories	FF 60,000
II.	Light colour video camera, electronic zoom, viewfinder, optional Genlock tripod Portable switching deck for intakes of pilot synchronizing generator Rostrum camera for document reading All-purpose 58-16mm colour film scanner, slides Half-inch video tape reproducer Video tape recording with half-inch editing Two video monitors Mixing console Record turntable Tape recorder 1 synchronizing regenerator Extra lighting, accessories	FF 170,000

of production tape involved will be three times the running time of the finished programme, including erasing cassettes used for previous shots. It is estimated that a cassette may be used from 100 to 200 times. The finished productions, which are to be kept as masters for future use, are copied in order that a copy may be available for duplication. This is why it is necessary to multiply the length of the tape by three as stated above (see 7.IV.2) (20 minutes of finished product = 60 minutes of cassette used, including the spare copy).

Analysis of operating conditions. Our estimate is based on an institution with 600 pupils and an average of 35 pupils per class, i.e. twenty classes, and four levels, ten different subjects and 900 school hours throughout the year.

a) Assuming that demand for produced material represents 5 per cent of school time (which represents the equivalent of forty-five hours per form, or 900 hours per year for twenty classes, i.e. 900 ÷ 4 = 225 original documents per level), production should be based on an average of twenty-three original programmes for each subject a year. This would seem to be a maximum. If we suppose that these programmes have an average duration of fifteen minutes and that ten times that length of time is needed to produce them in a studio, then the production equipment will be used for :

$\frac{15 \times 225 \times 10}{60}$ = 563 hours throughout the year, which represents only 63 per cent of the potential time available for utilization of the equipment (if we limit ourselves to school hours).

b) Outside filming for productions must be calculated in a different way. Given the time for transportation each way and the time required for setting up the equipment (removal from the boxes, assembling and installation, dismantling and storage), the average time during which the equipment is committed amounts to sixteen times the length of the finished programme. To produce a fifteen minute programme, the technical production equipment will therefore be in use for four hours.

c) If we suppose that one-third of the production will be made on location and two-thirds in the studio, we have the following distribution :

75 original 15-minute programmes, of the coverage type

$\frac{75 \times 240}{60}$ = 300 hours

150 original 15-minute programmes of the studio type

$\frac{150 \times 15 \times 10}{60}$ = 375 hours

i.e. a total of 675 hours

with a profitability rate of 75 per cent. This is what must be aimed at. The people responsible for the management of video media must bear in mind the need to maintain a high profitability rate and be fully aware of all factors relating to calculations for equipment utilization.

Transportation costs. The need to keep the equipment in good condition during transportation implies the purchase of padded boxes and of a heat-insulated station wagon without windows. Total expenses are estimated at FF 60,000. Depreciation of the vehicle and maintenance expenses - which include depreciation of the vehicle, repair and maintenance expenses, purchase of tyres, fuel consumption, insurance, garaging, etc. - will be added up and entered in the budget on the scale of twice the value of the vehicle every five years or after every 100,000 km.

Electricity. For studio filming, electricity is estimated at 2 per cent of the cost of production.

Management costs and small items. Management costs and the cost of manufacturing small production items (sketches, diagrams, models, etc.) are estimated at 10 per cent of the unit cost of production.

3. Premises

Studio. If no available room can be modified for the purpose, special premises will be required, with a floor surface of 48 square metres. The price per useful square metre must be multiplied by 1.5 to allow for sound insulation, acoustic treatment, power supply, etc.

i.e. FF 3,000 per square metre FF 144,000

Depreciation time for the buildings is estimated at twenty years.

Storage facilities. A room of 20 square metres will be fitted with four cabinets for storing the instruments and the tapes.

Buildings : FF 2,500 per square metre = FF 50,000
Instruments : 4 x FF 500 = FF 2,000
Total : FF 52,000

The service life of the cabinets is ten years ; buildings are written off over twenty years.

4. Wage costs

These do not include the cost of design but only that of production. They vary considerably according to the nature of the software to be produced. Only the technician's wages are taken into account on a yearly basis of 1,600 hours (level of qualification : qualified technician with *baccalauréat*). The work performed by all other operators is considered to be part of their jobs.

VI - ELABORATE PRODUCTION

1. Equipment

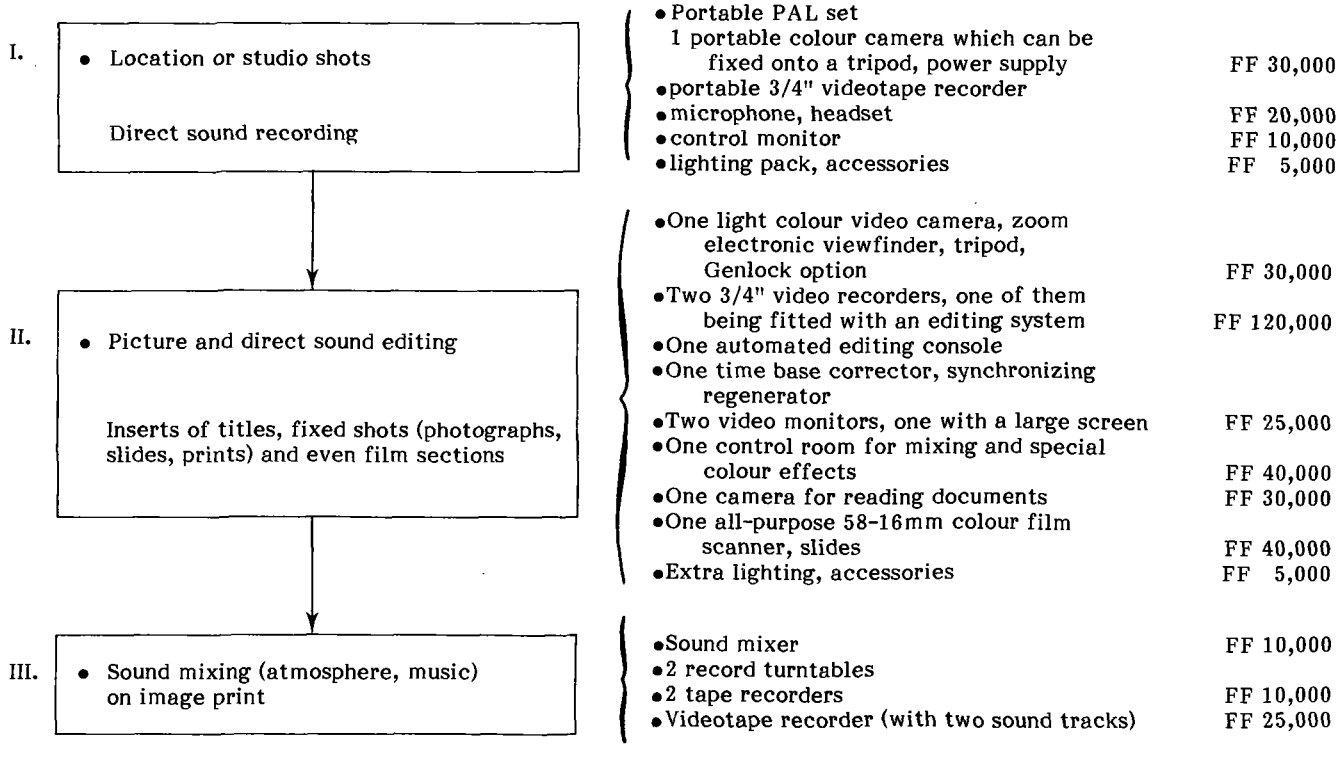
Basic video techniques have developed in several respects over the past few years : portable colour movie cameras, new recording standards (3/4" cassettes), portable 3/4 inch videocassette recorders and post-production techniques (automated 3/4 inch editing benches, portable colour control decks). Such evolution makes it increasingly possible to apply 16mm film production methods to basic video work and also brings the techniques of multi-camera studio recording into question. The editing of non-fixed modular structures which may be transformed to meet different situations, recording with one hand-held camera or one camera on a tripod, and using a control room during editing for inserting titles, fixed shots, and other devices that are all now within our competence. The adaptability of the equipment to different working conditions makes it possible to make expensive equipment profitable. Because of its mobility, it requires greater involvement on the technician's part and increases operating expenses; however, it helps reduce the initial infrastructure and start-up costs.

Now, 3/4 inch colour video may be adapted to match "institutional" standards and challenge 16mm films. The production diagram in Figure 5 indicates the costs involved.

Figure 5

Video production - portable 3/4" colour equipment (institutional type)

Separate picture editing and sound mixing



2. Operating costs

Service life. Some 3,000 hours of use, i.e. fifteen hours a week for five years. Accessories must be replaced every three years.

Maintenance. A technician with a good level of education (*Baccalauréat* + 2 years' experience) is required. He must be provided with maintenance equipment (the same equipment as for basic video) estimated at FF15,000. The cost of maintenance may then be estimated at 5 per cent per year of the purchasing price of the equipment.

Videotape. Prices of V-size cassettes are as follows:

- 10 minutes FF 100
- 20 minutes FF 120
- 30 minutes FF 130
- 1 hour FF 130
- 20 minutes for portable video recorder : FF130.

Transportation and management costs and the cost of manufacturing small items are the same as for the equipment described under "basic video".

3. Wage costs

The technician's wages and employer social security contributions must be taken into account.

VII - CONCLUSIONS

There are two sets of conclusions - technical and economic. From a technical point of view, it appears that half-inch colour videocassette recorders are not sufficiently reliable, especially for editing and duplicating from an original of the same format. Thus to make copies, we must now use 3/4 inch production equipment and edit in any new material at copy level, editing being made easier through the utilization of automated 3/4 inch benches (U format). Further improvements can be expected, however, in line with developments which have marked the evolution of videotape recorders using half-inch cassettes, which will make the production-broadcast process easier.

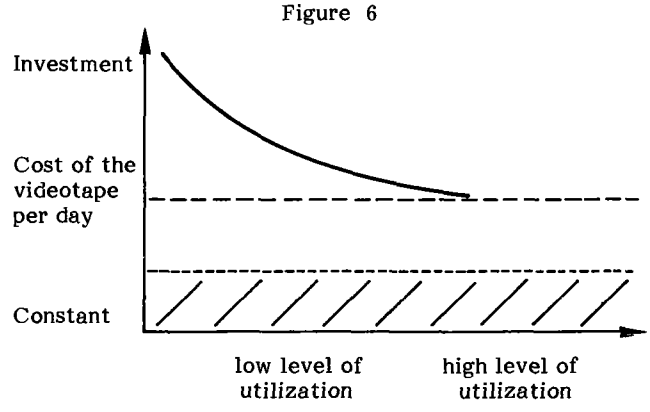
However, at production level, a technological barrier will still remain between "domestic" or "amateur" video equipment and equipment of the institutional type.

To obtain a good return on investment, we must endeavour to keep production costs at a reasonable level for all colour video equipment. To that effect, it is advisable to calculate the costs per day of use according to a formula of the following kind :

$$\text{Cost per day ofuse} = \frac{\text{investment}}{\text{number of days}} + \text{cost of the videotape per day} + \text{constant (fixed costs)}$$

and to draw a graph representing diminishing costs, with the following overall shape :

Figure 6



8. BROADCASTING EDUCATIONAL MATERIAL BY FILM AND VIDEO-CASSETTE

The purpose of the present chapter is to compare two broadcasting methods which help transmit audiovisual educational material to consumer bodies through postal services
- either on 16mm films (FILM LIBRARY)
- or on videocassettes (VIDEO LIBRARY).

A - FILM LIBRARY

I - GENERAL

We will take as an example the cost of a film library with a stock of 30,000 copies [1] and despatching 600 copies per working day. We will base our study on a year of 230 working days at the rate of 7 useful hours a day. The film library services 5,200 establishments.

We will limit the study of cost structure to the expenses incurred by the film library only ; all expenses incurred by the consumers for a certain number of technical functions are covered by the operating budget of the School or Institution concerned.

Subject to the above conditions, the following cost structure has been selected : costs related to the storage function, costs related to the checking-maintenance function, costs related to handling, stock-taking and the preparation of shipments, costs related to transport and costs related to management.

II - STORAGE EXPENSES

1. Cost of buildings

The required floor surface area, including corridors, is estimated to be 1.5 square metres for every 100 copies of 16mm film. The optical system of storage is used. Films are stored in a horse-shoe arrangement onracks for ease of access and identification. Each rack (or 'cradle') holds 25 films. This means that only one quarter of the floor surface area can be regarded as useful.

It will therefore be necessary to plan for a building of $\frac{1.5 \times 30,000}{100}$ = 450 square metres rounded up to 500 square metres to include the annexes (four offices + areas for packing and reception), i.e. at the rate of FF 2,500 a square metre of floor :

2,500 x 500 = FF 1,250,000.

The building is depreciated over twenty years, and included in the depreciation cost are expenditure on maintenance together with miscellaneous expenses such as electricity.

2. Investment costs for furniture

Number of cradles : $\frac{30,000}{25}$ = 1200 at FF 500 for each cradle, 500 x 1200 : FF 600,000. Depreciation is over ten years.

3. Investment costs for film stock

The stock of copies estimated at 30,000 COMOPT 16mm colour copies [2] represents an initial outlay of about FF 1,000 (housing included) per 30mm colour copy (not including the purchase of the rights), i.e. the sum of FF 1,000 x 30,000 = FF 30,000,000. It is considered that a copy may be run about 300 times if properly projected, checked and maintained. Given the high cost of film copies, it must be stressed that the level of holdings of a film library is a matter which must be studied very carefully since the assumption is made that it will be used to the full.

The problem is complex since several factors have to be considered : the number of institutions served and the distribution of the pupils into groups at specific levels of education ; the various programming requirements connected with the constraints of the curriculum which mean that the user only requires the film at particular times of the year ; and the pedagogical service life of a film which depends on its content which may become out of date.

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[1] If we study the cost of film libraries, it appears that overheads do not increase in line with the number of film copies distributed each year. For the most profitable return on operating expenses, a film library distributing 30,000 copies a year is the ideal size.

[2] COMOPT : Copy with optical-reading sound track; it is the standard release print.

4. Method for assessing the required number of copies for a film library

a) Various programming requirements

Programming requirements in an educational environment lead us to consider three categories of films : (1) those which must be included in the programmes on a fixed basis - the institutions need it at the same time or during the same fortnight, and then will not require it again until the next school year or the next training period ; (2) those which may be shown throughout the year because they are of a more general nature; and (3) those which are suitable for pupils or groups at different levels of education, a factor which extends the period of utilization.

b) Pedagogical service life of the film

A few topics soon become out-dated and some films must be remade every two, three or four years. In contrast, others will be used for a longer period of time, in particular those related to some of the classical or scientific subjects ; depreciation will then be spread out over a longer period of time.

Such considerations are important because the greater the number of copies in a film library, the heavier the organization expenses and the longer the period of depreciation. A copy may be withdrawn because of wear before the content of the film is considered out-dated or obsolete. This is why it is necessary to determine the expected life of one single copy used within the same institutions on the basis of the number of showings.

c) Number of times a film is shown in a borrowing institution

We will consider an establishment with from eight to twelve groups of pupils at the same level distributed for each subject among two to four teachers[1].

Each teacher familiarizes himself with the film in which he is interested and screens the whole film once, possibly twice, to locate specific sequences, a process which generally amounts to from two to eight showings [2].

We will assume that there will be one showing for each group of pupils and, if necessary, a second showing for special sequences, which will amount to from eight to twenty-four showings.

Therefore, the same copy may be shown from ten to thirty-two times in the same establishment. We will base our study on the average figure of twenty, the number of showings ranging from ten to thirty.

d) Examples of applications for assessing the number of copies

Let E be the time of useful service of the film during the school year and D the complete duration of the rate of turnover of a copy (duration D runs from the date of despatch from the film library and its use by the addressee until the actual return date to the film library or to a neigbouring establishment). Duration D is estimated to be two weeks.

1st example : Average case

E, useful period of the film, covers ten weeks.
D, since this covers a period of two weeks, the same copy may be used by five establishments at a maximum.

The number of copies in a film library necessary for servicing the 5,200 establishments would then be 1,050.

Each copy may be run ten, twenty or thirty times in each establishment, which corresponds in the present case to 5 x 10, 5 x 20 or 5 x 30 showings a year, and will be discarded because of wear after 300 showings, i.e. after six years, three years or two years.

Now we will consider the number of copies of our stock of 1,050 to be written off over a period of two to six years.

2nd example : Favourable case

For a more general film which can be used by the library's clients at any time during the year, useful duration E is thirty weeks. With the standard rate of turnover of two weeks, the same film may be shown in fifteen establishments during the year. The optimum number of copies is then brought down to 350, and the same calculation as for the first example shows that the film is then depreciated over a period ranging from twenty weeks to two years.

3rd example : Unfavourable case

The film can only be shown at the time of the year appropriate to curriculum requirements : therefore, E is limited to two weeks.

With such a film only one copy could be shown in one establishment at a time, with an average of twenty showings per copy.

In such circumstances, 5,200 copies are theoretically necessary and each would be written off over fifteen years. In reality, it comes down to allocating one copy to each establishment for its exclusive use.

Generalization - Application formulae

To determine the theoretical number of copies for a film library, we will use the same parameters as given above, viz -

D : the rate of turnover per copy (two weeks in principle)
E : the period when the film can be used during the school year (E ranges from two to thirty weeks)
N : the number of establishments to be served
X : the number of copies estimated for the film library

$$X = N : \frac{E}{D} = \frac{N \times D}{E}$$

To estimate the depreciation time (A) of the film, if we call Y the average number of showings per year of the same copy in the same establishment (Y ranging from 10 to 30), a copy serves $\frac{E}{D}$ establishments a year at the rate of $\frac{E}{D} \times Y$ showings a year ; we thus have the following formula :

$$\text{serviceable life : } A = \frac{300 \times D}{E \times Y}$$

The application of this formula is shown on the graph in Figure 7.

The graph provides two different values for N, viz : N = 1,200 establishments and N : 5,200 establishments. D is taken as a constant and equal to two weeks. The variable E, which ranges from two to thirty weeks, is on the *x* axis.

The continuous line corresponds to the average

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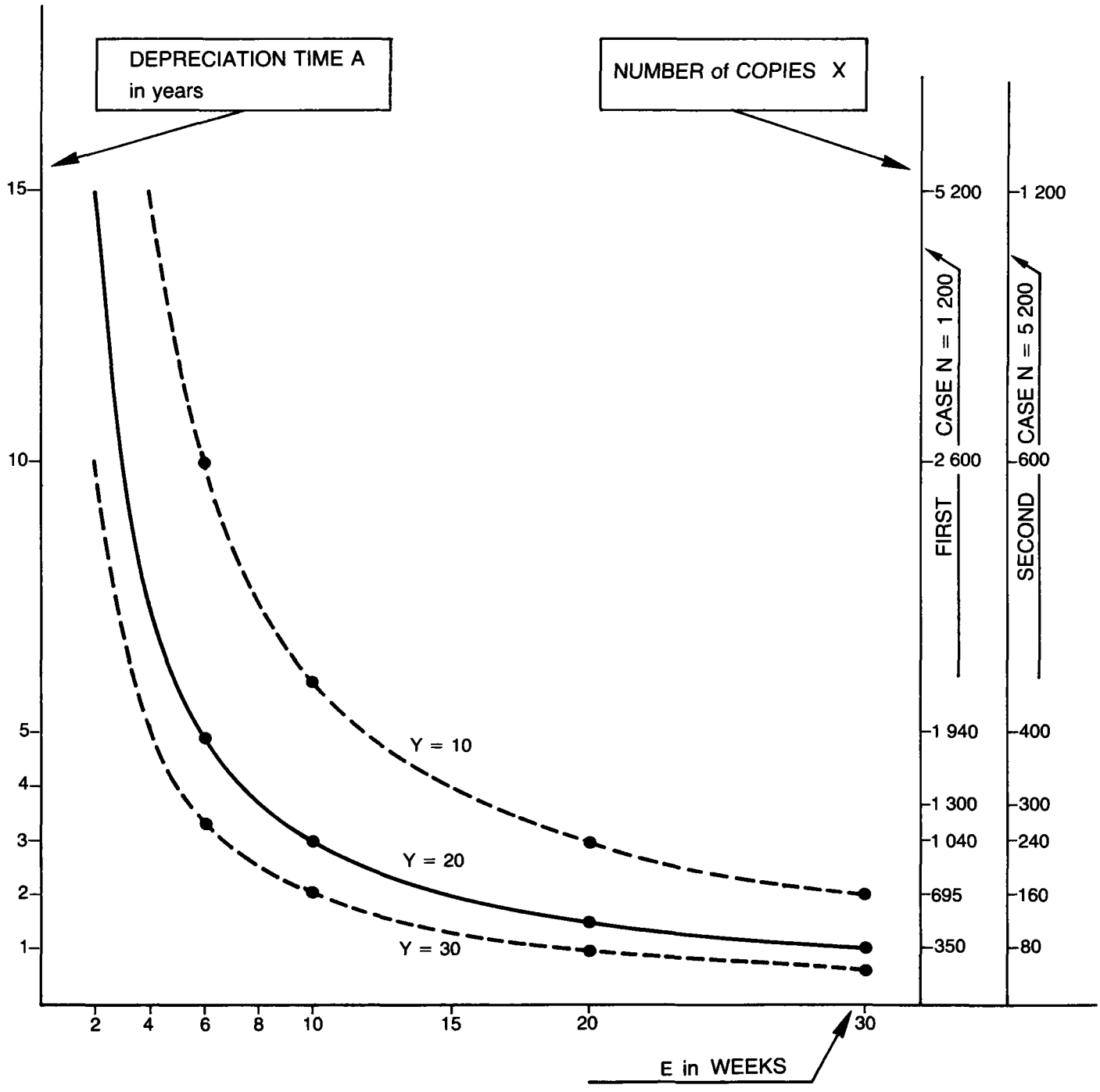
1 Calculation made on the average consumer establishments of the State Education Film Library of the French Ministry of Education.

2 These figures get smaller if the same teacher uses the film several years in a row.

Figure 7



DEPRECIATION TIMES A and ALLOCATION OF COPIES X
ACCORDING TO THE USEFUL TIME OF UTILIZATION E

case with Y = twenty showings per establishment ; the interrupted lines correspond respectively to ten showings and to 30 showings per establishment.

The graph is useful to determine :

1°) on the left-hand axis *y* of ordinates, the *depreciation time* A according to the yearly time of use E and the average number of runs Y in each establishment.

2°) on the right-hand axis *y* of ordinates, the *number of copies required for supplying all the establisnments*, for N = 1,200 and N = 5,200 according to E. It is worth noting that the number of showings Y does not have any impact on the required number of copies.

The scale used for the right-hand *y* axis of ordinates has been drawn up in reference to the continuous line: Y = 20.

III - CHECKING COSTS

If we assume that it takes from five to ten minutes on average to check a 16mm COMOPT copy thirty minutes long, depending on the condition of the copy, it is possible to estimate the number of checking stations, on the basis of seven working hours a day, for the film library chosen as an example and corresponding to 600 shipments a day :

$$\frac{5 \text{ mins} \times 600}{7 \times 60} < n < \frac{10 \times 600}{7 \times 60} \text{ i.e. } 7 < N < 14$$

Given the above range, ten checking stations are required.

Equipment

Each station shall be fitted with :

1 16 mm screening desk (no sound track)	FF 6,000
1 16mm splicer	FF 5,000
2 tanks	FF 500
	FF 11,500

i.e. for ten stations :

11,500 x 10 = FF 115,000

Maintenance expenses are estimated at 10 per cent a year.

Depreciation is calculated over ten years.

Staff

Male or female checkers work on a full-time basis. The total payroll taxes account for about 40 per cent of the wages, viz : a total of FF 45,000 (according to 1980 figures in France), i.e. FF 45,000 a year x 10 = FF 450,000.

Other expenses

For leaders, housing, or replacement cores, glue, etc., FF 4,000 a year.

IV - HANDLING, STOCKTAKING AND SHIPPING EXPENSES

These expenses cover the collection of the copies returned to the film library, their distribution to the checking stations, their storage in the storage areas, stocktaking, and the preparation of shipments.

Equipment

Shelf units and shelving

Shelves, tables and miscellaneous elements	FF 10,000
10 carriages at FF 500 each	FF 5,000
3,000 plastic containers for shipping the films at FF 50 charged for the containers	FF 150,000
Extinguisher	FF 4,500
Addressing machine	FF 15,000
TOTAL	FF 184,500

Offices and common areas

2 sets of office furniture, armchairs, filing cabinets, etc. : 1 for the programming officer	FF 4,000
and 1 for the head storeman	FF 4,000
Staff areas : changing room (lockers, etc., small items)	FF 4,000
Estimate for all furniture	FF 16,000

All the equipment will be depreciated over ten years (excluding the containers used for shipments which will be depreciated over five years).

Staff

Annual wages are as follows :

1 programming officer	FF 60,000
1 head storeman	FF 48,000
10 storemen : FF 38,000 x 10 =	FF 388,000

V - COST OF TRANSPORTATION

Transportation expenses depend on two factors : the means of transportation used, and the volume of the shipments to be effected.

Such factors vary from one case to another. For the present example, we have tried to assess the cost of transportation by post for an annual volume of shipments of 600 x 230 = 238,000, i.e. about 230,000 loans. Allowing a margin for unspecified factors, it costs FF 15 to send one copy (non inclusive of tax) on average, i.e. an annual cost of : FF 15 x 230,000 = FF 3,450,000. Of course, local conditions may involve the use of a different means of dispatch and the creation of a special servicing system. It is difficult to assess the configuration of such a system theoretically (the number of vehicles to be used, the distribution circuits, the number of kilometres covered which will differ depending on the country, the area, the density of the establishments, etc.).

VI - MANAGEMENTEXPENSES

These are all the administrative expenses incurred for the management and the secretariat.

Head of the film library

1 complete set of office furniture	FF 4,500

Secretariat

1 typewriter	FF 2,000
1 calculating machine	FF 800
1 typist's chair	FF 350
1 typist's desk	FF 1,500
Storage units and cabinet	FF 2,000
	FF 6,650

Depreciation of the furniture is calculated over 10 years.

Staff

Annual wages amount to :

1 head of the film library	FF 85,000
1 typist	FF 45,000

Other expenses

It is estimated that office supplies and miscellaneous expenses correspond to 10 per cent of the typist's wages, i.e. FF 4,500 a year rounded up to FF 5,000 to cover supplies to the head of the film library.

TOTAL FF 5,000

Estimated cost of a loan

The average cost of a loan is logically obtained by dividing all the expenses incurred for the film library by the number of loans effected during the year.

B - VIDEO LIBRARY

I - GENERAL

The diagram in Figure 8 illustrates the way video-cassettes are distributed :

- the originals are read on an appropriate reader (videotape reproducer or film scanner)
- the signal is passed on to the 'slave' copiers for duplication
- the copies are stored and then shipped by express service to the different customer establishments
- users may, after reading the copy, either keep it for later use (storage) or duplicate it if they have two videotape recorders (duplication), or simply return it to the video library.

The same costs as for the film library will be examined.

II - STORAGE EXPENSES

Cost of buildings

If we consider that out of every square metre of storage area, only one-quarter of the surface is useful (taking corridors into account), it follows that one square metre of floor space is required to store 1,000 cassettes. The same total surface area as that outlined for the film library should be provided for the offices, and packing, addressing and collecting the cassettes. We will base our calculations on 500 copies on half-inch VHS cassettes per square metre, i.e. at the rate of 30,000 videocassettes and FF 2,500 per square metre of floor :

$$\frac{30{,}000 \times 1 \times 2{,}500}{500} = \text{FF } 150{,}000$$

The building is written off over twenty years, and the cost of maintenance per square metre may be included in the depreciation costs.

Furniture costs

The shelving accommodates five cassettes per linear metre, 10 cm deep, arranged on shelves mounted on simple supports.

The value of the shelving units is estimated at FF 10,000.

Depreciation is calculated over ten years.

Investment in videocassettes

We will take as a basis for calculation the average cost of duplication for 20-minute programmes (cost of the master included), all the operations being performed on an industrial scale :

i.e. FF 100 for one half-inch 20-minute VHS colour cassette ;

i.e. a total of FF 100 x 30,000 = FF 3,000,000 (excluding the possible purchase of the rights).

It is considered that a cassette may be used about 150 times. Allowing for possible mechanical breakdowns, if we assume that there are about 3,000 original titles, we can estimate that the cost incurred for renewing the cassettes corresponds to one-third of the start-up costs (including the updating of the titles in the catalogue).

III - CHECKING AND MAINTENANCE EXPENSES

Since the users are generally familiar with the correct manner of use for the cassettes (how to clean the heads of the videotape recorder in particular), the replacement costs for broken tapes are absorbed within other sections and therefore no separate figure is given under this heading.

IV - HANDLING, STOCKTAKING AND SHIPPING EXPENSES

The cassette must be removed from its cardboard packing, classified, entered in the inventory, removed from the shelf, packed, and placed in the 'out' basket. All these operations constitute the work of about one person at a rate of two minutes per cassette. Since the video library is geared to sending out 600 cassettes a day, the handling staff will be composed of $\frac{600 \times 2}{7 \times 60}$ = 3 full-time employees

VIDEOCASSETTES BY POSTAL SERVICE

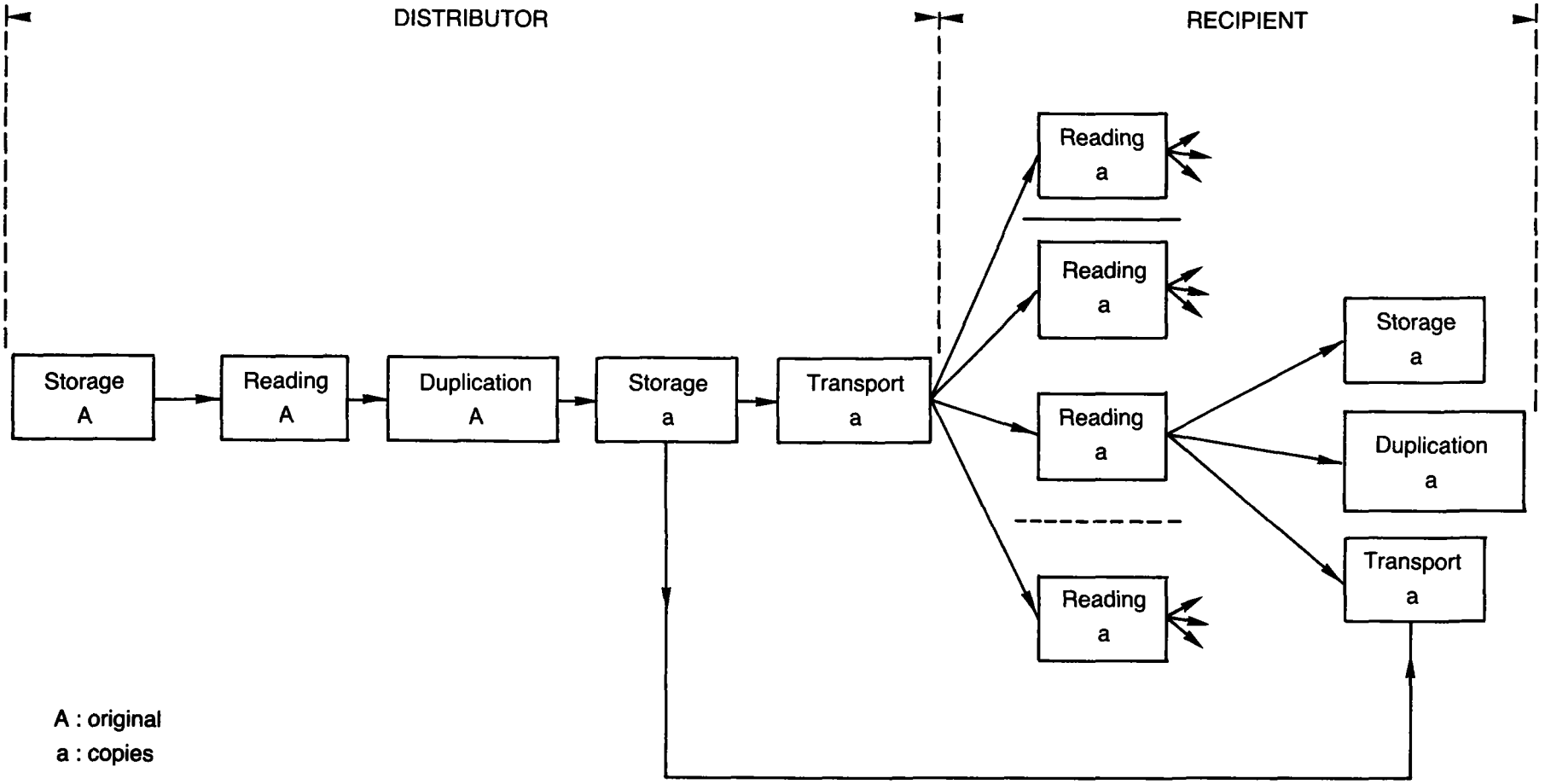


Figure 8

Equipment

Shelving, tables, staging, stools

racks and miscellaneous items	FF 5,000
extinguisher	FF 4,500
addressing machine	FF 15,000
TOTAL	FF 24,500

Offices and common areas

These are identical to those of the film library, i.e. FF 16,000.
All the equipment is depreciated over ten years (except for the 'out' baskets which are depreciated over five years).

Staff

All wages are annual :

1 programming officer	FF 60,000
1 head storeman	FF 48,000
3 storemen (38,000 x 3)	FF 114,000
TOTAL	FF 222,000

Other expenses

Cardboard for packing, labels, office supplies and items for the common areas	FF 60,000/year

V - TRANSPORTATION EXPENSES

If we use the same basis for calculation as for the film library (post), the average forwarding expenses for one cassette amount to FF 2.00, i.e. an annual cost of FF 2.00 x 230,000 = FF 460,000.

VI - MANAGEMENT EXPENSES

These are the same as for the film library.

VII - ESTIMATED COST OF A LOAN

The average cost of the loan of a videocassette is calculated on the same basis as the average cost of the loan of a film by a film library.

C - CONCLUSION

The utilization of one of the broadcasting systems studied (film or videocassette) depends not only on the economic data that we have considered.

In fact, demand is not the same in all cases ; that is why it is also necessary to analyse :

- the total volume of requests for the year
- the volume of demand at different times throughout the year
- the duration of use of a cassette
- its delivery time.

However, two factors seem to play a major role: the volume of demand for one specific title and the concentration of demand in time, or the extension of the time of utilization to a level which prevents *any possible turnover.*

PART TWO

Assessment and Analysis of the Costs of Educational Media

From the identification of the costs incurred for operationalizing some of the media used in education, which was the purpose of Part One, we will now deal in turn with the method used for analysing the costs, the application of the method to determine the actual cost per medium, pupil or pupil/hour of each medium and the problems of choice confronting those who must make decisions as to the use of media in education.

1. SOME METHODOLOGICAL QUESTIONS

I - WHICH COSTS ARE RELEVANT ?

For each medium studied in Part One, a list of costings has been made for certain debit items : equipment, staff, expendable materials, premises, management, etc. For an economist, there are no free resources: all the debit items or "inputs" (equipment, expendable materials, premises, staff, management, etc.) are therefore necessarily relevant.

It may seem obvious, but decision-makers are sometimes tempted to overlook certain costs which they treat as minimal without examining them closely. Let us take as an example a situation where a head teacher decides to turn an unoccupied classroom in an existing building into a photography laboratory. The assumption is made that the room is a free good and the only costs incurred are those associated with the change of use. Thus, he might forget that the room, although it is not used for classes, could well serve other purposes : as a library or a canteen for the pupils, a staff room for the teachers who do not have such a facility, or a classroom for pupils from an overcrowded school located elsewhere. In essence, the choice of the head teacher is limitive since it involves giving up all possible alternative uses of the room and, in particular, an alternative which could have been the most interesting from an economic point of view. He therefore bypasses the *opportunity cost* exercise which helps the economist determine the best solution in the light of all the alternatives. The opportunity cost of the photography laboratory should be calculated by considering the cost of construction of an extra classroom in the neighbouring school at present overcrowded, less the (extra) cost of transportation, if any, to ferry the pupils who would then use the unoccupied room for which an alternative use is contemplated. The cost should obviously be equal to the building cost of the new classroom on the other school site, less the (extra) cost of transportation of the pupils. In practice, to simplify calculations, and on the assumption that it is extremely rare for a room not to have any alternative possible uses, the opportunity cost is considered to correspond to the expenses incurred for rebuilding identical premises as of today. (We will see later how this cost is depreciated.)

In addition to the buildings, other resources may be regarded as free by the decision-makers : this holds true for the staff. In fact, since the staff required for operating the media are remunerated by the government, the headteacher may believe that this debit item should not be included in the budget of the school. This may even apply to a vehicle used for the project or for work connected with the alterations carried out by personnel on the establishment of the school. Expenses are then perceived as limited to the cost of the supplies.

It is essential to identify the resources which are sometimes considered free, and to estimate their cost, even though it may not be possible for practical reasons to do it with complete accuracy.

II - WHICH PRICES ARE RELEVANT ?

We have just seen how the cost of an existing building could be assessed. There are two other current difficulties: how to determine the cost of staff and the procedure for tax accounting. As far as the staff is concerned, its cost incorporates the wages plus the payroll taxes, which may be high if we take into account pension benefits, National Insurance and paid holidays.

Should we use prices before taxes or prices inclusive of taxes ? This is a much debated question. As a matter of fact, since education is state-financed, taxes which are levied on the equipment constitute a revenue, not an expenditure, for the state. If the state pays those taxes, it is a break-even deal. Taxes are not always insignificant. In some countries, taxes levied on imports (electronic equipment, vehicles) are sometimes greater than the actual price. In others, materials used for educational purposes are tax free.

Cogent arguments can be made both for the inclusion and for the exclusion of taxes (if taxes are excluded, how should educational projects with private financing be treated ? How should the wages paid by the state and which bring in extra taxes indirectly, be treated?).

The solution we offer is, in our opinion, the least disputable alternative : *take into account only what is actually paid on the project.*

III - FIXED COSTS AND VARIABLE COSTS

The distinction between 'fixed costs' and 'variable costs' is essential when analysing the cost of the media, for this is what differentiates the projects substantially.

In fact, traditional education mainly involves *variable costs* which are proportional to the number of pupils. If the national education system takes in twice as many students, then twice as many schools, books and teachers will be needed, and the cost per pupil will remain unchanged. At the very most a slight saving can be made on administrative expenses (a second minister is not needed), although experience

shows that administrative expenses per pupil do not tend to go down when the education system expands.

As far as audio-visual media are concerned, the cost structure is totally different. When we produce radio or televised programmes, sound cassettes or videocassettes, educational computer programmes or films, the design, development and making of the original software constitute what is called a *fixed cost*, totally independent of the number of pupils who benefit from them. Similarly, if we broadcast radio or televised programmes, the cost of broadcasting is independent of the actual number of listeners or viewers. Contrary to variable costs, fixed costs are inversely proportional to the number of pupils.

However, the training staff, the reproduction of copies from original material and the receiving equipment constitute variable costs. Depending on the medium considered, the share of fixed costs will be high (radio) or small (language laboratory : the building up of a stock of original tapes generates fixed costs).

Variable costs and fixed costs are differentiated with reference to the pupils. Some writers apply a similar distinction to the actual material produced and consider that it is possible, with a specific television studio, to make 50 hours of programmes a year or 100 hours of programmes a year. Fixed costs (depreciation of the studio) are independent of the number of programme hours and variable costs (casual employees, tapes, electricity, repairs) are proportional to the number of programme hours.

We do not recommend such an approach for two reasons. In the first place, it may be confusing and second, it implies that, if it is possible to produce a variable quantity of software with the same equipment, it is not unreasonable to argue that the equipment is under-utilized. Now, from an economic point of view, it is necessary to oppose the common tendency to acquire too much equipment which is subsequently under-utilized. It is wiser to buy less sophisticated and less expensive equipment of lower performance and to meet the variable costs of production with the funds saved, at the same time being able to use the equipment to the full.

In too many instances the total budget is committed to the purchase of equipment which is later considerably under-utilized through lack of the necessary finances for its operation. In all the cases quoted in Part One of this publication, the type of application envisaged is geared to a fairly high rate of utilization, bearing in mind the constraints associated with educational institutions, e.g. long holidays.

In practice, at the present simplified level of this economic analysis, it is possible to identify the *variable* cost (VC) per pupil and the *marginal* cost (MC). Marginal cost corresponds to the increase in total cost which results from an increase in output, the output being the pupil to whom a certain quantity of knowledge is added. If the system takes in one more pupil, the total cost of the project increases by one unit of variable cost per pupil (or marginal cost).

The average cost is the total cost divided by the number of pupils (N). It represents, therefore, the total of variable costs and fixed costs divided by the number of pupils. It may also be expressed as the fixed costs divided by the number of pupils, plus the variable cost per pupil (or marginal cost).

$$\text{Average cost} = \frac{\text{total cost}}{N} = \frac{fc + vc}{N} = \frac{fc}{N} + mc$$

IV - COST ANNUALIZATION

In educational media projects, some inputs (premises, equipment) have a serviceable life of more than a year. They are therefore used by several generations of pupils although they are paid for at the time of purchase. How should the cost of these inputs be dealt with when calculating costs per pupil ? It is obvious that the start-up cost cannot be charged against the first generation of pupils and be overlooked later on. Hence the use of *annualization* which consists in dividing the cost of inputs with a longer life into annual portions. Such a method is similar to that of depreciation which is well-understood by private companies, but it is more wide-ranging. It applies not only to the buildings and materials but also to those items which are used by several generations of pupils. If a film or a television programme costs one million units of currency and if it is shown to five generations of 20,000 pupils five years in a row, the cost of its production must not be charged exclusively to the 20,000 pupils of the first year, but to the 100,000 pupils who will see it.

How is annualization calculated ? Annualization depends, in the first place, on the probable serviceable life of the input considered and, second, on the interest rate selected. Why an interest rate ? Because the immobilization for several years of the funds required for buying the inputs corresponds to a cost equal to what the funds would have yielded if they had been invested on the financial market or *used for interest-bearing investments*. By deciding to invest in educational media, other possible applications (the opportunity cost) which could have yielded some profit are foregone. Since we subsequently endeavour to compare the cost of those media with the profit they generate, our approach demands that the profits foregone be identified and assessed.

We are perfectly aware of the slightly artificial feature of such assessments : have the profits foregone been assessed with enough accuracy ? To take these objections into account, we propose to consider a set of three interest rates which cover virtually all possible cases, i.e. 0 per cent (which corresponds to the absence of any interest rate), 15 per cent which seems to be a maximum, and 7.5 per cent which is a safe average.

Estimated serviceable life ranges from twenty to thirty years for a building, approximately ten years for furniture and equipment and about five years for vehicles, electronic equipment and any educational programmes produced.

When any expenditure can be annualized, it is sufficient to multiply it by the corresponding coefficient in table 16 as appropriate, to the serviceable life and the interest rate.

Table 16

Service life	Coefficients of annualization		
	Interest rate 0%	Interest rate 7.5%	Interest rate 15%
3	0.333	0.385	0.438
4	0.250	0.299	0.350
5	0.200	0.247	0.298
7	0.143	0.189	0.240
10	0.100	0.146	0.199
15	0.067	0.113	0.171
20	0.050	0.098	0.160
25	0.040	0.090	0.155
50	0.020	0.077	0.150

V - ASSESSMENT OF UNIT COSTS

There are two kinds of unit costs : costs per unit of software produced (1 programme hour, 1,000 metres of film) and costs per pupil.

Costs per unit of software produced. The assessment of costs per unit of software produced allows us to compare the performances of different types of equipment and of different types of organization of the production teams. Since the unit must be standardized, we will apply the cost of one programme hour.

Costs per pupil. In the present case, costs per pupil are average costs resulting from the division of the total annualized costs (fixed costs plus variable costs) by the number of pupils.

Our analysis should not be limited to the assessment of the average annual cost per pupil, for such cost is not sufficiently representative as regards the volume (in time and in quantity) of contacts between the medium considered and the pupil. It is not the same thing to have access to one hour of radio programme a week or to one hour a day. Therefore, the annual cost may be misleading if it is not controlled by a quantity indicator. It is advisable to make an overall estimate of the total annual hours of contact with the medium, and to divide the annual cost per pupil by that number of hours, to be in a position to make comparisons between the media and the systems.

2. EXAMPLES OF ASSESSMENT OF COST PER STUDENT

The estimated costs per student indicated in this chapter relate to the theoretical examples described in Part One. Four media have been selected : photography, radio, video and the language laboratory. For each medium, from two to five types of applications have been selected. Costs per student mainly depend on the application of the medium rather than on the medium itself.

I - COST PER STUDENT OF PHOTOGRAPHY AT SCHOOL

1. Introduction to picture-taking, i.e. seven three-hour sessions a year for a group of twelve students, with instant camera.

Table 17

	0%	7.5%	15%
- 3 cameras at FF 200 = FF 600 (5 years)	120	148	150
- Storage units			
refrigerator	100	124	149
cabinet	50	73	95
Sub-total	270	345	394
- Maintenance		60	
- Instant film magazines		1,200	
- Miscellaneous supplies		120	
- Files and envelopes		500	
- Training staff : 1/30th of teacher		2,666	
Total for 12 students a year	4,816	4,891	4,970
Cost per student and per year	400	408	414
Cost per student and per hour	19.00	19.40	19.70

2. Normal production work, i.e. thirty hours a year, in groups of twelve, black and white photography with reflex cameras, for one level (150 students).

Table 18

	0%	7.5%	15%
- Equipment : 5 sets at FF 5,000 (over 5 years)	5,000	6,792	8,195
- Maintenance	2,750	2,750	2,750
- Photography laboratory (over 20 years)	7,500	14,700	24,000
- Equipment	600	741	894
- Furniture (over 10 years)	200	292	398
- Isothermal units	90	1,314	1,791
Sub-total	17,450	26,539	38,028
- Maintenance and electricity for the isothermal units		1,350	
- Film		630	
- Processing and enlargement		275	
- Training staff : 1 teacher		80,000	
Total cost	99,705	108,844	120,283
Cost per student and per year	665	726	802
Cost per student and per hour	22.15	24.20	26.70

The main technical difference between options 1 and 2 lies in the processing method (instant processing for option 1 and printing in a laboratory for option 2). It is worth noting that costs per student/per hour do not vary greatly (FF 19 and FF 24 respectively), but the cost structure is quite different. With instant processing, reloading purchases represent more than 25 per cent of the total cost, whereas with option 2, supplies (films, chemicals and paper) do not account for more than 1 per cent of the total cost. However, the premises and equipment represent from 15 to 30 per cent of the total cost, and since such expenditures must be amortized, the choice of a non-zero interest rate has a much great influence than in option 1 where it is insignificant.

In both cases, costs related to the training staff are important (55 per cent for option 1 and 75 per cent for option 2).

II - PRODUCTION COSTS

The costs of production of radio programmes vary according to how elaborate they are. Six levels of elaborateness, in growing order, have been determined (categories A, B, C, D, E1 and E2).

Table 19

1) Hourly cost of production

Type	Hourly cost in French francs in 1980
A Coverage	632
Studio	975
B Coverage	896
Studio	1,371
C Studio	2,184
D Studio	2,730
E1 Studio	3,356
E2 Studio	4,542

2) Hourly broadcasting cost (all French territory)

8,607

3) Cost per student and per year

This cost (uc) depends on three factors : the number of hours spent on production and broadcasting ; the type of programme selected, and the number of students involved. For example, one weekly hour of programme type A in studio, for thirty weeks, would cost :

$$\frac{(975 \times 30) + (8{,}607 \times 30)}{N} = \frac{29{,}250 + 258{,}210}{N} = \frac{287{,}460}{N}$$

When N = 1,000, unit cost = FF 287.46
N = 10,000, unit cost = FF 28.75
N = 100,000, unit cost = FF 2.87

General formula :

uc = Cost of production per hour and per type (tc) x Number of hours (H) + Broadcasting cost (dc) per hour (H) x Number of hours (H) divided by the number of students (N)

$$uc = \frac{tc \times H + dc \times H}{N} = \frac{H(tc + dc)}{N}$$

For each type of programme, the cost function becomes:

Type A Coverage $\frac{H(635 + 8{,}607)}{N} = \frac{H\ 9{,}242}{N}$

Type B Coverage $\frac{H(896 + 8{,}607)}{N} = \frac{H\ 9{,}503}{N}$

Type B Studio $\frac{H(1{,}371 + 8{,}607)}{N} = \frac{H\ 9{,}978}{N}$

Type C $\frac{H(2{,}184 + 8{,}607)}{N} = \frac{H\ 10{,}791}{N}$

Type D $\frac{H(2{,}730 + 8{,}607)}{N} = \frac{H\ 11{,}337}{N}$

Type E1 $\frac{H(3{,}356 + 8{,}607)}{N} = \frac{H\ 11{,}963}{N}$

Type E2 $\frac{H(4{,}542 + 8{,}607)}{N} = \frac{H\ 13{,}149}{N}$

It is then very easy to represent the above equations graphically to provide an immediate reading of the cost per student corresponding to each N value.

Thus, line C2 shows the changes in the cost per student when one hour of programme type E2 is broadcast each week for thirty weeks, in relation to the number of students (roughly FF 400 for 1,000 students and less than FF 2.00 for 200,000). The space included in between C1 and C2 (that is between type A which is the least expensive production option and type E2 which is the most expensive option) covers all possible unit costs when the total number of hours spent on producing and broadcasting during the year is 30. Thus we can see that the type of programme has little impact on the cost per student, in comparison with the number of students which is the main variable.

Lines C3 and C4 are also divided by a narrow strip which covers all possible unit costs when the total number of hours spent on producing and broadcasting is 150 a year (one hour a day for thirty five-day weeks). Once again, the key variable is the number of students, not the type of programme produced. With an expenditure per student of FF 10.00 (line A), it is possible to broadcast a type-A programme to 28,000 students every week, or a type-E2 programme to 38,000 students every week, or a type-A programme to 140,000 students a day, or a type-E programme to 200,000 students a day (plus all intermediate combinations as to the type of programme).

If it is intended to reach 10,000 students (line B), the cost per student will be FF 29.00 if they are shown a type-A programme each week, FF 39.00 if they are shown a type-E2 programme and FF 140 if they are shown a type-E2 programme every day. For a given number of students, therefore, the key variable which determines the cost per student is the *broadcasting rate* of the programmes (daily or weekly) and not the type of programme.

III - COST OF VIDEO AS AN EDUCATIONAL MEDIUM

1. Recording - broadcasting [1]

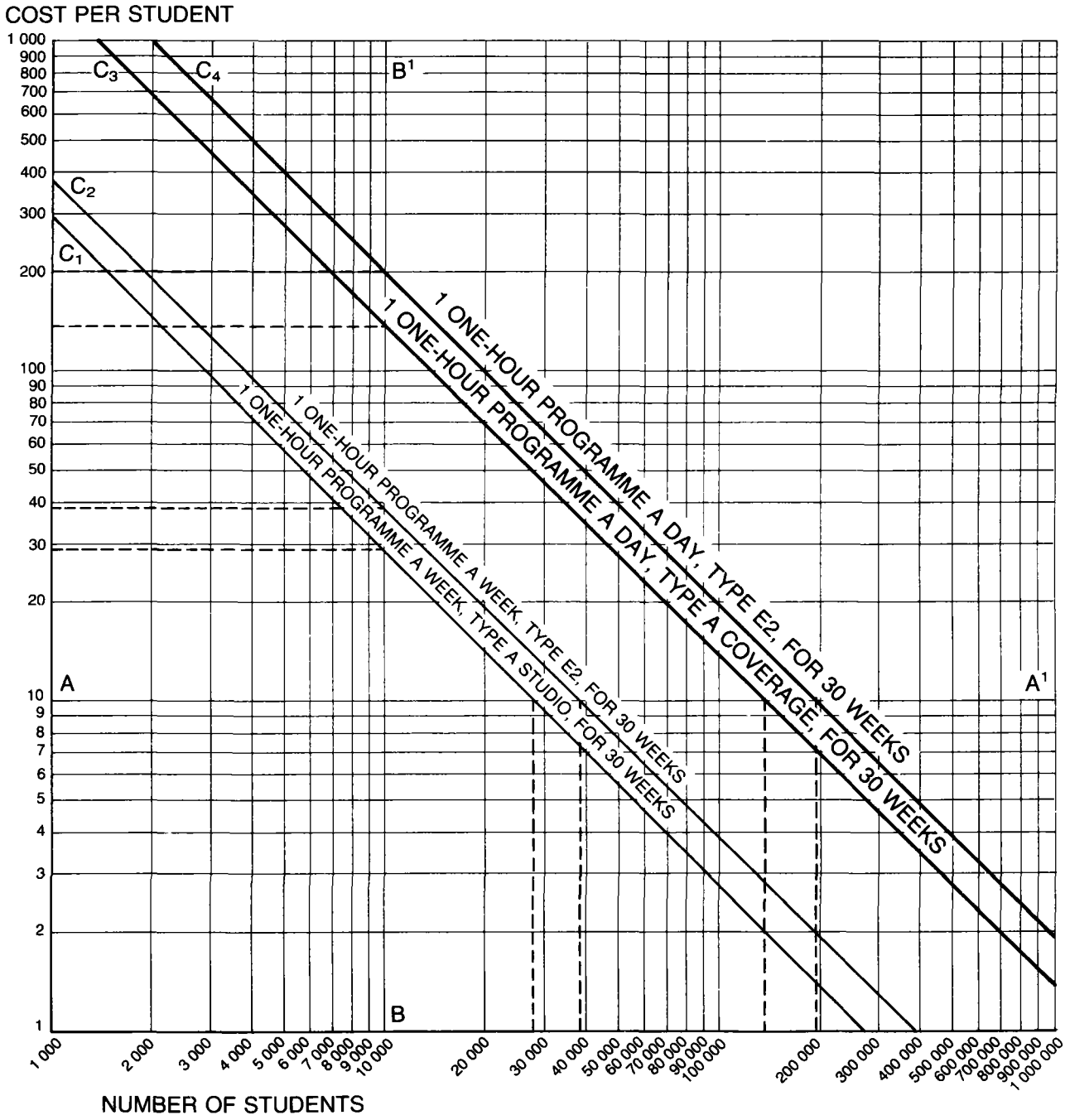
Table 20

	0%	7.5%	15%
- Equipment (5 years)	6,200	7,567	9,238
- Maintenance	3,100	3,100	3,100
- Stock of 80 one-hour cassettes	1,280	1,580	1,907
- Premises		negligible	
- Staff : 1 operator	50,000	50,000	50,000
Total per year	60,580	62,247	64,245

Cost per student-hour : On the basis of fifty recording hours a year - additional programmes being acquired from a videotape storage centre - and of classes of twenty-five students on the average, the equipment can be used for 550 hours x 25 students = 13,750 active hours maximum. Consequently, if the equipment is used at full capacity, the cost per student-hour is roughly FF 4.50.

[1] The calculation is based on a recording-broadcasting capacity of 600 hours a year (or 3,000 hours over 5 years).

Figure 9



Graph 1
Cost per student according to :
— the number of students
— the type of programme
— the number of hours

2. Coverage package

Table 21

	0%	7.5%	15%
- Equipment (5 years)	7,000	8,645	10,430
- Maintenance	5,250	5,250	5,250
- Stocks of tapes (5 years) [1]	8,000	9,880	11,920
- Storage (2 cabinets, 10 years)	160	234	318
- Wages [2]	80,000	80,000	80,000
- Management	8,000	8,000	8,000
Total	108,410	112,009	115,918

[1] This is based on 2,000 hours of utilization over 5 years, 25 per cent of the tapes being preserved, i.e. a total stock of 500 one-hour tapes.

[2] This is based on 15 weekly hours corresponding to one full-time teacher.

Cost per student : There are fifteen hours of utilization a week for thirty weeks for groups with five students in each group, i.e. 15 x 30 x 5 = 2,250 student-hours a year. The cost per student-hour therefore is :
FF 48.00 at 0 per cent, FF 50.00 at 7.5 per cent and FF 52.00 at 15 per cent. For one-week training courses with five students per group, the cost is approximately FF 750 per student. The ratio of labour costs (almost 80 per cent) compared with the cost of electronic hardware (20 per cent) must be emphasized.

3. Basic colour video production

Table 22

	0%	7.5%	15%
- Equipment (5 years)	49,000	60,515	73,010
- Maintenance	12,250	12,250	12,250
- Maintenance technician	70,000	70,000	70,000
- Purchase of vehicle (5 years)	12,000	14,820	17,880
- Vehicle expenses	12,000	12,000	12,000
- Premises (20 years)	9,800	19,208	31,360
- Production technician	70,000	70,000	70,000
Sub-total	235,050	258,793	286,500
+ Management and electricity (12% of the sub-total)	28,206	31,055	34,380
Total	263,256	289,848	320,880
Cost per 15-minute programme (225 a year)	1,170	1,288	1,426
Cost per hour of programme	4,680	5,152	5,704
Cost per year and per student (for 23 programmes) [1]	768	846	937
Cost per student and per programme	33.40	36.80	40.70

[1] 23 programmes correspond to the number envisaged for each class.

* The cost per year and per student (FF 850 approximately) is undoubtedly the most significant statistic since it represents about 20 per cent more than the annual cost of a student for whom no such video facility is available. It is therefore necessary to determine the gains made in learning through the use of equipment which increases the student cost by about 20 per cent.

4. More elaborate production

Table 23

	0%	7.5%	15%
- Equipment (5 years)	83,000	102,505	123,670
- Maintenance :			
- technician	80,000	80,000	80,000
- other expenses	20,750	20,750	20,750
- Stock of 500 tapes (5 years)	18,000	22,230	26,820
- Purchase of vehicle (5 years)	12,000	14,820	17,880
- Vehicle expenses	12,000	12,000	12,000
- Premises (20 years)	9,800	19,208	31,360
- Production technician	80,000	80,000	80,000
Sub-total	303,550	351,513	392,480
- Management and electricity (12% of the sub-total)	36,426	42,182	47,098
Total	339,976	393,695*	439,578

* The annual cost of this equipment is approximately FF 400,000.

It is not very easy to assess the unit costs for we do not know how many programme hours can be produced, nor the number of students who can attend the production sessions simultaneously. We could base our calculations on the production volume estimated for the preceding example of basic production, but it would imply that it takes as much time to produce elaborate programmes as it does for simple programmes. If so, the unit costs of basic production assessed in chapter III.3 must be increased by about 33 per cent. If the time cost of more elaborate programmes reduces production by 50 per cent, then unit costs will be 167 per cent up, which increases the hourly cost to about FF 14,000 and the annual cost per student to FF 2,260, i.e. a 50 per cent increase on the cost of a student in a traditional context.

Clearly, costs do change substantially comparing those incurred for the recording-broadcasting of television programmes (chapter III.1) to those of the present example in which the students contribute in small groups to the production of programmes ; they rise from less than FF 4.50 per student-hour in example 1 to over FF 200 per student-hour in this example. It is true that the educational objectives are wholly different. However, it is important to note that the TV concept covers widely different forms of utilization, a factor which has a major effect on costs.

5. Special examples of closed circuit TV used for teacher-training

As outlined in Part One, three different utilization situations are studied : the recording and broadcasting of programmes, the production of programmes, and autoscopy and heteroscopy.

a) Recording-broadcasting of programmes

The difference between the present example and the example described in chapter III.1 lies in the fact that the number of viewing monitors is greater to allow for more intensive use by the students.

Table 24

	0%	7.5%	15%
- Equipment (5 years)	12,200	15,067	18,178
- Maintenance	6,200	6,200	6,200
- Cassettes	24,000	24,000	24,000
- Storage of furniture (10 years)	80	117	159
- Premises (20 years)	438	857	1,400
- Staff	50,000	50,000	50,000
Total	92,918	96,241	99,937

Cost per student-hour. Since each of the five monitors for viewing are to operate 600 hours a year, there is a total of 3,000 broadcasting hours. With an average of 30 students per session, we achieve the number of 90,000 student-hours, i.e. a cost of slightly more than FF 1.00 per student-hour.

In comparison with example 1 in chapter III.1 (Table 20), the significant reduction in the hourly cost is due to the fact that the same person is required to operate two units. This means that in each of these situations, the person concerned will have to carry out work of varying degrees of intensity.

Furthermore, the figure of 90,000 hours is more a theoretical maximum than a likely average. It would imply that each student watches five hours of televised programmes every week, which is a great deal. An effective rate of utilization would be half that amount. This would be more realistic and would bring the hourly cost to FF 2.00.

b) Production of programmes

We will only consider two levels of complexity out of the three described in Part One (see Part One, chapter 7).

As regards the first level, one single unit is used by 300 students at the rate of 30 weeks of 15 hours, which gives 450 hours per group of 15 students, i.e. 6,750 student-hours or 22.5 hours per student a year.

As far as level two is concerned, one single unit is used by 150 students at the rate of 3 hours a week for 30 weeks in groups of 15, i.e. 90 hours per student a year, or 13,500 student-hours a year.

Table 25

	Level 1			Level 2		
	0%	7.5%	15%	0%	7.5%	15%
Equipment (5 years)	6,960	8,596	10,370	92,000	113,620	137,080
Small accessories (3 years)	667	770	876	667	770	876
Maintenance	5,220	5,220	5,220	73,000	73,705	74,470
Cassettes	24,000	24,000	24,000	54,000	54,000	54,000
Transport	-	-	-	24,000	26,820	29,880
Storage - furniture (10 years)	80	117	159	160	234	318
- premises (20 years)	438	857	1,400	9,800	19,208	31,360
Staff [1]	80,000	80,000	80,000	150,000	150,000	150,000
TOTAL	117,365	119,660	122,025	403,627	438,357	477,984
+ 12% for administrative expenses and electricity				48,435	52,602	57,358
				452,062	490,959	535,342

[1] the equivalent of one full-time teacher, fifteen hours a week.

The cost per student and per year is :

I	II
FF 390 at 0%	FF 3,000 at 0%
FF 400 at 7.5%	FF 3,250 at 7.5%
FF 410 at 15%	FF 3,600 at 15%

The cost per student and per hour is :

I	II
FF 17 at 0%	FF 33 at 0%
FF 17.5 at 7.5%	FF 36 at 7.5%
FF 18.20 at 15%	FF 40 at 15%

c) Autoscopy and heteroscopy

Both the above levels of utilization are possible, but that given for Level I is less expensive (FF 17.50 a student-hour). If 90 hours per student and per year are required to apply this method efficiently, it is necessary to buy two other units for training 300 students. The cost per student and per year then becomes

17.55 x 90 = FF 1,575.

IV - COSTS PER STUDENT OF A LANGUAGE LABORATORY

We have assessed the cost per student of language laboratories using tapes bought from commercial supplies and of language laboratories using original material produced by the school.

These estimates are based on the same criteria as in Part One, namely an establishment with 1,000 enrolled students, five levels of education and offering classes in four languages.

a) Cost [1] per student and per year of a 20-booth language laboratory, for a high school with 1,000 enrolled students having access to the laboratory one hour every two weeks, i.e. 15 hours a year

Table 26

Unit : 1980 French franc

	0%	7.5%	15%
Capital			
Building (20 years)	7,650	14,994	24,480
Electronic equipment (10 years)	15,900	23,214	31,641
Furniture (10 years)	850	1,241	1,691
Master tapes (10 years)	4,000	5,840	7,460
Maintenance equipment (5 years)	130	160	194
Total capital	28,530	45,449	65,466
Operation			
For copying tapes		40,000	
Maintenance		6,500	
Maintenance staff		38,050	
Training staff [2]		239,400	
Operating total		323,950	
TOTAL (Capital plus operation)	352,480	369,399	389,416
Total per student and per year	352.50	369.40	389.40
Total per student and per hour	23.50	24.60	26.00

Analysis and comments : The introduction of a language laboratory in an establishment raises the hourly cost of education per student by FF 23.50 to FF 26, depending on the interest rate chosen for capital amortization, i.e. a 150 or 160 per cent increase.

The annual cost for a student who uses the laboratory for fifteen hours is approximately FF 370, which is slightly higher than the cost of an alternative method whereby each student is provided with tapes for practice at home. It must be noted that the main reason for this extra cost does not lie in the equipment but in the necessity to split the classes, which multiplies the staffing requirements by two. If there were laboratories with forty individual consoles, the resulting additional cost would only amount to FF 13.70 per student-hour instead of FF 24.60 (for an interest rate of 7.5 per cent), i.e. an increase of 85 per cent instead of 155 per cent.

However, this arrangement is considered unacceptable by specialists from an educational point of view, although it is only a happy medium between the standard teacher-student contact time and the students' free access to the booths without the assistance of a teacher. In the first example, the teacher who has fifteen students, can give up to four minutes of individualized assistance in each one-hour class ; in the second example, there is no such assistance ; in the arrangement that we suggest, assistance is of two minutes' duration.

b) Extra costs per student and per year involved in the production of original drills for the lenguage laboratory

Table 27

Unit : 1980 French franc

	0%	7.5%	15%
Fixed costs			
Capital			
Premises (20 years)	850	1,666	2,720
Recording equipment (10 years)	1,660	2,424	3,303
Total capital	2,510	4,090	6,023
Operation			
Maintenance	1,600	1,600	1,600
Total fixed costs	4,110	5,690	7,623
Variable cost per hour [1]		3,090	

Cost function

Hourly cost (at 7.5%) $3{,}090 + \frac{5{,}690}{N}$

N being the number of programme hours produced

[1] On the basis of FF 2,940 for salaries and wages and FF 150 for magnetic tapes produced per hour.

Analysis and comments : The cost involved in the production of original programmes depends on the number of hours of programmes produced each year, since fixed costs per hour decrease when the number of hours increases. We have considered two eventualities depending on whether original programmes account for one-fifth of laboratory hours or for one-third of them. (3 hours a year for one level and one

---

[1] This is the additional cost involved in the laboratory. The cost of the teacher without the laboratory, i.e. FF 16 per student-hour, must be added to it.

[2] Additional staff for the laboratory means that classes will be divided into two groups.

specific language, or 5 hours, i.e. 60 or 100 hours of original programmes.)

Therefore,
If N = 60, the hourly cost will be

$$3.090 + \frac{5.690}{60} = 3.185$$

If N = 100, the hourly cost will be

$$3.090 + \frac{5.690}{100} = 3.147$$

The hourly production cost is not really affected by the number of produced programme hours, because variable costs are proportionally quite important in the present case.

On the basis of sixty hours, extra costs per student for producing three hours of original programmes a year amount to :

$$\frac{3,185 \times 60}{1,000} = \text{FF } 191$$

which gives for each hour of utilization of the language laboratory :

$$\frac{\text{FF } 191}{15h} = \text{FF } 12.75$$

If locally-produced original material is used during one-fifth of laboratory hours, the cost of the laboratory per student-hour is :

$$12.75 + 24.60 = \text{FF } 37.35$$

which is almost 5 times the cost of the traditional class hour and over 1.5 times that for a student-hour in laboratory with tapes purchased from a commercial supplier.

If locally-produced original material is used during one-third of laboratory hours, the cost of one student-hour is :

$$21 + 24.60 = \text{FF } 45.60$$

Taken as a whole, these costs are high. They are almost equivalent to the costs of private lessons the educational efficiency of which should be compared with that of language laboratories.

When we analyse table 27, it is clearly evident that annual costs and hourly costs vary considerably depending on the medium used, or with the same medium, on the way it is used.

Obviously, radio seems to be the cheapest medium, even though fixed costs represent a major share ; but the cost per student is inversely proportional to the number of listeners, fixed at 10,000. This arbitrary basis for calculation is the one chosen in order to analyse all other utilization situations considered in the present study; it is considered a reasonable one to use.

Video offers the broadest range of costs with hourly costs ranging from FF 2 to FF 200 depending on the type of utilization ; it must be pointed out that applications may be very economical when programmes recorded outside the local area are used, or very expensive when the programmes are designed and produced on the school premises. The last statement remains hypothetical for it is unlikely that many schools have the necessary facilities for local production. Whatever the medium considered, costs are significantly higher when switching from software[1] produced outside the local area to software designed and produced on the school premises (this has already been made clear as far as language laboratories are concerned).

However, it is obvious that, with photography, it is necessary to produce finished work at school.

As a rule, the media listed in the table almost without exception have a two-fold function : the transmission of cognitive matter to the student which we have good reason to believe is achieved more efficiently than through any other traditional means (classes or books) ; and the introduction of students to the design and production of educational material which is of value in the development of certain skills and aptitudes which to date are neither assessed nor considered within the prevailing criteria (*baccalauréat* for example).

Thus it is difficult to determine the cost-efficiency ratio of these media which, to a certain extent, could reduce the chances of examination success of students who are enthusiastic about them by diverting their efforts from the study of public examination subjects - and photography is an obvious example.

Costs per student must be considered with reference to the average annual cost of a student in a secondary school, estimated at FF 6,000 in France in 1980. Some forms of media utilization have an insignificant impact (just a small percentage) while others have a much greater one - about 37 per cent for television.

It is essential not to embark upon the generalized use of media equipments without first giving much thought to the objectives being pursued and to those highly-relative aspects of the costs of educational media considered in the present study[2] .

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[1] The word 'software' covers programmes (videotapes, sound tapes, etc.) as opposed to the word 'hardware' or equipment (tape recorders, videotape recorders, etc.).

[2] These costs incorporate the staff's wages. It is not recommended that these costs and percentages be automatically applied to any context, in particular to countries where wages are lower and equipment is imported ; in such instances, the assessment of the relative cost of the media will show that it is higher than in the tables given in this text.

V. - SUMMARY OF COSTS PER STUDENT FOR THE DIFFERENT MEDIA

Table 28

Comparative table of costs per student for the different media

Medium	Type of utilization	Annual volume	Annual cost	Annual cost expressed in % annual cost per student in traditional context (6,000)[1]	Hourly cost
Photography	a) introduction to picture-taking, instant processing	20 hours, in groups of 12	400	6,7	20
	b) production of finished work ; processing and printing effected at school	30 hours in groups of 12	750	12,5	25
Radio	a) radio programme in studio (basic technique)	1 hour a week for 30 weeks for 10,000 students	30	0,5	1
	b) elaborate programme	1 hour a week for 30 weeks for 10,000 students	40	0,7	1,30
	c) radio programme in studio (basic technique)	1 hour a day for 150 days for 10,000 students	140	2,3	1
	d) elaborate programme	1 hour a day for 150 days for 10,000 students	200	3,3	1,30
Video	a) recording-broadcasting	50 hours a year, classes of 25 students	50	0,8	4,5
	b) video coverage	1 one-week training course during the year	75	1,25	5
	c) basic production	production of one 15-minute programme a week for 25 weeks, in groups of 5	850	14,2	140
	d) elaborate production	production of one 15-minute programme a week for 25 weeks, in groups of 5	2260	37,6	200
	e) autoscopy - heteroscopy	90 hours per student and per year	1575	26,2	17,50
Language laboratory	a) 20 booths used 1 hour every two weeks, i.e. 15 hours a year		370	6,2	6
	b) example of a language laboratory where one-fifth of the programmes are produced by the school		561	9,3	37,4

[1] The annual cost of a pupil aged from 11 to 15 years is estimated to be FF 6,000 in France in 1980, that is, for 750 hours a year, a cost per student-hour of FF 8.00.

3. EXAMPLES OF OPTIMIZATION OF EDUCATIONAL MEDIA SELECTION AND PLANNING

As already stated, the costs of media vary widely depending on the uses to which they are put. Faced with such a variety, what are the selection criteria or, in an economist's language, what are the 'optimization' criteria ?

The optimum is an ideal situation which cannot be achieved in reality. It is a normative reference point towards which the decision-maker must strive. In actual practice, costs are evaluated in the light of the outcomes of different strategies.

We would like to refer to an example drawn from the Philippines. Although it does not specifically deal with a choice between two types of media, it is nonetheless analogous to a similar decision-making process. In the Philippine situation, pupils in primary schools were provided with free books, on the grounds that 90 per cent of them could not afford to buy them.

The assessment of the project indicated that the allocation of books increased test scores by 15 per cent, while the cost per pupil was only 1 per cent up. It is interesting to compare this cost/advantage ratio with another strategy generally regarded as likely to improve school results, that is a reduction in the number of pupils per teacher. A reduction from forty to thirty-nine pupils does not generally improve the results in a statistically significant way, but increases the cost per pupil by about 2.5 per cent. The most optimistic research done on the impact of the size of classes on school performances shows that, to obtain the same effort as with books (i.e. a performance improvement of 15 per cent), it would be necessary to reduce the number of pupils per class from forty to twenty, i.e. to increase the cost per pupil by almost 100 per cent.

In other words, in the Philippine example, the selected strategy had a cost/efficiency ratio about 100 times better than that achieved by reducing the size of classes. We do not therefore suggest a theoretical model to solve all existing problems, but we should look at a few examples derived from various situations described in Part One.

We have selected five of them : the reproduction of documents (systems and equipment recommended related to various needs), instant photography versus traditional photography, the maintenance of equipment using own internal staff or external servicing companies, the production of software (programmes bought in or produced on the premises) and language laboratories (the conditions required for better utilization).

I - REPRODUCTION OF DOCUMENTS

1. Characteristics to be taken into account for economic optimization

Unit reproduction costs (documents 21 x 29.7 printed on one side) vary according to four elements : the required number n of copies of the same document, the reproduction process selected (or the size of the equipment), the (monthly or annual) volume N of processed copies, and the desired quality of reproduction.

There are two major families of equipment : duplicating machines which require the use of a matrix or a master, and reprography devices or copiers which do not require the use of a master. For the latter, the manufacturers use a special invoicing system which has, in fact, the same consequences, namely a cost per unit which decreases as the number of copies produced increases.

In fact, the differential rating system of the copiers has always been a competitive characteristic for comparison with the cost system of duplicating machines, since, from the beginning, the goal was to deprive the latter of all or part of their market share.

With copiers, therefore, there is no direct link between the cost of the inputs and the price of the output, since the duplication on the tenth copy of the same document is no cheaper than that of the first copy. We know that the user can only turn, as an alternative, to even more expensive master systems if he needs only one copy.

In view of the above, we could ask why copiers which do not require the use of masters, do not without exception replace traditional duplicating systems.

There are two reasons. First, the lower limit of fixed costs is lower for simple hectographic devices. The cheapest copiers involve a more elaborate technology and therefore higher depreciation and maintenance costs. If the monthly or annual volume to be reproduced remains below a given threshold, hectography is competitive despite the production cost of the original matrix. Second, for very large printing operations, the cost of the masters becomes insignificant. Quality problems (copiers are little adapted to the reproduction of photographs) and staff qualification problems are limiting factors: everybody can use a copier but the operation of an offset press calls for special skills.

2. Unit costs, utilization situations and system selection

Table 29 gives the main data relating to the examples in Part One concerning unit costs for the different duplicating systems. Below ten copies, there is no real alternative : copiers are supreme. From 10 copies upwards, the problem becomes more complicated because the volume of documents duplicated within the establishment or institution must be taken into account.

Table 29

Unit cost of a copy, according to the number of copies, the duplicating process and the type of master

Duplicating system \ Number of copies	10			20			50			100			150			500			1 000		
	Typing	Thermocopy	Electrocopy	D	T	E	D	T	E	D	T	E	D	T	E	D	T	E	D	T	E
Hectography	122	26	-	64	16	-	29	10	-	18	8	-	14	8	-	-	-	-	-	-	-
Stencil	123	44	67	64	24	36	28	12	17	16	8	11	12	7	9	7	5	6	6	5	5
Offset	126	27	71	66	16	38	29	9	18	17	7	11	13	6	9	7	5	6	6	5	5
Copiers																					
2,000/month	-	46	46	-	46	46															
4,000/month	-	32	32	-	32	32															
20,000/month	-	19	19	-	19	19															

For 10 copies, technique with the lowest unit cost:

	less than 20,000/month	more than 20,000/month
Reproduction of an existing document taken from a book, a magazine, etc.	Hectography (thermo master) 26 centimes	Copiers 19 centimes
Reproduction of a document hand-written by the teacher	Hectography (hand-written master) 20 centimes	Copiers 19 centimes

We can see that for up to 10 copies, copiers are competitive until the volume of copies processed each month reaches a given threshold (20,000 copies). Hectography becomes competitive over 10 copies when the volume of processed copies is above this threshold.

Between 20 and 100 copies, that is the required quantity of copies for from 1 to 4 classes, hectography and offset printing are preferable to photocopying.

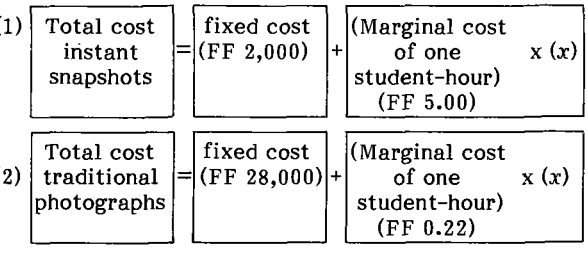
Over 150 copies, hectography and photocopying are no longer competitive. There are two possible techniques : offset printing and stencil printing with similar costs. Choice is made, as previously, according to the volume processed. If that volume requires the presence of a full-time qualified offset operator (100,000 copies a month), then offset printing is advisable. If not, regular stencils, which are easier to handle for non-professionals, seem to be the most judicious solution in the present state of the art. It is obvious that our recommendations would have to be altered should manufacturers launch upon the market easy-to-operate offset machines with fixed costs similar to those of regular stencil machines.

II - INSTANT PHOTOGRAPHY V. TRADITIONAL PHOTOGRAPHY

In the chapter on photography, we saw that the cost of reloads for instant photography was very high and represented about one-quarter of the total cost. Inversely, the cost of supplies (films, paper, chemicals) only accounts for 1 per cent of the annual cost for traditional photography, whereas capital costs are very high (FF28,000 instead of FF2,000).

We can therefore ask the following question for what volume of photographic activity with the pupils is it better to switch from instant to traditional photographs from a purely economic point of view? (We will not comment on the respective educational value of each system ; they are arbitrarily regarded as equivalent. Nor are we concerned with the different technical performances of both processes : e.g. aspects such as enlargement, multiple printing.) The answer is obtained by equalizing the total cost equations of both systems and by deducting from these equations the unknown x which is the number of student-hours used to achieve the skills desired (see Figure 10).

Figure 10



If we equalize both functions, we obtain

x = 5,440 student-hours.

Now, in both situations, the students are granted from 10 to 30 annual photography hours. The break-even point corresponds to having at least 180 students involved in that activity (in the example of thirty annual hours) or 270 (in the example of twenty annual hours). It must be stressed that such a volume of activities is rare in one single establishment and that, economically speaking, the choice of instant snapshot photography is fairly often mandatory.

III - SHOULD EDUCATIONAL INSTITUTIONS RECRUIT THEIR OWN MAINTENANCE STAFF OR USE THE SERVICES OF OUTSIDE AGENCIES ?

The cost of audio-visual equipment requires that the instruments be regularly maintained. Should maintenance be carried out by specialized technicians employed on a permanent basis by the establishment or by outside maintenance companies ?

The answer obviously is : *if, over one year,* the cost of maintenance is higher than the wages paid to an internally-employed maintenance engineer, the latter solution must prevail.

However, sometimes in educational establishments, the maintenance staff is highly under-utilized without it being a major concern for the head of the establishment; this occurs when the latter does not pay the employee on the budget of the establishment, but fills a vacancy provided for by his administrative supervisor. For the decision-maker at establishment level, it does not cost anything, whereas an operating budget needs to be prepared and involves tedious negotiations on a yearly basis ; this is why there are many economically-unjustified vacancies filled to simplify the job of decision-makers who are not concerned with the efficient deployment of manpower across the board but only at their own level.

IV - SHOULD EDUCATIONAL ESTABLISHMENTS PRODUCE THEIR OWN SOFTWARE OR BUY FINISHED PRODUCTS IN THE MARKET ?

This question must be considered for a great number of audio-visual aids : slides, audio-visual editing, radio and television programmes, computer programmes, etc. From an educational point of view, educationists are largely in favour of developing local production for two reasons : the intrinsic educational value of the productions and a better adaptation of the product to local educational requirements.

Both advantages must be analysed in terms of opportunity cost : the fixed costs of local software cannot be distributed between a great number of users. This implies that, given the reduced resources available, any local production of software involves : either a smaller quantity of programmes for the students concerned or a smaller number of students with access to the programmes.

These 'limitations' must be compared with the advantages derived from the local production of programmes. As regards the first advantage, that is the formative aspect of the design and production of the programmes, there are two classes of beneficiaries : the teachers and their students. As far as the teachers are concerned, this approach is probably not the most cost efficient. If such a level of competence is considered necessary, it is advisable to organize its acquisition more systematically, either during the initial training of teachers or during refresher courses with competent trainers.

With regard to the students, experience has shown that the acquisition of know-how in areas that are outside the examination system offers little advantage for the average student. Only a minority of highly motivated students benefit from it either at school level or later on in professional life. It would therefore be more appropriate first to identify and organize those pupils and then seek to include these activities in the academic scheme and its examination system. In this way, it would be possible to make sure that these activities really lead up to competence in skills of a negotiable value in professional life.

V - EXAMPLE OF THE LANGUAGE LABORATORY

We have seen in Section Two that the language laboratory was a fairly expensive medium and that, under current conditions of utilization, it is far from being cost-efficient.

Under a systematic approach to this medium from an educational, organizational and economic point of view, it is possible to improve the cost-efficiency ratio on the basis of the following assumptions :

. Educationally, greater emphasis should be given to free, direct access by the students to the equipment without the assistance of a language instructor. Such a practice would involve extra outlay for the purchase of sound cassettes but would considerably reduce staff costs.

. By better organizational management, a greater amount of access to the equipment, superior to the figures mentioned in the present report (900 to 1,000 hours a year) could be arranged. Actually, free access in particular would provide for use of the equipment for fifty hours a week. On the basis of thirty weeks a year, this would increase the utilization rate by 50 per cent (from 1,000 to 1,500 hours/year). Such an arrangement would increase the costs of maintenance and/or supervision of the equipment, but since total costs would be distributed between a total of student-hours 50 per cent higher, average costs would be smaller.

Table 30

Economic effects of free access for one-third of the time :	
Additional cost :	
1,000 sound cassettes at FF 6.00	FF 6,000
Economic effects of 50% extra access time :	
Additional cost :	
1 part-time supervisor	FF 38,000
Total additional cost :	
i.e. a 12% increase from the initial cost of FF 369,400	FF 44,000

Effects on the cost of one student-hour :

By comparison with the example studied in Section Two, the number of student-hours would move up from 15,000 to 22,500 and the cost per student-hour would drop from FF 24.60 to FF 18.40, i.e. a reduction of more than 25 per cent.

Methodological Summary

The costs stated in the present report relate to those current in France in 1980. This is why it is necessary to transpose the study to different national situations. To that effect, it is in our opinion useful to summarize in a table the different costs which must be considered.

I - A COST IS ONLY MEANINGFUL IN A GIVEN UTILIZATION SITUATION

In the final analysis, it is *unit costs* which help the decision-makers in making a choice.

But *unit costs per document* are related to the number of actual or potential student users, and the number of students depends on the utilization situation of the document.

Similarly, *unit costs per student* and per hour are directly linked to the educational circumstances which must be systematically described in terms of: number of sessions a year, number of hours per session, number of students per session, number of hours per student and per year, and nature and rate of supervision.

It will be necessary to analyse whether media planning must include any extra staff which would be taken into account in assessing the unit cost. For example, if a teacher provides an introduction to photography, the staffing cost need not be taken into account since the teacher incorporates such activity in his normal contractual obligations.

By contrast, a foreign language teacher who works in the language laboratory with groups of students representing half a class creates an extra cost which must be taken into account, just like the cost of a specialized technician attached to the language laboratory.

Eventually, it is necessary to make as accurate an estimate as possible of the share of material produced within the establishment in relation to the acquisition of that which is externally produced. We have already seen in the French example that the cost of the language laboratory per student-hour is one-and-a-half times higher when the establishment makes its own tapes than when it buys ones which are commercially produced.

II - INVESTMENT COSTS

A certain number of costs must be taken into account on a long-term basis. This holds true for : the **premises,** whose depreciation time may be calculated over a long period of 20 to 30 years (the cost of special premises must be included even though they are available upon the launching of an activity), and the **equipment** (instruments, vehicles, etc.) for which the serviceable life must be determined over five to ten years.

Improvements to equipment resulting from technological progress must also be taken into account. Instruments are increasingly up-dated, models and sizes changed.

The serviceeable life of the hardware is therefore increasingly reduced and it is advisable to use as a basis a maximum serviceable life of five years. (Over five years, it is no longer possible to maintain equipment, although it has been wekk looked after, owing to lack of spare parts, discontinuation of the model, etc.) This is why it is recommended that only equipment which will be intensively used is acquired. In this connection, the paramount rule which experience increasingly endorses is : 'Buy a small amount of equipment and use it to the best of its capacity'.

Assessment of unit costs will take annualization into consideration in order that the cost of the premises and of the equipment with a serviceable life of more than one year, can be divided into annual portions. It is also necessary to choose the most appropriate rate.

Finally, it is in the 'investment costs' column that the acquisition of programmes or materials (films, transparencies, etc.) for the media library of an establishment, must be entered.

III - OPERATING COSTS

They incorporate all the annual costs related to **wages** of any specialist staff, all payroll and other taxes included, **maintenance** expenses which account for 5 to 7 per cent of the start-up expenses incurred for the acquisition of equipment, each year and all expenses related to the **programmes or materials** produced inside the establishment.

IV - SUMMARY

ACTIVITY CONCERNED :

NUMBER OF STUDENTS/HOUR PER YEAR : [x]

INTEREST RATE : percentage chosen for investments.

PREMISES : ANNUAL AMOUNT x % interest

EQUIPMENT : ANNUAL AMOUNT x % interest

EXISTING DOCUMENTS : ANNUAL AMOUNT x % interest

MAINTENANCE : _____

WAGES OF THE STAFF : _____

SUPPLIES, ELECTRICITY, etc.
(All materials used for making the software or the buying-in costs of commercially-produced software) : _____

TOTAL COST [xx]

COST PER STUDENT AND PER HOUR : $\frac{\text{xx}}{\text{x}} = \square$

Conclusion

Over the past decades, the use of media by educational or training institutions has, on many occasions, come to a premature halt through lack of any strict definition of the educational goals, or of the proper allocation of the equipment to the uses envisaged or of a satisfactory rate of utilization.

Thus, investments made in precious educational and material resources did not produce the desired results. It does not follow that the policy of using media for educational purposes must be abandoned. Recourse to these modern educational methods is generally justified since their purpose is to improve practical pedagogy, to modernize the school system and to increase the efficiency of the educational process. But it is essential that the proper decision-making process is rigorously applied to obviate the practice of acquiring equipment or materials on the basis of individual or momentary preferences and of investing capital in a haphazard manner. In the field of education, nothing can justify a waste of resources.

Whatever their functions, teachers, heads of establishments, inspectors, directors or governing bodies, indeed all decision-makers must ask the following question before recommending the use of any particular equipment, or making any capital investment or sponsoring any project based on the utilization of media: Is it the best possible way of using these resources?

Their decision must also take into account the fact that the extra cost imposed by the use of media varies in a wide band and ranges from 0.5 per cent to over one-third of the cost of so-called traditional education. Therefore, this cost must be considered in comparison with other measures taken to improve the educational system (such as the reduction of the number of students in a class by one percentage point, which increases the cost of education by 2.5 to 3 per cent).

When making a decision, it will be wise to tackle the delicate problem of technological transfer and, more particularly, the transfer of a few fairly expensive advanced techniques, and to give some thought to the possibilities for using alternative media the pedagogical impact of which would not normally be regarded very highly.

The conclusions reached in the present guide as to the possibility of choosing one medium rather than another, or one planning mode instead of another, should also be relatively considered for they are geared to a specific context with a special price structure, available resources and specific goals. As we stressed earlier, the reference context is that of France in the early 1980s.

This is why this work is above all a guide towards a methodological and transfer effort. In the field of media, there are no universal conclusions or recommendations, apart perhaps from those which relate exclusively to methodology.

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