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A COST ANALYSIS OF INSTRUCTIONAL TELEVISION IN THE IVORY COAST

by

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SUMMARY

In an effort to improve the quality and relevance of primary schooling, the Ivory Coast has initiated an extensive educational reform which involves heavy reliance on a system of instructional television (ITV) and a substantial effort to improve the training of classroom teachers. This paper provides a detailed cost analysis of the ITV component of the Ivorian educational reform in a format designed to be as comparable as possible with cost case studies of other ITV projects examined by the authors and reported in Jamison, Klees, and Wells (1976). The data on which this study is based were gathered in the Ivory Coast by the authors in 1973 and has been discussed, in a different form, in Klees and Jamison (1973).

The Ivorian ITV system began broadcasting to the first grade of primary school in 1971, has extended coverage by one grade in each subsequent school year, and in the Fall of 1976 will begin its first year of full six grade coverage. The system is expanding geographically as well; in 1971 the system reached 21,000 students, next year it will reach approximately 400,000 students, and by 1980 plans call for all schools in the nation to utilize the ITV system with a project enrollment of almost 700,000 students. ITV programs are no longer than ten minutes each, and plans call for each grade to view a little more than one hour per day, yielding a total of about 190 hours of programming viewed annually per student. Given the lack of electrification in most regions in the Ivory Coast, about 85% of the classroom television receivers operate on battery power. Additionally, there is a large effort devoted to the production of printed materials for the teachers and students, keyed directly to the curricular materials presented in the ITV programs (the production and distribution of these printed support materials are considered in this report as a part

of the ITV component of the Ivorian educational reform and their costs are included in the analysis).

Year-by-year expenditures on the ITV system are projected to 1991 in the text. Total expenditures in the 1976 calendar year will run about ten million U.S. dollars (all cost figures given are in 1972 U.S. dollars), increasing to about $15 million by 1991. The costs of receiving the programs (television equipment in the classroom) and producing and distributing the printed support materials make up the largest part of these expenditures, forming about 80% of total system costs in 1980. There is a substantial amount of international aid directed toward the project, most notably from France (although Canada, the United Nations, the World Bank, the United States, Belgium, and Germany all play a part, the latter three concerned only with system evaluation); consequently in 1976 the Ivorian government only paid a little more than half of the project costs, although this percentage will increase rapidly and by 1981 the Ivory Coast is expected to assume complete system financing.

On a unit cost basis, the Ivorian ITV system costs fall to a reasonable level in comparison with other ITV projects; the average cost per student over a projected 20 year ITV system life (utilizing the AC_{ij} concept discussed in the text) is $20 annually. Excluding the costs of printed support materials reduces this figure to $15.50/student/year to supply the production, transmission, and reception components of an ITV system. Most existing ITV systems have higher unit costs (see Table 13 in the text for an international comparison), due primarily to lower student enrollments.

In total cost terms, however, the Ivorian system is perhaps the most expensive of any reasonably similar effort. Part of this is due to relatively high production costs, but much more important factors (ignoring the expense of printed support materials) are the high costs of reception system power (batteries

are an expensive way to power a television, about 35 times more costly than mainline current in the Ivory Coast) and maintenance. Both of these latter conditions are in large part consequences of the present state of economic development in the Ivory Coast, reflected in the lack of electrical power in most locales and the lack of easy access to most locales. Nonetheless, again we should point out that given the extensive actual and projected system utilization of the system, unit costs fall to a comparatively low level; with 1980 utilization projected at 654,400 students and 193 hours of programming/student, the annual cost per student per hour of ITV is only $.066 (again excluding the costs of printed support materials).

A final point examined in this study is the magnitude of the difference between costs estimated in the planning stage of a project versus those actually incurred once the project begins operations. It is unusual to find reported detailed cost analyses undertaken prior to the initiation of an instructional technology system; the Ivory Coast system, however, is an exception in that Ivorian and French educational planners paid careful attention to developing estimates of future system costs during the project planning stage. Cost projections made by Dr. Chau of UNESCO's International Institute of Educational Planning in 1970 were compared with those made in this report based on three years of actual system operation. This study indicates costs to be 70% higher than that estimated by the planning study. (This is not in any way meant as a criticism of Dr. Chau and his associates, but serves to point out the many potential sources of error in cost analysis, especially in the project planning stage.)

This case study provides what is perhaps the most detailed cost analysis available for an on-going instructional technology project. At this time we do not have any sound basis for evaluating the pedagogical, social, or economic

worth of the investment in the Ivorian educational reform, but it is hoped that future evaluations will provide information in this regard.

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INTRODUCTION

In recent years the Ivory Coast has been facing an increasingly serious set of problems associated with the provision of primary school education: first, only a small percentage (about 55%) of the relevant age group population is enrolled in primary school; second, the efficiency with which students pass through the school system is low due to high repetition rates, and to a lesser extent, high drop-out rates; and third, the primary schools seem to be encouraging unwanted rural-urban migration. In response to these and other concerns the Ivory Coast is in the process of introducing a substantial educational reform, which includes the introduction of one of the largest scale ITV systems of its kind to carry a significant portion of primary school instruction, plans to utilize the ITV system for informal post-primary and adult education, and a large effort to up-grade primary school teacher qualifications through the use of new teacher training programs and institutions, as well as with in-service ITV training.

In this report we will examine only that portion of the educational reform dealing with the introduction of instructional television in the primary school system; the increasing of teacher qualifications and the use of ITV for informal education, which is just beginning, will not be discussed.[1] The authors had an opportunity to study the costs of the primary school ITV operation in 1973, about a year and a half after broadcasts had begun, and due to the

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[1] This paper represents a revision of the work reported by Klees and Jamison (1973) and is designed to serve as a base on which to build future cost and cost-effectiveness evaluations of ITV in the Ivory Coast; the concepts and format of this report have been developed so as to parallel that presented in Jamison, Klees, and Wells (1976). This latter work looks at cost analysis in general, applies such analysis to instructional radio and television systems, and includes seven detailed case studies of such systems. The interested reader is referred to this work for data on other projects and a more extensive discussion of cost analysis and its concepts. Appendix A contains a list of the acronyms used in this paper. The 1973 official exchange rate was utilized to convert CFA francs to US dollars: 1 CFA = $.00405.

excellent availability of data one of the most detailed cost estimations available for an ITV project was made. The information in this chapter is mainly taken from that study, the results of which are reported in Klees and Jamison (1973). Furthermore, this project is perhaps the only one of its kind that underwent a quite detailed analysis of costs in the planning stage, prior to project initiation, as reported in Châu (1972c) and so we will be also able to examine the discrepancy between planned and actual costs.

In what follows Section 1 will give an overview of the system--its organization, technical characteristics, and the extent of its utilization (no studies of system effectiveness are yet available); Section 2 will present and analyze system costs; Section 3 will compare the projected costs made in the planning stages by Châu (1972c) with those presented in the previous section; Section 4 will examine the marginal costs of system expansion; Section 5 will discuss system financing; and Section 6 will summarize and conclude.

1. THE SYSTEM

Organization and Technical Characteristics

In the autumn of 1971 the instructional television system of the Ivory Coast began its first broadcasts to primary school students. Those students were in their first year of primary school; over a six year period broadcasts will be expanded to cover all six grades. Planning for the educational reform and its ITV component began, of course, much earlier, and a series of planning documents were completed that spelled out precise plans for the implementation of the reform (see SEEPTE, B, 1968).

In many respects the Ivorian educational reform represents an international effort; although plans call for the Ivory Coast to assume complete control and financial responsibility for the project by 1980, at present substantial aid is received from foreign sources. The French government played a substantive role in initiating the reform and at present subsidizes a large portion of the ITV components of the reform. The Canadian government is also supplying aid, primarily in the form of technical expertise, equipment, and operations expenses for the production of printed support materials. Various United Nations agencies are contributing to the teacher training component of the reform. The World Bank is supplying funds for several planning and evaluation activities, as well as financing about 50% of the costs of the new ITV complex. Finally, other nations, including Belgium, Italy, the United States, and West Germany, are providing small contributions, mainly directed toward system evaluation. (Section 5 will detail the financing shares from these various sources.)

The primary school reform, along with its associated ITV component, was put under the central administrative control of a newly formed subdivision of the Ministry of Education, the Secretary of State for Primary

Education and Educational Television, located in Abidjan. In essence this has placed the ITV reform directly under the supervision of those in charge of primary school education, a step that will hopefully avoid any intergovernmental rivalries that are often found when such a procedure is not followed. Early in 1976 this Secretariat was promoted to the status of a Ministry, giving even more weight to this ITV reform of primary education.

Television program production is located in an ITV complex in Bouake; when Klees and Jamison (1973) undertook their analysis, construction was just beginning on a new ITV/teacher training complex to which all production activities will be transferred upon completion. ITV programs have been mostly film based, as opposed to videotape based, due primarily to the French government's purchase of film production equipment. The ITV complex contains a large film editing division and also has the capabilities to produce technically sophisticated animations.

The television programs are transmitted over the one and only television channel that the country has; prior to the initiation of the ITV system, television programs were only broadcast for an hour at mid-day and in the evening and the ITV system is planned so as to rely on the transmission system's excess capacity. Existing facilities will only reach two-thirds of the nation's population but plans are being made to extend the coverage via the construction of more microwave links.

One of the main problems in developing the ITV system was how to handle the large regions in the country that did not have electricity to operate the television receivers (about 85% of the schools are in such areas). The decision was made to utilize battery power and thus each school using television in a non-electrified area has at least one set of thirty-two, 1.45 volt battery elements, hooked in series, capable of running a television receiver. Present plans are to equip each six classroom school with six televisions and two sets

of batteries; each three classroom school (two grades to a classroom--this is quite common in the Ivory Coast) would be equipped with three television receivers and one set of batteries.[2]

Finally, it should be noted that part of the primary school reform involved a substantial increase in the quantity and quality of printed material that the student receives. Printed support materials are usually in the form of workbooks keyed to the ITV lessons; this component of the reform will be considered as part of the introduction of ITV and will be costed in Section 2.

Utilization

In terms of student utilization the Ivorian ITV system will soon be one of the largest of such systems in the world. Student enrollment projections are given in Table 1 for both the academic and the calendar year; the calendar year conversion was made since cost data was available on that basis. It is planned to phase out traditional primary school education and to have all primary school classrooms equipped with television by the 1980/1981 academic year. The calculations reported in Table 1 assume the continuation of the observed 5% grade to grade drop-out rate, although the repetition rate is assumed to be zero since the ITV system has adopted a policy of automatic promotion (thus essentially eliminating by fiat a problem that the reform was intended to correct).

Instructional television program production is planned so that about one

[2] Jamison and Klees (1973) also examined the costs of equipping the six classroom schools with only three televisions and one set of batteries, which would entail the daily moving of students or televisions in order to view the broadcasts. Although the Ivorian government has decided to reject this alternative it is interesting to note that adoption of such a policy would have reduced per student costs by about 10%, saving on the average $1.2 million per year.

TABLE 1

ITV System Student Utilization[a]
(thousands of students)

Year	Academic Year Enrollment[b]	Calendar Year Enrollment[c]
1970		
1971	21.0	7.0
1972	61.9	34.6
1973	121.8	81.9
1974	199.7	147.8
1975	294.7	231.3
1976	395.0	328.2
1977	484.9	424.9
1978	564.7	511.5
1979	635.2	588.2
1980	692.8	654.4
1981	739.0	708.2
1982	783.4	753.8
1983	825.4	797.4
1984	865.9	838.9
1985	905.9	879.3
1986	947.7	919.8
1987	991.2	962.2
1988	1036.2	1006.2
1989	1084.7	1052.4
1990	1135.3	1101.5
1991	1187.9	1152.9

See footnotes on next page.

Footnotes to Table 1

[a]Enrollment in the ITV system for CP1 from 1971/72 to 1979/80 is taken from SEEPTE (A, 1972, Document #1). Enrollment in CP1 for 1979/80 to 1991/92 is projected in Châu (1972, A), following his middle growth hypothesis. From SEEPTE (E, 1972) it was found that the average grade to grade drop-out rate for the 1969/70 to 1970/71 (before ITV) was about 5%. In projecting total student enrollment this drop-out rate is assumed to stay constant through 1991/92. The repetition rate is assumed to be zero due to the ITV system adoption of automatic promotion.

[b]Academic year enrollment represents student enrollment in the academic year beginning in the year shown on the table.

[c]Calendar year enrollment was calculated for any listed year by summing 1/3 of the same listed year's academic year enrollment and 2/3 of the academic year enrollment for the previous listed year (e.g. calendar year enrollment for 1972 = 1/3 x academic year 1972/73 enrollment + 2/3 x academic year 1971/72 enrollment.

hour per day per grade will be shown five days a week for the 33 week school year, building up to 1.17 hours per day per grade (35 hours of programming per week) after the six grades are fully covered. This results in a student annually viewing 165 hours of programming initially, or 193 hours of programming after the system reaches its intended terminal capacity.

2. SYSTEM COSTS

Year by Year Costs

This sub-section presents detailed cost tableaux for each of the administrative, program production, transmission, reception, and printed support materials components of the ITV aspect of the Ivorian primary education reform. The general aspects relevant to each particular cost component will be discussed under the respective sub-headings; for detailed information regarding the precise assumptions on which the cost information was calculated the reader is referred to the appropriate table footnotes.

Several general assumptions were made in the cost calculations. First, all costs for ITV system equipment were based on prices that excluded Ivorian import taxes. Such import taxes can be realistically viewed as an internal transfer of funds, within the Ivorian Government, and as such is not a real cost incurred by the Ivory Coast for the ITV system, although the expenditures do come from the budget of the Ministry of Education. Second, we have assumed that foreign aid, in its varied forms, will be continued until about 1979/1980, after which the Ivory Coast will assume total ITV system responsibility. Third, throughout this section salaries are assumed to remain constant in real terms unless special circumstances dictated otherwise (deviations from this constant salary hypothesis will be noted in table footnotes when they occur). Fourth, all cost data is presented by calendar year although a few documents list items by academic year. In this latter case, reasonable assumptions have been made to determine in what calendar year any expenditure item is incurred (e.g., television receivers needed for any academic year are probably purchased in the calendar year in which that particular academic year begins). Finally, all cost data were converted to 1972 U.S. dollars, in order to make the results comparable to those reported for other case studies in Jamison, Klees, and Wells (1976).

An overall time horizon of twenty years from initial student utilization of the ITV system (i.e., to 1991) is used as a maximum useful planning and forecasting horizon. The various component costs in any particular year are obviously not exact, but they do seem reasonably good indications of future costs based on what we know about the system at present and what we believe are reasonable assumptions as to the direction of its future growth. In some cases, sub-component costs have been broken out somewhat arbitrarily because of lack of good information, but overall the cost figures given seem reliable and consistent with past and present experience.

Administration. The costs of ITV system central administration are given in Table 2. Most of the overall system administration is situated in Abidjan; the administration of the ITV program production complex in Bouake is not included here, but is considered in the following subsection. The costs of direct central ITV system administration by personnel at the Ministry of Education in Abidjan is not included due to the unavailability of data. This is unfortunate, but it is probably not of great significance when looking at the total system costs (administrative costs are generally a small percentage of total system costs for a large technology system such as this).

Program production. The costs of the various sub-components of the ITV program production system are detailed in Table 3. It should be emphasized again that these costs include only those costs associated with the production of educational television system programs. The costs of teacher training in any of its forms--ENI, CAFOP, or in-service--are not included.

Generally it is assumed that program production will follow the plans described in SEEPTE (B, 1968, Volume I)--about one hour per day per grade will be shown five days a week for the 33 week school year, building up to 1.17

TABLE 2

Costs of ITV System Central Administration[a]
(thousands of dollars)

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Administrative Personnel																							
Foreign[b]		63	67	65	65	65	65	65	65	65	65	65											
Foreign Lodging[c]		14	17	16	16	16	16	16	16	16	16	16											
Evaluation Unit[d]			136	158	183	213	239	238	243	247	252	257	172	175	179	182	186	190	193	197	201	205	209
Information Processing Unit[e]																							
Personnel[e]					40	43	45	45	45	47	47	48	32	33	34	34	35	36	36	37	38	38	39
Equipment[f]					13	0	4								-13	0	4						
Operations[h]					9	13	17	17	17	17	18	18	19	19	19	19	20	20	21	21	21	22	22
Studies[i]																							
Management	36	35	122	32																			
Pedagogical	143	138		25	60																		
Total costs	180	250	342	295	385	350	386	380	386	392	399	405	222	226	244	236	245	245	250	255	260	265	271

See footnotes on next page.

Footnotes to Table 2

[a]Due to the unavailability of data, this table does not include the costs of central ITV project administration by Ivorian personnel at the Ministry of Education in Abidjan. Administration costs of the program production system at the ITV complex in Bouake is included under the cost of ITV program production in Table 3.

[b]Only personnel associated with the French aid mission are included in this item. These costs are found in SINCRO (1972, Vol. III). Although UNESCO personnel do have some responsibility related to the overall ITV project, most of UNESCO's effort is directed toward teacher training which is not costed in this report.

[c]Lodging costs for foreign personnel are generally assumed by the Ivory Coast. A cost of $4050 per foreign expert per year is assumed.

[d]This item is based on projections made by M. Marchl, Coordinator of the Evaluation Unit, for the years 1973-1976. Costs were projected backwards for 1971 and 1972 assuming a 14% per year increase in costs for this period. Costs after 1976 were assumed to increase by 2% annually. Foreign aid for evaluation is assumed to end in 1980, so that 1981 costs are assumed to drop to 2/3 of the 1980 level (this does not necessarily imply a decrease in services, being due mainly to the salary differential between national and foreign personnel).

[e]The costs of the Information Processing Unit are based on the projections for 1973-1976 made by M. Dekens in SEEPTE (A, 1972, Document #20). Thirty percent of the total costs of each of the cost categories for this unit are included here as allocated to the ITV project (in accordance with the estimate made by M. Dekens).

[f]Equipment for this unit is assumed to have a ten-year life.

[g]Personnel costs for 1973-1976 include 30% of those estimated by M. Dekens augmented by the assumption of 30% of two foreign personnel and the costs of their lodging. After 1976 costs increase at 2% per year. In 1981 costs fall by 1/3 under the assumption that foreign personnel withdraw from the project.

[h]After 1976 operations costs are assumed to increase at 2% per year.

[i]The costs of various project studies are found in SINCRO (1972, Vol. III). Management studies consist of those done by SINCRO and pedagogical studies consist of those done by FAC.

TABLE 3

Costs of ITV Program Production
(thousands of 1972 US dollars)

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Administrative Personnel[a]																							
Ivorian		11	11	11	12	12	12	12	12	12	12	16	16	16	16	16	16	16	16	16	16	16	16
Foreign				11	26	26	26	26	26	26	26	26											
Foreign Lodging				7	16	16	16	16	16	16	16	16											
Operations																							
Personnel:[b]																							
Ivorian		71	136	160	156	168	182	188	220	293	287	290	290	290	290	290	290	290	290	290	290	290	290
Foreign		158	501	713	775	874	940	927	770	652	300												
Foreign Lodging		65	134	200	221	244	262	259	215	182	84												
Expenses[c]		107	264	416	438	483	528	337	281	247	225	213	202	202	202	202	202	202	202	202	202	202	202
Buildings Construction[d]	137	175	41	190	39																		
Equipment		123	667	448	825							123	667	448								123	667
Maintenance[f]																							
Personnel:[g]																							
Ivorian					8	8	8	8	8	16	24	24	24	24	24	24	24	24	24	24	24	24	24
Foreign					94	94	94	94	94	94	94												
Foreign Lodging					16	16	16	16	16	16	16												
Expenses[h]					83	122	142	162	173	196	215	237	61	67	74	81	89	98	108	119	130	143	61
Total Costs	137	709	1754	2155	2709	2064	2227	2045	1837	1750	1300	946	1260	1047	606	613	621	630	640	651	663	793	1260

See footnotes on next page.

Footnotes to Table 3

[a]The source of administrative costs for the ITV project through 1973 is SINCRO (1972, Vol. III), which, in this case, only indicated costs for the ITV complex as a whole, thus including the costs of the ENI and CAFOP teacher training centers. It was assumed that 45% of these total costs should be allocated to the ITV project, the 45% figure being derived from an analysis of the relative size of 1973 budget items for ENI, CAFOP and ITV production. Foreign administrative aid personnel are assumed to withdraw in 1980 (one year after the withdrawal of foreign technical assistance). Due to this withdrawal, the Ivorian personnel costs are assumed to increase by 1/3 in 1980. No estimate was available for recurrent administrative expenses, however, much of this is probably included in the budget for operations expenses given below.

[b]Operations personnel costs are based on SINCRO [1972, Vol. III] and SEEPTE (B, 1968, Vol. I). Salary costs are assumed to remain at their 1972 level, in real terms (except for Ivorian personnel for 1975-1980 where a 2% per year increase is assumed to cover the cost of better qualified personnel prior to the withdrawal of foreign aid), and the number of personnel assigned to each year is 90% of the planning figures given in SEEPTE (B, 1968, Vol. I), (10% are assumed to work on in-service teacher training). Foreign technical assistance is assumed to end in 1979. Maintenance personnel are included here through 1972, and listed separately below for 1973 and beyond.

[c]Through 1973 operating expenses are assumed to equal 90% of the operations budget (10% goes towards salary expenses above). After 1973 changes in expenses are assumed proportional to changes in the number of hours to be produced annually as estimated in SEEPTE (B, 1968, Vol. I).

[d]The cost of buildings construction (administrative, studios, etc.) is from the SINCRO (1972, Vol. III) and is assumed to have a twenty-five-year life.

[e]The cost of studio and other production equipment is from SINCRO (1972, Vol. III). Production equipment is assumed to have a ten-year life. However, by 1980, due to the planned reduction in program output (about 15% of programs for each grade level being re-taped annually) there should be a need for only two studios. Therefore, the 1973 expenditures for equipping the third and fourth studios are assumed not to be replaced. It is possible that the studios could be re-equipped for other production purposes (e.g. secondary school or out-of-school program production) but then costs should not be allocated to this particular project. The $122.7 thousand expenditure in 1971 is to equip a studio-school (at Ivorian Radio-Television) used to assist in the training of Ivorian production personnel. Other costs for the training school were not available.

[f]The costs of Ivorian maintenance personnel are assumed to increase by 100% in 1978 and 50% in 1979 to make up for foreign personnel withdrawal in 1979.

[g]Production equipment maintenance costs for 1973-1976 are estimated in SEEPTE (C, 1972).

[h]Maintenance expenses (spare parts for repairs mainly) are assumed to increase at 10% per year after 1976. After 1980 they fall to their approximate early 1970's level due to the replacement of studio equipment (this is repeated again after 1990).

hours per day per grade (35 hours of programming per week) after the six grades are fully covered. Programs are assumed to be revised annually in accord with the SEEPTE planning document, beginning with 40% in their second year and decreasing gradually to 15% in their seventh year and thereafter. Program production appeared somewhat behind the intended schedule, but present broadcast schedules indicate that at least the initial program production goal will be reached this year (program revision may proceed more slowly than planned, but our cost estimates are not overly sensitive to this factor).

The decision has been made to go ahead with plans to build the new ITV complex in Bouake. The costs of the new complex are presented in Table 4. Again, these are only the costs of the ITV program production part of the complex, assumed to be 50% of the total complex costs (based on construction cost estimates in World Bank, 1969). In general, it seems that the costs of building the complex are strictly an add-on to total system costs.

Transmission. The additional costs to the Ivorian television signal transmission system due to the ITV system are estimated in Table 5. This includes the cost of existing capital equipment through allocation of depreciation based on the number of ITV broadcast hours. However, not included are the proposed capital (and therefore operating) expenditures of the planned extension of the ITV system into the southwest of the country, nor the expenses to be incurred through proposed plans to better the existing transmission system through replacement of certain transmitters and repeaters and through the construction of more microwave links.[3] The impetus for most of the expenditures above are directly attributable to the existence of the ITV system (although they may

[3] As estimated by CATEL (1972), about 8% of the new ITV schools began for the 1972/73 academic year had poor signal reception.

TABLE 4

Costs of the Proposed New ITV Complex[a]
(thousands of 1972 US dollars)

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Administration[b]				16	16	16	16	16															
Planning Studies[c]		58	45	76	12																		
Land[d]			158																				
Construction					162	984	446																
Total Costs		58	203	92	190	1000	462	16															

See footnotes on next page.

Footnotes to Table 4

[a]The costs indicated on this table only include the part of the complex devoted to the educational television system, excluding that part reserved for ENI and CAFOP. Based on the relative costs of construction of the three parts of the complex (Source: World Bank (1969)) the ITV part of the complex is assumed to account for 50% of total costs. This assumption has been made in determining the costs below.

[b]The SINCRO (1972, Vol. III) estimates administration costs through 1973. They are assumed to continue through 1976, one year after the proposed completion of the project.

[c]Planning costs are given in SINCRO (1972, Vol. III).

[d]The cost of the land for the project are found in SEEPTE (C, undated).

[e]Planned construction costs (including building furniture) are taken from Ministere du Plan (1973). These are in general agreement with the revised estimates made by the World Bank, although the figures given in the table may be somewhat conservative (recent indications are that the actual construction costs may run as much as 10% higher than shown here).

TABLE 5

Costs of ITV System Transmission[a]
(thousands of 1972 US dollars)

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Personnel[b]			47	142	142	142	153	164	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
Equipment[c]			49	147	147	162	176	191	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206
Power[d]			10	29	29	32	35	38	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
Total Costs			106	318	318	336	364	392	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421

See footnotes on next page.

Footnotes to Table 5

[a]The basic cost data for this table comes from SEEPTE (A, 1972, Document #10), which looks at diffusion costs for the ITV system under the assumption of 6-1/2 hours of broadcast per day for 290 days per year. The number of broadcast hours were varied as described in the footnotes below to make the costs more realistically in line with actual and planned ITV system expansion. The figure of 290 days per year was utilized, although, to the authors, it would appear to be an overestimate of system utilization (the rationale for the use of the 290 days per year figure was not contained in the SEEPTE document) as schools are in session about 33 weeks per year. For 1971 one third of the 290 day figure was used as the basis for cost calculations below.

[b]Through 1974 personnel costs were estimated under the 6-1/2 hours per day assumption, becoming 7 hours in 1975, 7-1/2 hours in 1976 and 8 hours in 1977 and subsequent years. This is based on the broadcast utilization time schedule described below and the additional assumption that personnel will be needed for at least one hour per day more than the number of hours of broadcast per day

[c]Equipment utilization costs are based on the hypothesized broadcast hours schedule of 5 hours per day until 1973, 5-1/2 hours in 1974, 6 hours in 1975, 6-1/2 hours in 1976 and 7 hours per day in 1977 and subsequent years.

[d]Costs for power are estimated under the broadcast hours schedule described above.

have been done eventually anyway) and clearly some share of their cost should be allocated to the ITV system. Furthermore, the ITV system in the future will for all practical purposes saturate the Ivory Coast's existing one television channel transmission capabilities and already there has been some speculation of creating a second channel. A rough cost estimate of 8.1 million dollars for the installation of a second channel capability were made in SEEPTE (A, 1972, Document #10). Again, a case may be made to charge a portion of this cost to the existence of the educational television system.

Reception. The decision has been made that there will be one television receiver for each classroom and one battery (where mainline current is not available--about 85% of the schools) for every three televisions. This means each six classroom school will have six televisions and two batteries and each three classroom (two grades to a classroom) school will have three televisions and one battery. The costs of system reception are presented in Table 6.

There are a few points that should be noted with regard to the costs of the reception system in general. In an educational technology system reception costs (including printed support materials) are usually the dominant costs of the system; this is only reasonable considering that most other cost components are relatively fixed in a mature system while reception costs vary almost directly with additional student usage. This is the case in the Ivorian ITV system--in the next few years annual reception costs amount to about 40% of annual total costs growing to about 60% in 1991 (see Table 8). Therefore, if there is concern with the costliness of the system, as there appears to be in the Ivory Coast, the preferable area in which to try to reduce costs would be within the reception system.

The initial purchase and replacement of television receivers and batteries

TABLE 6

Costs of ITV System Reception[a]
(thousands of 1972 US dollars)

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Reception Equipment																							
Initial Installation:																							
Television Receivers[b]			416	344	719	425	880	765	714	664	623	372	355	369	338	320	346	336	356	388	403	422	433
Stands for Receivers[c]			80	96	122	167	225	195	182	170	159	95	91	94	86	82	83	86	91	99	103	108	111
Antennas and Masts[d]			185	185	200	338	354	262	215	174	174	104	122	139	122	139	157	139	157	174	174	192	192
Miscellaneous[e]			24	21	37	30	49	41	37	34	32	19	19	20	18	18	20	19	21	23	23	25	25
Replacement:																							
TV Receivers - Due to Theft[f]						30	38	56	71	85	98	111	118	126	133	140	146	153	160	166	175	183	191
TV Receivers - Due to Lifetime[g]								416	344	719	435	918	1236	1128	1469	1177	1401	1710	1622	1940	1636	1893	2198
Antennas and Masts[h]													185	185	200	338	354	262	215	174	174	104	307
Power Source																							
Battery:																							
Initial Installation[i]			200	212	281	470	495	358	294	252	196	131	147	164	134	154	174	154	174	194	190	210	213
Replacement[j]						200	828	829	1008	1156	1282	1380	1446	1520	1601	1669	1746	1833	1910	1997	2093	2188	2293
Mainline Current Consumption[k]						1	2	3	4	5	6	7	7	8	9	9	10	10	11	11	12	13	13
Maintenance																							
Equipment[l]		9	80	144	185	193	219	231	245	260	275	292	301	310	319	329	339	349	359	370	381	392	404
Services[m]			480	960	1234	1287	1458	1542	1633	1733	1837	1947	2006	2066	2127	2191	2257	2325	2394	2466	2540	2617	2695
Total Costs		9	1463	1952	2779	3142	4548	4697	4751	5252	5138	5376	6033	6128	6557	6566	7037	7374	7469	8002	7903	8345	9075

See footnotes on next page.

Footnotes to Table 6

[a]Reception costs in this table are based on the assumption that installation will proceed until all six classroom schools have 6 television receivers and 2 batteries (excepting those with access to mainline current of course) and all three classroom schools have 3 television receivers and 1 battery. The installation implementation schedule that is assumed below is based on actual implementation for 1971 and 1972 (and in some cases, such as purchase of receivers, for 1973) and the planned implementation schedule for 1973 through 1979 described in SEEPTE (A, 1972, Document #1). After 1979, the implementation schedule is based on the student enrollment middle growth hypothesis given in Châu (1972, A) and the assumption that 2/3 of the new students added to the system enter six classroom schools and 1/3 enter three classroom schools (this same assumption was made in the planned implementation schedule for 1976 through 1979). Cost data and historical and future (through 1977) needs for reception components were found in SEEPTE (A, 1972, Document #13) unless otherwise indicated.

[b]The costs of receivers are projected according to the assumptions above at the 1972 cost per receiver of $313.

[c]After 1973 it is assumed that one stand is required for each television receiver, at a price of $80 per stand.

[d]Historical and future needs (through 1977) for antenna and masts appeared to equal about 1.5 times the number of schools equipped with ITV. (The need for more than one antenna per school may be caused by the physical separation of classrooms within some of the schools.) This assumption was used to project antenna and mast requirements at a price of $324 for each antenna and mast.

[e]Costs of miscellaneous equipment (commutators, cable, etc.) are estimated at 4% of the cost of initial receiver, antenna, and mast requirements in any particular year.

[f]The theft of television receivers from the classroom has been a problem: the figures presented to the authors by M. Poli indicated 3% of the receiver stock has been stolen each year of the project so far. The projections made here rest on a more conservative assumption of 2% of the receiver stock each year being stolen, the lower rate hopefully resulting from greater security precautions. Through 1973 the cost of replacing the receivers stolen is included in the initial installation costs of television receivers.

[g]Television receivers are assumed to have a life of five years.

[h]Antennas and masts are assumed to have a life of 10 years.

[i]For the first year, 1971, the actual number of batteries installed are used to compute the cost. After 1971 it is assumed that the number of batteries installed in any given year is equal to 85% of the sum of the number of new CP1 and CE2 classes (85% of the number of new CP1/CP2 classes only, for three classroom schools) receiving television in the Fall of that year (15% of new ITV classrooms are assumed to have access to mainline electrical current). The price per set of batteries assumed is $509.

[j]Based on actual present and planned future classroom television utilization, it is assumed that for a three classroom school a battery will be used 10 hours per week the first year of operations, 20 hours per week the second, 25 the third, 30 the fourth and 35 for the fifth and subsequent years. For a six classroom school the hours per week of battery uses will be 10 the first year, 20 the second and 25 the third year and thereafter. The school year is assumed to be 33 weeks. Given a battery life of 2,000 hours, the above utilization schedule implies an average three-year life for batteries installed during the first two years of operations and an average two-year life for batteries (this latter life expectancy was translated into replacement costs by assuming 50% of the stock of batteries is replaced each year) installed in subsequent years. No allowance is made for the use of televisions and batteries for viewing non-ITV programs (see text for discussion of this point).

[k]It is assumed that 15% of the televisions installed operate off mainline electric current (the increased electrification of the country is counterbalanced in years to come by relative increases in future ITV installation in rural areas, forming the basis for the constant 15% assumption). Additionally assuming an average usage of 10 hours per week per television receiver operating on mainline current at a cost of $.008 per hour (Source: SEEPTE (E, 1972)) the costs shown here were calculated.

[l]The actual annual maintenance equipment costs for 1971 and 1972 are given here as reported in the SINCRO (1972, Vol. III). After 1972 maintenance equipment costs (including equipment replacement) are assumed to be 15% of maintenance service costs. These figures may be slightly conservative based on projections given in SEEPTE (A, 1972, Document #13), SEEPTE (C, 1972) and SEEPTE (E, 1972).

[m]Maintenance service costs represent actual costs of the contract with CATEL for 1971 and 1972 and CATEL's planned costs for 1973 through 1976. Costs from 1976 through 1980 are assumed to grow at 6% per year (the same rate as planned expenditure increases for maintenance services between 1975 and 1976), falling to 3% per year after 1980 as the rate of ITV system expansion drops considerably in that year.

form the major part of reception system costs amounting to about 50% to 55% of total reception system costs annually. Careful attention should be paid to cost reduction for these two reception component areas as they will obviously have the most impact on total system expenditures. Reducing the expenditures on television receivers may be difficult unless a receiver can be found that is less expensive than the CEF one currently used. However, less expensive does not refer only to initial purchase price, but must include that factor along with the lifetime of the receiver and the cost of receiver maintenance.

Reducing the expenditures on batteries is of even greater significance than the size of battery purchase and replacement costs on Table 6 might indicate. The battery costs on the tables do not include the cost of usage due to viewing of commercial broadcast programs during the evenings. If ITV in-service teacher training programs remain at their present level (about 6 hours/week of battery usage), they increase battery replacement costs by 20% annually. Evening viewing of commercial programs may have an even greater effect. Preliminary indications are that the batteries installed during the first year of the ITV system were used an average of 10 hours per week (on a 52 week per year basis) for non-ITV system usage (over and above in-service teacher training usage). If this level of utilization is maintained, outside viewing could add 45% annually to battery replacement costs. Of course, it must be remembered that this extra-curricular viewing is not without its benefits in terms of the social integration (through information provision and perhaps eventual non-formal evening educational programs) of the population as well as the pleasures of a new source of entertainment.

The costs of battery usage to the Ministry of Education are even more substantial than indicated as the battery price used in the cost calculations

did not include the rather large Ivorian import tax. To reduce the costs to the Ministry of Education it may be desirable to grant tax exempt status to equipment used for the ITV system. Another suggestion that has been made is for the Ivory Coast to manufacture the batteries themselves (see SEEPTE, A, 1972, Document #12) which at the very least would contribute to the national economy and might possibly result in a lower price. Another alternative that seems even more desirable (and has already been suggested and examined to some extent--see SEEPTE, E, 1972 and Societe Central des Inventions Pratiques, 1972) is to seriously look for an alternative less expensive power source. Electrification of the country, according to present plans, does not appear to be capable of making a substantial change in the need for local sources of autonomous power.

Printed support materials. The costs of printed support materials are presented in Table 7. The personnel component costs assume that course materials are fully developed and that initial substantial revisions are accomplished before the Canadian aid is withdrawn (with regular revision of perhaps 10-15% of the course materials occurring thereafter). If major course material redevelopment is needed or deemed desirable after this time personnel costs will be higher. The cost of printed support materials, like television reception system costs, varies with the number of students in the system and thus accounts for a reasonably large percentage of total system costs each year, the percentage growing larger as the system expands over time. Cost reduction efforts in this area, if desired, would best focus on the cost of paper and other material that vary directly with the quantity of printed material produced. Such efforts might simply take the form of looking for less expensive paper of acceptable quality. In addition, it probably would be

TABLE 7

Costs of ITV System Printed Support Materials
(thousands of 1972 US dollars)

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Production																							
Personnel:																							
Ivorian[a]			15	27	27	63	85	109	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Foreign[b]			253	464	628	808	840	689	504	263	175												
Foreign Lodging[c]			32	69	101	150	182	162	109	53	35												
Construction[d]			86																				
Equipment[e]			183	152	334	319							183	152	334	319							183
Operations:																							
Paper[f]			11	132	263	461	611	818	1005	1171	1317	1436	1532	1624	1712	1795	1878	1965	2055	2149	2249	2353	2463
Other Material[g]			1	11	21	37	49	66	81	94	105	115	123	130	137	144	150	157	164	172	180	188	197
External Printing[h]			41	41	81																		
Distribution[i]																							
Personnel			8	23	34	46	61	67	74	81	89	94	98	103	108	113	119	125	132	138	145	152	160
Equipment			20	60	88	126	179	197	217	239	263	276	290	304	319	335	352	370	388	407	428	449	472
Operations			21	64	20	41	77	60	66	72	79	83	87	92	96	101	106	111	117	123	129	136	142
Total Costs			669	1041	1597	2051	2085	2167	2200	2116	2208	2147	2456	2548	2850	2952	2749	2872	3000	3132	3274	3423	3760

See footnotes on next page.

Footnotes to Table 7

[a]The number and cost of Ivorian production (of printed materials) personnel for 1971-1973 is found in SEEPTE (D, undated) for 1971-1973. Projected personnel requirements through 1975 may be found in SEEPTE (A, 1972, Document #14). It is assumed that, given existing initial delays in the development of the training program for Ivorians, the 1975 projections (43 skilled technicians and 25 unskilled) are not fulfilled until 1977, with the number of Ivorian personnel growing at a constant rate during the 1973-1977 interim period. Skilled personnel are assumed to receive $2630 annually and unskilled $1215 annually. After 1977 the number of Ivorian production personnel is assumed to remain constant.

[b]The assumption is made that Canadian aid will be extended for four years (1975 through 1979), beyond the 1971 through 1975 existing commitment. Actual and projected aid for the 1971-1975 period in terms of foreign personnel was obtained in conversations with the Canadian coordinators of this project. Projected aid figures for 1975-1979 were made by the authors taking into consideration future project needs and a gradual withdrawal of personnel. For the 1971-1978 period it is assumed that the annual foreign personnel requirements for pedagogical experts are as follows: 8, 15, 20, 25, 25, 20, 15, 8. For the same period the requirements for foreign technicians are assumed to be as follows: 0, 2, 5, 12, 20, 20, 12, 5. It is assumed that the foreign personnel in 1978 stay on until the end of the 1978-1979 school year. Annual salaries for the former average $30,375 and for the latter $4,050.

[c]The costs of lodging foreign personnel is assumed to average $4,050 per year per person.

[d]Construction costs mainly represent the costs of the building in which the printed support materials project is housed as estimated in SINCRO (1972, Vol. III).

[e]Equipment costs were arrived at through discussions with the Canadian project coordinators. It is assumed that no additional equipment will be needed after 1974 and that the equipment has a ten-year life.

[f]From conversations with the Canadian project coordinators planned and actual requirements for paper were found for the 1971-1974 period. The 1972 cost of paper is $658 per metric ton. (Paper costs for any given academic year are assumed to be incurred in the calendar year in which that particular academic year begins.) Paper requirements are expected to be about 3 Kg. per student. Paper costs after 1974 are projected according to the above assumptions and projected student usage (see Section 2 on student utilization). Actually, the cost projections increased the student usage by 5% in each year to take into account some over-production due to uncertainty as to the exact number of students (the 5% figure may be somewhat conservative judging by 1971-1974 printed material production estimates).

[g]Other material consists mainly of ink and film/plates which are assumed to cost 8% of annual paper requirements.

[h]During the first three years of the project there was need for some external printing due to the delayed arrival of the printing presses and some initial difficulty in setting them up for operation. This is not expected to be a problem in future years.

[i]The costs of printed material distribution is somewhat uncertain judging by the various documents discussing the subject. The figures given here for 1971-1975 comes from SEEPTE (A, 1972, Document #14). They are projected assuming a 10% growth per year in distribution expenses from 1975 to 1979 and a 5% annual growth rate thereafter. This differential growth rate is intended to take into account the slower rate of ITV system expansion after 1980. (Equipment costs for 1971-1975 were linearly smoothed before projecting them to 1976 and subsequent years.)

worthwhile to consider the use of printed support materials with a lifetime longer than one year. Although the use of workbooks instead of textbooks (or instead, of a combination of textbooks and workbooks) might conceivably have some pedagogical advantages (although this point is not at all indicated by any empirical evidence), they may be outweighed by the additional costs of having to replace a workbook every year.

Summary. Table 8 summarizes the cost and utilization information thus far presented.

Annualized Cost Functions

Based on the information presented in the previous sub-section, we can derive an approximate annualized cost function for the instructional television component of the Ivorian educational reform, of the following form:

$$TC(N, h) = F + V_N N + V_h h, \qquad (1)$$

where TC = total system costs,

N = the number of students enrolled in the system,

h = the number of hours of programming broadcast,

F = fixed system costs,

V_N = variable cost per student,

and V_h = variable cost per hour.

The division of costs into fixed, variable per student, and variable per hour categories is difficult and at times arbitrary. The categorization depends to some extent on the question being asked: given a long enough time horizon, or given the desire to replicate elements of the Ivory Coast's ITV system in

TABLE 8

Total Cost and Utilization Summary of the Ivory Coast ITV System[a]
(thousands of 1972 US dollars)

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Central Administration	180	250	342	295	385	350	386	380	386	392	399	405	222	226	244	236	245	245	250	255	260	265	271
Program Production	137	709	1754	2155	2790	2964	2227	2045	1837	1770	1300	946	1250	1156	606	613	621	630	640	651	663	795	1260
New Complex		58	203	92	190	1000	462	16															
Transmission			106	318	318	336	364	392	421	421	421	421	421	421	421	421	421	421	421	421	421	421	421
Reception		9	1463	1952	2779	3142	4548	4697	4751	5252	5211	5376	6033	6128	6557	6566	7037	7374	7469	8002	7903	8345	9075
Printed Support Materials			669	1041	1557	2031	2085	2167	2200	2116	2208	2147	2456	25[illegible]	2850	2952	2749	2872	3000	3132	3274	3423	3760
Total Costs	317	1027	4456	5863	8019	8943	10071	9698	9594	9952	9538	9295	10393	10430	10677	10788	11074	11543	11780	12461	12521	13252	14787
Number of Students (in thousands)			7.0	34.6	81.9	147.8	231.3	328.2	424.9	511.5	588.2	654.4	708.2	753.8	797.4	838.4	879.3	923.8	962.2	1006.2	1052.4	1101.5	1152.9

See footnotes on next page.

Footnote to Table 8

[a]This table summarizes the utilization and component costs estimated in Tables 1 through 7.

other nations, most cost components will be variable, to some degree, with student enrollment or programming hours produced; on the other hand, in the short run, many more costs will be fixed. This problem is further complicated by the fact that there are more parameters that affect costs than N and h, and thus the equation above represents a substantial simplification of reality (for a more detailed analysis of cost functions and what system variables they may depend upon, see Jamison, Klees, and Wells, 1976). Nonetheless, these distinctions were made and the coefficients F, V_N, and V_h of the cost function are given by cost component in Table 9 for social rates of discount of 0%, 7.5%, and 15%.

Given the substantial foreign aid and technical assistance invested in the Ivory Coast project, most coefficient estimates were developed from the base recurrent costs of system operation at maturity in the 1980's. The foreign technical assistance (in the form of personnel) given was treated as a human capital investment and amortized over the hypothesized 25 year lifetime of the project.

Administration costs were assumed to be fixed, although for a substantially smaller project, it is likely that such expenses would be fewer. All program production and transmission costs are hypothesized to vary directly with the numbers of hours produced. The total production costs per hour of programming are $1287 when the future is nc discounted, $1889 at 7.5%, and $2648 at 15% (based on 1158 programming hours produced annually to cover all six grades).[4]

Reception costs are generally assumed to be variable with the number of students in the system, although a part of equipment maintenance costs are assumed to be fixed (since this linear formulation of maintenance costs gives a better fit to the projected cost data). Reception costs assume an average

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[4]Preliminary results from a study currently being completed on the Ivorian ITV program production system, Evans and Klees (1976), indicate that the costs of producing an hour of ITV are about five times those reported here, although when taking account of program life the costs are only 1 1/2 times those reported above. The primary source of the discrepancy is that the number of hours broadcast annually was utilized in this report, while Evans and Klees were able to obtain estimates of the number of hours produced annually.

TABLE 9

Annual Cost Function Coefficients for the Ivory Coast ITV System[a]
(fixed cost in thousands of 1972 US dollars; variable costs in 1972 US dollars)

Interest rate	0%			7.5%			15%		
		Variable			Variable			Variable	
	Fixed	Student	Hour	Fixed	Student	Hour	Fixed	Student	Hour
ADMINISTRATION	304.2			347.1			423.7		
PROGRAM PRODUCTION									
Personnel and Expenses			1093			1563			2156
Equipment			107			156			213
New Complex			88			171			280
TRANSMISSION			364			364			364
RECEPTION									
Televisions		1.701			2.102			2.541	
Antennas and stands		.329			.544			.808	
Power		1.859			2.069			2.285	
Maintenance	1348.7	1.414		1348.7	1.414		1348.7	1.414	
PRINTED MATERIALS									
Production personnel, construction & equipment	507.6			808.8			1191.4		
Paper and materials		2.239			2.239			2.239	
Distribution	223.8	.402		223.8	.402		223.8	.402	
TOTAL	2384.3	7.944	1652	2728.4	8.770	2254	3187.6	9.689	3013

See footnote on next page.

Footnote to Table 9

[a]The cost data in this table reflects the assumptions--as to costs, lifetime, etc.--detailed in the cost tables presented in the previous sub-section. Sometimes the separation of costs into fixed, variable by student, and variable by hour is difficult to make and some breakdowns may be somewhat arbitrary (depending sometimes on whether one is conceiving of the cost function for the Ivory Coast as operating, or as useful for other nations to plan, with the latter case assuming most costs are variable). Further, the base figures for deriving the cost function are the projected costs when the system reaches maturity, in the 1980's, after foreign technical assistance is projected to be withdrawn. Such aid is treated as a capital investment (in many instances, one of human capital) and is amortized over an assumed 25 year project life. All forms of capital are costed at discount rates of 0%, 7.5% and 15%; all costs are in annual terms.

Administration. The recurrent administrative expense averages $247.1 thousand. The average value of foreign administrative assistance, is $57.1 thousand at 0%; $100.0 thousand at 7.5%; and $176.6 thousand at 15%. It is assumed that administration costs are fixed, although given much smaller enrollments than the plans for the 1980's project, administration costs would probably be less than indicated here.

Program production. The recurrent costs of Ivorian personnel and production expenses is $637.5 thousand. The average value of foreign production assistance is $627.8 thousand at 0%; $1172.1 thousand at 7.5%; and $1859.4 thousand at 15%. Production equipment and the new ITV complex costs are annualized over a 10 year period and a 20 year period respectively. Each cost figure was divided by 1158 hours per year to yield average costs per programming hour produced.

Reception. All reception costs assume an average class size of 39 students. The cost of television, stands, and antennas (masts are included in this latter figure) include miscellaneous costs associated with installation as well as loss due to theft (for televisions). The power costs are based on the per student costs for batteries of $2.176 at 0%, $2,424 at 7.5%, and $2.676 at 15% where utilized and a recurrent cost of electricity of $.068 per student where used. The costs presented in the table reflect 85% of the battery cost plus 15% of the electricity costs as per the division between non-electrified and electrified areas. (In actuality the costs of receiver power should depend on h, as well as N, and the cost calculation therefore assumes an h = 193 hours/student/year.) Reception equipment maintenance costs were approximated by the linear expression = $1,348,000 + $1.414 X N.

Printed Materials. Production personnel, construction, and equipment costs consist of Ivorian personnel at a recurrent cost of $143.8 thousand and the amortized costs of foreign assistance, equipment, and construction, in thousands of dollars, respectively of 216.6, 98.8, 3.4 at 0%; 513.1, 144.2, and 7.7 at 7.5%; and 837.9, 196.4, and 13.3 at 15%. Production distribution expenses were approximated by the linear expression = $223,800 + $.402 X N.

class size of 39 students. Furthermore the costs of power reflect the existing 85%, 15% split between non electrified and electrified areas; in actuality (as presented in the table footnote) the costs of battery power per student average \$2.176 at 0%, \$2.424 at 7.5%, and \$2.676 at 15%, while the recurrent cost of electricity is only \$.068 per student (note that battery power is about 35 times as expensive as electrical power)—the cost of power presented in the table is 85% of battery costs plus 15% of electricity costs. It should be noted that the costs of power should also be a function of h, but since such complications are beyond the treatment developed here, the cost was made to reflect full system utilization of 193 hours of programming per grade per year through the appropriate choice of the lifetime of a set of batteries (1.7 years). Finally, the cost of printed support materials to accompany the ITV lessons is hypothesized to be partly fixed and partly variable.

Below we may summarize the total cost function and present average cost information for the year 1980, when the system will have achieved full development, as follows:

	Total cost equation	AC_N	AC_N/V_N	Cost per student-hr.
r = 0%	TC = 2,384,300 + 7.94 N + 1652 h	14.51	1.83	.075
r = 7.5%	TC = 2,728,400 + 8.77 N + 2254 h	16.93	1.93	.087
r = 15%	TC = 3,187,600 + 9.69 N + 3013 h	19.89	2.05	.103

The average cost information above assumes an enrollment of 654,400 students and that each student views approximately 193 hours of instructional television lessons during the year. It should be observed that not discounting the future may cause the understatement of system costs by over 25% (an average cost of \$14.51 at 0% versus \$19.89 at 15%). The quite low value of the ratio of average cost per student (AC_N) to variable cost per student (V_N) indicates that most

economies of scale will have been achieved given projected student enrollment in 1980. The summary cost figures (at r = 7.5%) should be interpreted as indicating that the average cost of providing a student with ITV in the year 1980 will be about $17, or about 9¢ per student for each hour (about six ten minute lessons) viewed.

AC_{ij}'s

We can utilize information presented in the year by year cost tables above to derive summary measures of the average cost per student of the project, which takes into account changing utilization over time. Specifically, we can compute AC_{ij}, that is, the average cost per student from year i to year j, where:

$$AC_{ij} = \frac{\sum_{k=i}^{j} C_k/(1+r)^{k-i}}{\sum_{k=i}^{j} N_k/(1+r)^{k-i}} \qquad (2)$$

The formula above provides a measure of average costs that discounts the future, for both costs and student utilization. This provides a more interesting and useful measure than the average cost figure derived in the previous section since the latter only takes into account utilization at one point in time. The AC_{ij} measure also allows the project planner to determine the length of time the project needs to continue to permit unit costs to fall to a reasonable level. It also permits one to look at project costs from different points in time over the life of the project.

Tables 10, 11, and 12 present the AC_{ij}'s for selected years of the instructional television system in the Ivory Coast at social rates of discount of 0%, 7.5%, and 15% respectively. They serve to illustrate several points. First, costs decrease quite rapidly as we project the system to continue for more than a few years. For example, if the system were to be discontinued

TABLE 10

Average Total Costs of Ivorian ITV from Year I to Year J
Interest Rate = 0.0%
(in 1972 US dollars)

	To Year J											
From Year I	1969	1971	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991
1969	∞	829	159	77	46	33	26	22	20	18	17	16
1970		783	157	76	46	33	26	22	20	18	17	16
1971		637	148	74	45	32	26	22	20	18	17	16
1972			119	66	42	31	25	21	19	18	17	16
1973			98	59	38	28	23	20	19	17	16	16
1974				50	34	26	22	19	18	16	16	15
1975				44	30	23	20	18	17	16	15	15
1976					26	21	18	17	16	15	14	14
1977					23	19	17	16	15	14	14	14
1978						18	16	15	14	14	13	13
1979						16	15	14	14	13	13	13
1980							14	14	14	13	13	13
1981							15	14	13	13	13	13
1982								14	13	13	13	13
1983								14	13	13	13	12
1984									13	13	12	12
1985									13	12	12	12
1986										12	12	12
1987										12	12	12
1988											12	12
1989											12	12
1990												12
1991												13

TABLE 11

Average Total Costs of Ivorian ITV from Year I to Year J
Interest Rate = 7.5%
(in 1972 US dollars)

	To Year J											
From Year I	1969	1971	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991
1969	∞	847	166	82	51	37	30	26	24	22	21	20
1970		794	163	81	50	37	30	26	24	22	21	20
1971		637	153	79	49	36	30	26	23	22	21	20
1972			120	69	45	33	28	24	22	21	20	19
1973			98	60	40	31	26	23	21	20	19	18
1974				50	35	27	23	21	19	18	17	17
1975				44	30	24	21	19	18	17	16	16
1976					26	21	19	17	16	16	15	15
1977					23	19	17	16	15	15	14	14
1978						18	16	15	15	14	14	14
1979						16	15	14	14	14	13	13
1980							14	14	14	13	13	13
1981							15	14	14	13	13	13
1982								14	13	13	13	13
1983								13	13	13	13	13
1984									13	13	12	12
1985									13	12	12	12
1986										12	12	12
1987										12	12	12
1988											12	12
1989											12	12
1990												12
1991												13

TABLE 12

Average Total Costs of Ivorian ITV from Year I to Year J
Interest Rate = 15.0%
(in 1972 US dollars)

	To Year J											
From Year I	1969	1971	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991
1969	∞	865	174	88	56	42	35	31	29	27	26	25
1970		805	170	87	55	42	35	31	29	27	26	25
1971		637	158	83	54	41	34	30	28	27	25	25
1972			121	71	48	37	31	28	26	25	24	23
1973			98	61	42	33	28	25	24	23	22	21
1974				51	36	29	25	23	21	20	20	19
1975				44	31	25	22	20	19	18	18	18
1976					26	22	19	18	17	17	16	16
1977					23	19	17	17	16	15	15	15
1978						18	16	15	15	15	14	14
1979						16	15	15	14	14	14	14
1980							14	14	14	13	13	13
1981							15	14	14	13	13	13
1982								14	13	13	13	13
1983								13	13	13	13	13
1984									13	13	12	12
1985									13	12	12	12
1986										12	12	12
1987										12	12	12
1988											12	12
1989											12	12
1990												12
1991												13

this year, the average cost per student over the lifetime of the project ($AC_{1969,\ 1975}$) would be $82 (at a 7.5% interest rate). Assuming a twenty-year lifetime, the average cost ($AC_{1969,\ 1991}$) would be considerably less, $20.

Second, we see that in general, the project cost picture changes as we examine it from different points in time, as well as with different assumptions as to its duration. As we assume a longer project lifetime, average costs usually decline, due primarily to enrollment increasing faster than total costs (as is true in most instructional technology projects). We also see that, in general, the further into the project we are, the less expensive it is to continue, due primarily to many initial project development expenses becoming sunk costs, and due also to enrollment expansion.

Finally, we observe that the choice of a discount rate is quite important; as the opportunity costs of resources become greater, so do the real costs of the project. Neglecting the discount rate (that is, choosing a zero discount rate), as many cost studies unfortunately do, serves to understate project cost substantially, even more so than the average cost figure derived in the previous section for 1980, since utilization was not discounted in this latter figure. For example, if we look at the average cost per student from 1969 to 1991 (i.e., assuming a 20-year lifetime for the project subsequent to the initial enrollment in 1971), not taking the value of resources over time into account (i.e., using a zero discount rate) can result in understating costs by more than 35% if the appropriate rate is 15% (i.e., $16 per student vs. $25 per student).

Discussion

Given the rather high projected student utilization for the Ivory Coast's

instructional television system, costs, at least on a per student basis or per student-hour basis, fall to a reasonable level in terms of comparison with other ITV projects. Nonetheless, overall the Ivory Coast's ITV project is one of the most expensive of such projects in the world, as can be seen by careful comparison with the costs of other projects. Table 13 presents a summary of the costs of the Ivory Coast project (with and without the costs of printed support materials) along with those of four other ITV projects directed toward primary and/or secondary schooling coverage that were examined in detail in Jamison, Klees, and Wells (1976) and Jamison and Klees (1975). Cost case studies for all of these projects were undertaken by the authors of this paper and every effort has been made to describe the systems in a similar manner so as to facilitate comparison. Nonetheless, it is clear that there are many problems with interpreting such international cost comparisons given the uniqueness and the necessarily different thrusts of each project, and therefore the reader should treat the results with caution.

In general we can see from Table 13 that the average costs per student (AC_N), the average costs per student over the project lifetime (AC_{ij}), and the cost per student hour for the Ivorian ITV system fall within the range presented for the other projects listed in the table. However, in total annual cost terms (total costs for each project may be computed from information provided in the table, using equation (1) which was presented earlier) the Ivorian project is more expensive than any of the others; it is due to the large project enrollments that per student costs for the Ivorian system fall to a reasonable level. The most relevant comparison is probably with the ITV system of El Salvador, assuming El Salvador continues to expand to cover primary schooling in addition to secondary (El Salvador (b) in Table 13). Under this circumstance the average cost to El Salvador would be $2.88 per student or $.017 per student-hour, as

TABLE 13

Cost Summary of Five Instructional Television Projects[a]
(in 1972 U.S. dollars)

Project	Year of Information Source	N	h	F	V_N	V_h	AC_N	$AC^e_{1,j}$	AC_N/V_N	Cost Per Student Hou
Ivory Coast[b]	1973									
(a) Total Costs		654,400	1,158	2,728,400	8.77	2,254	16.93	20.00	1.9	.087
(b) Without printed materials		654,400	1,158	1,695,800	6.13	2,254	12.71	15.53	2.1	.066
El Salvador[c]	1972									
(a) Sec. only		48,000	540	1,116,000	1.10	--	24.35	14.97	22.1	.143
(b) Elem. & Sec.		990,000	1,530	1,920,000	.94	--	2.88	10.00	3.1	.017
Hagerstown	1973	22,000	1,440	234,500	.90	652	54.23	53.40	60.3	.460
Korea[d]	1975	1,000,000	560	214,000	1.81	2,128	3.22	--	1.8	.045
Mexico	1972	29,000	1,080	0	4.23	538	24.27	23.00	5.7	.067

[a]Values in this table were computed with a social rate of discount of 7.5%. The symbols are defined as follows: N = Number of students using project (in the given year, unless otherwise noted); h = the number of hours of programming broadcast per year; F = annualized fixed costs; V_N = annualized variable cost per student; V_h = annualized variable cost per hour broadcast; AC_N = average annual cost per student for the given values of N and h; $AC_{1,j}$ = the average annual cost per student from year 1 to year j, where j is that year in which the project has been broadcasting to students for 20 years--for the Ivory Coast and El Salvador we report $AC_{1,23}$, for Hagerstown $AC_{1,20}$, and for Mexico $AC_{1,21}$; and the student hour cost is the annual cost per student hour of viewing for the given values of N and h. This table was drawn from Jamison, Klees, and Wells (1976, Table III.2) and Jamison and Klees (1975, Table IV).

[b]The N and h for the Ivory Coast reflect projected ITV system utilization for the year 1980.

[c]The cost function for instructional television in El Salvador was derived solely as a function of V_N; therefore V_h is not given in the table (costs that are variable per hour broadcast are thus included in the project's fixed cost figure). El Salvador (b) refers to projections that include the extension of ITV coverage from secondary schooling to primary, and N and h reflect such usage as projected for the year 1980.

[d]The N and h for Korea reflect planned utilization of the system as discussed in Jamison, Klees, and Wells (1976, Chapter X).

[e]The data for this column are taken from the case studies presented in Jamison, Klees, and Wells (1976, Part three). Sufficient data were not available to allow calculations of AC_{ij}'s for the Korean instructional television project.

compared with $12.71 per student or $.066 per student-hour for the Ivory Coast (not including the costs of printed support materials). Of course the El Salvador system cost projection is based on a somewhat large enrollment than projected for the Ivory Coast--990,000 vs. 654,400; however, even if we assumed this larger enrollment for the Ivory Coast system the average cost per student and per student-hour would only fall to $10.48 and $.054 respectively, still substantially larger than those estimated for El Salvador.

The production costs per hour are relatively high for the Ivory Coast ITV system (for example, over 3.5 times higher than those of the Mexican Telesecundaria), as are the fixed costs of the system, and these both contribute to the high per student and per student-hour costs. However, a more important factor, given the large student enrollment projections, is the relatively high variable cost per student of the system (V_N in Table 13). Part of this high variable cost per student is due to the extensive production of printed materials to accompany the ITV lessons. Yet even ignoring the costs of printed materials, the variable cost per student is still higher than that of any other ITV project. Much of this is due to the particularly high costs of reception system power (batteries are an expensive way to power a television) and reception system maintenance, both of which are in large part consequences of the present state of economic development in the Ivory Coast, reflected in the lack of electrical power in most locales and the lack of easy access to most locales.

3. PLANNED COSTS VERSUS ACTUAL COSTS

Unfortunately, it is unusual to find detailed cost analyses undertaken prior to the initiation of an instructional technology system; the Ivory Coast system, however, is an exception in that Ivorian and French educational planners paid careful attention to developing estimates of future system costs during the project planning stage. Building on the substantial efforts made by the project planners in this regard, Dr. Châu of Unesco's International Institute of Educational Planning made a study of the costs of the Ivorian educational reform in 1970, and his results are reported in Châu (1972c). In this section we compare the cost projections made by Châu prior to project initiation with the cost projections detailed in the previous section, made by the authors three years after Châu's study. Our purpose is not to criticize Dr. Châu's study, which we consider excellent, but to examine the differences between a cost analysis conducted in a project's planning stage with one conducted after actual operations have begun.

Table 14 presents the costs of the instructional television system component of the Ivorian educational reform and projected student enrollment as reported by Châu (1972c); some costs are only projected by Châu through 1980 and thus Châu's analysis was extended in order to generate a year by year cost table comparable to the summary cost table (Table 8) developed in the previous section (the assumptions on which this extension was based are reported in the footnote to Table 14). Châu does not examine the costs of printed support materials as a part of the ITV component of the reform,[5] and thus for the pur-

[5] Châu (1972c, p. 52) does suggest that the cost of "classroom materials and supplies" will be about $8.10 per student under the educational reform. It

TABLE 14

Planned Costs of ITV in the Ivory Coast[a]
(thousands of 1972 US Dollars)

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Production																							
Facility	330	659																					
Equipment	233	525	370	101							233	625	370	101									
Operations	144	720	1350	1504	1598	1665	1714	1693	1538	1378	1055	786	810	810	810	810	810	810	810	810	810	810	810
Transmission																							
Operations		9	78	188	217	242	267	299	311	311	314	320	320	320	320	320	320	320	320	320	320	320	320
Reception																							
Equipment		176	524	553	647	778	895	795	763	700	496	188	191	197	203	214	217	225	231	236	249	255	267
Replacement							151	452	487	580	704	958	1206	1272	1[illegible]28	1300	1145	1397	1469	1540	1452	1237	1624
Maintenance Service	198	421	78	82	78	75	63	75	69	59	66	66	66	66	66	66	66	66	66	66	66	66	66
Operations			120	398	540	723	917	1144	1388	1589	1780	1918	1938	1957	1976	1996	2017	2036	2057	2077	2098	2120	2139
Total Costs	707	2387	2863	2822	3084	3486	4013	4446	4562	4627	4641	4861	4901	4723	4713	4706	4575	4854	4953	5049	4995	4808	5226
Number of Students (in thousands)			9	42	94	168	261	373	482	582	668	730	753	774	798	821	847	871	898	1025	953	982	1011

See footnote on next page.

Footnote to Table 14

[a]Cost data are based on planning data given in Châu (1972c) for 1969 to 1979. The rationales for each projection (1980-1990) or departure from Châu's estimates are explained below. All cost and enrollment projections are for the calendar year so as to make them more directly comparable with the data in Section 2; Châu's cost and enrollment data were converted from academic year estimates to calendar year estimates by multiplying the academic year data preceding each calendar year by 2/3 and adding the resultant figure to 1/3 of that of the following academic year (e.g., 1970 cost or enrollment data = 2/3 x 1969-1970 academic year data + 1/3 x 1970-1971 academic year data).

Production facility. This assumes a 20 year lifetime.

Production equipment. This assumes a 10 year lifetime.

Production operations. This projection was made by Châu.

Transmission operations. This projection was made by Châu.

Reception equipment. After 1978 this expense grows proportionally to the following year's increment in student enrollment, assuming an average class size of 44 and an average cost per receiver and antenna of $400.

Reception equipment replacement. This is based on the equipment cost stream shown above and an assumption of a five year life.

Reception maintenance service. This is based on Châu. High initial set-up costs are followed by relatively constant costs that are more or less independent of the size of the system.

Reception operations. This category includes the cost of battery and mainline current power, as well as some types of equipment maintenance expenses. After 1979 this is assumed to remain fairly constant (increases at 1% per year) as more and more schools need not rely on batteries.

Number of students. After 1979 the student enrollment is assumed to grow at 3% per year.

The cost data presumably does not include teacher training, the development, distribution, or printing of student and teacher guides, nor provision for additional transmission equipment (the transmission time is taken from the existing stations which presently have excess capacity) that will be needed to cover the whole country (only 2/3 of the population is presently covered).

poses of comparison we will not include the cost estimates we developed for these materials in our analysis here.

A comparison of Table 14 with Table 8 allows us to observe some gross differences in cost estimates between Châu's study and ours. Considering the period from 1969 to 1991, Châu's planning study depicts an average annual cost of $4,174,000, while the estimates we report in Table 8 indicate an average annual expenditure (excluding the cost of printed support materials) of $7,186,000 a difference of $3,012,000 per year, totalling $69,276,000 over the 23 year planning horizon utilized in the tables. This represents an underestimate of yearly costs of about 42%.

Part of the difference between the cost estimates made during the project planning stage and those made by the authors is that the former neglected the additional central administrative costs that would be incurred by the ITV system. However, central administrative costs average only $299,000 per year over the project's lifetime and do not account for a large fraction of the $3,012,000 annual discrepancy between the two studies reported above. Most of this difference is reflected in the cost estimates for other system components. If we examine Châu's cost estimates for ITV system production, transmission, and reception we find that, on the average over the 23 year planning horizon, Châu estimates are respectively 90%, 75%, and 52%, of the estimated costs presented for these components in Table 8. Châu's estimates of total reception

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is difficult to compare this cost figure with ours for two reasons: first, our estimate of printed support materials costs include substantial components that are not variable with the number of students and thus would yield a higher cost figure at low student utilizations (e.g., about $32 per student at 1972 level enrollment) and a lower cost figure at high student utilizations (e.g., about $2.40 per student at 1980 level enrollment); and second, it is likely that Châu's cost estimate refers to more than just the materials in support of ITV programs.

costs would be even lower than that given in Table 14 if he had been able to utilize more recent enrollment projections, which are lower than those in Table 14.

Another means by which to compare Châu's planning study with ours is through an annualized cost function; from Table 14 we may calculate such a function based on Châu's data and compare it with the one derived in the previous section. Production operations are assumed to have a normal annual cost of $860,000 if the system were broadcasting to all six grades. As in Section 2, costs above this incurred in production operations during the first ten years of the project were treated as a start-up investment and were annualized over the assumed 25 year lifetime of the project. Recurrent transmission and reception maintenance costs were estimated at the full six grade operations level of $340,000 and $70,000 respectively. The recurrent cost of reception operations (this category primarily includes Châu's estimates of the cost of battery and electric current power) are estimated by the following linear expression: $432,000 + $1.73 N.

Below we summarize the total cost function and present average cost information for the year 1980, when the system will have achieved full development, as follows:

	Total cost equation	AC_N	AC_N/V_N	Cost per student-hr.
r = 0%	TC = 527,000 + 3.55 N + 1413 h	6.51	1.83	.034
r = 7.5%	TC = 559,000 + 3.98 N + 1636 h	7.34	1.84	.038
r = 15%	TC = 600,000 + 4.44 N + 1849 h	8.19	1.84	.042

The average cost information above assumes an enrollment of 730,000 students and that each student views approximately 193 hours of instructional television

lessons during the year.

In order to compare this cost function, based on Châu's data, with the one we derived in the previous section we need to re-calculate our cost function, excluding the costs of printed support materials. The total cost function and average cost information for 1980, based on our cost data, would then appear as follows:

	Total cost equation	AC_N	AC_N/V_N	Cost per student-hr.
r = 0%	TC = 1,652,900 + 5.30 N + 1652 h	10.75	2.03	.056
r = 7.5%	TC = 1,695,800 + 6.13 N + 2254 h	12.71	2.07	.066
r = 15%	TC = 1,772,400 + 7.05 N + 3013 h	15.09	2.14	.078

The average cost information in this formulation is again based on assuming the broadcast of 193 hours of television lessons annually for each grade; however, in contrast to Châu, our revised enrollment projections forecast 654,400 students in 1980 instead of 730,000. In comparing the two equations we see that our estimates of fixed costs are about three times greater than Châu's; part of this is due to Châu's neglecting central administration costs, but most of it is due to underestimating the fixed costs of reception maintenance services. Our estimate of the variable cost per student averages a little over one and a half times that of Châu's, primarily due to the planning study's underestimate of the costs of battery power utilization and the variable cost of reception equipment maintenance. Our estimate of the variable cost per hour of ITV lessons broadcast annually averages about 40% greater than Châu's, primarily due to underestimates of production cost, as opposed to transmission cost.

If we examine the average cost per student (AC_N) in 1980 as a summary

measure of the project's operation we find that our study indicates costs 65% higher than Châu's at a zero discount rate, 73% higher if r = 7.5%, and 84% higher if r = 15%. This increasing relative difference in cost estimates, as the discount rate increases, indicates that Châu's planning study significantly underestimated the magnitude of capital investment that the Ivorian ITV project would require. Although part of the difference in the average cost per student reflects different estimates of student utilization (as well as cost differences), it seems appropriate to include this difference in comparing the two studies since evaluation of the project's economic viability at any stage must consider both costs and enrollment; however, even if Châu had utilized the lower enrollment projections, the average cost per student would still be 57%, 62%, and 75% higher than Châu reports, respectively at the three rates of social discount.

A final means of comparing the two cost studies is to utilize the AC_{ij} conception, which should provide the best overall summary measure of the difference in cost estimates. From the data in Table 14 we can calculate $AC_{1969,.1991}$, the average cost per student of ITV in the Ivory Coast from its inception in 1969 to the assumed 1991 terminal horizon year, to be $9.16 at a 7.5% social rate of discount. From the data in Table 8 we can re-calculate our estimate of $AC_{1969,\ 1991}$, excluding the costs of printed support materials, to be $15.53 at a 7.5% social rate of discount, 70% higher than was indicated by the planning study. Even if Châu had utilized our lower enrollment projections instead of his own, the estimate of $AC_{1969,\ 1991}$ based on our data would be 60% higher than his (calculated to be $9.41 using our enrollment projection).

This section is intended to illustrate the extent to which a cost analysis

undertaken during the project planning stage may underestimate the costs of a project; we found that a cost analysis made after actual operations had begun (our cost study) indicated costs that were 70% higher than that indicated by the planning study. Again, this is not in any way meant as a criticism of Dr. Châu and his associates, but should be taken as an indicator of the many potential sources of error in cost analysis (as discussed in detail by Jamison, Klees, and Wells, 1976) and the hazards of placing too great a reliability on cost projections made during the project planning stage. This is not to say that planning stage cost studies should not be undertaken, indeed they are necessary to evaluating the potential worth and feasibility of the project. However, much care needs to be taken in these studies and the realization that most planning studies tend to significantly underestimate costs should exhort us to be much more conservative than usual in formulating the assumptions on which we base our cost projections.

4. THE COSTS OF SYSTEM EXPANSION

This brief section is intended to examine the costs of certain types of system enrollment expansion and to emphasize that the marginal costs of expansion are quite a bit lower than the average costs of operations. Table 15 presents the marginal costs of adding one student place to the ITV system for six classroom schools and three classroom schools, and for schools that use batteries for power versus those that utilize mainline current. As we can see the marginal cost per student is somewhat greater for three classroom schools as opposed to six classroom schools, and is significantly greater for schools that utilize battery power as opposed to mainline current.[6]

It should be pointed out that the total marginal cost figures given in Table 15 essentially assume that we are adding student places by the conversion of an additional existing school to the ITV system; that is we need to add receivers, stands, antennas, a power source, and the appropriate printed materials. If an additional classroom were added to a school already equipped for the ITV system many of these additional expenses might not have to be incurred as the antenna and mast would already be in place, and existing TV receivers could be shared. The costs would be still less if we consider system expansion through the addition of a student to an already existing ITV classroom, that is, increasing the class size, given that excess classroom capacity is available. In this

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[6] This illustrates the importance of providing incentives for schools to use the electrical mains when they are available. It is the author's understanding that some schools who could use the mains fail to do so for the fairly simple reason that batteries are provided free whereas power from the main must be paid for by the school. It would seem wise to reimburse the schools that use mains for the cost of their electricity, at least, in order to create an appropriate incentive.

TABLE 15
The Marginal Cost of Adding a Student to the ITV System[a]
(1972 US dollars)

Cost Components	Six Classroom School r = 0%	7.5%	15%	Three Classroom School r = 0%	7.5%	15%
Reception Equipment:						
TV Receivers and Stands	1.78	2.28	2.86	1.78	2.28	2.86
Antennas and Masts	.19	.29	.39	.38	.58	.78
Maintenance	1.41	1.41	1.41	1.41	1.41	1.41
Power:						
(A) Battery	1.82	2.06	2.30	2.57	2.83	3.10
OR						
(B) Mainline Current	.04	.04	.04	.08	.08	.08
Printed Support Material	2.64	2.64	2.64	2.64	2.64	2.64
TOTAL (A) = w/Battery	7.84	8.68	9.60	8.78	9.74	10.79
TOTAL (B) = w/Mainline Current	6.06	6.66	7.34	6.29	6.99	7.77

[a]The cost information presented above is based on the data given in Table 9 and its footnote, separated by type of school. Batteries are assumed to have a lifetime of 2.4 years in six classroom schools and a lifetime of 1.7 years in three classroom schools, due to differing utilizations of receivers. Further, three classroom schools are hypothesized to serve on the average, half the students that a six classroom school does (i.e., 117 students vs. 233 students). The marginal costs per student of reception equipment given above essentially assume the conversion of an additional school to the ITV system; if only a new classroom is added, or if a new student is added to an existing classroom, only a subset of the component costs are relevant.

case the marginal cost per student would likely be only $2.64, the cost of additional printed support materials.

For any enrollment expansion or construction decisions that the Ivory Coast is currently considering, it is these marginal cost figures that are relevant. In most instructional technology system projects it is possible to achieve significant economies of scales and as long as marginal costs are lower than average costs, which they almost always are, expansion, if educationally justified, can result in more efficient utilization of resources and correspondingly lower average costs per student.

5. SYSTEM FINANCING

It is important not only to examine how much is expended in total for a project, but also to consider who is paying these costs. Decisions as to the efficiency and equity of the project can be affected significantly by such considerations. We do not have information available on the sources of the Ivorian component of project financing--for example, as to the extent of progressivity or regressivity of the tax system which raises the money to support the project--so it is not possible to make the type of equity inferences resulting from studies of tax incidence. However, the Ivory Coast ITV project is especially interesting in that it is the result of a multi-national effort, and we do have data available on the contributions of the major financial backers of the project.

Table 16 presents the relative contribution of each of the major financers of the project from 1969 through 1991. Foreign aid is generally assumed to be extended through 1979 or 1980 as detailed in the footnotes to the table. It should be noted that at present the Ivory Coast is only assuming a little more than half of the annual costs, but under the foreign aid withdrawal assumptions made here, their percentage is increasing rapidly and by 1981 the Ivorians will find themselves paying the total system costs.

TABLE 16

Sources of ITV System Finance[a]
(contributions in per cent)

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Ivory Coast	43.2	35.7	36.1	50.5	42.0	51.1	54.2	56.4	58.4	62.6	79.8	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Canada[b]			10.9	13.6	16.6	18.2	14.9	16.2	16.6	15.4	1.8												
France[c]	45.3	47.3	48.9	33.8	38.1	24.2	27.8	26.5	24.2	21.3	18.2	1.2											
UNDP/UNESCO[d]		10.7																					
World Bank[e]	11.5	6.3	4.1	2.1	3.3	6.5	3.1	0.9	0.8	0.7	0.8	0.8											
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total Costs[f] (thousands of 1972 US dollars)	317	1027	4436	5363	8019	8943	10071	9698	9594	9952	9538	9295	10393	10480	10677	10788	11074	11543	11780	12461	12521	13252	14787

See footnotes on next page.

Footnotes to Table 16

[a]In addition to the sources listed in the table a small amount of aid has already been contributed by the United States Agency for International Development, the European Development Fund, Belgium, and Germany (Source: SINCRO, 1972, Vol. III)).

[b]Canadian aid is furnished by ACDI to the printed support materials groups. Contributions to this group include foreign expertise, equipment and operations expenses. The present agreement is for 1971 through 1975. It is assumed in this report that this agreement will be renewed and continued through 1979 (major expenditures are assumed to terminate in 1978), after which the Ivory Coast will assume total cost responsibilities for this part of the project.

[c]French aid is furnished by FAC to the ITV system expenditures for central administration, program production and reception. Under the central administration category FAC contributes personnel and has undertaken a number of pedagogical studies. For program production FAC supplies administrative, operations and maintenance personnel as well as production equipment. Under the reception category it is assumed that FAC furnishes the equipment necessary for initial installation (including replacement of stolen television receivers) and one-half the equipment needed for reception system maintenance. FAC agreements with the Ivory Coast are re-negotiated each year. It is assumed that the aid indicated above will be discontinued after 1979, except for administrative personnel who are assumed to stay on an additional year.

[d]UNDP/UNESCO has contributed substantially to the teacher training part of the ITV project. Since teacher training is not costed in this report their contribution appears very slight. It consists of providing funds for the construction of the first studio in 1970.

[e]The World Bank has supplied or will supply funds for the SINCRO study, a part of the costs of the Evaluation Unit and about 50% of the costs of the new ITV complex (Source: SINCRO (1972, Vol. III)). Funds for the Evaluation Unit (personnel salaries) are assumed to end in 1980.

[f]See Table 8 for details of total costs.

6. CONCLUSIONS

This case study provides what is perhaps the most detailed cost analysis available for an on-going instructional technology project. We have seen that the system is a relatively expensive one, in large part due to the lack of electrical power in most locales and the lack of a well developed transportation system, making delivery of materials and maintenance both difficult and expensive. Nonetheless, significant economies of scale can be achieved if the system expands as planned, yielding average costs per student that may be considered reasonable.

Although this case study only examines the instructional television component of the Ivorian educational reform, it is important to realize that the reform is a package and, within the Ivory Coast, needs to be evaluated as such. On the cost side, careful attention needs to be given to the implications of the decision to up-grade classroom teachers, an uncommon companion to the introduction of an ITV system; teacher up-grading will yield quite significant future financial obligations (see Eicher and Orivel, 1976 and Chau, 1972c for a discussion). Further, the impact of the expanded primary school system on secondary and higher level schooling in the Ivory Coast needs to be closely studied. This should involve an examination of the impact of the reform on the cost and structure of post-primary schooling, as well as an analysis of the economic and social benefits to the nation of a more highly educated populace.

Finally, we must remember that at this time we do not have any sound basis for evaluating the worth of the Ivorian reform or its ITV component. As in El Salvador, the objective of reducing the grade repetition rate was accomplished by fiat. No comparative testing has been done to examine the relative efficacy of the reform or of ITV instruction, although plans do exist for such analyses.

It is also not clear to what extent the reform can stem unwanted rural-urban migration, especially given the use of an identical curriculum in both regions. In sum, the Ivorian ITV system is one that has received substantial financial and human resources directed toward developing a high quality instructional system and it will be interesting to view the results of forthcoming evaluation to see if such investment is justified.

APPENDIX A

GLOSSARY OF ACRONYMS

ACDI	Aide Canadienne pour le Développement International
BIRD	Banque Internationale pour la Reconstruction et le Développement
CAFOP	Centre d'Animation et de Formation Pédagogique
CATEL	Compagnie Africaine de Télévision
CEF	Centre Electronique de France
CP1	Cours Préparatoire 1ère année--first grade
CP2	Cours Préparatoire 2ème année--second grade
CE1	Cours Elémentaire 1ère année--third grade
CE2	Cours Elémentaire 2ème année--fourth grade
CM1	Cours Moyen 1ère année--fifth grade
CM2	Cours Moyen 2ème année--sixth grade
ENI	Ecole Normale d'Instituteurs
FAC	Fonds d'Aide et de Coopération
SEEPTE	Secretariat d'Etat de l'Enseignement Primarire et de la Télévision Educative
SINCRO	Société d'Informatique, de Conseils et de Recherche Opérationnelle
UNESCO	United Nations for Education, Science and Culture Organization
UNDP	United Nations Development Program

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