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INTRODUCTION

Responsibility for the study was undertaken by Industrial Projects Service (IPS) an autonomous consulting house under the Ethiopian Ministry of Industry. WS Atkins International was commissioned to help IPS with the work under a UNIDO assistance scheme.

Atkins staff paid two visits to Addis Ababa, in October 1984 and January/February 1985. An Interim Report of working papers was submitted in January 1985. The present Report is the culmination of the work. It was prepared in Ethiopia and is presented as a joint IPS/Atkins effort. It will form the basis of a subsequent Final Report by IPS but at present is submitted by Atkins to UNIDO as the Final Report under UNIDO contract 84/79.

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I SUMMARY

Introduction

This study is intended to be an overall review of the potential for electronics development in Ethiopia. It reviews, in a balanced manner, the market, possible developments, and the organizational framework within which such developments should take place. This study follows a feasibility study undertaken in 1980 by the Ministry of Industry, of local radio manufacture, and an electronics review undertaken in 1983 by OPSA.

The conclusion of the present study is that there is an opportunity for combined radio and television manufacture in Ethiopia. The project is a suitable form of industrial development for Ethiopia despite the present economic difficulties. When the plant is in full operation it will compete with import prices (before duties). Hence only a small amount of protection will be needed. Military radios could also be made economically. There are few other opportunities, although telephones are worth further consideration. The consumer product plant does, however, introduce the manufacture of printed circuit boards. This is an essential technology which will underpin future electronic product development in Ethiopia. The consumer product plant will be able to make at least:

- 300,000 radios of various types
- 20,000 monochrome 20 inch TVs
- 5000 colour TVs
- Printed ciruit boards for some other products

Markets

Consumer products made up 16 percent of electronics imports into Ethiopia during 1978-82. Spares for consumer goods were another 13 percent. Thus nearly one third of imports were of consumer goods. During this period the imports were severely restricted. Under free market contitions they would have been much higher. Consumer goods are the most important element of electronics imports. Specified telecommunications and broadcasting goods account for nearly 20 percent of imports. They also form a large part of unspecified imports. Industrial electronics goods form a small part of the total. Ethiopia's product distribution is typical at this stage of development. In the industrialised countries the emphasis is on data processing electronics and component manufacture especially silicon - based devices.

It is very important to remember that the developing countries which have entered the field of industrial and professional electronics have industrial economies very much larger than Ethiopia's. Indeed, in most cases their industry sector was much bigger in the early 1960s, when they entered electronics, than Ethiopia's industry will be in the 1990's. Industry in China and India is 40 - 60 times the size of Ethiopian industry. Singapore and Ireland are eight times the size. Electronics development in Ethiopia must be viewed in this light.

The demand for radios has been determined by estimating the size of the current radio stock, estimating a growth rate in future, and calculating also the rate of discarding of radios. The present stock of radios has been estimated by several methods. They agree; it is about $1\frac{1}{4}$ million. This is much lower than recent official estimates. The radio stock has probably fallen in recent years from a peak of nearly 1.4 million in 1980. Growth has been erratic. The surge in imports during 1974-1977 was followed by import restrictions. The long-term growth rate has been about 9 percent, very similar to growth rates in other poor countries. The medium growth forecast of stock increase is 10 percent per year. Taking the typical industrialised country life for radios in future, the free market sales would be :

	radio sales
1986	163,000
1990	267,000
1994	392,000

Television demand has been estimated using similar principles. The present stock of TV's is about 40,000. Various methods of estimation agree. The trend growth rate has been about 10 percent. Various methods of estimating future growth point to 15 percent as a medium forecast. Two of the models indicate 21 percent but this is not thought to be substainable in the long term. The 15 percent stock growth, associated with a longer than usual life in Ethiopia, produce the following monochrome TV sales forecast:

	B/W TV sales
1986	6,900
1990	11,600
1994	16,500

It would be several years before monochrome TV could be made in Ethiopia. There is a case to be made for continuing to suppress demand until local manufacture can benefit from increased sales.

The demand for colour TV can be manipulated through availability and pricing. It is assumed in the forecasts that the free-market demand for colour TV would increase steadily from 10 percent of total TV sales at present to 30 percent in the mid - 1990's. This demand is shown below. A decision on supply of colour TV could also be made on foreign currency grounds. Locally made colour TV's would incur an additional 130 Birr of imports over and above monochrome TV.

	colour TV sales
1986	900
1990	2,600
1994	6,400

The demand for military radios has also been considered. In the late 1980's this could be around 4,000 sets per year, the majority being of the hand-held VHF/FM type. Non-military radio demand is very small.

Telephones may offer a manufacturing opportunity. The modern digital phone will replace the existing types. Strong growth is forecast. The new phones are based on printed circuit board technology and would therefore be most appropriate to an Ethiopian electronic product assembly line. Sales should reach 23,000 per year by 1990.

Manufacturing economics

The cost of manufacture of radios at 300,000 per year in Ethiopia has been compared to high volume (2 million) production in SE Asia. The 2-band battery mains model used as a basis of comparison can be delivered (duty free) to

Addis Ababa for 28.2 Birr. It costs 31.9 Birr to make here (including a 10 percent return on investments). On this basis the project is marginal from the commercial point of view. The actual works cost of the SE Asian radio is only 59 percent of Ethiopian works costs, but foreign selling company costs and transport remove most of the foreign cost advantage. Ethiopian local manufacture would not compete until about 500,000 sets per year.

A similar excercise conducted on a small Ethiopian monochrome TV plant places Ethiopian manufacture at a more serious disadvantage. The Ethiopian works cost is 236 Birr wheras a SE Asian set made at 200,000 per year costs about 196 Birr delivered to Addis Ababa. At 20,000 sets per year a TV plant is very heavily under-utilised and such a project could never be justified.

Although radios and televisions as separate projects are not commercially attractive, the two combined can show an adequate return on investment. Inherent in a 300,000 set/year radio plant is the capacity to make considerably more printed circuit boards and subassemblies. The extra cost of making say 20,000 B/W TV's and some colour TV's is less than it would be in a separate plant. It is this benefit which makes combined radio and TV manufacture attractive.

The cost of parts forms a very high proportion of radio and TV local manufacturing costs, 73 percent of all costs in radio and 52 percent in TV. Manning costs are only 6 percent in radios and 9 percent in TV's. Local manufacture in Ethiopia suffers relatively high capital equipment and building costs but the financing cost is low compared to commercial ventures in industrialised countries.

Military radios can probably be made in Ethiopia much more cheaply than they can be imported. An overall cost advantage of nearly 30 percent can be obtained if the local venture is sensibly designed. Local assembly of military radios is often seriously considered once demand exceeds about 1000-1500 per year. The Ethiopian demand at around 4000 per year is well above the minimum scale of production. The nature of military radios, with their extraordinary attention to quality and huge amount of testing means that they are never integrated with consumer products. The manufacture of the printed circuit boards could however be common.

Small electronic components, like resistors or capaciters cannot be justified except at very high volumes. The prices are determined by producers whose annual production of a single type of component exceeds Ethiopia's annual demand for all types.

Projects involving only final assembly of consumer goods are not commercially viable nor in the long-term national interest. They should not be pursued. Ethiopia should build a printed circuit board making capability and develop from there. Consumer product electronics is the opportunity to do this.

International experience

Most developing countries begin in electronics by satisfying their own consumer product demand. To do this they obtain foreign technology. The countries with very large markets, like India and China, have retained their emphasis on consumer products while expanding steadily into professional and industrial electronics. They continue to seek foreign technology while at the same time slowly developing their own technological resources. They export very little, less than 5 percent typically, and electronics grows at a modest rate, around 15 percent per year. Ethiopia is not in a position to follow this course.

Smaller developing countries, including most of the SE Asian electronics countries soon moved on from consumer product manufacture for local markets. They did so by the simple expedient of attracting foreign investment always with some form of financial incentive. The foreign investment has normally been devoted to the manufacture of components, especially semi-conductor devices, for export. These countries have acquired large electronics employment and high rates of growth. At first such foreign investment does not produce economic linages but this follows in time. Wholly owned Korean and Taiwanese electronics companies are beginning to establish their own design centres in the USA.

The proposed integrated consumer product project

Although it is most unusual there is no reason why radio and TV should not be merged. A radio manufacturing plant installed in Ethiopia would, after supplying local radio demand, have adequate capacity to make TVs. It is proposed to establish a printed circuit board facility which will silk screen, and etch the copper plated boards on which the electronic components are inserted and soldered. A single PCB assembly line would prepare the sub-assemblies for a variety of consumer products. Final assembly, of radios, monochrome TV's, and colour TV's would each be undertaken on separate lines working full-time. The whole plant would operate one shift.

The plant would require a fixed investment of 9.3 million Birr of which 6.3 million Birr is in foreign currencies. The largest item of capital investment is 4.2 million Birr in buildings. Plant and equipment costs only 2.5 million Birr. Working capital requirements total 6.5 million Birr because of the need for large stocks of imported parts. Total employment is 188 people.

The foreign investment required at the outset for fixed investment and working capital is 11.3 million Birr.

When the plant is in full operation it will save about 4.4 million Birr per year compared to importing the same volume of consumer goods. The foreign investments will be recovered in some 2½ years of full operations. But because production builds up over several years it will be more like 4 years before the initial foreign currency investments are recovered in foreign currency import savings.

It must be pointed out however that the annual foreign exchange requirement for a free-market consumer product plant will still be much greater than the foreign exchange consumed in importing only a small number of radios and TVs. Under normal circumstances and with a well priced product, the sales of radios and TVs will increase sharply.

A normal technical development of the plant would involve 1½ years of introduction of radios, then 2 years of introduction of B/W TV's. Colour TV, the final step, would begin 3½ years after start-up, or 5 years after start of construction. The present economic difficulties probably preclude the possibility of any construction starting until 1987, in which case colour TV would start in 1992.

The project also offers the chance to make injection moulded radio cabinets and wooden TV cabinets. Both projects show substantial savings over imports (about 16 percent). Together they require 1.5 million Birr of foreign currency in fixed and working capital, and save 0.7 million Birr of foreign exchange each year at full output.

Preliminary estimations of a military radio plant suggest that a 4,000 set/plant could be built for about 15 million Birr (although some quotes will be for much more than this).

Working capital amount to 2.6 million Birr. Employment will be about 150 people. The plant could save over 5 million Birr of foreign currency in a full year.

Acquisition of technology for a consumer plant

The main ways of acquiring the necessary technology are:

- Joint Venture with foreign investor
- Purchase of an E Bloc package
- A licence
- Self-development with contract experts.

There are no precedents for self-development and in any case it would be attended by serious technical and commercial disadvantages. A licence agreement would be difficult to arrange at Ethiopia's stage of development, and is inferior to the first two schemes. The choice is between a Joint Venture and an E. Bloc project package.

The E. Bloc project usually takes the form of a set of product designs, sale of plant and equipment, technical support and a cheap financing arrangement. They will also supply the necessary electronic and mechanical parts. Such an arrangement could be made with an export corporation in say E Germany or Bulgaria. Previous experience suggests that the plant and equipment is usually expensive(partly compensated by concessionary financing). The plant is likely to be of a standard design which will not take proper account of the unusual nature of the local opportunity. Modification is usually very difficult to achieve. Technical support will probably be adequate but not of the broad ranging form desirable for a country setting out on a long path of electronics development. There will be no product brand name and probably no prospect of eventual exports. Overall the package will be relatively costly and very inflexible.

A Joint Venture has the important advantage that it brings foreign exchange to the project as equity. It also brings a high level of flexible, responsive technical expertise. It is a well proven path to commercial success and has nearly everything to commend it in Ethiopia. The legal framework for a Joint Venture exists, published in 1983, but there are no Joint Ventures and no discussions at present likely to lead to Joint Ventures in any field. There is also some evidence of a lack of interest in Western industralised nations in investing in Ethiopian industry. Economic stability and a political determination to support and encourage business are rated highly by foreign investers.

A Joint Venture should be energetically sought. The prospect is poor but it should not be dismissed unless determined efforts prove fruitless. Ethiopia does have some advantages, especially a substantial local market and a good geographical location. An essential part of the development strategy should be a genuine, comprehensive, and well coordinated effort to improve the local business climate and re-create confidence. This may sound like a forlorn hope in present economic circumstances but there really is no alternative.

Those countries which have succeeded with electronics developments have all planned their success very well. Three organizational characteristics will be essential here:

- The commercial venture needs a substantial degree of autonomy. It umust be responsive to the market. Strategy can be formulated centrally but policy must be left to the company. External interference over pricing, volume of production, product type etc. will be damaging.

- The venture should come under the control of an organization which will also be responsible for other ventures of a similar sort. Existing organizations do not seem well suited to the taste. A new body is needed, possibly a new corporation. The electronics venture will have much in common with other future light and precision engineering ventures.

- There needs to be a high level body able to influence all parts of Government which can affect the current fortunes and longer-term development of an electronics venture. Many matters will need tobe reviewed. Most countries with electronics industries have some form of Electronics Council though a less grand organ might be more appropriate to start with in Ethiopia. One possibility is an Interministerial Committee. This could expand to fuller representation in time. It could also oversee other related business ventures.

The need for sound training programmes has already been recognised in the formation of an Electronics Institute. This report makes various training recommendations. Training is an essential support to electronics development. There will also be strong links to other related industries. A sound training infrastructure should be regarded as an integral part of the strategy.

This project is a very suitable industrial venture for Ethiopia. It will provide a basic product which is no widely regarded, not as a luxury, but as an essential part of the social fabric of a nation. It will be counterproductive to continue to suppress the demand for radio and TV. If a way can be found to promote- such a plant, preferably with some foreign equity, then it should go ahead. If a Joint Venture proves impossible then an E. Bloc project with a long period of grace on loans should be sought (provided the overall cost structure conform to that described in this report). This project should be one of the better manufacturing industry possibilities open to Ethiopia.

II BACKGROUND TO THE STUDY

This will be drafted by IPS for their final report

III THE MARKET

A. THE ETHIOPIAN MARKET

1. Imports of Electronic Goods

Import of electronic goods have been extracted from the Customs statistics and are shown in Table III-A.1. They vary from 21 to 36 million Birr per year during 1978-1982. Consumer goods obviously form a large part of the total and have been presented separately. In 1982 Ethiopian GDP was $4.01 billion and so the total imports of electronic goods is equivalent to just under 0.4 percent of GDP. By comparison, in a highly industrialized market economy like USA, electronics goods are around 3½ percent of GDP excluding all defence and national space industry activity, and over 5 percent including these activities.

The information in Table III-A.1 has been summarised in Table III-A.2 where the percentage distribution is also shown. Consumer goods account for 16 percent of all imports. It is also interesting to note that consumer goods spares, at 13 percent, are almost equal to the finished goods themselves. Clearly much effort is being devoted to keeping existing consumer goods in service.

The next largest area after consumer goods is telecommunications, at 11 percent. Thereafter the separately specified classes of goods each fall below 10 percent of the total and 2.0 million Birr/year. As is normal, the goods in the not elsewhere specified categories form a large part of the total. Most of this is in the heading 764 which also includes radio, broadcasting, telephonic, navigation, etc. equipment and probably does not therefore include much industrial equipment.

TABLE III A-1

ETHIOPIAN ELECTRONICS IMPORTS

PRODUCT	IMPORTS IN THOUSAND BIRR				
	1978	1979	1980	1981	1982
Navigational (764.831,832)	2675	147	225	394	1272
Broadcasting (764.310)	2893	1829	278	316	3083
Radio spares (764.931)	1387	6017	3319	2231	3579
Microphones & speakers (764 210)	433	177	340	576	275
Telecommunications (764.110)	8918	1552	1874	1307	1558
Typewriters electric(751.110)	243	128	274	103	410
Cash, A/C, Calculating (1)	1018	316	670	402	513
Office Equip. Parts(759.000)	640	641	1092	963	1515
TV Cameras/transmission(2)	236	16	77	47	761
Data processing (752.000)	679	906	468	766	1001
Not elsewhere spec.	11620	10695	7108	8793	9034
Transformers small (771.111)	163	646	526	497	259
Electromedical (774.100)	17	37	141	281	79
Transistors, valves (776.000)	2	56	53	33	10
Signalling (778.820, 831,839)	49	46	131	82	175
Measuring (874.210,800)	914	776	1052	898	910
Sub-Total	31887	23985	17628	17689	24452
Consumer goods:					
Radios	2160	1564	2090	584	1453
Cassette radio	1516	359	686	2276	3102
TV	89	81	927	1954	3134
Radiogram	11	10	52	84	21
	3776	2014	3755	4898	7710
Sub-Total	35663	25999	21383	22587	32162

(1) 751.230; 751.220; 751.210

(2) 764.820; 764.311

(3) 764.910; 764.920

TABLE III A-2

DISTRIBUTION OF ELECTRONICS IMPORTS

Product	Average Import Value Million Birr *		Percent	
Consumer goods	4.4		16	
Consumer goods spares	3.7		13	
		8.1		29
Telecommunications	3.0		11	
Broadcast equipment	2.0		7	
Navigation	0.9		4	
Office machines	1.8		7	
Data processing	0.8		3	
Other goods specified	1.4		5	
		9.9		37
Unspecified goods		9.5		34
TOTAL		27.5		100

* Annual average of imports 1978-1982 in money values, uncorrected for changing value of money.

SOURCE: Worked up from Customs Statistics.

The Ethiopian distribution may be compared with distributions in other countries at a more advanced stage of industrialisation. The market for the most industrialised of all nations, the USA is shown in Table III-A.3. In this case consumer electronics is a small item at only 13 percent and spares forms an insignificant item. The major consumption of electronic goods is in data processing, almost 40 percent, and semiconductors, 21 percent, most of which go to the data processing industry anyway.

The production distribution is snown for three countries in Table III-A.4. China, India and the UK all have huge markets. They also demonstrate the way in which the proportions change. The bigger and more advanced the industry the smaller is the proportion of consumer goods manufacture; capital goods increase; and components become an important item of production.

These lessons show where Ethiopia might go in the very long-term. For the moment however, volumes are sufficient to consider manufacture only in consumer products and possibly in some communications equipment. The market for industrial equipment and data processing is probably of the order of 10 million Birr. Even if this grows at 10 percent per year for a decade it will still be of the order of only 20-30 million Birr. The range of goods covered in this category will be huge and the volumes of each item far too small to consider manufacture. Much of the electronic requirement will be imported as part of projects or incorporated in other goods and this will also limit the manufacturing opportunity. The opportunity for manufacturing components will also be restricted by the volume of local requirements. It will be seen later that the big component manufacturers in SE Asian make more of a single type of component in a year that the entire annual demand for all types of components in the whole of the Ethiopian consumer goods market).

TABLE III A-3

USA ELECTRONICS MARKETS

Medium-Term Growth %	MARKET	1984 Market Distribution %		
18	Data processing:			
	Systems	23.3		
	Storage	5.6	39.6	
	Peripherals	10.7		
17	Office equipment:			
	Copying	2.8		
	Word processing	2.3	6.3	
	Other	1.2		
13	Communications*			
	Radio/TV equipment	2.4		
	Data	1.9	6.1	
	Other	1.8		
15	Industrial and Commercial:			
	Industrial controls	4.2		
	T & MI	3.8		
	Medical	2.9	13.7	
	Automotive	0.8		
	Other	2.0		
8	Consumer			
	TV	3.6		
	Audio	3.1		
	Microwave ovens	1.8		
	Video	1.4	13.0	
	Games	0.9		
	Time pieces	0.7		
	Calculators	0.5		
	Other	1.0		
9	Components			
	Active	3.1	11.3	
	Passive	8.2		
19	Semiconductors:			2'
	Discrete	1.3		
	IC's	8.2	10.0	
	Optoelectronics	0.5		
		100		

Source: Worked up from Electronics, January 1981.
* Excluding PT & T.
Excludes all Government expenditures (defence, Nasa etc.).
Total value of table is $127.7 Billion.

TABLE III A-4

PRODUCTION DISTRIBUTIONS IN OTHER COUNTRIES

	PERCENT IN 1980		
	CHINA (1981)	INDIA	UK
Consumer goods	37	27	8
Communications	26	23	69: Inf. Tech. 32
Control, dp, instruments		21	capital equip. 37
Aerospace, defence	not spec.	8	
Components	37	21	23
	100	100	100

Source : UNIDO country reports; DPSA/UNCTAD report; UK Government Publications.

The segmentation and interdependence of the electronics industry is illustrated in Figure III A.1 The areas which merit further market attention at present are:

- radios
- televisions
- telephones
- radio communications
- some components for above products.

B. MARKET FOR RADIOS

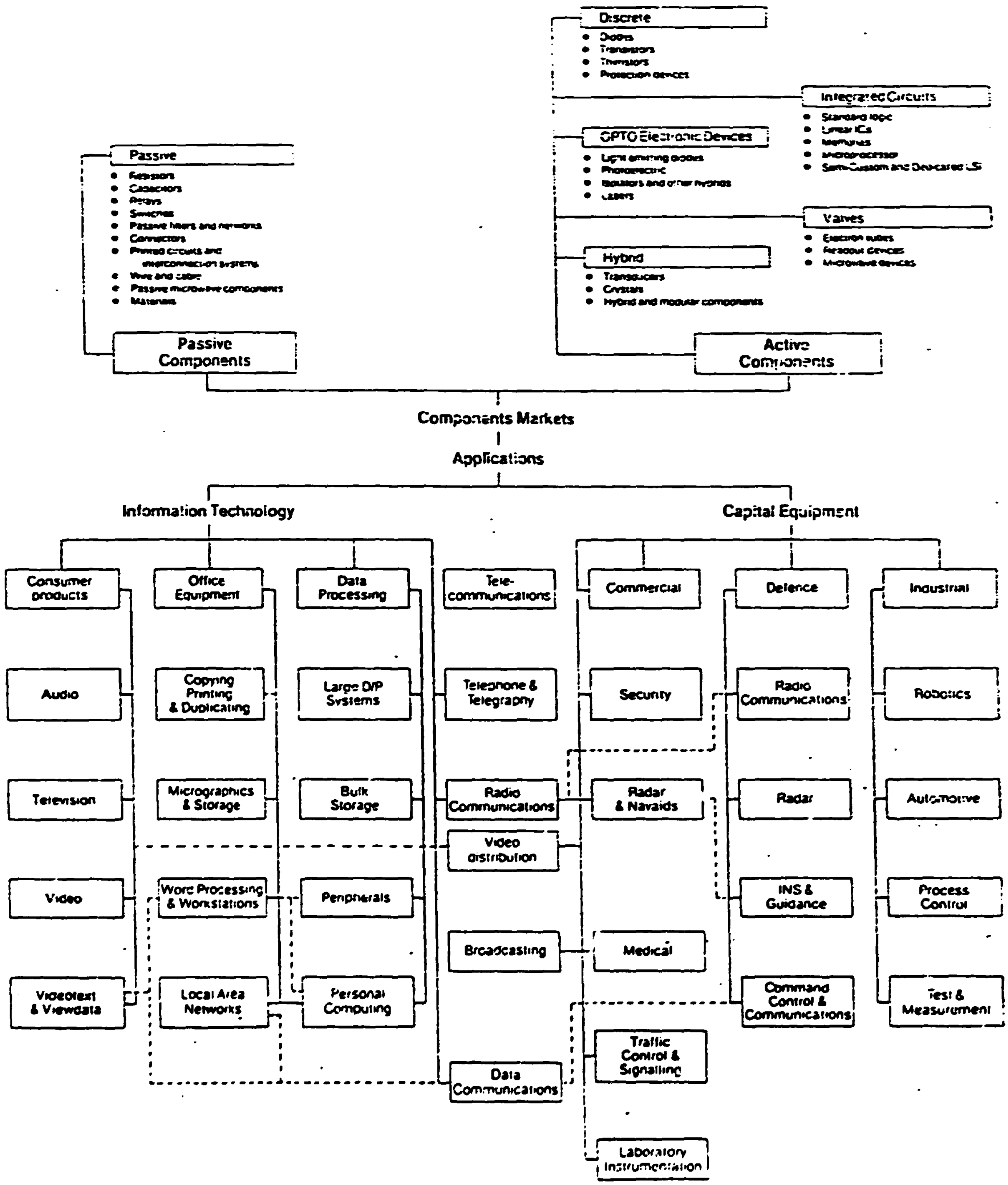
The market forecast for radios has been developed by estimating the present number of radios in use and applying to this a reasonable growth rate under normal commercial conditions.

1. Imports of Radios

Radio imports from 1966 to 1984 are summarised in Table III B-1, the information being supplied by the Customs Department for the years up to 1982.

Imports for the years 1983-84 are based on discussions with the leading importer, Philips. In 1982 Philips held 77.5 percent of the total import of radios (non-cassette types). Their imports have increased slightly and this confirms the subjective opinion that total imports have risen in the same way. Their 1982 percentage is assumed to be maintained in 1983-84. Cassette radios have been increased by the same amount.

FIGURE III A-1 SEGMENTATION OF ELECTRONICS INDUSTRY



Note: This structuring is not intended to be comprehensive but aims to illustrate the structure and interdependency of the industry.

TABLE III - 3.1

RADIO IMPORTS

YEAR	IMPORTS IN THOUSAND SETS PER YEAR			
	RADIOS	CASSETTE RADIOS	CONTRABAND	TOTAL
1966	17.2	not		17.2
1967	42.1	extracted		42.1
1968	46.4	2.9		49.3
1969	69.6	0.7		70.3
1970	118.4	0.7		119.1
1971	70.0	1.7		71.7
1972	35.3	1.3		36.6
1973	70.4	1.2		71.6
1974	124.9	0.9		125.8
1975	209.1	14.3		223.4
1976	215.9	23.3		239.2
1977	218.5	31.8		250.3
1978	56.1	16.9	not significant	73.0
1979	69.9	2.0	0.9	72.8
1980	77.3	5.7	6.1	89.1
1981	15.9	9.3	27.3	52.5
1982	46.5	15.3	6.5	68.3
1983	57.0	18.8	6.2	82.0
1984	60.2	19.9	9.8	89.9

SOURCE: 1966-1982 Customs Dept.
1983-84 estimates
All contraband figures customs estimates

Contraband importing is regarded as having become more serious since the controls imposed in 1978. Consequently estimates do not exist before that time. The contraband estimates are based on sets seized in Asmara and Addis Ababa, and on the very rough assumption at the Customs Department that these seizures represent only 10 percent of the total contraband traffic. Furthermore the proportion of overall contraband seized in Addis Ababa and Asmara averaged 23 percent of seizures in the whole of Ethiopia. This percentage is assumed to apply also to radios. Contrary to general opinion, contraband still does not represent a very high proportion of imports. Apart from 1981 when 630 sets were siezed (and total traffic was assumed to be 27,000) the contraband has averaged around 9 percent of total imports.

In most of the year 1978-82 (and, it is believed, in 1983-84) cassette radios were around one third of non-cassette radios. This reflects the fact that a high proportion of radios are imported personally rather than by the trade. Most personal imports are cassette radios. In earlier years (1968-1975) radios were imported in bulk and cassette radios formed only 6 percent of the total.

The erratic movement of radio imports is clearly demonstrated in Figure III B-1. The increased demand from 1974 is explained by a strong interest in the reporting of current events following the introduction of the new Socialist Government. The decline in sales from 1978 is explained by severe import restrictions following foreign currency shortages. Sales are probably now rising slowly but import restrictions remain in force.

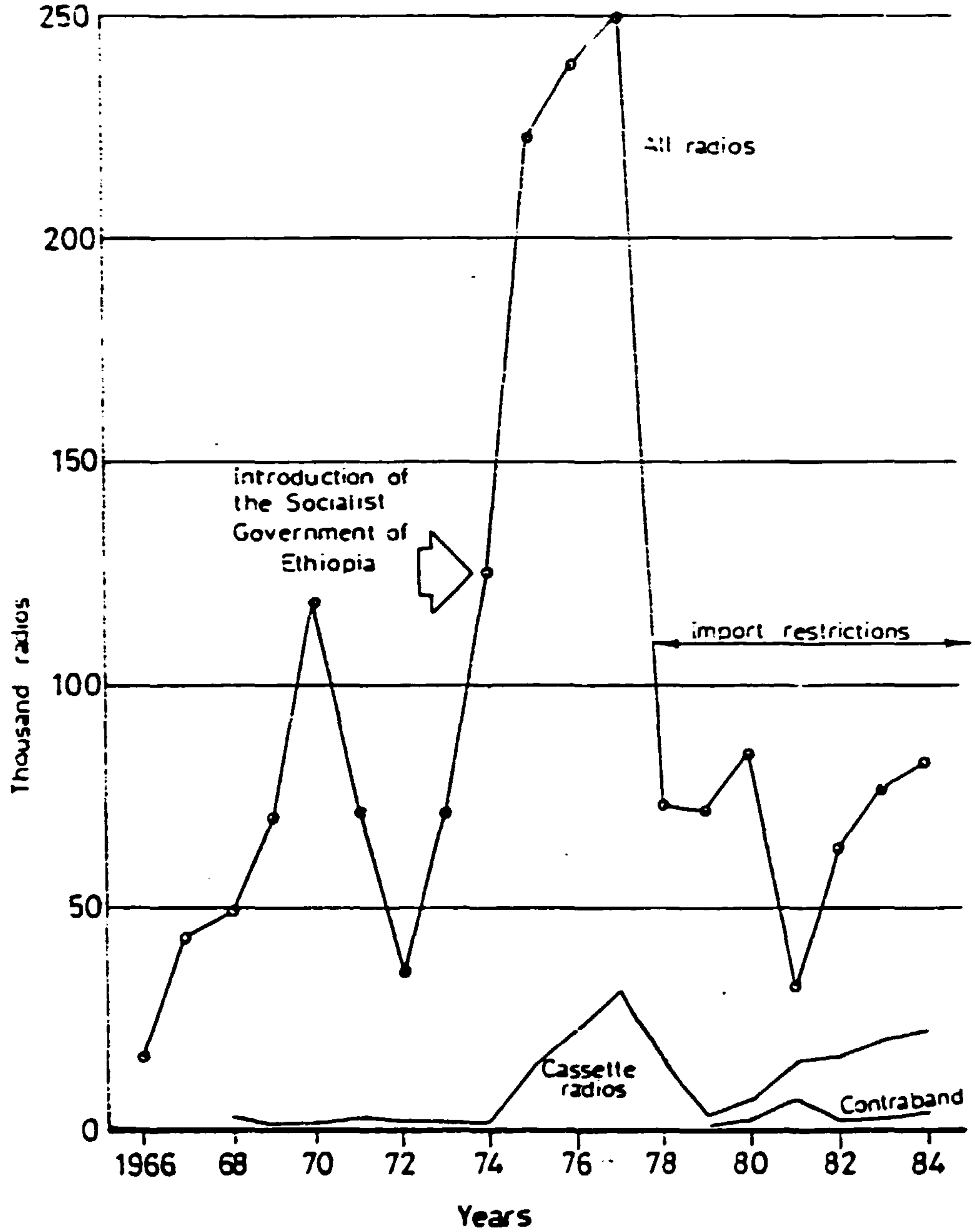


FIGURE III B-1 MOVEMENT OF RADIO IMPORTS

2. Radios in Use

Estimates of total radios in use in Ethiopia vary widely. The DPSA report makes a very subjective estimate of 2 million. The Ten Year Perspective Plan states 3 million, an estimate which also contains some very subjective elements.

A crude estimate can be obtained from the cumulative imports. These are:

Last 10 years	1.24 million
Last 15 years	1.66 million
Last 20 years	approx. 1.8 million

The life of a radio in Europe is now about 7 years but this has been reduced in recent years by the portability (greater risk of damage) of modern radios. Given the economic circumstances of Ethiopia it is likely that the radio life is appreciably longer, probably 10-15 years. This cumulative imports indicate a radio population of around $1\frac{1}{3}$ million.

It is useful to compare Ethiopia's radio stock with that of other developing countries. Selected data are prepared in Table III-B.2. The radio data are drawn from the UN Statistical Yearbook 1981, which in turn is drawn from UNESCO Statistics. The data are not presented on a year-by-year basis and so the growth rates are for the period as a whole. Per capita GNP is obtained from the World Bank Development Report 1981. It should be stated that the UNESCO figure of 220,000 for radios in use in Ethiopia in 1979 is manifestty incorrect and has not been included in the Table.

TABLE III-3.2

STOCK OF RADIOS IN SELECTED COUNTRIES

COUNTRY	GNP PER CAPITA 1979 $ US	RADIO SETS PER 1000 PEOPLE 1979	GROWTH OF RADIO NUMBERS 1970-79 PERCENT
Lao	-	83	22
Bhutan	80	9	-
Bangladesh	90	8	-
Chad	110	23	6
Ethiopia	130	-	-
Nepal	130	18	18
Somalia	140(est)	23	5
Mali	140	14	5
Burma	160	21	6
Burundi	180	34	10
Upper Volta	180	16	3
India	190	34	8
Malawi	200	43	10
Rwanda	200	32	20
Sri Lanka	230	47	4
Benin	250	58	10
Mozambique	250	25	12
Sierra Leone	250	99*	30*
Haiti	260	21	2
Pakistan	260	66	5
Tanzania	260	28	14
Zaire	260	5*	10*
Niger	270	39	4
Guinea	280	25	33
Cen. A. Rep.	290	18	10
Madagascar	290	135	9
Uganda	290	19	-
Mauritania	320	69	8
Lesotho	340	23	22
Togo	350	208*	37*

COUNTRY	GNP PER CAPITA 1979 $ US	RADIO SETS PER 1000 PEOPLE 1979	GROWTH OF RADIO NUMBERS 1970-79 PERCENT
Indonesia	370	40	10
Sudan	370	74	4
Kenya	380	35	3
Ghana	400	106	6
Yemen AR	420	18	5
Senegal	430	54	1
Zimbabwe	470	42*	-
Egypt	480	132	2
Yemen PDR	480	54	0
Liberia	500	177	8
Zambia	500	22	6
Honduras	530	49	2
Bolivia	550	92	3
Thailand	590	128	9
Philippines	600	45	1
Portugal	2180	160	-
Italy	5250	240	2
UK	6320	931	5
USA	10630	2040	5

* Based on another year, usually 1978;
** Estimated in this study

SOURCE: UN Statistical Yearbook 1981 and World Bank Development Report 1981 (Per Capita Incomes)

The data in Table III B-2 have been subjected to a superficial regression analysis. First the 44 countries from Bhutan to the Philippines were analysed using a model of the form:

$$\log Y = a \log X_1 + b \log X_2$$

Where Y = per capita ownership of radios in each country

X_1 = per capita GNP

X_2 = percent urban population

a and b are constants

Urban population is not included in the Table because it contributed very little to the results. The data were very poorly correlated. Per capita income and urban population explained only 36 percent of the variation. (i.e. r^2, called the correlation coefficient =0.36). There is therefore no good and persistent relationship between per capita income and radio ownership for all countries up to 600 dollars per capita GNP.

A different picture, however, emerges when only the 14 countries from Bhutan to Benin are considered. In this case a simple linear regression of radio ownership against GNP per capita was correlated 80 percent (r^2 = 0.80). A further improvement was obtained by excluding Chad (unusually high) and Upper Volta (unusually low). The remaining 12 countries produced a correlation coefficient of 0.92. Thereafter, the addition of further countries produced a very rapid decrease in the correlation.

The equation for the 12 countries mentioned above is:

R (radios per 1000 people) = -$19.3 + 0.29 (GNP percapita) blank

If we take the percapita GNP of Ethiopia as $130 (in 1979) then the radio intensity is:

$$(0.29 \times 130) - 19.3 = 18.4 \text{ per thousand people}$$

It should be stressed that this predictor applies only to countries up to $600 per capita GNP (in 1979).

The average growth of radio stock in these countries during 1970-1979 was 8.75 percent. The average growth of population for the same countries during 1970-82 (World Bank Development Report 1984) was 2.47 percent. An indication of the average growth of radio intensity during this period may be taken as:

$$\frac{1.0875}{1.0247} = 6.1 \text{ percent}$$

If the radio intensity indicated above for Etniopia in 1979 increases at 6.1 percent from 1979 to 1984 it becomes 24.7 radios per 1000 people in 1984. This analysis suggests that if the radio stock of the 12 poorest countries continued to change in the manner of the years 1970-79, and if the Ethiopian radio stock is fitted on the linear plot mentioned above, then in 1984 the Ethiopian radio stock would be about 25 radios per 1000 people (assume 24.7 as above).

On this basis the number of radios in use in Ethiopia would be 0.84 million with population at 34 million and 1.03 million with population at 42 million.

If these figures are related to Table III B-1 they equal the cumulative imports over about 9 years, implying 9 year life. This is quite possible in Ethiopia although the life of a radio in Europe is 7 years.

Intuitively it may be supposed that the radio stock follows an 'S' type of relationship. Certainly there is a considerable flattening of demand since the "poorest 12" linear relationship given above, considerably over-predicts the rich country radio stock.

A further approach to the radio- stock is to consider the radio census taken in 1976 in Addis Ababa. The total number of radios was 139,000. The Addis Ababa population was given as 1.15 million. The urban population can be calculated at 3.36 million at that time. Extrapolating the Addis Ababa radio population to the whole urban population we obtain 406,000 radios in use in urban areas. From Table III B-2 the mean growth rate for the number of radios in use in 12 countries from Chad to Benin was $8\frac{3}{4}$ percent. If this figure is applied for 8 years, to the urban population, then this becomes 785,000 radios in use in urban areas. The present urban population is estimated to be 5.2 million. This puts the urban radio intensity at 151 radios per thousand people. This seems a reasonable figure; at this level it approaches the circumstances of the poorer industrialised nations (e.g the whole of Portugal was 160).

According to the Addis Ababa survey in 1976 there was a sudden increase in the number of radios per household at about 25 Birr/month income. By 200 Birr/month income nearly all households had a radio. This effect is shown in Table III B-3.

The rural population may be around 35 million with say 30 million within the economy (as opposed to those who have nothing and are outside the economy). Here the radio intensity will be very low probably around 10 to 20 per 1000 people. This amounts to 300,000 to 600,000 radios. Thus the urban and rural radio total could be 1.1-1.4 million.

TABLE III 3-3

RADIOS CENSUS IN ADDIS ABABA

1976

INCOME 1976 BIRR/MONTH	RADIOS PER HOUSEHOLD	RADIOS PER 1000 PEOPLE*
1-9	0.14	29
10-24	0.19	40
25-49	0.37	77
50-74	0.54	113
75-99	0.62	129
100-	0.68	142
150-	0.78	163
200	0.87	181
250-	0.93	194
300-	0.95	198
350-	0.87	181
400-	1.00	208
450-	0.90	187
500-	1.00	208
600-	0.94	196
700-	0.88	183
800-	1.00	208
900-	1.00	208
1000-	1.00	208
1250+	1.00	208

* Given the Addis Ababa total population of approx. 1.15 m and the number of households as 243,340 this implies 4.8 persons per household. (However the Statistical Abstract suggests a lower figure).

The figures in the Table assume a maximum of one radio per household though at the higher incomes there may of course be more.

The various approaches to estimating the number of radios in service may be summarised as follows:

	million
Official estimates	2.0 - 3.0
10-15 years cumulative imports	1.2 - 1.6*
Well-correlated regression of 12 poor countries	0.8 - 1.0
Census-related estimation	1.1 - 1.4

These approaches suggest very strongly that the actual number of radios in use is much less than previously thought and lies in the range 1-1½ million.

The assumption made hereafter in this study is that the radio stock in 1984 was $1\frac{1}{4}$ million.

* excluding discards which in Table III-B.5 are shown as 0.4 to 0.5 million respectively. This would reduce the totals considerably.

3. Plans and Radio Growth

A summary of the transmission facilities used by Voice of Revolutionary Ethiopia was contained in the UNCTAD/DPSA Report of July 1983. The studios are located in Addis Ababa and programmes are transmitted from Addis, Asmara and Harar. The transmitters are listed in Table III B-4.

The quality of reception is higher with medium wave transmission. The range of the 100 kw medium wave transmitters in Ethiopia is around 200 kms.

According to Voice of Revolutionary Ethiopia, medium wave broadcasts reach 15-20 percent of the country and, since broadcasts are located in the more populated regions, probably a higher percentage of the population. The 1 kw transmitter has a range of around 100 kms. The short wave transmitters (with poorer reception) cover the whole country.

Figure III B-2 presents the area coverage of medium wave transmissions. The reception circles are drawn at around 200 kms radius. They confirm the view that present medium wave coverage is 15-20 percent of the country. It is also reported in the questionnaire from Voice of Revolutionary Ethiopia that medium wave coverage will increase to 50 percent within the decade. The dotted lines in Figure III B-2 indicate the increased coverage from medium wave transmitters at Jimma, Awasa and Bahr Dar. It does not look as though the three new transmitters will achieve an increase to 50 percent coverage. Expenditure on expansions is expected to exceed 40 million Birr (current prices).

TABLE III B-4

RADIO TRANSMITTERS

WAVE BAND AND LOCATION	POWER KW	FREQUENCY MHz	METRE BAND
	EXISTING		
Medium Wave:			
Addis Ababa	100	0.872	345
" "	1	0.989	300
Asmara	50	0.954	315
"	1	1.475	200
Harar	100	NOT SPECIFIED	
Short Wave:			
Addis Ababa	100	5.990	49
	100	7.110	41
	100	7.165	41
	100	7.610	31
	PLANNED		
Medium Wave:			
Awasa	100		
Jimma	100		
Bahr Dar	100		

SOURCE: List of stations from Voice of Revolutionary Ethiopia's response to IPS Questionnaire. Frequencies and wavelengths from UNCTAD/DPSA report 1983.

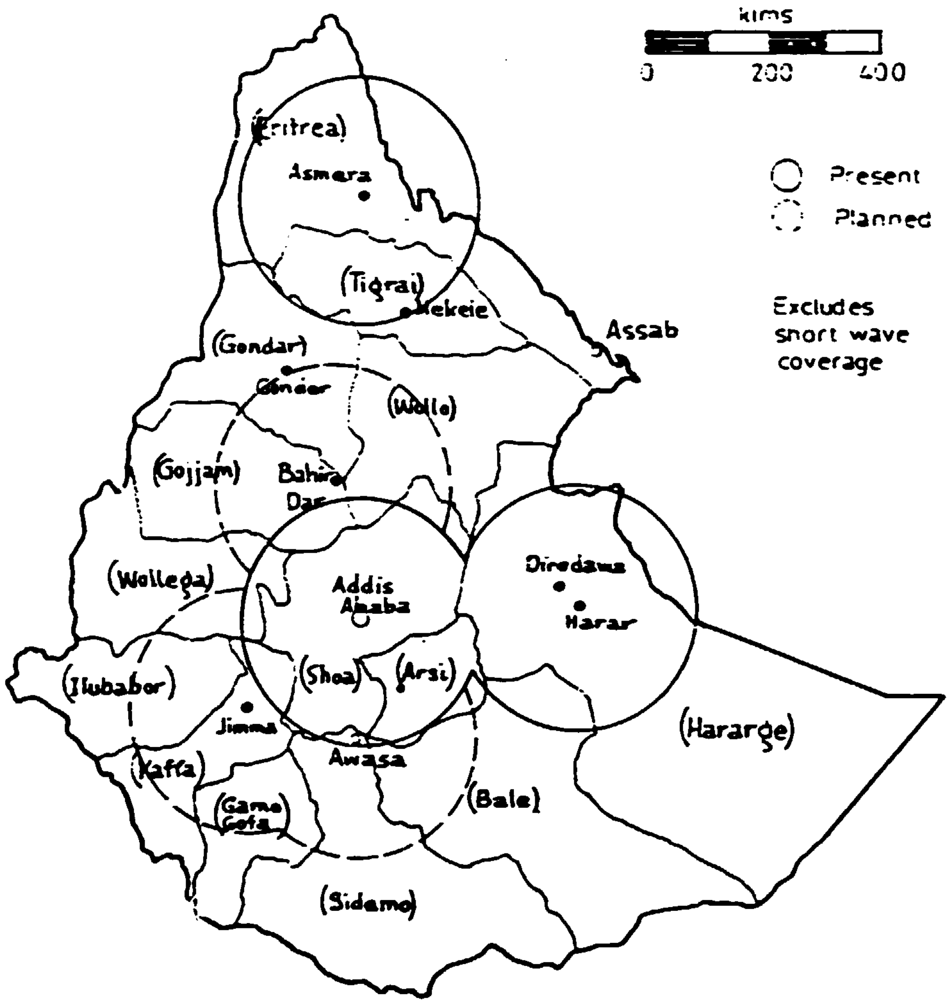


FIGURE IIIB -2 MEDIUM WAVE RECEPTION OF
VOICE OF REVOLUTIONARY ETHIOPIA

In addition to the transmitters of Voice of Revolutionary Ethiopia there are also twelve transmitters operated by EMMS (The Education and Mass Media Service). These are all 1 kw stations with very limited range (probably 30-90 kms):

Wolita (Sidamo)
Legadadi (Shoa)
Alemaya (Harar)
Robe (Bale)
Gore (Illubabor)
Ghimbi (Wolega)
Dessie (Wollo)
Debre Marcos (Gojam)
Bahr Dar (Gojam)
Asmara (Eritrea)
Mekele (Tigre)

In future these stations are expected to operate at 10 kw (statement made in the UNCTAD/OPSA report). This will substantially increase their coverage to 120-150 kms but will still leave large parts of the country without EMMS broadcasts.

These extensions of broadcasting services will contribute to the spread of radio use so that it is not only growth of per capita income which will determine the growth of the radio stock.

The growth rate of radios in use in Ethiopia can be calculated. First it is necessary to generate a replacement rate model. This is shown in FigureIII B-3. The life of radios in Europe is about seven years. The probability of failure (leading to discarding). follows a classic form with a steep rise to the year of maximum failure (7 years) followed by a long tail.

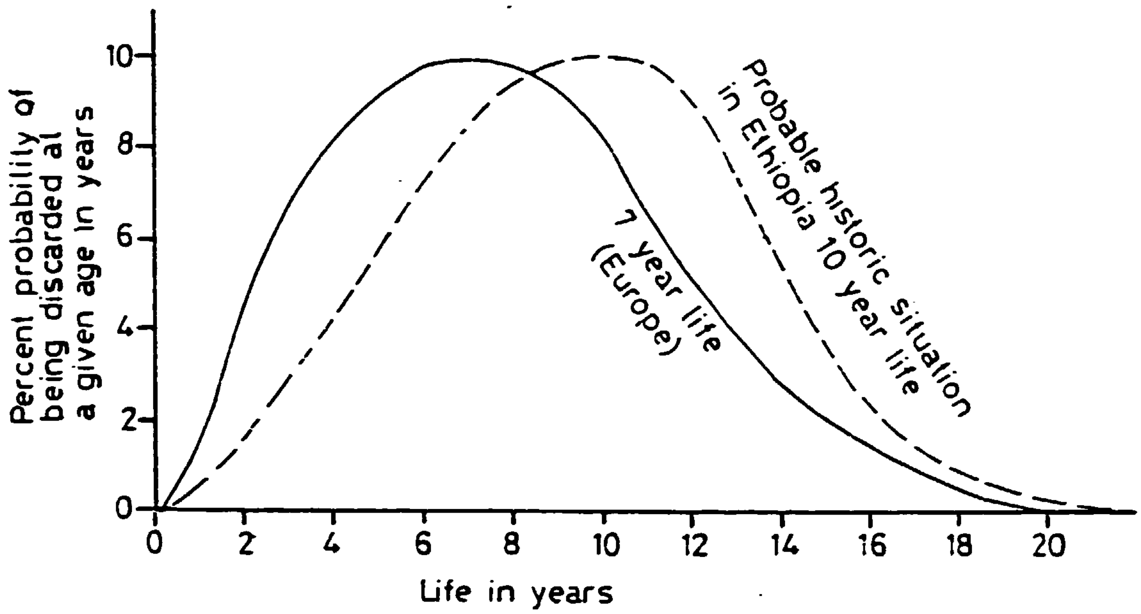


FIGURE III B-3 RADIO REPLACEMENT MODELS

In Ethiopia the life may be longer due to less interest in fashion and technical obsolescence, more care and a greater readiness to accept a reduced standard of reception or scope of performance. A second curve is plotted on Figure III B-3. that of a 10 year life.

The 10 year life probablity model has been used to calculate the rate of loss of stock of radios. The method can be seen below:

> The breakage or discard probability is 2 percent for a 2 year old radio. Thus of all the new radios (ie. imports) of 2 years ago, 0.02 of them will need to be replaced this year. Likewise of all the new radios (imports) of 9, 10 and 11 years ago, ten percent of each year's imports will need to be replaced this year. The cumulative probability of replacement of radios during 20 years is of course 1.0 (or 100 percent). Half the radios are over 10 years old.

It is now possible to calculate the net increase in stock in each year. This is the difference between imports and discards. Then working backwards from an estimated 1.25 million radios in 1984 (see section III B-2) the stock in each year can be calculated. This procedure is shown in Table III B-5.

The information in Table III B-5 is presented graphically in Figure III B-4. The manner of change in radio stock can be clearly seen. During the years 1965-1978 the radio stock increased at an average of 9 percent per year, with its highest sustained rate during the period 1964-1973. Growth flattened during 1970-73. After 1973 there was a steep rise, which for the short period 1973-77 was 18 percent per year. In the last few years, due to import restrictions the growth rate has fallen at $1\frac{3}{4}$ percent per year.

TABLE III B-5

RADIOS IN USE 1964-1974

YEAR	THOUSAND RADIO SETS			
	IMPORTS	REPLACEMENT OF EXISTING STOCK LEVELS (DISCARD	IMPORTS LESS BREAKAGE	STOCK IN USE
1964	18	14	4	441
1965	20	16	4	445
1966	17	18	(1)	449
1967	42	20	22	448
1968	49	22	27	470
1969	70	23	47	497
1970	119	24	95	544
1971	72	25	47	639
1972	36	26	10	686
1973	22	28	(6)	696
1974	126	32	94	690
1975	223	36	187	784
1976	239	40	199	971
1977	250	52	198	1170
1978	73	64	9	1368
1979	73	78	(5)	1377
1980	89	94	(5)	1372
1981	53	106	(53)	1367
1982	68	118	(50)	1314
1983	82	110	(28)	1264
1984	90	104	(14)	1250

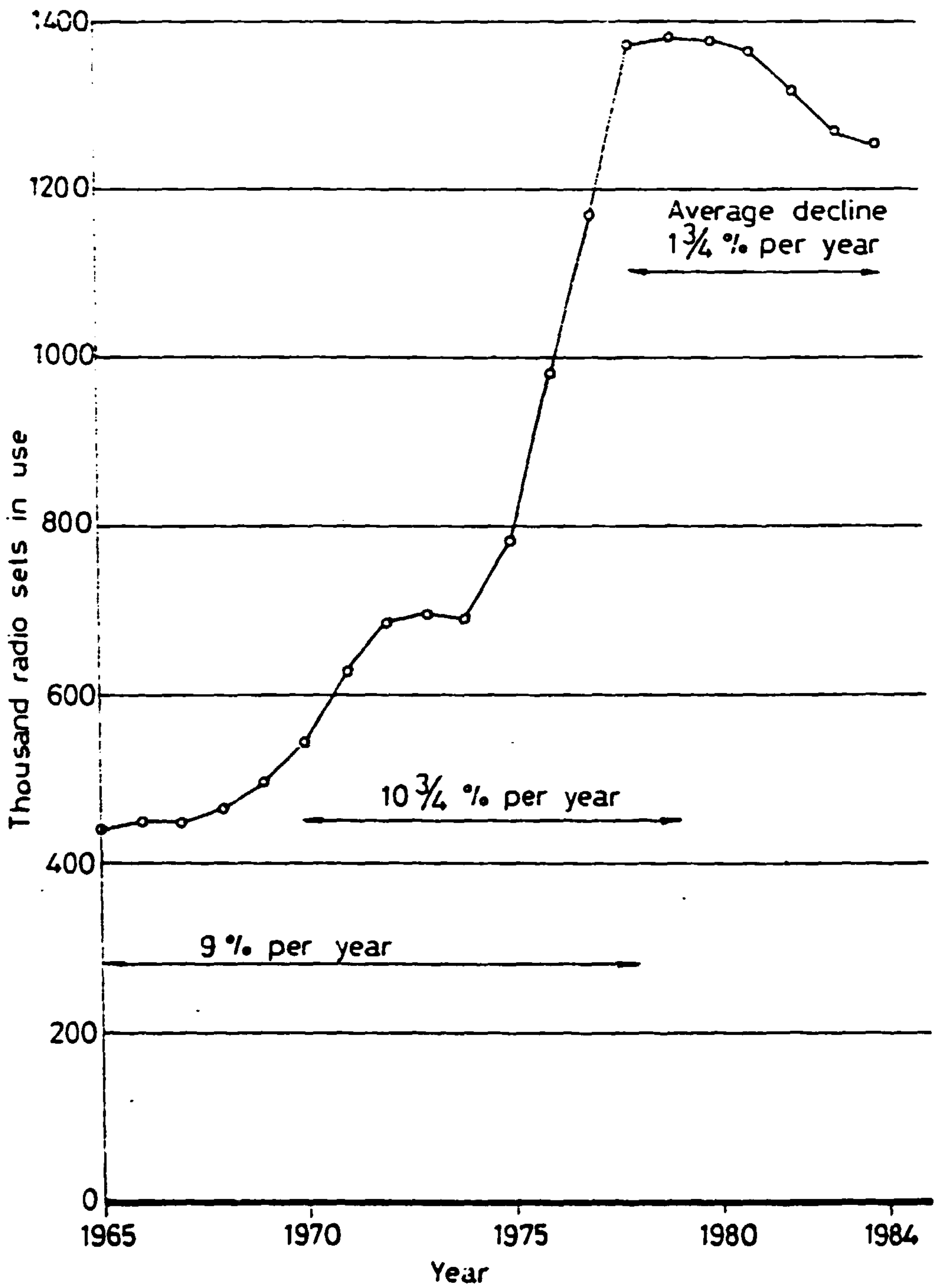


FIGURE III B-4 RADIO STOCK HISTORIC GROWTH

The growth rates may be compared with those shown in Table III A-2 for selected countries. The average growth rate for 12 poor countries (Chad to Benin) was $8\frac{3}{4}$ percent with a range 3-20 percent. Ethiopia during the same period was $10\frac{3}{4}$ percent.

The 17 countries from Mozambique to Ghana had an average growth rate of 13½ percent per year but with a very wide range (2-37 percent).

There is a strong suggestion of a rate around 9-13 percent typical for the poorer countries. It is interesting to note that Ethiopia's rate for the period 1965 up to 1978 (the import restrictions) was 9- percent per year.

It may be expected that Ethiopia's radio growth rate will increase sharply if well-priced radios are freely available and widely distributed. In this case a growth rate of say 13 percent could well be achieved (especially following a period of decline). If restrictions remain in force then growth will be lower than the average figure for the poorer countries ($8\frac{3}{4}$ percent) and the sustained Ethiopian growth of 1965-1978 (8½ percent). A figure of 7 percent will be used for the low growth case.

4. Radio Manufacturing Opportunity

From the previous sections an overall demand for radios can be calculated using:

- 1984 radio stock at 1.25 million
- Average radio life 7 years
- Average growth of stock 7-13 percent, taking the medium of the two rates as 10 percent but allowing for development of the long term growth as follows:

1985	2 percent
1986	5 percent
1987 etc.	10 percent

The growth of imports is then as shown in Table III B-6. The total reaches about 200,000 in 1987 and about 300,000 in 1991.

Supplementary calculations have been made of imports in the 7 percent and 13 percent growth cases. The three growths are shown in Figure III B-5 and summarised below:

	7% GROWTH	10% GROWTH	13% GRWOTH
		THOUSAND SETS PER YEAR	
1986	157	172	183
1988	203	250	301
1990	214	281	362
1992	233	336	478
1994	273	413	591

TABLE III B-6

FUTURE GROWTH OF RADIO DEMAND

YEAR	THOUSAND SETS IN USE			
	STOCK	INCREMENT IN STOCK	REPLACE-MENT	DEMAND
1984	1250	(14)	104	90
1985	1275	25	136	161
1986	1339	64	108	172
1987	1473	134	105	239
1988	1620	147	104	251
1989	1782	162	104	266
1990	1960	178	104	282
1991	2156	196	112	308
1992	2372	216	120	336
1993	2629	237	136	373
1994	2870	261	152	413

Growth rate of stock 1985 2%; 1985 5%; 1987 10%.

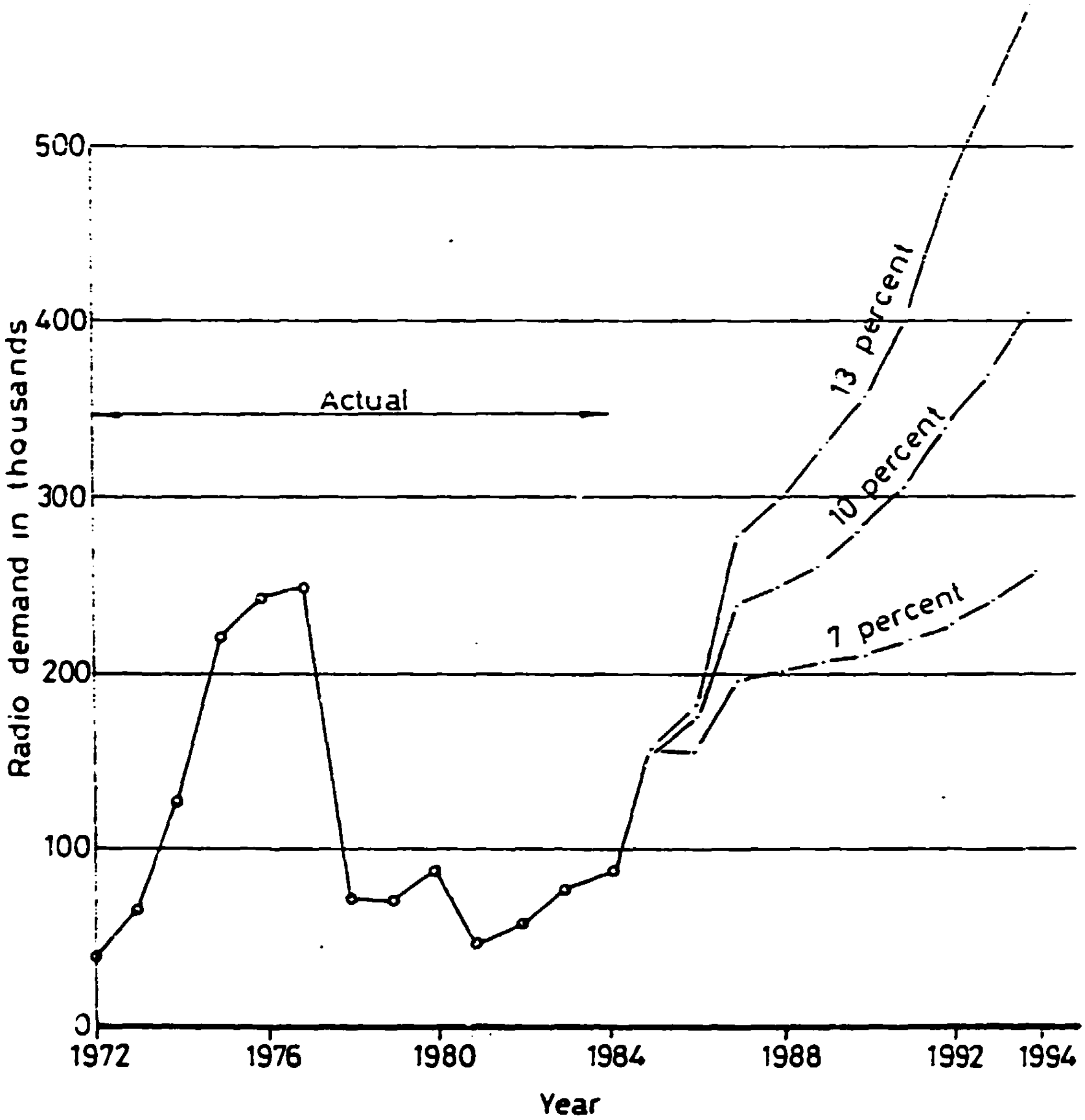


FIGURE III B-5 FUTURE GROWTH OF RADIO DEMAND

The product range must reflect the fact that although eventually most of the production will be able to receive medium wave transmissions there will still be some people who will find that short wave (although normally inferior to a strong medium wave signal) will be better. Moreover there may be some people who may wish to pick up foreign transmissions on short wave. There will also be some people who may chose the 2-band (medium and short wave) for purely subjective reasons. Although it will be more costly they may decide they prefer a more sophisticated set.

Very few of the radios imported into Ethiopia for resale have more than two bands. It would be possible to satisfy nearly all the local market with MW or MW/SW reception. A MW-only radio would be the cheapest design.

Cassette radios are common although appreciably more costly than a simple 2-band receiver. Cassette radios form about one quarter of imports at present but many of these are personal imports. If radios were sold in higher volumes the proportion of cassette radios might fall, the high cost and low availability of cassettes being a disincentive. Furthermore if radios are distributed more widely in the lower income bracket then the higher cost of the cassette radio will be a disincentive in itself. It may be assumed that cassette radios will be 2-band.

The overall distribution of radios will probably take the following form:

	Percent
Medium wave	24
MW/SW	48
Cassette radios	23
Other models	5 (imported)
	100

The most appropriate product mix would be to produce the first 3 models above. Variations of case design could be introduced to increase the product range while maintaining essentially the same basic technical specifications.

The prices of imported radios are given in Table III B-7. The average price of all non-cassette radios imported in 1983 was 30 Birr. This price has changed very little over the years from 1968. The progressive cost reductions have largely been able to compensate for the inflation in the price of imports. The major importer (Philips) is understood to import from Hong Kong, India and Singapore. Their respective average inflation rates during 1970-1982 were 8.6 , 8.4 and 5.4 percent. The mean of these three is 7.5 percent. If the current prices of radios are deflated at 7½ percent per year then the prices in the early 1970's were twice their present level.

The retail prices currently charged by the major importer are shown in Table III B-8. The wholesale prices are normally marked up by about 30 percent to produce the retail price level. The retail price of a small 2-band radio is about 68 Birr and the wholesale price about 55 Birr. (In this case the mark-up is lower than 30 percent).

It is assumed that the wholesale price includes the taxes paid on imports. These amount to 69 percent. If the 55 Birr wholesale price is divided by 1.69 then the CIF price appears to be 33 Birr.

The range of CIF prices for a small 2-band radio appears to be around 30-33 Birr.

The procedure for importing radios is to apply to the National Bank for the foreign exchange. Part or all of this application may be approved. Radios may be freely priced but any radio over 50 Birr attracts a 55-75 percent surcharge.

TABLE III B-7

CIF PRICES OF NON-CASSETTE RADIOS

Year	Number of Sets Imported	Value of Imports CIF BIRR	Value Per Set Current Value	Value Per Set (Constant 1983 Values)
1968	46,389	1,512,086	32.6	96
1969	69,637	1,802,237	25.9	71
1970	118,418	2,688,178	22.7	58
1971	68,995	1,775,577	25.7	61
1972	35,273	949,176	26.9	60
1973	70,454	2,150,739	30.5	63
1974	124,858	2,814,159	22.5	43
1975	209,067	4,387,949	21.0	37
1976	215,868	4,122,971	19.1	32
1977	218,511	4,708,832	21.6	33
1978	56,115	2,160,058	38.5	55
1979	69,910	1,564,107	22.4	30
1980	77,256	2,990,588	27.1	34
1981	15,865	584,240	36.8	43
1982	46,491	1,453,704	31.3	34
1983	59,918	1,799,723	30.0	30

Deflator used for constant 1984 values is 7.5 percent being the average of inflation rates (1970-82) in Hong Kong, India and Singapore;source of other data : customs.

TABLE III B-8

RADIO RETAIL PRICES

TYPE OF RADIO	APPROXIMATE PRICE IN BIRR	
	WHOLESALE	RETAIL
Pocket medium wave	20	27
Small 2-band (battery)	55	68
Bigger 2-band, dc only	69	88
AC/DC 2-band	85	104
Cassette, single speaker	139	180
11-band	199	259

SOURCE: Philips 1984

The distribution of prices of radios handled by Ethof is shown in Table III B-9. In 1983 almost all the radios (95 percent), imported by Ethof had a CIF price under 50 Birr. After taxes and mark-ups the proportion still under 50 Birr had fallen to 48 percent.

It is assumed that radios retailing at 50 Birr, and with a 30 percent retail mark-up and 69 percent taxes, must have a CIF value of 23 Birr. Such radios appear to have constituted nearby half Ethof's imports in 1983, 72 percent of their 1982 imports and around 67 percent of their 1981 imports.

The distribution chain has weakened considerably since the imposition of restrictions and the reduction of sales. Most of the many shops retailing radios have ceased to do so. It is now thought that in many small towns there may be no one retailing radios. An effective distribution and retailing network would have to be reestablished to secure the outlet for volume local production of radios.

The market opportunity is summarised in Table III B-10. The low growth rate represents the relaxation of current severe import restrictions. The medium growth forecast assumes active encouragement of a radio plant and good protection against import competition. The high growth rate would probably only be achieved by an all-out effort to maximise radio sales.

There is an opportunity to make around 250,000 radios in 1988 (medium case). If the non-cassette versions can be sold at around 30 Birr they should compete with imports (before taxes). Even if locally manufactured prices were comparable with imports, however, some tariff protection would be needed to secure the local market.

TABLE III 3-9

SOME RADIO COSTS AND PRICES FROM ETHOF

Year, and Permit of Cost or Price	NUMBER OF RADIOS			
	Price under 50 Birr	Price 50-100 Birr	Price over 100 Birr	TOTAL
In year 1981*:				
CIF Addis/Asmara	6000	3000	-	9000
Retail	6000	3000	-	9000
In year 1982*:				
CIF Addis/Asmara	27,600	-	-	27,600
Retail	19,900	7700	-	27,600
In year 1983:				
CIF Addis/Asmara	13,637	700	31	14,368
Retail	6,852	7285	231	14,368

SOURCE: ETHOF. The samples do not include all of ETHOF's imports, but typically 60-90 percent.

TABLE III B-10

FORECAST RADIO SALES

YEAR	THOUSAND SALES PER YEAR											
	LOW GROWTH 7%				MEDIUM GROWTH 10%				HIGH GROWTH 13%			
	MW	MW SW	CASS	TOTAL	MW	MW SW	CASS	TOTAL	MW	MW SW	CASS	TOTAL
1984	23	45	22	90	23	45	22	90	23	45	22	90
1985	38	76	39	153	38	76	39	153	38	76	39	153
1986	38	75	37	150	41	82	40	163	44	88	43	175
1987	47	94	46	187	57	114	56	227	67	134	66	267
1988	48	98	47	193	60	119	59	238	72	143	71	286
1989	50	100	50	200	63	126	64	253	79	158	78	315
1990	51	102	50	203	67	134	66	267	86	172	86	344
1991	54	106	54	214	73	146	74	293	96	192	96	384
1992	56	110	56	223	80	160	79	319	114	228	114	454
1993	60	120	61	241	89	177	88	354	127	253	126	506
1994	65	130	64	259	98	196	98	392	140	280	141	561

Based on 95 percent of total sales

MW radios a constant quarter of sales

Cassette radios a constant quarter of sales

2-band non-cassette radios are half of sales

C. MARKET FOR TELEVISIONS

The market for televisions has been obtained by estimating the present number of TV's in use and applying to this a forecast growth rate.

1. Imports of Televisions

Television broadcasting began in Addis Ababa in 1964. Import statistics are available for the years 1966 to 1983. These are presented in Table III C-1, together with rough estimates for the early years 1964 and 65, and also for 1985. It is assumed that with the introduction of TV broadcasting there would have been a substantial import of receivers. These are assumed to be at about the 1966 level. The figure for 1984 includes the 3000 sets donated by Japan rewards the Revolution celebrations and assumes about 2500 sets imported by Ethof. It is understood that Ethof import TV's in batches of around 2000 and that they would have imported specially for the celebrations.

Contraband importing, although important to the radio market is not considered significant in televisions.

Colour television was introduced in 1984. The number of colour TV's is not known exactly but the Japanese gift was of colour TV's and it may be assumed that part of the Ethof imports were colour. There were some pre-existing colour sets bought in preparation for colour broadcasting and also for use with video tapes. Overall the number of colour sets is probably exceeds 5000. In the opinion of the Television Authority it could be as much as 20 percent of the total.

TABLE III C-1

TV IMPORTS

YEAR	NUMBER IMPORTED
1964	2000 } est.
1965	2000 } est.
1966	1952
1967	1549
1968	2037
1969	2267
1970	3752
1971	2003
1972	1730
1973	2934
1974	1549
1975	1387
1976	1209
1977	1296
1978	748
1979	237
1980	2422
1981	5121
1982	5709
1983	3631
1984	5500

Imports of TV's have moved in an erratic manner as Figure III C-1 shows. There was a very sharp increase from 1979. In this respect TV was different to radios (the peaks of radio sales and television sales are quite often separated in other countries). This sharp increase in imports was preceded by a long downward trend from 1970, punctuated only by a temporary recovery in 1973.

2. Television Receivers in Use

Current estimates of the number of television receivers in use put the figure at around 45,000 to 50,000. These official estimates include the Television Authority and the Ten Year Perspective Plan.

Cumulative imports are as follows:

Last	10 years	27,000
Last	15 "	39,000
All	21 "	51,000

Some of these imports will now have been discarded. The mean life of a television in Europe is about 10 years. If it is assumed that the maximum life in 25 years then a characteristic profile can be drawn for the probability of any given set being discarded in any given year. This is shown in Figure III C-2. Thus, using the 10 year life model a set purchased 10 years ago has a 9 percent probability of being discarded this year, and a set aged 5 years has a 5 percent probability of being discarded this year.

In Ethiopia both the mean life and the maximum life will be appreciably longer. The maximum life may extend to 30 years (in due course) and the mean life will probably be about 15 years. There will be a greater readiness

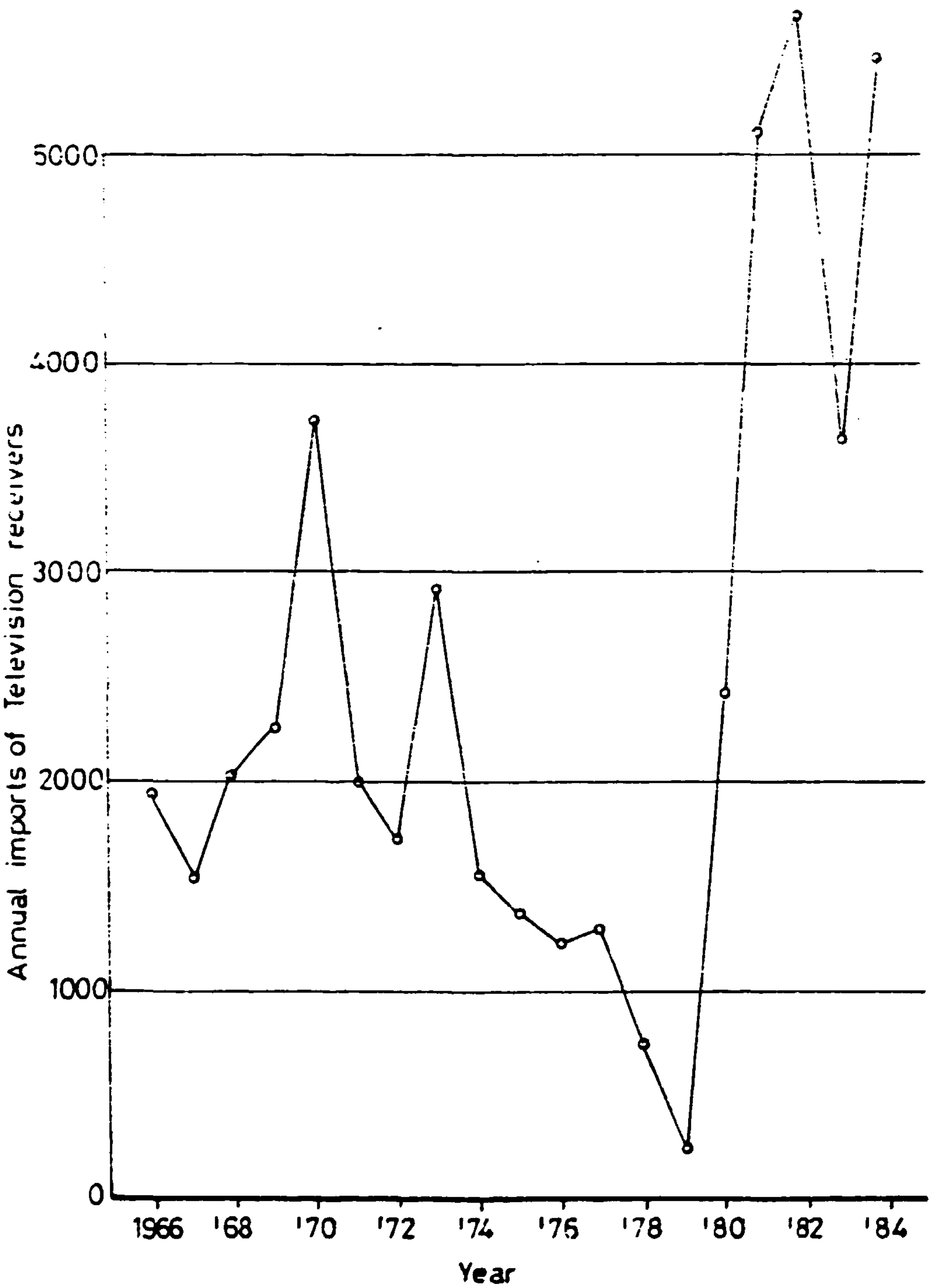


FIGURE III C-1 MOVEMENT OF TV. IMPORTS

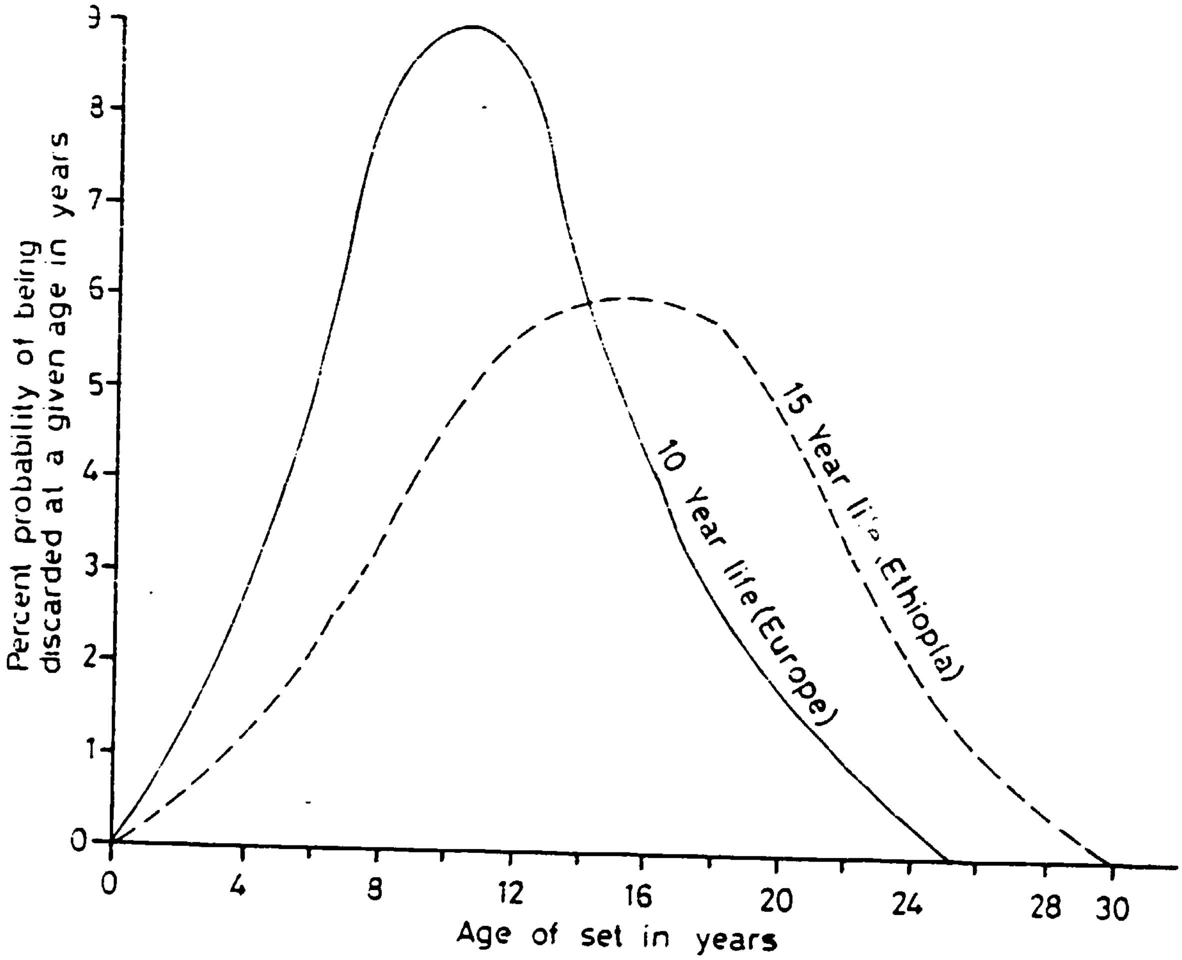


FIGURE III C-2 MODEL OF TELEVISION RECEIVER LIFE to maintain sets, to replace the picture tube (typically after about 10 years) and very little inclination to discard or sell the set for design reasons. The discard probabilities of an Ethiopian set with 15 year mean life and 30 year maximum life is also shown on Figure III C-2.

Using the discard model described above the discards can be calculated from the new sets (ie the imports). Table III C-2 shows these discards, together with the imports. The net increase each year contributes to the stock which is assumed to be zero in 1963. The import reaches 50,800 in 1984. The discards total 12,600 leaving a stock of TV's in use of 38,200.

The results of the model may be compared with the UNESCO figures for Ethiopia in 1970 and 1979. These would have been supplied by the Ethiopian Government. These figures are abstracted from the UN Statistical Yearbook 1981. In 1970 the UNESCO reports Ethiopian television stock as 8000. Since cumulative imports must by then have been at least 14,000 the figure must be wrong. In 1979 UNESCO report the TV stock as 25,000, which is much closer to the model figure of 23,000.

Another approach to determining the number of TV sets in use is to compare Ethiopia with other countries. Table III C-3 presents the information from the UN Statistical Yearbook 1981. Urban population percentage is included because in developing countries television reception is concentrated in urban areas. A logarithmic regression model of the 27 countries from 90 to 600 dollars per capita GNP was prepared. The form was:

$$\text{Log } Y = a \text{ Log } X_1 + b \text{ Log } X_2$$

Where Y = per capita ownership of televisions

X_1 = per capita GNP

X_2 = urban population percent

a and b are constants

TABLE III C-2

TV STOCK

YEAR	THOUSAND SETS		
	IMPORTS	SETS DISCARDED	NET STOCK IN USE
1963	-	-	0
1964	2.0 } est.	-	2.0
1965	2.0 }	-	4.0
1966	2.0		6.0
1967	1.5	-	7.5
1968	2.0	-	9.5
1969	2.3	0.1	11.7
1970	3.8	0.2	15.3
1971	2.0	0.2	17.1
1972	1.7	0.3	18.5
1973	2.9	0.3	21.1
1974	1.5	0.5	22.1
1975	1.4	0.5	23.0
1976	1.2	0.8	23.4
1977	1.3	0.7	24.0
1978	0.7	1.0	23.7
1979	0.2	0.9	23.0
1980	2.4	1.3	24.1
1981	5.1	1.2	28.0
1982	5.7	1.5	32.2
1983	3.6	1.4	34.4
1984	5.5	1.7	38.2
TOTAL	50.8	12.6	38.2

TABLE III C-3

USE OF TV IN SELECTED COUNTRIES

COUNTRY	Per Capita GNP 1979 $ US	TV Sets Per 1000 People 1979	Urban population 1980 Percent	Growth of TV Numbers 1977-79 Percent
Bangladesh	90	0.5	11	-
Ethiopia	130	0.8	15	13
Upper Volta	180	1.0	9	2
India	190	1.0	22	44
Benin	250	0.1	14	-
Mozambique	250	0.1	9	-
Sierra Leone	250	6.0	15	23
Haiti	260	3.0	28	4
Pakistan	260	9.0	28	25
Tanzania	260	0.3	12	-
Zaire	260	0.3	34	-
Niger	270	0.1	13	-
Central A. Rep.	290	0.3	41	-
Uganda	290	5.0	12	-
Togo	350	0.6	20	-
Indonesia	370	8.0	20	38
Sudan	370	6.0	25	10
Kenya	380	3.9	14	16
Ghana	400	4.4	36	13
Yemen AR	420	0.2	10	-
Zimbabwe	470	10.0	23	4
Egypt	480	32.0	45	11
Liberia	500	11.0	33	13
Zambia	500	11.0	38	-
Bolivia	550	18.0	33	-
Thailand	590	17.0	14	10
Philippines	600	21.0	36	11
Portugal	2180	122	31	13
Italy	5250	231	69	3
UK	6320	394	91	na
USA	10630	635	73	6

SOURCE: TV data worked up from UN Statistical Yearbook 1981. Per capita GDP and urban population from World Bank Development Report 1981.

The data are poorly correlated (r^2, the correlation coefficient, = 0.517). On this basis it must be concluded that per capita GNP and urban population percent are poor predictors of television use. Nevertheless both variables are significant. Linear regression of selective series of countries failed to improve the correlation.

The data are plotted in Figure III C-3. Pakistan and Egypt are countries with acknowledged high development and also relatively high urbanization. There are however seven countries donated as black dots which have remarkably low TV intensities (Benin, Mozambique, Tanzania, Zaire, Niger, Central African Republic and the Yemen). Further work would be needed to explain this phenomenon. The remaining countries lie approximately on the lower part of an 'S' cover, the plot suggests that,at Ethiopia's current GNP per capita (140 dollars),the TV intensity is about 0.9 per thousand people, equal to 31,000 at 34 million population and 38,000 at 42 million population.

The current stock of TV receivers in Ethiopia may be summarised as follows:

opinion of TV authority	45,000 - 50,000
15-20 years imports	39,000 - 51,000
Discard/import model	38,000
cross section analysis	31,000 - 38,000

The discard/import model is probably the most reliable estimate of TV stock. This suggests under 40,000. A figure of 40,000 is assumed in this study.

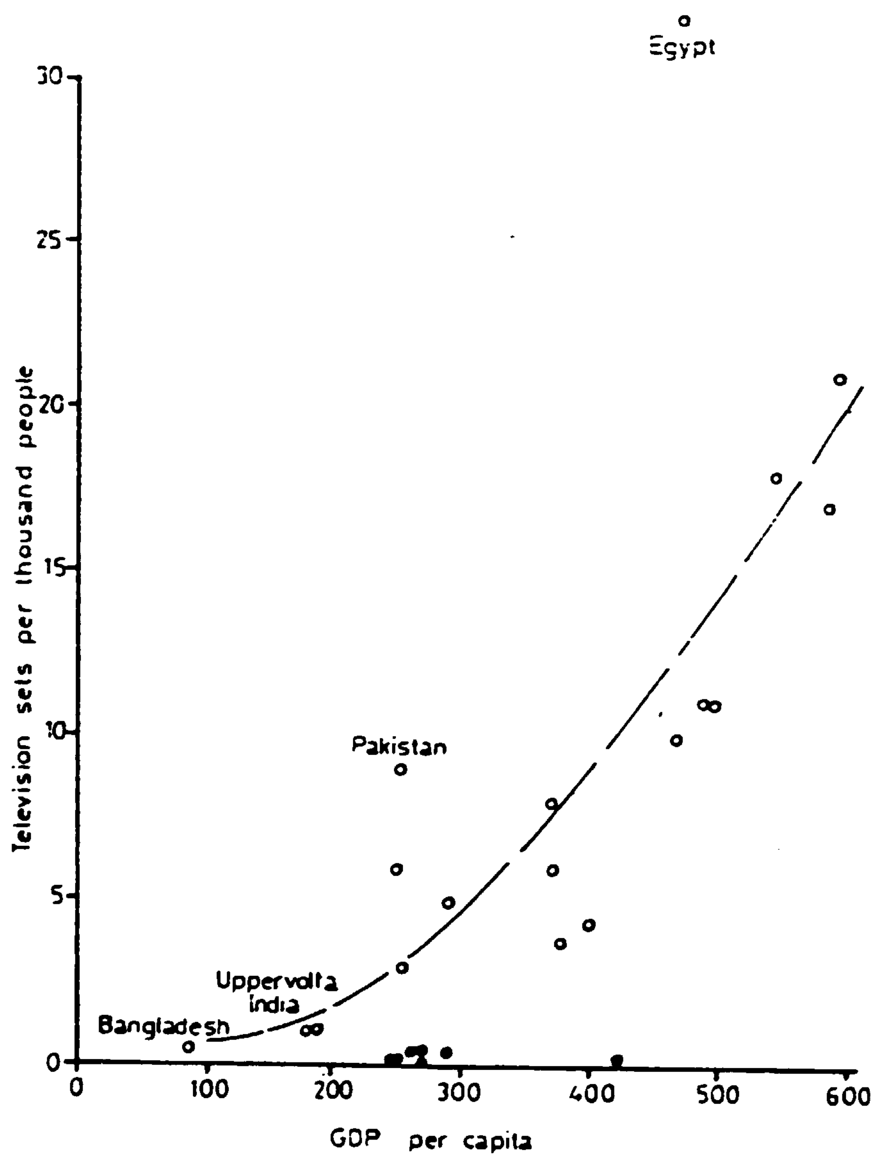


FIGURE III C-3 TV INTENSITY RELATIONSHIP

3. Plans and TV Growth

Broadcasting began in Addis Ababa in 1964. Transmitters were added in Asmara, Nazaret, Debrezeit, Harar and Diredawa. All other stations have been built in the last 1½ years. The Television Authority receives Government instructions regarding areas to be served with broadcasts.

Future plans include as priority transmitters in Bale, Gojam and Gondar. Others have not been decided. They will depend on the outcome of a study about to be undertaken. The Authority does not, for example, know what the reception quality is at various locations, nor which sites will achieve the most effective coverage.

In order to achieve 100 percent coverage of the areas which need to be served it will be necessary to install transmitters at about 2 per year for 10 years (i.e. about 20 more).

Present equipment is 2 studios each with 3 cameras. Two new mobile studio vans, each with 3 cameras were purchased for the celebrations. VTR's will be installed in the second Addis Ababa studio. No regional studios will be built.

The 10 year Perspective Plan is now out of date for television, and will be revised. Part of the longer-term development was brought forward. A new transmitter is envisaged at Addis Ababa (Furi),of 10 kw,with a range 120-150 km. The Nazaret transmitter may then be moved, although Debrezeit will have to be retained because of terrain problems. The plan includes 2.7 m. Birr for the Addis Ababa transmitter. There are 5-6 other stations in the plan. A new studio site is also included. The present Municipality building is considered very unsuitable. Government spending priorities may change from year to year so investment will not necessarily be steady. It is by no means certain that the necessary coverage will be achieved by 1994.

The main problems at present are a lack of skilled manpower and unsuitability of studio site. Direct satellite reception has never been considered. Broadcasts are received via the ground station from the Indian Ocean satellite, and perhaps later from the Atlantic Ocean satellite.

There is broadcasting 4-5 hours per day and this will probably not change in the foreseeable future. By end-84 all broadcasts will be in colour except the telecine films made previously (cine films converted to video for broadcast). During the last 10 years about 75 percent of programmes have been locally produced. This is now decreasing to about 60 per cent. Sub-titling and dubbing equipment has been purchased. Apart from music there is virtually no locally produced light entertainment and the Authority employs no actors. Locally-acted light entertainment is not planned at present.

Several years ago the Government wished to use TV for school education. This could have meant 10 hours of broadcasting per day. The Authority did not think the equipment reliable enough and could not do it. Now most new transmitters have a standby and additional broadcasting by EMMS has become a possibility.

These changes in the Television service will enhance the attractiveness of TV and promote growth.

The present TV transmitters are summarised in Table III C-4. A 1 kw station has a service radios of up to 90 kms with a good signal (60 dB). Difficult, undulating terrain can reduce this to 30 kms because television reception is largely by line-of-sight. It will be assumed here that the average service radios of 1 kw transmitters in Ethiopia is 60 kms. This exceeds the normal service radius in the UK where, for the most part, the terrain is flat. A 500 W transmitter will then have a range of 15 kms, and a 200 W station a range of 2½ kms.

TABLE III C-4

TELEVISION TRANSMITTERS

YEAR OF INSTALLATION	LOCATION	POWER
1964	Addis Ababa	
1976	Expansion	1 KW
	Asmara	1 KW
1981	Nazaret*	1 KW
	Debrezeit*	200 W
1976-81	Harar	1 KW
	Dire Dawa	250 W
1983-84	Jimma	2 x 500 W
	Shashemene	1 x 1 KW
	Dilla	2 x 500 W
	Yirgalem*	1 x 200 W
	Gondar	2 x 500 W
	Bahr Dar	2 x 500 W
	Nekempt	2 x 500 W
	Dessie	1 x 1 KW
	Assab	1 KW**
	Mekele	1 x 1KW
	Jijiga*	2 x 200 W
	Metu/Gore	2 x 500 W

SOURCE: Discussion with Television Authority

* Transposer station
** Data not given; hence assumed.

Figure II C-4 shows the service coverage of the present TV transmitters. Geographical coverage is about 7 percent although the population coverage will be much higher than this. According to the TV Authority the present geographical coverage is 40 percent of the area which needs to be served, which in turn is 40 percent of Ethiopia's area. Thus it was suggested that coverage is around 16 percent. The service radius map indicates a much lower figure. The mas also contains four dotted circles intended to demonstrate the coverage of 20 more 1 kw transmitters. The circles are not intended to indicate location, since this is not yet known, but merely to create the impression of the extra coverage achieved by 20 non-overlapping stations. In this case geographical coverage increases to 26 percent. This is still far short of the 40 percent which is held to be the area which needs to be served.

The cost of the 20 extra transmitters will be around 25 million Birr so it is not at all certain that such works can be completed during the next ten years.

Several approaches may be adopted for forecasting future growth rate. These are:

- Extrapolation of trend
- Development planning model
- Experience in other countries

Historic growth rates are shown in Figure III C-5 over the period 1967-1984 the average annual growth rate was 10 percent but this concealed changes within the period. The growth rate was $16\frac{3}{4}$ percent in the early years then becoming flat from around 1974, accelerating again in 1980. Over the last five years it has been $10\frac{1}{2}$ percent. Thus 10 percent may be taken as representative of the historic trend.

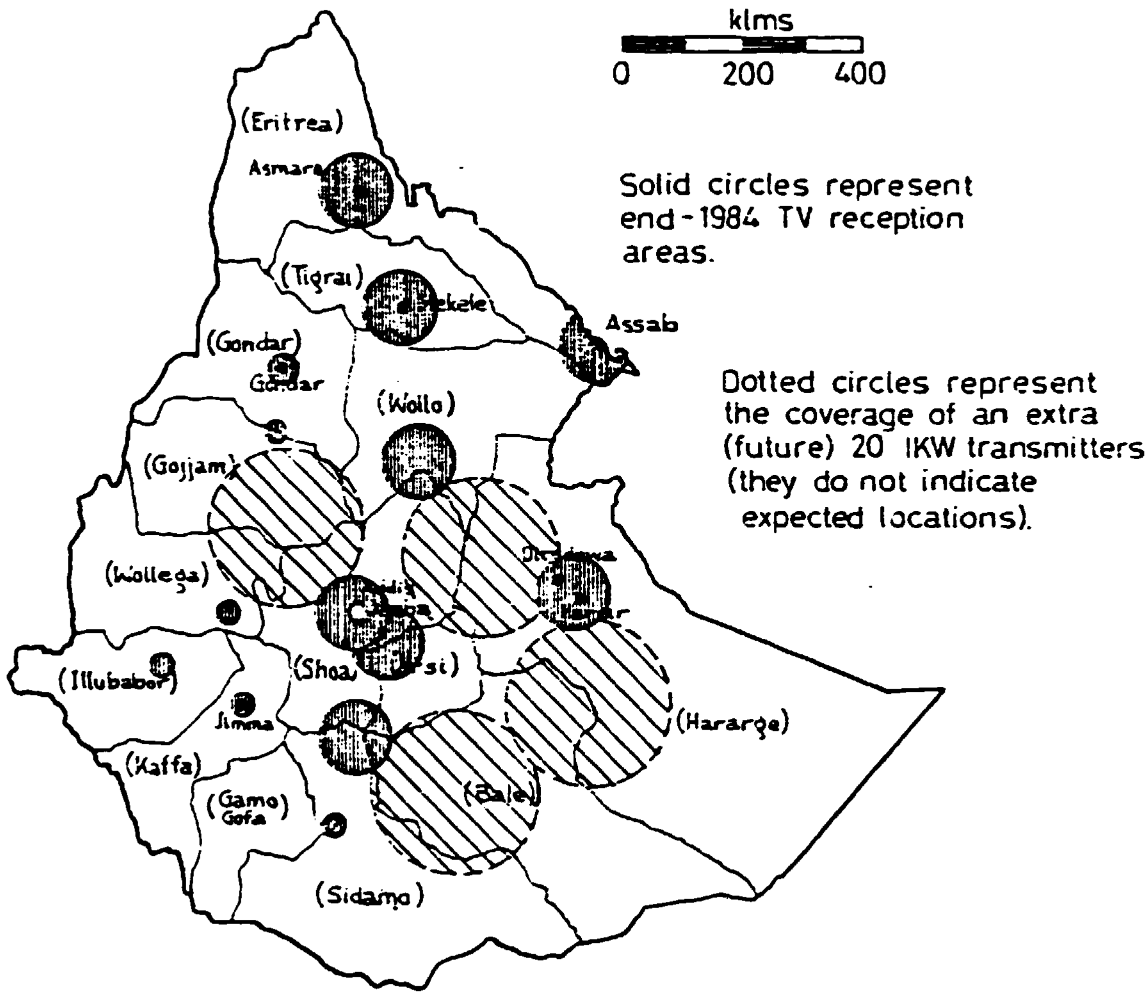


FIGURE III C-4 INDICATIVE COVERAGE OF PRESENT AND PLANNED TV TRANSMISSION.

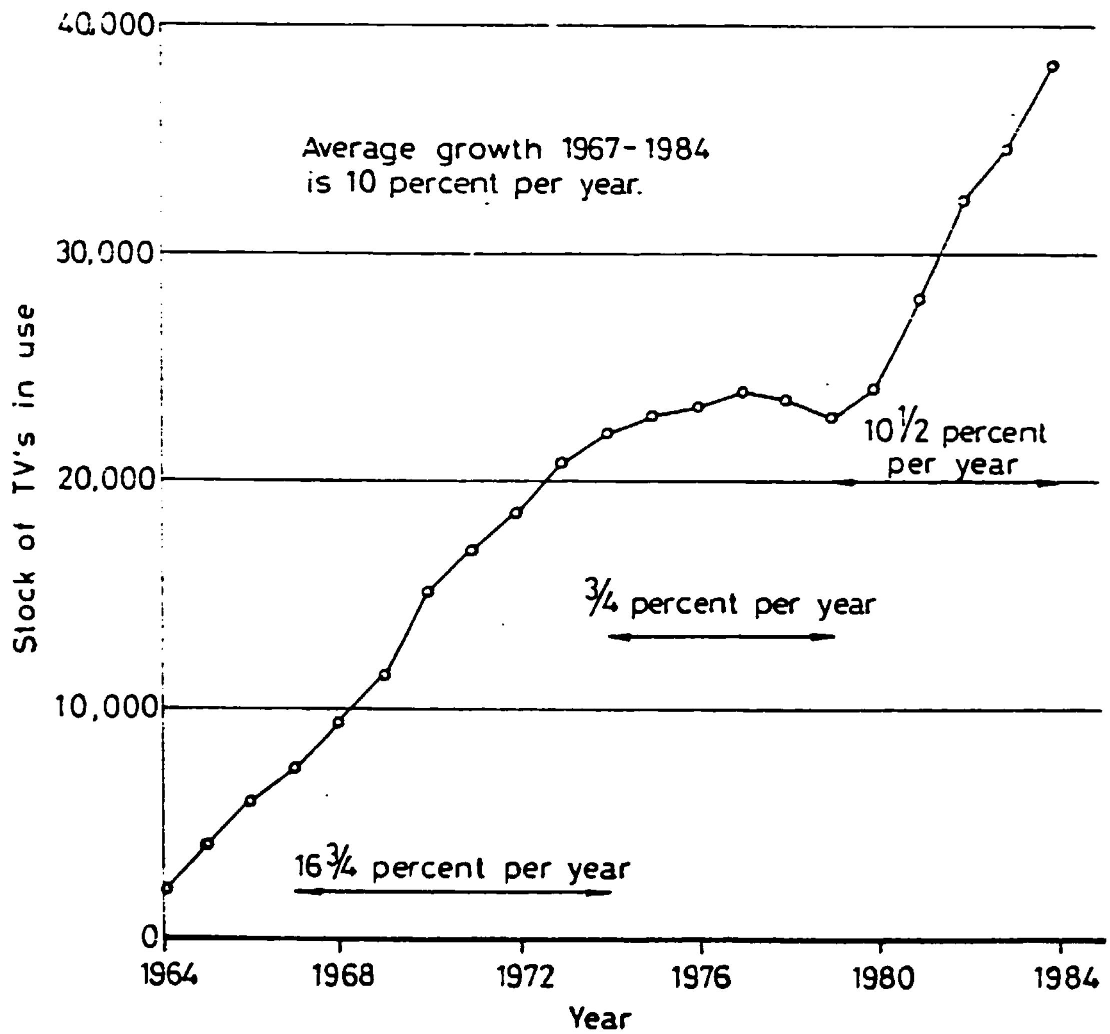


FIGURE IIIC-5 HISTORIC TV GROWTH RATES

The development planning model is based on official or semi-official statements regarding the growth of TV intensity.

The broadcast area is described as 'the area which needs to be served'. This is thought to represent approximately the urban area. The urban area (towns over 2000) was given in the 1980 Statistical Bulletin as 4.2 million. This is considered officially to be growing at 5.26 per cent. On this basis it is now 5.2 million. The TV authority consider that they now cover approximately 40 per cent of the area to be served (although Figure III C-4 does not corroberate this). This was a subjective judgement. On this basis the present coverage is 0.4 x 5.2 = approximately 2.1 million people. The TV intensity has increased from 1.58 sets/100 people in 1979 to 2.4 sets/100 in 1984 (using Television Authority estimates). The TV intensity has therefore grown at 5.3 per cent/year.

The TV authority expect that by erecting on average, 2 masts per year for 10 years, they will achieve 100 per cent coverage of the area which needs to be served. This is a coverage of the whole urban population of 8.6 million. Coverage increasing from 0.4 to 1.0 in 10 years is 9.5 per cent/year.

The growth rate of TV population can therefore be compounded from three rates and amounts to 21.3 percent per year:

Urban population growth	5.26%/year
TV intensity growth	5.3%/year
Coverage growth	9.5%/year

While such a growth appears realistic within the assumptions given it must be remembered that it will increase Ethiopia's TV intensity from its present level at around 0.9 per 1000 population to around 4.5 per 1000 population. This would place it very much out of position relative to its GDP per capita (although such anomalies do exist).

Consideration of the growth rates in other countries in Table III C-3 shows a very wide variation, from 2-4 percent in Upper Volta, Haiti and Zimbabwe to 38-44 percent in Indonesia and India. The average for the fifteen poorer countries showing growth rates is 15.8 percent. However the lower GDP per capita countries display higher growths on average. The lower 7 countries (Upper Volta to Sudan) average 20.9 percent. The other 7 countries (Kenya to Philippines) average 11.1 percent. The rate of growth also falls with the high income countries in Europe and the USA.

We may now summarise these growths:

Ethiopian trend 1967 - 1984	10 percent
Ethiopian trend 1979-1984	10½ percent
Development planning model	21.3 percent
7 poorest countries	20.9 percent
15 poor countries	15.8 percent

Growth scenaries vary from 10 percent to over 20 percent. A good medium figure seems to be 15 percent. In this case, as Table III C-5 shows, the annual demand reaches 10,000 in 1988, 15,000 in 1991, and 20,000 in 1993.

TABLE III C-5

MEDIAN GROWTH OF TV DEMAND

YEAR	THOUSAND SETS PER YEAR			
	STOCK	INCREMENT IN STOCK	REPLACEMENTS	DEMAND
1984	40.0			
1985	46.0	6.0	0.8	6.8
1986	52.9	6.9	0.9	7.8
1987	60.8	7.9	1.0	8.9
1988	70.0	9.2	1.0	10.2
1989	80.5	10.5	1.1	11.6
1990	92.5	12.0	1.2	13.2
1991	106.4	13.9	1.3	15.2
1992	122.3	15.9	1.4	17.3
1993	140.7	18.4	1.6	20.0
1994	161.8	21.1	1.8	22.9

Growth rate of stock at 15 percent per year.

A 10 percent low growth case, and a 21.3 percent high growth case have been calculated. The results are shown in Figure III C-6. From the Figure it is easy to believe the 10-15 percent growth rates compared to the past imports. The 21.3 percent growth however does represent a sharp change in the form of demand. It is nonetheless achievable, at least in the medium term, if the appropriate steps are taken to secure it. But it seems less likely than the others. The overall demands are compared below:

	LOW GROWTH 10%	MEDIUM GROWTH 15%	HIGH GROWTH 21.3%
		THOUSAND SETS	
1986	5	8	11
1988	6	10	15
1990	8	13	22
1992	9	17	33
1994	11	23	48

A portion of these sets will be colour. The actual demand for colour will depend to some extent on pricing policy. If a decision is taken to make B/W TV then colour will not be encouraged in the early years. In a free market it may be taken as about 10 percent now, increasing linearly at about 2 percent per year to 28 percent in 1994. The respective manufacturing opportunities will then be as shown in Table III C-6. The effect of colour is to reduce the B/W demand substantially. Demand for B/W sets remains below 15,000 per year until 1994, even in the medium growth case.

Retail prices of TV sets at present are extremely high. A B/W set is said to cost around 2000 Birr and a colour set up to 4000 Birr. Imports for resale are at present prohibited. In the event of personal import, taxes are applied in a manner which brings the total cost to a level approaching the figures above. Ethof's Official prices were around 2000 Birr for a colour TV and 1500 Birr for a B/W set.

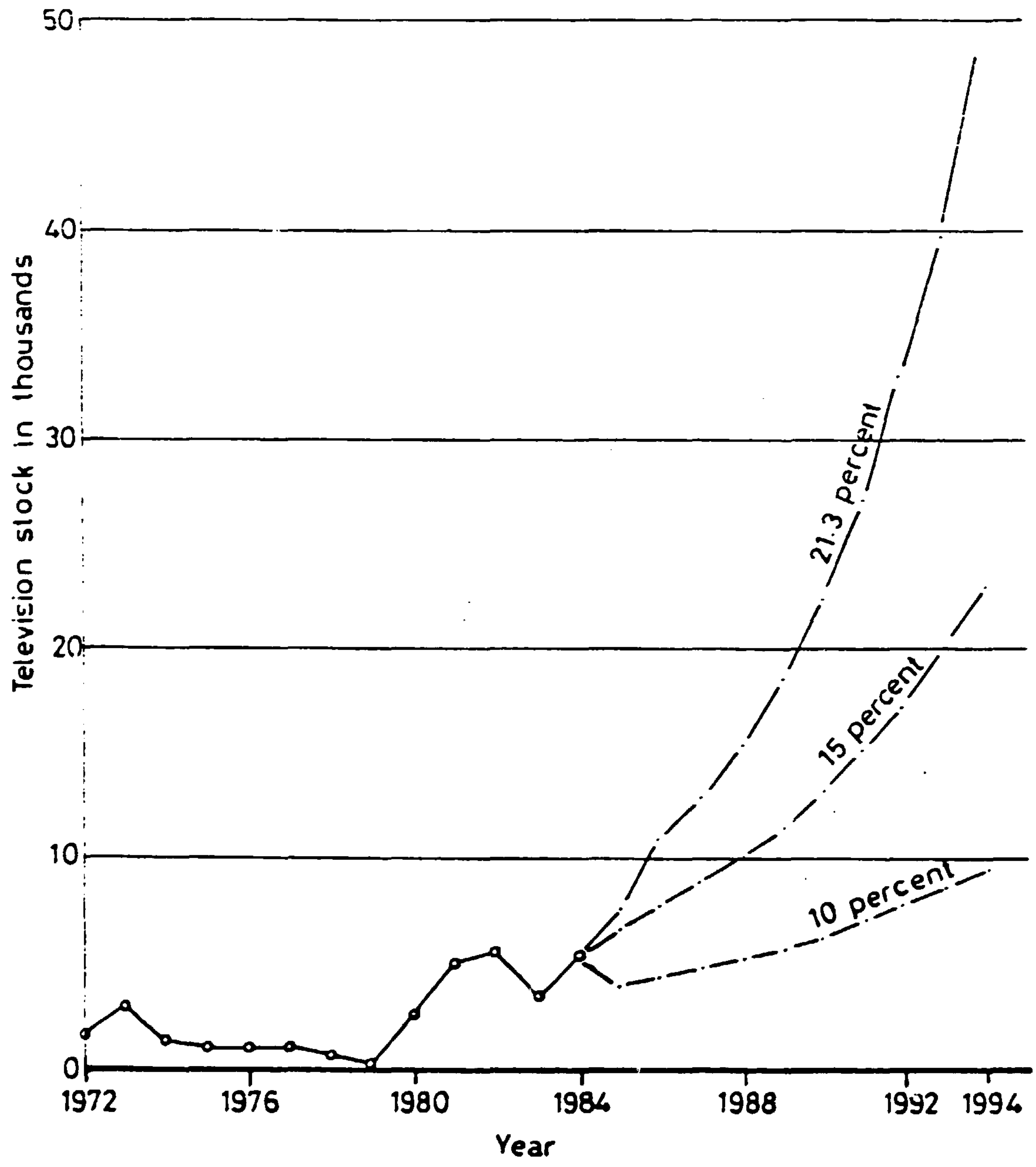


FIGURE III C-6 VARIOUS TV DEMAND GROWTH FORECASTS

TABLE III C-6

B/W AND COLOUR TV DEMAND

YEAR	THOUSAND SETS					
	LOW GROWTH		MEDIUM GROWTH		HIGH GROWTH	
	B/W	COLOUR	B/W	COLOUR	B/W	COLOUR
1985	4.3	0.5	6.1	0.7	7.0	0.8
1986	4.7	0.6	6.9	0.9	9.4	1.3
1987	5.1	0.8	7.7	1.2	11.1	1.8
1988	5.4	1.0	8.6	1.5	12.9	2.5
1989	5.7	1.2	9.5	2.1	15.3	3.3
1990	6.1	1.5	11.6	2.6	17.9	4.5
1991	6.4	1.8	11.9	3.3	21.1	6.0
1992	6.9	2.2	13.2	4.1	24.9	7.9
1993	7.4	2.6	14.8	5.2	29.5	10.3
1994	7.9	3.0	16.5	6.4	34.6	13.5

Colour grows linearly from 10 to 28 percent of total.

D. COMMUNICATIONS EQUIPMENT

Two aspects of communications equipment are considered, telephone systems and radio communications.

1. Telephone Recent Development

The telephone network in Ethiopia has developed very steadily from 46,000 telephones in 1970 to 86,000 in 1980 and then to 107,000 in 1983. These details are shown in Table III D-1. The average rate of growth of telephones was 6.7 percent from 1970 to 1983, almost the same as the 6.5 percent average from 1980 to 1983. Use of phones has increased very much. Urban calls, which account for 98 percent of all calls, increased at 16 percent per year.

The number of automatic and other exchanges is also shown in Table III D-1. This has remained reasonably constant in recent years, although the number of manual exchanges has increased slowly. Pay stations, which have relatively very few lines, increased appreciably in 1981.

Automatic exchanges represent about 85 percent of all lines. Although the number of exchanges has not changed appreciably the number of connected lines has been increased from 52,000 to 71,000 as shown below:

	Automatic Exchange Thousand Lines	Percent Capacity Utilization
1979	51.8	80
1980	53.6	85
1981	57.7	83
1982	62.6	73
1983	71.4	78

TABLE III D-1

ETHIOPIAN PHONE DEVELOPMENT

	1979	1980	1981	1982	1983
Phone lines	61165	64065	68792	74562	83798
Apparatus	81902	85977	91551	97782	107385
Apparatus per line	1.34	1.34	1.33	1.31	1.28
Automatic exchanges	19	19	20	20	18
Manual exchanges	314	335	358	365	374
Pay stations	44	44	72	77	81

SOURCE: ETA Statistical Bulletin 1983

The capacity utilisation of automatic exchanges has remained at a high level, around 80 percent. Automatic exchanges account for about 85 percent of all lines. The remaining 15 percent of lines are nearly all on manual exchanges and these are 58 percent utilised.

The number of telephone apparatus connected to the lines has fallen slightly from 1.34 per line in 1979 to 1.28 in 1983.

The distribution of phones in 1981 is shown below. Addis Ababa accounts for 72 percent of the total. Addis Ababa and Asmara, while less than 40 percent of the urban population, account for 85 percent of all phones. There is considerable scope for extension of phone usage in other urban areas.

Ethiopia's telephone density is compared with that of other countries in Table III D-2. These UN statistics correspond closely with those described above. The information is presented graphically in Figure III D-1. There is clear evidence that Ethiopia is positioned well above the point normally expected for its GDP. These factors suggest a continuation of steady growth and probably rule out any rapid growth of phone usage. The Telecommunication Authority has plans for continued strong growth.

The average growth for the first 10 countries with figures given (excluding Ethiopia) is 9.1 percent. This compares with Ethiopia's figure of 7.6 percent.

Ethiopia's record of satisfying telephone demand is very good, as Table III D-3 shows. In 1980 only 16 percent of registered demand for phones was unmet. Only in Malawi and India was the percentage lower.

TABLE III D-2

PHONES IN SELECTED COUNTRIES

Country	Per Capita GDP $ US 1979	Phones Per 100 People (1980)	Growth of Phones 1970-78 Percent	Thousand Lines in 1980
Bangladesh	90	0.1	10.6	104(1979)
Ethiopia	130	0.3	7.6	64
Nepal	130	0.1 (1979)	13.2	14(1978)
Somalia	140	0.2	-	-
Mali	140	0.1(1979)	-	-
Burma	160	0.1	3.6	37(1979)
Burundi	180	0.1	4.7	3(1977)
Upper Volta	180	0.1	13.0	9(1978)
India	190	0.4	9.4	2424(1979)
Malawi*	200	2.9(1979)	9.5*	29(1979)
Rwanda	200	0.1(1979)	10.0	5
Sri Lanka	230	0.6	3.9	84
Benin*	250	1.6(1978)	13.0*	16(1978)
Sierra Leone	250	0.3(1979)	-	10(1978)
Haiti	260	0.7	-	-
Pakistan	260	0.4	-	367
Tanzania	260	0.6	10.9	93
Niger	270	0.2	12.4	8(1979)
Madagascar*	290	3.7(1979)	9.5*	37(1979)
Uganda*	290	4.7	4.6*	47
Togo*	350	1.0	5.2*	10
Indonesia	370	0.3	7.7	487
Sudan	370	0.3	3.5	65
Kenya	380	1.2	-	192
Ghana	400	0.6	5.9	67(1979)
Senegal	430	0.8(1979)	-	40(1979)
Egypt	480	1.2	-	534
Zambia	500	1.1	-	61
Thailand	590	1.1	11.6	497
Philippines	600	1.1	8.7	702

Country	Per Capita GDP $ US 1979	Phones Per 100 People (1980)	Growth of Phones 1970-78 Percent	Thousand Lines in 1980
Portugal	2180	13.8	6.2*	1372
Italy	5250	33.7	7.5*	19277
UK	6320	49.7	6.6*	26651
USA	10630	83.7	4.2*	180424

SOURCE:

1. Telecommunications and Economic Development, Saunders et al, for the World Bank 1984. Published by John Hopkins Press. Tables 1.3 and 1.4 phones per 100 people and growth rates (except those countries with asterisk).
2. UN Statistical Yearbook 1981 (countries with asterisk) and all data on number of phone lines.
3. Per capita GDP from World Bank Development Report 1981.

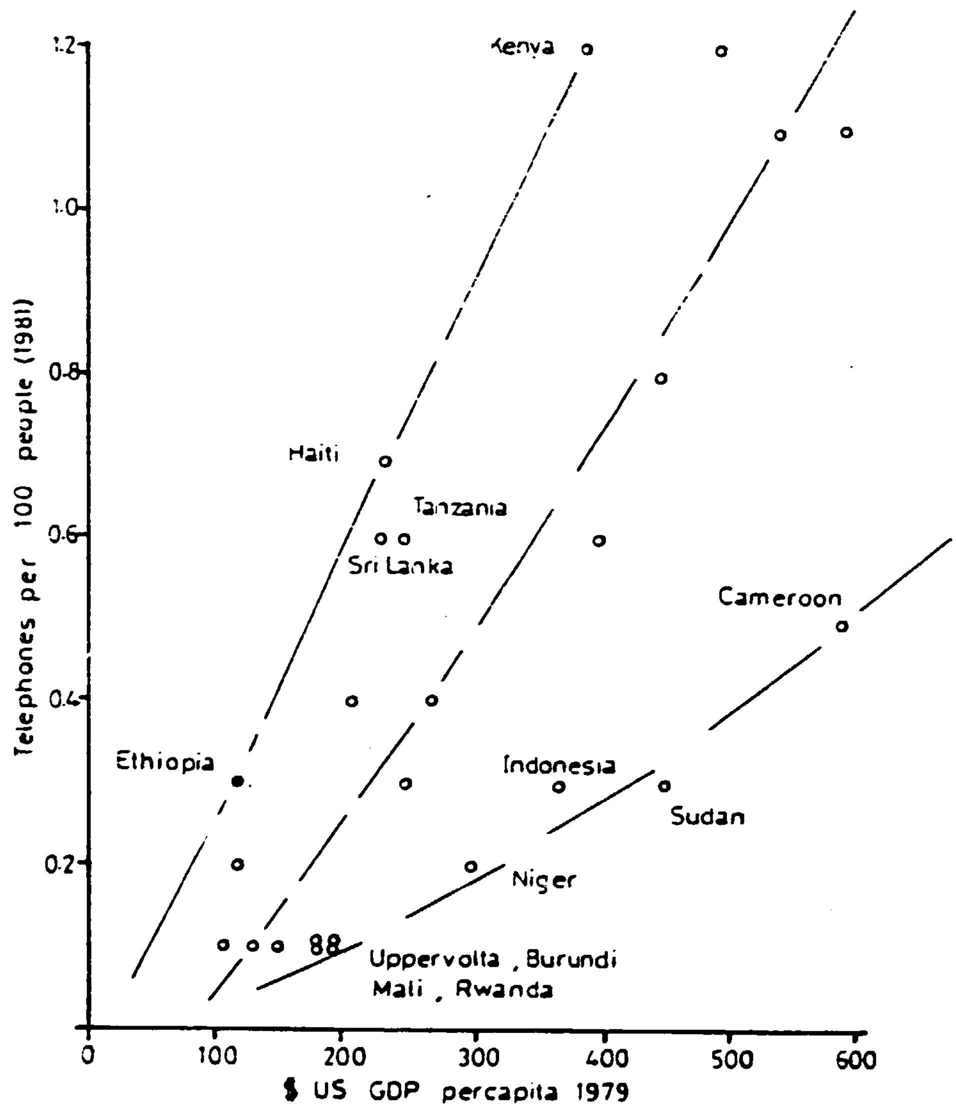


FIGURE III D-1 TELEPHONE DENSITY COMPARISON

Source: Telecommunication and Economic Development saunders et al for the World Bank 1984 published by John Hopkins press.

TABLE III D-3

UNMET DEMAND FOR PHONES

Country	Year	Percent Of Registered Applications Unmet
Africa:		
Egypt	1979	52
Ethiopia	1980	16
Ghana	1979	31
Kenya	1982	45
Malawi	1979	10
Sudan	1980	26
Tanzania	1980	63
Upper Volta	1980	21
Asia:		
Bangladesh	1981	32
Burma	1980	41
India	1980	14
Nepal	1978	51
Pakistan	1981	42
Philippines	1980	27
Srilanka	1980	37
Thailand	1980	42

SOURCE: Telecommunications and Economic Development (see previous Table)

2. Future Telephone Development

The Ministry of Communications has published development plans in its Sixth Five-Year Plan. These are as follows:

- 50,000 new automatic exchange lines
- 12 new automatic exchanges in cities
- 200 new rural stations
- 570 new public stations
- 70,000 new phones

- Expansion of interurban links with improvements to interconnection exchanges, including 2 new interconnection exchanges.
- Improved international services with a new class B Ground station focused on the Indian Ocean Satellite.

These plans are well reconciled with each other. 50,000 automatic lines at 1.28 phones per line is 64,000 phones. This accords with the 63,000 automatic exchange lines implied below.

The rural exchanges now average about 25 lines each. Thus 200 new rural exchanges is about 5,000 lines There will be about 63,000 lines for the 12 automatic exchanges. Currently there are 12 stations with over 500 lines, averaging about 5½-6 thousand lines each. Thus the new exchanges will probably be of the same size as the existing larger exchanges.

The introduction of 70,000 new phones in 5 years is equivalent to a growth rate of 10.5 percent from the 1983 level of 107,000 phones. This is higher than the historic growth rate of 6.7 percent, and higher than the average for 10 poor countries, of 9.1 percent. Furthermore, Ethiopia already has a relatively high telephone density for its per capita GDP, so its future growth will probably not be much above average.

The plan to achieve an extra 70,000 phones in 5 years is presented in Table III D-4 and this 10½ percent growth rate then falls to 7 percent from 1990. Taken together with a 15 replacement life of phone apparatus, the demand for new phones reaches 20,000 in 1988 but growth slows after 1990.

The high cost of extra phone lines must be taken into account in appraising future plans. According to Bjorn Wellenius of the World Bank (see his paper in Finance & Development September 1984) each new telephone line has a total cost of $1500-$2000. Thus some 55,000 lines in Ethiopia might cost 155-207 million Birr in 5 years. The World Bank plans a major project to extend the telephone network in Ethiopia. This will amount to some 315 million Birr (IBRD Monthly Operational Summary, October 1984). For this reason the ETA planned growth is assumed to 1990. Thereafter the growth rate may be assumed to fall back to about 7 percent.

A brief statement must be made about telex and phone exchanges. Table III D-5 shows Ethiopia's telex lines compared to other countries. The growth rate is relatively low and the total lines in service, extrapolating the 1978 figure to 1984 is about 60, growing at only around 60 per year. There is no manufacturing opportunity.

Likewise with telephone exchanges. The number is small. The average number of small exchanges to be installed per year is about 40. The number of PABX (private Automatic Branch Exchange) will be around 70 per year.

TABLE III D-4

GROWTH OF PHONE DEMAND

	THOUSAND PHONES			
	Number of Phones in Use	Increase in Stock	Replacements	Demand
1983	107	9		
1984	118	9	2	11
1985	131	11	3	14
1986	144	13	3	16
1987	160	16	3	19
1988	177	17*	3	20
1989	196	19	4	23
1990	215	19	4	23
1991	230	15	4	19
1992	246	16	5	21
1993	263	17	5	22
1994	282	19	5	24
2000	423	28	8	36

TABLE III D-5

TELEX LINES

Country	Percent Growth of Telex Lines 1971-1978	Lines in Service in 1977/78
Sudan	20.8	416
Rwanda	27.4	60
Upper Volta	20.7	175
Tanzania	17.2	350
Niger	13.0	155
Cameroon	9.9	495
Ethiopia	9.2	359
Ghana	3.3	187
Bangladesh	26.5	256
Indonesia	22.6	2345
Sri Lanka	21.0	255
Burma	12.4	43
India	16.1	13339
Philippines	5.1	4930

SOURCE: Telecommunications & Economic Development (reporting from International Telecommunications Union).

3. Transceivers

These comments are unofficial and are made only for the purpose of judging the possible scale of electronics activity in radio communicator manufacture.

The military requirement is considered to be approximately as follows:-

	1987	1988	1993
Hand-held VHF/FM	300	1500	3000
VHF man packs	110	500	1000
HF-SSB	60	100	100

Life of good military radio communicators is 5-10 years, depending on the quality of maintenance. Based on an 10 year life in Ethiopia, the 1993 projections shown above, imply a long term transceiver population of 30,000 hand held sets and 10,000 VHF man packs. Based on European defence force practice this is appropriate to a standing army of 120,000 - 180,000.

The military requirement does not include the Peoples Militia, which is probably larger than the army. (European Yearbook declares figure to be 150,000). They presumbly use paramilitary transceivers, of a type more commonly in use by police forces. However, nothing is known of the long term future of the Peoples Militia and it may be unwise to assume any substantial long term requirement for communicators.

Estimates from a leading importer of transceivers suggest that the total annual requirement outside of military and para-military requirements is 400-500 hand-held transcievers and perhaps 50-60 man-packs/vehicle sets. Enquires made during this study did not lead to a comprehensive estimate but do tend to corroberate the above figures.

IV. ECONOMICS OF PRODUCTION

A. TECHNOLOGY

1. Radio and TV Technology

The major elements of a 2-band radio receiver are shown in Figure IV-A.1. Radio signals are picked up either by the short wave telescopic aerial or by the medium aerial in the form of a ferrite rod (consisting of sintered iron powder).

Operation of the SW/MW hand switch selects the appropriate wave band and the tuning control (tuning capacitor) is adjusted to change the resonant frequencies of the aerial and oscillater circuits to select the required radio programme.

The frequency changer, part of the IC (integrated circuit) converts the signal to a predetermined fixed intermediate frequency (IF) which is then amplified in the second half of the integrated circuit (IF gain). Rejection of unwanted signals is achieved by the frequency selectivity characteristics of the tuned transformers IFT 1 and IFT 2 (and to some extent by the aerial coils themselves).

The intermediate signal from IFT 2 is demodulated by diode D and the resistance R and capacitance C, so that the audio signal is separated. This is then fed through the volume control to the second integrated circuit (IC2) which gives the voltage and amplification needed for satisfactory loudspeaker output.

Radios are energised by a DC supply, commonly 9 volts, which is obtained either from a 1.5V cell combination or by rectification of the mains supply via a transformer.

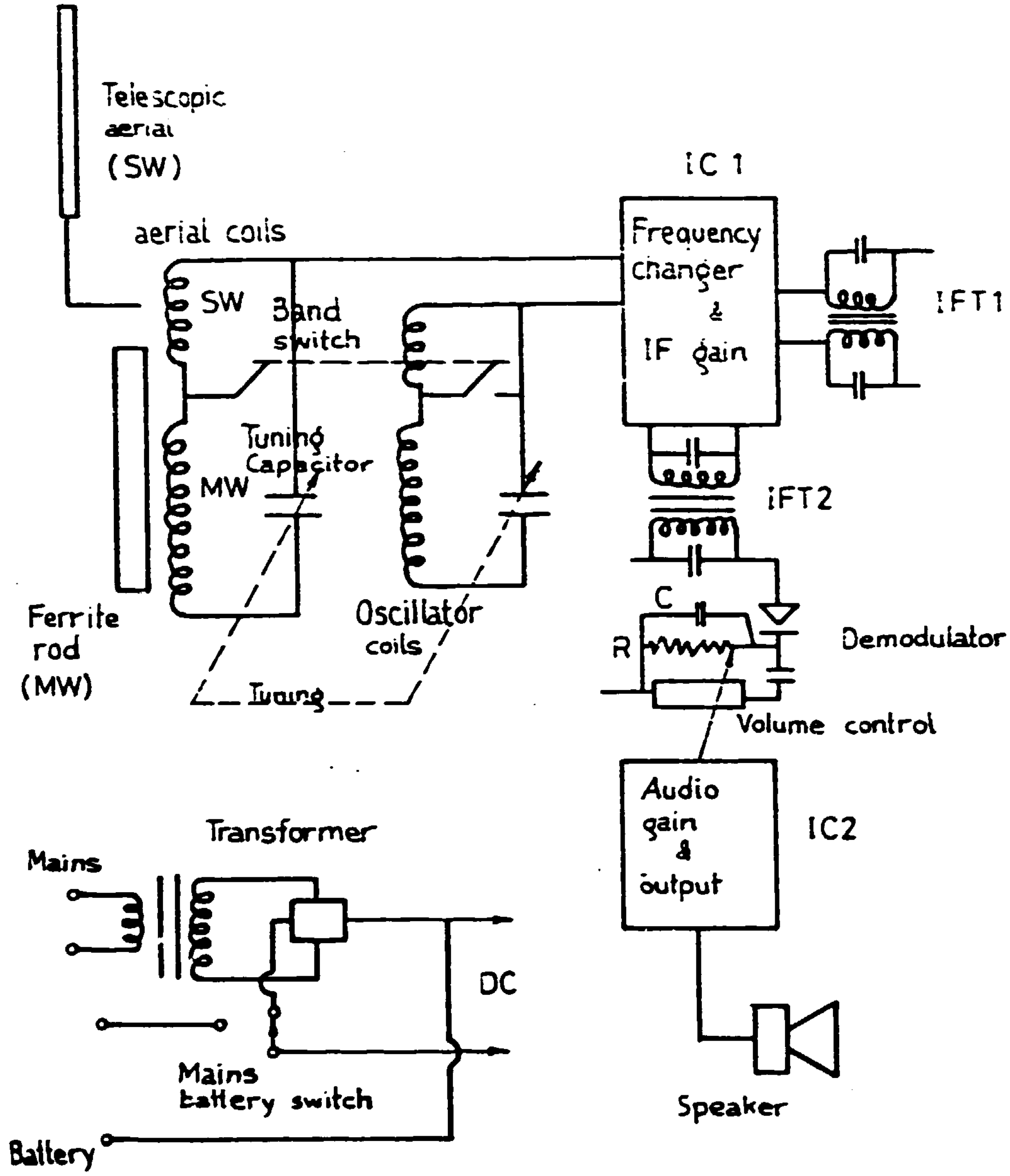


FIGURE IV A-1 SIMPLE RADIO CIRCUIT

Selection of the supply source is made by the auto-operation of battery/mains switch when the mains is plugged into the radio.

Apart from the loudspeaker, telescopic aerial and mains transformer the other components are assembled on a single printed sircuit board within the radio cabinet.

Possibilities for local manufacture may exist for the transformer, loudspeaker, aerial coils and printed circuit board. The ferrite rod, variable capacitor, oscillators, intermediate frequency transformers and integrated circuits require high capital expenditure which is only justified by very high production levels.

The major elements and circuit functions of a B/W TV receiver are shown in Figure IV A-2. TV signals received by the dipole aerial are fed into the tuner. Operation of the channel selector adjusts the tuner to the desired channel or frequency. The tuner has two or three active stages which, with resonant circuits, amplify and change the frequencies to a fixed intermediate frequency (IF). The precise shape of the pass band essential for good TV reception is determined by the Surface Wave Filter (SWF) following the tuner. This is manufactured with exact characteristics required by a given broadcasting standard.

The IF signal, now with correct frequency and amplitude form, is processed by integrated circuit 1 (IC1) to give further amplification, demodulation and separation of the picture and sound information. It is also necessary to separate out the pulse trains needed to synchronise the picture tube scanning circuits and the generation of waveforms for these circuits.

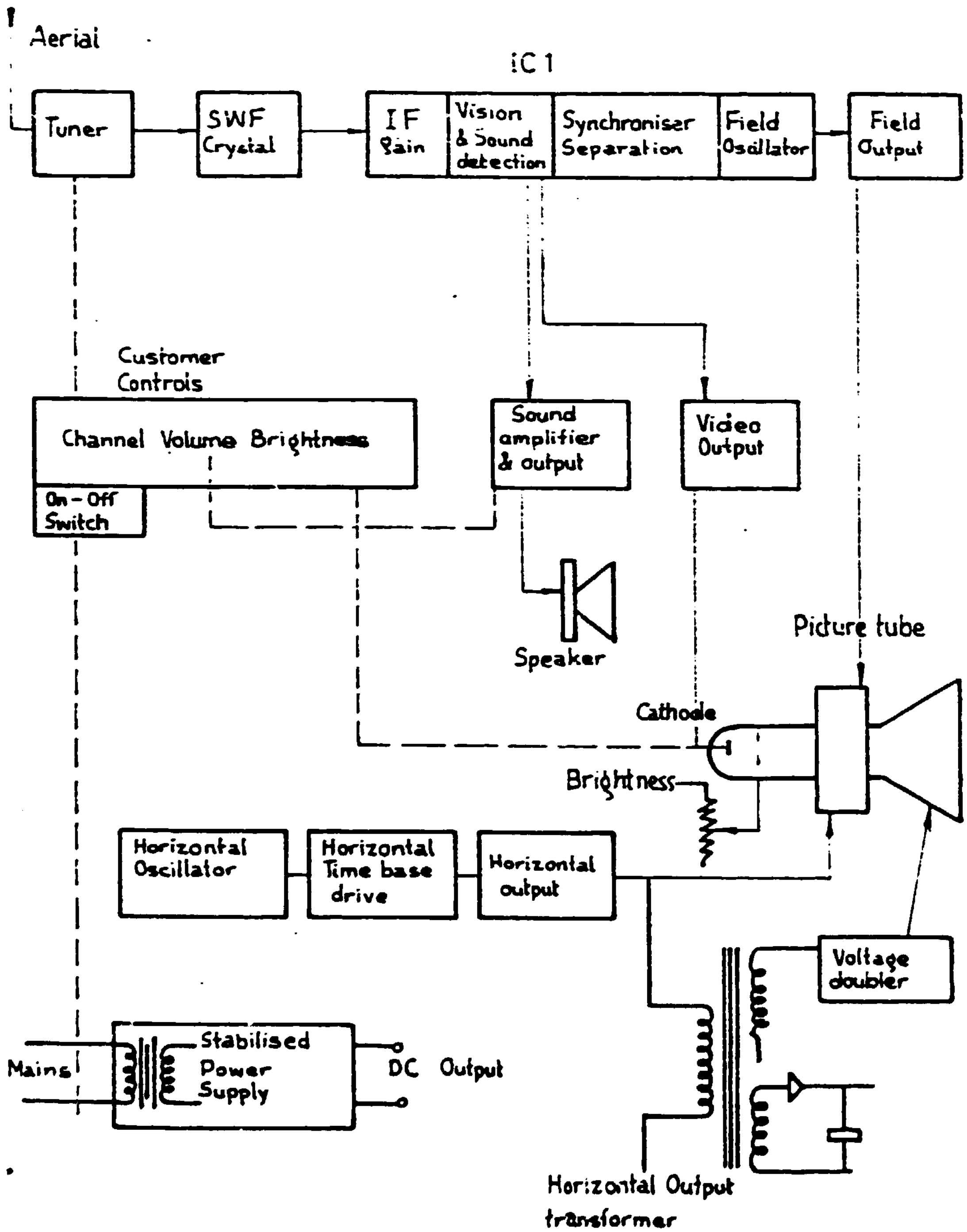


FIGURE IV A-2 SIMPLE TV CIRCUIT

The sound signal is passed to the next integrated circuit (IC2) which amplifies the signal and provides an audio output for the loudspeaker. The picture is displayed on a cathode ray tube, the electron beam of which is caused to traverse the screen horizontally with a periodic vertical shift resulting in a raster of 625 lines which are repeated 25 times per second. This is achieved by applying vertical and horizontal magnetic fields to the beam by supplying suitable wave forms to the deflection yoke. These waveforms are generated by the horizontal and vertical time bases. The picture information (video output) is applied between the cathode and the grid of the picture tube, producing instantaneous variations of brightness of the raster on the screen. This forms the picture. The picture tube works at a high voltage derived from doubling the horizontal output voltage. Voltages of 16-18 KV are needed to achieve rapid accurate deflection of the electron beam.

The major components of the TV receiver are:

Picture tube
Tuner
Integrated circuits
Horizontal output transformer
Deflection yoke
Loudspeaker
Printed circuit boards (2)
Surface wave filter
mains transformer
Power and signal transistors

Many of these are of complex design with exacting specifications. Their manufacture requires very high capital investment with heavy technical support covering a wide range of disciplines. Production rates of 0.5 - 2.0 million per year are needed for viability. The picture tube, tuner, horizontal output transformer, IC's, surface wave filter and transistors fall into this category. The deflection yoke requires a high level of production expertise but could be considered for local manufacture at 0.2 million per year. Mains transformers can be considered at lower volumes than this.

2. TV and Radio Circuitry Development

The last 25 years has seen the almost total replacement of thermionic devices by solid state devices as the active elements of electronic circuitry, the prime advantages being:-

1. Greatly reduced power consumption
2. Compactness of design, particularly noticeable in complex equipment (e.g. computers) and those of a portable nature.

The compactness and the inherent repeatability of the solid state elements have allowed their coupling together to enable specifications and applications to be achieved that are neither economic nor practicable by other means.

The basis of all these devices is the chip, generally of silicon, suitably processed and to which connections have been bonded to allow later connection into user equipment. The simplest form usually provides one circuit function and has three connections (e.g. a transistor) and is commonly referred to as a 'discrete device. Such devices have been widely used in radio and TV designs for more than 20 years.

Where a number of such devices are used as a circuit and in close proximity, it has been found possible to combine their functions on single larger chip together with the equivalent of a number of their peripheral external components. By incorporation of their interconnections, the number of external connections can also be reduced. Such a device is known as an integrated circuit.

The degree of integration possible is progressively increasing as production technologies advance.

The choice between discretes and ICs depends on the application and specification, and on the cost.

The factors have a bearing on cost of these devices:-

- The production yield
- The number of external connections required

Improvements in production techniques have greatly improved the yield to a point where the difference between the yields of discretes and ICs is no longer significant against other costs.

The number of external connections in a well designed IC is significantly less than the summation of those of the equivalent discretes.

Such ICs have had broad acceptance in television during the last 14 years and in radio during the last six years.

A further step in integration using even larger chips with more complex circuits, has been made whereby features and performances, not practicable with discretes, are being achieved. These are known as LSIs (Large Scale Integration) and are finding application in both television and sophisticated radios (e.g. FM stereo). They are unlikely to have application in the short term to the products under discussion in this study. The development of ordinary radios is not expected to change substantially in the next decade, the major changes having taken place in the last 15 years or so. There will of course continue to be steady improvement in production technology and non-electronic materials technology.

In connection with the present project a number of factors should be considered when making the choice between discretes and ICs.

- The materials costs of the devices and the periphals affected by the choice.
- The respective labour costs.
- The imports/local content of such costs.
- The availability of material.
- The availability of know-how support for each option, particularly if the route chosen involves 'buying in' assembled circuit boards.

It will be seen from Table IV A-1 that, on a simple radio receiver the costs are evenly balanced between the two technical solutions, both having a materials and labour cost of approximately $4.5. The discrete component PCB has 88 components. The IC radio has 55 components. Radios are not now normally made without ICs. The cost of ICs is only slightly higher than for ICS. The two effects cancel out. The comparison is based on high productivity (3.5 minutes of assembly for the IC PCB). In less productive environments (less experienced workers or lower volume production) there could be a cost advantage of up to about 12 cents in favour of ICs.

Although no substantial reduction in circuitry costs is expected in future, ICs are more likely to offer cost improvement than are the discretes. Circuits based on ICs are also more likely to be available than discrete PCBs. The IC know-how will also be

TABLE IV A - 1

EFFECT OF TECHNOLOGY ON COST OF A SIMPLE RADIO RECEIVER PCB

Cost item	$US per set	
	Based on discrete components	Based on integrated circuits
Materials :		
imported	4.06	4.11
local	0.26	0.26
	4.32	4.37
Labout	0.15	0.09
	4.47	4.46

Based on the PCB cost of a MW radio, o.6 million/year
Discrete components - 88; ICs - 54
Labour cost based on $1.07/hour. This rate is appropriate to Far East and to Ethiopia. Direct labour 5.5 minutes for discrete components and 3.5 minutes with integrated circuits, plus 50 percent extra for indirect labour cost.

More readily available. These observations follow naturally from the fact that the mass producers of radios are concentrating on improvements through use of ICs rather than discretes.

Integration of circuits has little effect on production costs for simple radios. It has some effect on costs of more complex equipment such as televisions and audio equipment. But here it is the technological trend which is more important than the immediate cost savings. Fewer electronics goods are made without ICs; the sources of designs and sound technical support are also diminishing. Quality standards have also been raised by integration and this affects acceptance standards for discrete component technology. In the more sophisticated products, especially in data processing the requirement for speed and data resolution and reliability rules out the use of discrete components (electronic devices are also faster if circuit wiring is minimised).

It is now common practice to employ ICs in the signal processing and audio stages of both mono and colour receivers. This reduces costs of ICs which, together with a lower peripheral component count, means a lower material cost and assembly time than for the discrete alternative.

Integration is standard practice in other areas of colour receivers, e.g. the colour processing stage. The improved performance obtained, over previous discrete solutions, has become the market acceptance standard for colour receivers. Standards achievable with the discrete alternative are no longer acceptable.

In special feature receivers, for example, those with remote control or with facilities for data display, there is often no practical alternative to ICs.

Table IV A-2 presents the major cost savings and labour differences obtained by integrating the signal processing and audio sections of mono and colour receivers. The changes affect only imported components - therefore there is no change in the value of local material. The local content naturally changes due to changes in labour content. Based on European rates the savings amount to $\frac{1}{4}$ dollar on B/W TVs and nearly $ ½ on colour TVs.

No substantial changes are expected in B/W TV technology. Indeed, the amount of R & D work on the product has reduced greatly. Efforts now concentrate on colour TV where changes are being brought about by the use of the TV as a home Information technology console. These changes will not affect Ethiopian Televisions. The changes in colour TV circuitry will be available to Ethiopia in the form of improved components.

The range of choice of process technology for the volume of production under consideration is very limited. The equipment has been specified to up-to-date western standards. The PCB work transfer systems and the silk screen process are essentially manual. These can be up dated to automatic methods without wastage of equipment. In the sub-assembly areas conveyors are used but component insection is manual. Automatic work transfer, for example cabinet and picture tube overheat conveyors for TV plants are justified only at rates 5-10 times those envisaged in this study. They can always be introduced if cercumstances justify.

TABLE IV A - 2

COSTS SAVINGS FROM TV COMPONENT INTEGRATION

	B/W TVs		Colour TV	
	No. of assembly operations	Value of components $US/set	No. of assembly operations	Value of components $US/set
Discrete components	130	3.03	163	3.88
Integr. circuitry	68*	2.81	7	3.45
Annual saving	o.o6hrs		0.39hrs	$0.43
	$0.34	$0.22	$0.50	$0.43

* Effect of integrating the signal processing and audio stages of the circuit.

Time savings are based on low volume production with time at $5.6/hour (many TVs are made in developed countries. The rate in South East Asia, and in Ethiopia would be 20 percent of this).

Component insertion would be manual, the number of actions each operator takes being limited to about eight. When radio and TV is in full operation, at rates discussed later in this report, there may be a case for using automatic or semi-automatic insection equipment, but certainly not at the outset.

An interesting comparison can be made between the cost of fully automatic insertion equipment and the light assisted manual insertion method (where lights shine to guide the operator to the corect hopper and then the corect location on the PCB). Four semi-automatic assembly machines have a total cost of 320,000 Birr. A single fully automatic machine would probably cost an extra 160,000 Birr. This would have an annual capital charge of 24,000 Birr. It would displace about 8 direct workers thus saving 28,000 Birr per year. There would be other savings in indirect labour and savings in manpower related costs such as buildings, expenses etc. With PCB sub-assembly at say 400,000 per year, automatic insertion can probably be justified. It may not therefore be worth semi-automating the line. The final decision work depend on the social considerations. In any case some manual would need to be retained for flexibility.

Wherever possible automatic soldering should be used and wave solder baths are proposed. This process is much cheaper and more reliable than manual soldering.

At very high volumes PCB sub-assemblies for industrial and professional equipment can be tested automatically. This is not usual in consumer product technology where the tests are few and simple. On transceiver equipment this is common and of course on data processing sub-assemblies. These considerations are not relevant in Ethiopia.

3. Technology of Other Electronic Products

In this section reference is made to the technology of component manufacture, and to the present situation in radio transceiver manufacture.

The basic building block of all electronics goods is the printed circuit board. This technology, above all the others, is the essential requirement for entry into electronic product manufacture. The next step, silicon device technology is one which will not be of interest to Ethiopia for very many years. There are additional requirements, both in materials and processes for some professional and military product PCB's. Nevertheless the basic technology is the same and the extra requirements can be incorporated, usually simply by adding supplementary machinery. For example precision drilling may require numerically controlled drilling machines, and double-sided boards may require special plating equipment.

The common elements of PCB manufacture are such as to justify a common facility for the products which Ethiopia might make in the forseable future.

Many products require small iron-cored transformers and small coils as parts of electronic circuits. The very small coils require special equipment justified only at very high volume production. However, where local manufacture of small transformers and wound coils is justified, a single facility only is necessary.

The next stage in consumer product manufacture is component preparation. Once again the same equipment is suited to the preparation of all discrete components, and wiring harness machines are also common. However, component preparation must be carried out in the same factory as the sub-assembly operation (fitting components onto the boards). A common organization could handle the procurement of components for all products.

At the sub-assembly stage there are differences between professional equipment and consumer products. The consumer products have long runs and few variations in design. The professional equipment has short runs of a varied nature. Moreover the professional equipment usually has a high packing density of components on the board. The insertion equipment is sometimes of a special nature and the work is undertaken to higher quality standards, and often in controlled environments. There is also more inspection and testing. Separation of manning and supervision of consumer and professional product areas is highly desirable if an appropriate standard of workmanship is to be maintained in both. The planned maintenance of machinery in all areas can however come under a single control.

Final assembly and test areas display the widest variation of work content. Separate operations are needed for nearly all products.

The manufacture of small electronic components has not been considered this report. As mentioned in the market chapter, the world prices are determined by companies making such components at annual outputs of hundreds of times the Ethiopian requirement.

The differences between the technology of consumer products and professional equipment is quite well illustrated by the component count and types of components in professional transceivers (radio communications). Table IV A-3 shows the components in some military radios, and an advanced non-military set (the military radio counts are also applicable to the military radios considered in chapter V. The most modernof the four sets in the Table is the non-military mobile phone. It is noticeable how this is based on integrated circuits, there being about 100, compared to 20-30 in the military radios. The use of integrated circuits is accelerating and is a major contributor to the decreasing size (and increasing releability and lower hear output) of hand held radios. The density of packing of the PCBs and the increasing use of hybrid circuits and integrated circuits is tending to reduce the scope for manual work.

The other transceivers are still vastly more complex than the 2-band radio included for comparison. In fact the hand held transceiver, which is substantially smaller than the 2-band radio, contains about 15 times as many components (after allowing for the combining effect of the ICs. The amount of labour in assembly is 20 times as much, and the amount of testing is over 100 times as much. The use of miniature circuitry has also led to the adoption of laser trimming of components which, in consumer products, can be electronically aligned with a tiny screwdriver.

Hybrid circuits are also becoming more common. In this case some of the components are burnt onto the silicon chip itself and some are added as discrete or separate integrated circuits. A further important change which is affecting both professional and consumer products (but not the simple ones envisaged to start with in Ethiopia) is surface mounting. Surface mounting of com-

TABLE IV A-3

TRANSCEIVER COMPONENT COUNTS

Component	MILITARY			Non-Military	2-Band
	Hand-held VHF/FM	Man Pack HF/SSB	Man Pack VHF/FM	Mobile Phone(5)	Radio(fo Compar-ison)
PCBs	16(1)	5(3)	18(2)	3 (multi-layer)	*
		Number of Components			
Discrete components					
Capacitors	211	181	300)	)	
Diodes/trans.	71	293	169)	)	
Inductors	24	24	37)	220)	45
Resistors	223	392	376)	)	
Other (incl. hybrids)	6	80	47)	)	
	535	970	929	220(4)	45
ICs	29	21	23	100	2
Mechanical	220	909	780	na	50
		Hours			
Assembly*	8	28	13	6	0.4
Testing	8	5	6	1	-

* Excluding PCB manufacture

(1) Some components surface mounted
(2) Many components surface mounted
(3) This model is not a new design
(4) Includes 18 hybrid circuits
(5) Essentially a hand held device

ponents is fast becoming more common in transceiver manufacture, as it is in consumer products, especially in Japan. It is now thought that in Japan about 20 percent of manufactured components are surface mounted, most going into consumer products.

Surface mounting has important advantages. It is considered to be much more reliable. There are no wire leads which in some applications can vibrate and fatigue, and can be electrically unsatisfactory due to the inductance of the wires. There are also savings on through-hole plating of printed circuit boards. The number of interconnections on the board can also be cut. Boards may be thinner and fewer are needed.

Surface mounting emerged 20 years ago with hybrid circuits in which thick film resistors were fired onto ceramic substrates and other components were added afterwards. Now the components for surface mounting are automatically placed on a solder pad on the PCB (screen printed into place) and the board is heated, for example with infrared, to make the joint. The components sit closer to the board. The leg spacing on integrated circuits can be 0.05 inches, which the half the minimum with a through-the-board inserted PCB. Conventionally mounted components are added to the board after the surface mounting and are then wave soldered underneath.

Surface mounted components can be placed by hand but it is more difficult than with conventional components. The majority are automatically placed on machines that typically can place 50,000 to ½ million components per hour.

A major difference between military and non-military radios is the scale of production. Usually non-military radios are made at production rates over 50,000 per year. At this level automatic test equippment can be justified. This is very costly. The equipment for automatic testing of a sophisticated non-military hand-held transceiver would cost about $6-7 million. Military equipment also has to be vibration proof and watertight. These requirements are not likely to apply to non-military equipment.

The simple non-military radios do not usually have double sided boards and will have little requirement for hybrid circuits and surface mounting. The most sophisticated have a technology level equal to military equipment.

The question is often asked whether military and non-military radios can be made in the same plant. They rarely are, although in principle parts of the operation could be combined.

The price of a non-military radio is determined largely by the high volume producers. Economics of scale have reduced costs very considerably. The more labour intensive assembly of military equipment on a small scale (1000 ± per year) and the unusually large amount of testing, increase costs very substantially.

Much of the plant and equipment needed for the military equipment could be effectively utilised for non-military equipment. If no fixed charges are allocated to non-military product manufacture (i.e the whole cost of the equipment is borne by the military radios) then this would reduce the total cost of the non-military radios. This would still not be enough to enable non-military radios to compete with imports.

There is also the matter of a design for non-military radios. The military products are not designed so they can be down-rated to non-military use with consquent saving in parts and labour. It would still be necessary to acquire a range of designs.

There could be a possibility of making some non-military radios at the military plant, utilising at least PCB making and the general plant overheads. It is highly unlikely that such a scheme would compete with imports.

B. ECONOMICS OF RADIO MANUFACTURE

1. Radio Manufacturein SE Asia

Radio manufacture includes, as its last stage, final assembly. Final assembly may be undertaken using wholly imported components. In this case it can never compete with imports. Even when the cases are made locally it remains a high price product at any scale of output.

A typical cost structure for a SE Asian radio can be seen in Table IV B-1. This is a simple 2-band battery/mains radio, a specification for which can be found in Appendix C. When manufactured at a volume which realizes all the economies of scale (2 million/year) the radio has an ex-works cost of $10.7. Containerized transport to Addis Ababa amounts to about $1 per set. There is also a selling company charge which has been included at a typical level of 17 percent of the other costs. The radios are not usually sold direct by the manufacturing operation, but pass through a selling company which could be wholly owned, or independent of manufacturing. The price C.I.F. Addis is then US$13.65 per set. (28.2 Birr)

The parts are assumed to be bought from local suppliers in the country of manufacture. The list of parts can be seen in the radio manufacturing profile in Chapter V. The scope of the operation is similar to that of the Ethiopian profile.

Manning levels are based on 10 minutes of direct labour per set, with the indirect workforce at 25 percent of the directs. This places the total employment in the 2m set plant at 231 people (assuming 1800 of work per employee per year). The weighted mean average wage cost is

TABLE IV B-1

ECONOMIES OF SCALE OF RADIO MANUFACTURE

(Based on SE Asian Conditions)

COST ITEM	$ US PER SET		
	AT 300,000 Per Year	AT 2 million Per Year	DIFFERENCE
Materials	9.36	9.04	0.32
Manning	0.36	0.21	0.15
Other operating costs	0.82	0.54	0.28
	10.54	9.79	0.75
Capital charges	1.44	0.55	0.89
Working capital	0.50	0.33	0.17
Ex-work costs	12.48	10.67	1.81
CIF to Addis Ababa		1.00	
Selling company charge		1.98	
Duty-free CIF price		13.65	

$1 per hour per employee, which is very similar to that of Ethiopian workers. The figure of $1 per hour overall labour cost is representative of SE Asian countries such as Malaysia.

The other operating costs are based on typical annual costs as shown below:

utilities	0.40
vehicle operations	0.18
maintenance materials and spares	0.31
Expenses	0.16
	$ 1.08 m

Capital charges are based on the range of PCB and sub-assembly operations described in the Ethiopian project profile in Chapter V but the operations are semi-automated. The further utilization of plant and equipment, the smaller number of direct employees relative to the output, and the small number of indirect workers means that building size is much reduced. In addition it is not necessary to carry large stocks. This greatly reduces storage space. Some modern operations with nearby suppliers work with an average stock as low as 3 days.

The capital charges are based on a total capital cost of $5.04 to which a Capital Recovery Factor 22 percent has been applied (see Appendix A). The cost of financing is higher, the project life probably shorter, and it is assumed that the company pays taxes. The distribution of plant items is as follows:

Plant and equipment	2.22
Buildings and siteworks	1.19
All other costs	1.63
	$5.04 m

Working capital charges are based on relatively costly financing with a capital recovery factor of 14 percent of the total working capital (see Appendix A).

The economy of scale between 2 million sets per year and 300,000 (typical of the Ethiopian requirement) is well illustrated in the Table. The works cost rises by $1.8 or 17 percent. The largest change occurs in the fixed capital charges. This is because the plant which is needed to make 300,000 sets is capable, with hardly any modification, of making 750,000 sets. The second largest change is in the cost of parts which is estimated to be about 3½ percent extra for the lack of volume discounts.

In practice, of course, there are no such 300,000 set plants operating in the high performance areas of SE Asia, but the exercise serves to show the effect on costs of decreasing volumes.

The manning is based on 16½ minutes of direct labour, and with indirects at 30 percent of directs. The factory employs 58 people. The higher working capital charges derive largely from the need to carry a longer period of stock.

2. Ethiopian Costs

Cost structures at different outputs have also been prepared for an Ethiopian manufacturing operation. These are shown in Table IV B-2. The assumptions for the 300,000 sets case are drawn from the project profile in the next chapter.

TABLE IV B-2

Radio Economies of Scale in Ethiopia

	$ US Per Set		
	150,000 Per Year	300,000 Per Year	600,000 Per Year
Materials ex-works	9.91	9.83	9.73
Aggregation charge	0.25	0.24	0.24
Transport	1.28	1.26	1.25
	11.44	11.33	11.22
Manning	1.32	0.91	0.61
Other operating costs	1.23	0.97	0.46
	13.99	13.21	12.29
Capital charge	2.21	1.48	0.99
Working capital charge	0.76	0.72	0.68
Total	16.96	15.41	13.96
		Birr	
Total	35.1	31.9	28.9

The change to 600,000 assumes only a 1 percent reduction in parts cost. They will still be delivered by whole container, only more frequently. Manning is based on a total of 22 minutes (direct and indirect labour) per set. The other operating cost items will vary differently but they all change within the band 70-85 percent of the 300,000 case. Capital costs reduce by approximately one third overall. In fact the final assembly plant has to be doubled in size (although QA and development do not change). But the PCB and sub-assembly plants increase by only about 10 percent in cost. Working capital charges show very little change as volumes change nearly proportional to output. Overall the comprehensive cost of production falls by 9 percent.

When the total costs are scaled down to 150,000 using the same principles the unit cost increases by around 10 percent.

The cost structure is unlikely to be very much affected by underutilisation at a given level of output. This is because most of the cost is almost directly variable (being parts).

3. Comparison of Ethiopian & SE Asian Costs

At this point it is possible to compare the Ethiopian and SE Asian cost structures. Table IV B-3 shows the 300,000 set Ethiopian plant compared to the 2 million SE Asian plant (the data are drawn from the previous two Tables). The Ex-works cost of the Ethiopian radio is 45 percent higher than the SE Asian radio. Half of this disadvantage is accounted for by the cost of parts and their transport. The capital cost disadvantage is not very large because although the plant is much more economically sized, the capital charges are higher. The low ex-works

TABLE IV B-3

COMPARISON OF ETHIOPIAN AND SE ASIAN RADIO MANUFACTURE

COST ITEM	BIRR PER SET		
	ETHIOPIA 300,000 PER YEAR	SE ASIA 2 MILLION PER YEAR	DIFFERENCE
Materials	20.3	18.7	1.6
Aggregation & Transport	3.1	-	3.1
Manning	1.9	0.4	1.5
Other operating costs	2.0	1.1	0.9
	27.3	20.2	7.1
Capital charges	3.1	1.1	2.0
Working capital charge	1.5	0.7	0.8
Ex-works	31.9	22.0	9.9
Selling company	-	4.1	(4.1)
Transport to Addis	-	2.1	(2.1)
TOTAL	31.9	28.2	3.7

cost of the SE Asian plant is partly offset by the final product transport cost and the selling company charges. Still the SE Asian radio is 12 percent cheaper than the local product. This price comparison is probably more reliable than comparing local cost estimates with spot import prices. It should be noted that the Ethiopian costs at 600,000 sets/year are very similar to the SE Asian high volume cost C.I.F. Addis.

The Economies of scale and the relative geographical costs are shown in Figure IV B-1.

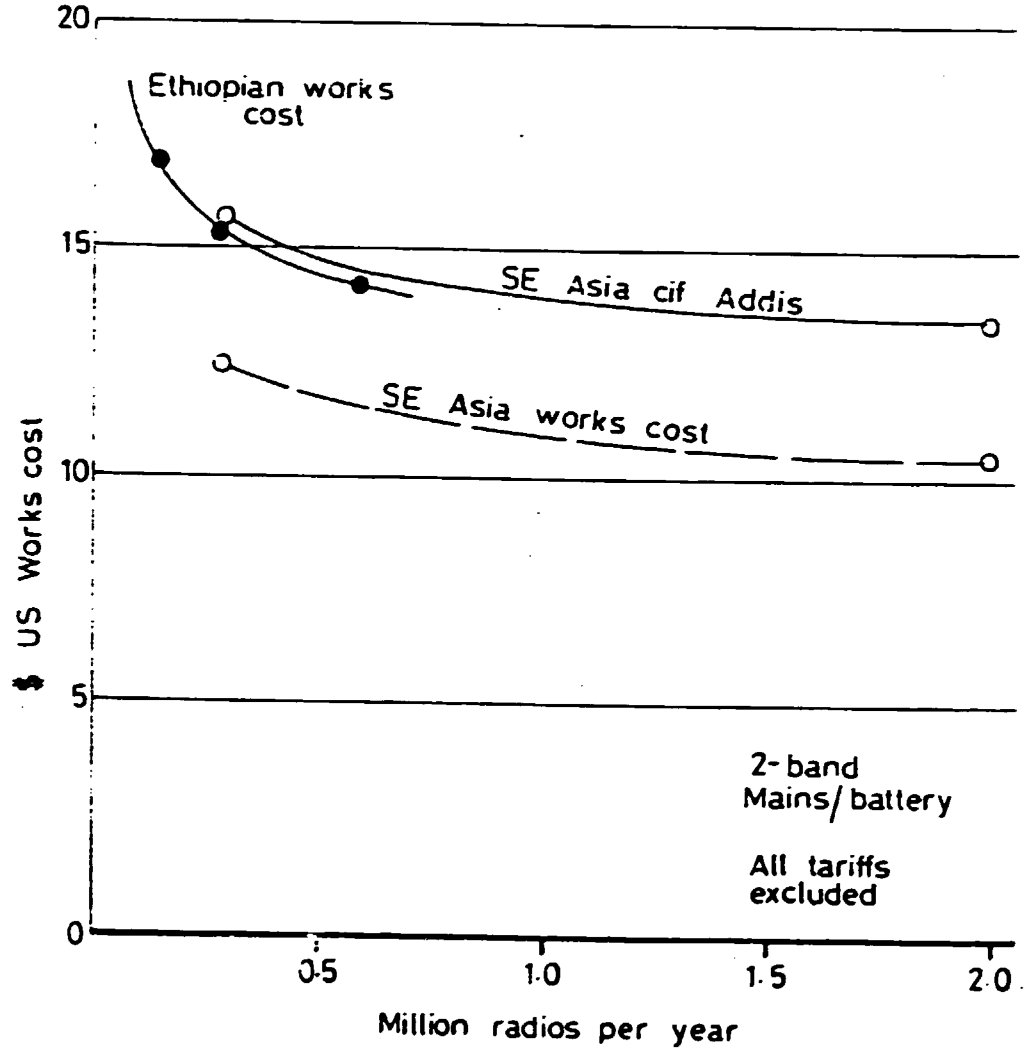


FIGURE IV B-1 ECONOMIES OF SCALE OF RADIO MANUFACTURE

C. ECONOMIES OF SCALE OF TV MANUFACTURE

1. Television Manufacture in SE Asia

Television, like radio, cannot be competitive when the operation consists only of final assembly. Such operations, if they buy their components overseas, have to be strongly protected.

A model of B/W TV manufacture has been constructed for SE Asia. The costs have been enumerated at 200,000 sets/year which is generally considered to be the level at which full economy of scale is obtained. The cost structure is shown in Table IV C-1. The total works cost is $130.7 and it is estimated that such 20 inch TV's could be delivered to Addis Ababa (duty free) for $196. Televisions are bulky items and transport costs are high.

Volume purchases, especially of picture tubes do offer price discounts and 3 percent is assumed from 40,000 to 200,000 sets. A further important saving in parts cost is achieved with a move to plastic moulding, made economic by high volume production. This together with the moulded back (instead of card) saves approximately $2.1 per set.

Manning costs are based on 50 minutes of direct labour per set. Together with indirect labour at 30 percent of direct employees and $1 per hour this produces a total workforce of approximately 122.

The capital costs total $3.86 million. There are few changes in equipment from the items given in the project profile in Chapter V. Additional signal transmission testers are required and some further assembly meters and items for the Quality Assurance/Development Laboratory.

TABLE IV C-1

TV COST STRUCTURE IN SE ASIA

COST ITEM	$ US PER SET		
	40,000 Per Year	200,000 Per Year	Difference
Parts	54.32	50.61	3.71
Manning	1.79	1.10	0.69
Other Operating Costs	6.82	4.71	2.11
	62.93	56.42	6.51
Capital Charges	12.36	4.25	8.11
Working capital charge	2.60	2.47	0.13
Ex-works cost	77.89	63.14	14.75
Selling company charge	15.79	15.79	
Transport to Addis	15.79	15.79	
Duty free cost	109.47	94.72	

The main change in cost comes from the inclusion of over-head conveyers for tubes and cabinets and in the increased cost of jigs and tools. There is very little change in the equipment in the PCB shop or on the TV chassis assembly line, although the number of work stations and test stations increases and a 30 second work cycle can be used. Building size is about 2000 square metres (with a specific cost slightly less than in Ethiopia. It should also be noted that the total building area is less in the SE Asian case at 200,000 TV's than it is in the Ethiopian project at 20,000 TV's/year).

The effect of reducing the plant size to 40,000 units is to increase works costs by nearly $15 or 23 percent. The main differences arise due to parts and capital charge. There is a 3 percent increase in parts cost and the slightly larger cost increase due to switching to a higher cost wooden cabinet appropriate at low volumes. The tooling costs and machine underutilization for plastic moulding at low volume would be far greater. The overall capital cost decreases from $3.85 million to $2.25 million although the production volume decreases five times.

The cost penalty attached to small volume TV manufacture is serious, more so than with radios.

2. Economies of Scale in Ethiopia

In Table IV C-2 the cost are presented in almost the same form as in the project profile in Chapter V (the totals are about 2 percent higher in this example). These costs have then been re-estimated at 40,000 sets/year. The effect is to reduce the total cost by some 19 Birr, which is a 17 percent reduction.

TABLE IV C-2

TV ECONOMIES OF SCALE IN ETHIOPIA

COST ITEM	$ US PER SET		
	20,000 Per Year	40,000 Per Year	Difference
Parts	57.61	57.04	0.57
Aggregation charge	1.44	1.42	0.02
Transport	7.38	7.31	0.01
	66.43	65.77	0.66
Manning	9.76	4.98	4.78
Other Operating Costs	12.03	7.58	4.45
	88.22	78.33	9.89
Capital Charges	21.96	12.74	9.22
Working Capital Charge	3.91	3.71	0.20
TOTAL	114.09	94.78	19.31
	Birr	Birr	
TOTAL	236.2	196.2	40.0

Again the main effect is the capital charge, with manpower also showing a considerable saving. The other operating costs reduce substantially because these are heavily influenced by the unusually high manning levels assumed on the small Ethiopian plant. The cost of the plant and equipment in the 20,000 set plant is 0.804 million Birr. This increases to only 0.954 million Birr in the 40,000 set plant, the main increase being a doubling of signal transmission testing equipment and small increases in the requirement for assembly meters and the assembly conveyor. The building requirement does not change at all.

Total manning on the 20,000 set plant is 101. This increases to only 104 in the 40,000 net plant. Unit manning costs are therefore almost halved.

It should be restated here that a 20,000 set manufacturing plant makes no economic sense at all if embarked on as a stand - alone venture. The plant and equipment and a large part of the workforce would be idle for much of the time. This is why the costs are so high.

3. Comparison of SE Asian and Ethiopian Costs

Data from both the cases described above are compared in Table IV C-3. The high volume SE Asian manufacturing case has a works cost of only 55 percent of the low volume Ethiopian case. This advantage is reduced to only 17 percent however after taking account of the high finished product transport costs and the typical 25 percent selling company costs.

All the economy of scale information is summarised in Figure IV C-1. At 40,000 sets per year a plant in Ethiopia would complete with SE Asian imports but Ethiopian costs rise very sharply below this level.

TABLE IV C-3

COMPARISON OF ETHIOPIAN AND

SE ASIAN TV MANUFACTURE

COST ITEM	BIRR PER SET		
	ETHIOPIA 20,000 PER YEAR	SE ASIA 200,000 PER YEAR	DIFFERENCE
Parts	119.3	104.8	14.5
Aggregation & Transport	18.3	-	18.3
Manning	20.2	2.3	17.9
Other Operating Costs	24.9	9.7	15.2
	182.7	116.8	65.9
Capital Charges	45.5	8.8	36.7
Working Cap. charge	8.1	5.1	3.0
Ex-works	236.3	130.7	105.6
Selling company	-	32.7	(32.7)
Transport to Addis	-	32.7	(32.7)
TOTAL	236.3	196.1	40.2

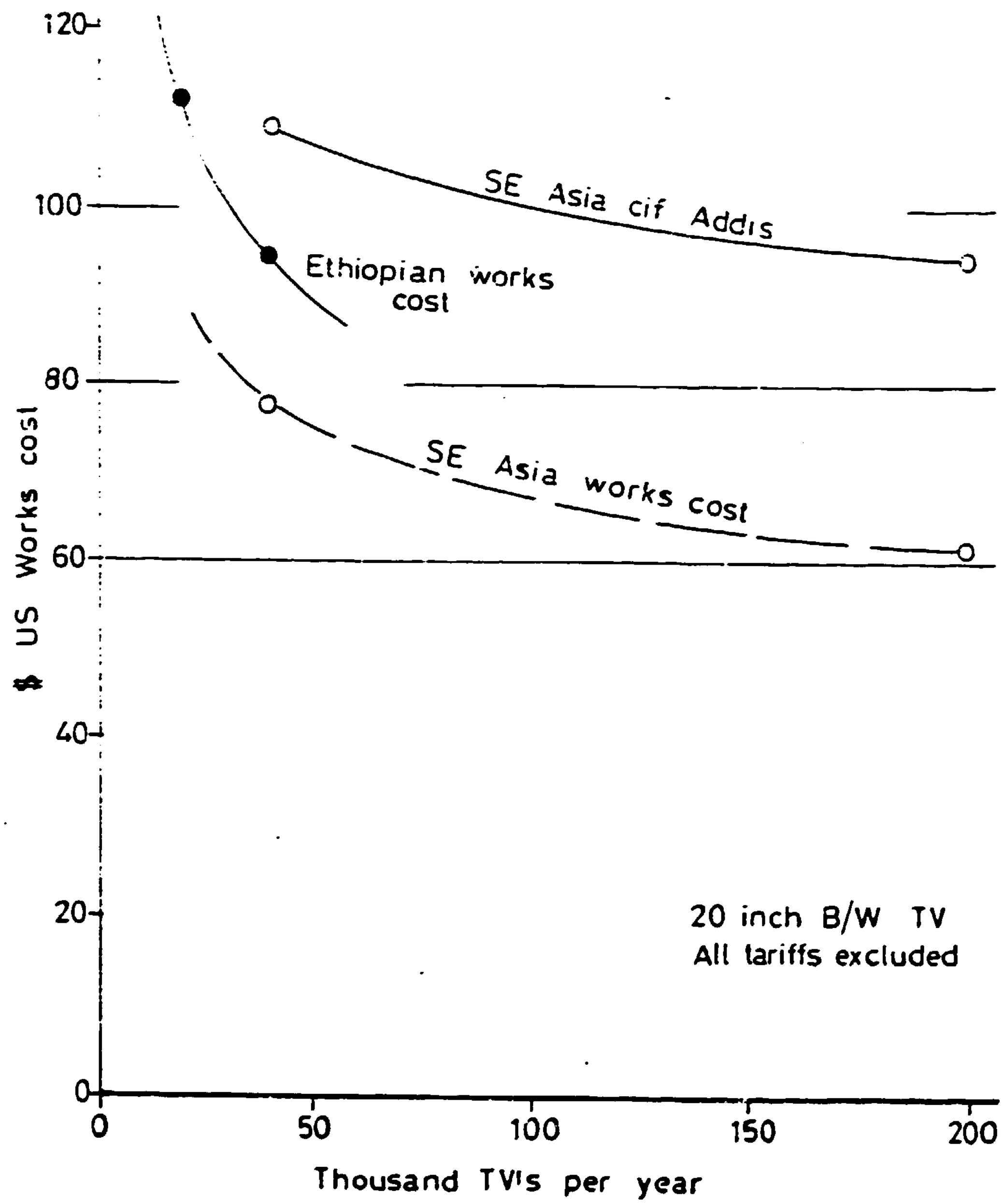


FIGURE IV C-1 ECONOMIES OF SCALE OF TV MANUFACTURE

D. ECONOMIES OF SCALE OF TRANSCEIVERS

This very brief excercise looks at the economies of scale of military transceivers. It is a generally held opinion that military transceiver manufacture begins to become an economic proposition soon after the requirement reaches 1000 per year. Estimates of costs and prices of military transceivers are subject to a wide band of uncertainty. However, since the Ethiopian requirement is probably for several thousand sets per year, the possibiity that this production level is substantially above the minimum economic scale of production must be verified, at least approximately.

In Table IV D-1 the cost structure given in the project profile in Chapter V is setout and this has been very crudely adjusted to give the cost structure at 1000 sets per year. The data refer to the VHF/FM hand held communicator.

The capital charges are the largest item of cost. There will be little total saving, although some saving will result due to a smaller workforce and this will affect the building size,vehicles, training etc. A 15 percent fixed investment reduction is assumed.

Military transceiver manufacture is based very much on specific man-hours of assembly and testing per unit. These direct workers will reduce but there will not be corresponding reductions in the large indirect workforce. Overall the workforce is assumed to reduce from 153 to 100.

The cost of imported parts will only increase slightly but the small amount of parts, mainly mechanical, which can be made locally will suffer from diseconomy of scale.

TABLE IV D-1

ECONOMIES OF SCALE OF

TRANSCEIVER MANUFACTURE IN ETHIOPIA

COST ITEM	AT 3000 PER YEAR	AT 1000 PER YEAR
	BIRR PER SET	
Capital Charges	516	1390
Parts	486	560
Manpower	140	280
Other Op. Costs	167	360
Working Capital	52	60
Licences	272	300
TOTAL	1633	2950
	$ US	
	789	1425

Hand-held VHF/FM military transceiver.

Other operating costs reduce to 80 percent in total, partly due to the manpower reduction. Working capital has been adjusted in proportion to parts. Licences and technical support costs are 20 percent of all other costs in the 3000 set case. This amounts to 0.816 million Birr per year ($394,000). It is unlikely that a foreign company would greatly reduce the total sum if the required volume were to be cut to one third. A fee of $300,000 has therefore been allocated to the 1000 sets.

On the above basis the unit cost nearly doubles. Great uncertainly attaches to all these figures and to the methodology in general. However in Figure IV D-1 the economy of scale curve has been plotted with a band of ± 200 dollars. The assumed volume import of these transceivers is assumed to be at around $1100 each (the small volume sale is much more than this. This $1100 price has also been plotted with a band of ± 150 dollars.

The medium price and the medium comprehensive cost intersect at about 1850 sets per year suggesting that at 3000 sets per year Ethiopia is well above the minimum economic scale of production. The extreme case of highest import price and lowest comprehensive cost shows an intersection at about 1000 sets per year. The other extreme of lowest import price and highest comprehensive cost intersects at 3000 sets per year. The suggestion therefore is that even applying wide bands of uncertainty, Ethiopia would be operating at an economic level of production at 3000 sets per year.

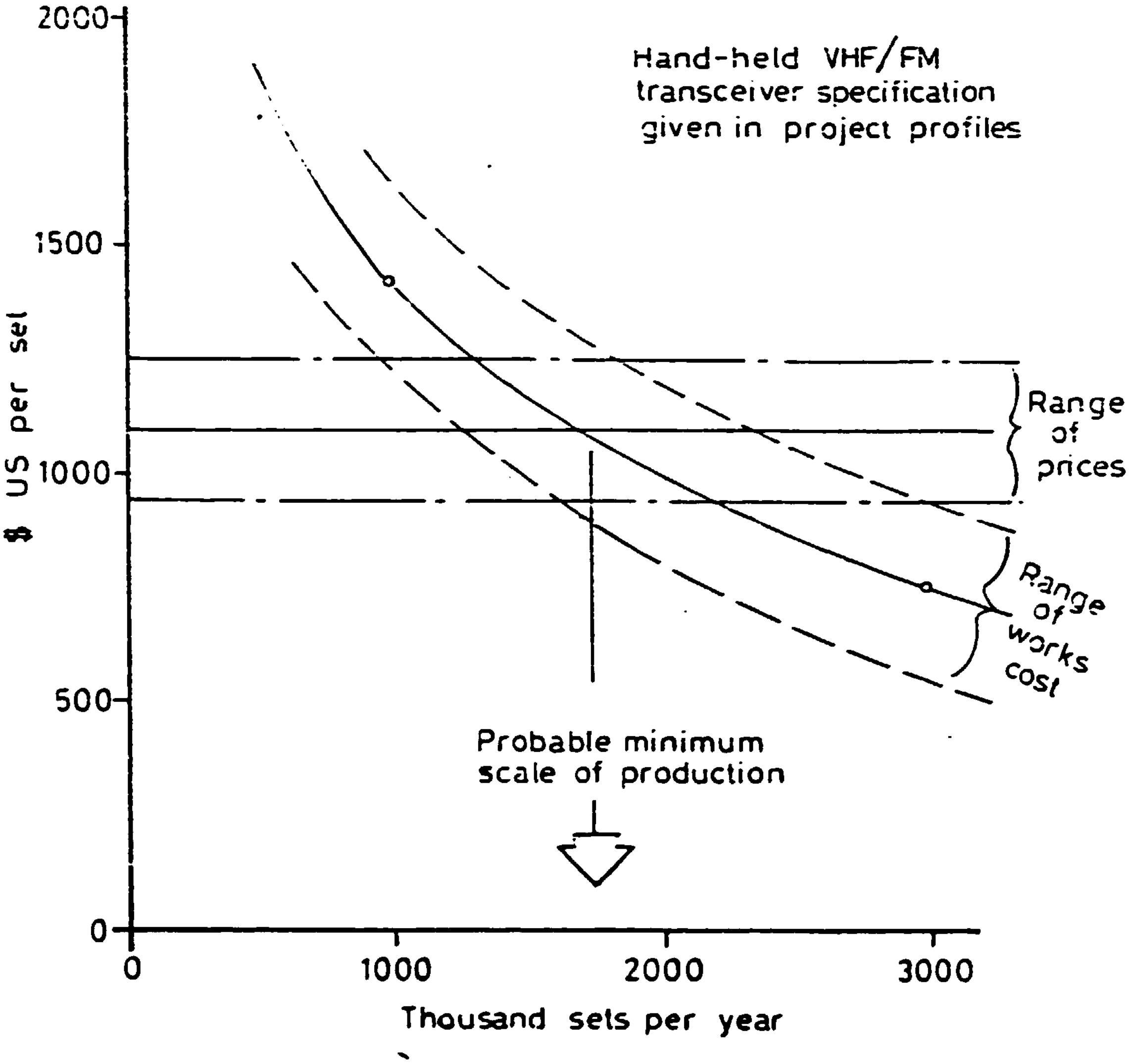


FIGURE IV D-1 ECONOMIES OF SCALE OF MILITARY TRANSCEIVERS IN ETHIOPIA

V. PROJECT POSSIBILITIES

This chapter is based on 9 project profiles which were submitted in an interim report at the end of stage 2 of the study. Following the preliminary market research work it was clear that further attention would have to concentrate on the following possibilities.

- Final assembly of radios
- Radio manufacture (including printed) circuit boards and sub-assembly
- Final assembly at TV's
- TV manufacture (black & white)
- Colour TV manufacture.
- Military radios
- Radio and TV cabinets
- Loud speakers
- Telephones

Each of the profiles was prepared, as far as possible as a stand-alone project based on a market size which was considered to be relevant to ethiopia. In some cases the market size was obviously too small for economic production. Monochrome TV's for example cannot be manufactured at 20,000/year with any prospect of competing with untaxed imports. Nevertheless, the project profile does set out the requirements of a TV manufacturing plant so

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that later, when efforts are made to devise ways in which TV manufacture might be blended with other consumer goods production, the project profile serves as a very useful data base.

A. RADIO ASSEMBLY AND MANUFACTURE

1. Radio Assembly

This project assumes only final assembly of radios at 200,000. The assembly operation is very simple. The parts are issued from stores, some 5 percent of PCBs having been fully tested to prove the quality of the purchases. The assembly takes place on a bench, with some 7-8 separate stages. The number of stages is calculated so that each person on the assembly line has a limited number of operations to complete, and can perform the task within about 1 minute. Where longer assembly stages are used there is a risk of the assembler forgetting the sequence and making a mistake. Additional equipment can be purchased to assist the assembler but at this stage it is better to avoid such costs.

The front pannel assembly is prepared first, with the speaker,then the transformer and mains socket is added, the wiring harness is made up and soldered on to the printed circuit board. Then the PCB is inserted in the

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the case and the soldering completed. Finally the back is fitted and the radio checked. Cassette radios have a few extra parts to be fitted.

200,000 radios per year implies about 750 per day which on 375 minutes of actual track operation, means about 30 seconds for each operation. The jigs carrying the radios move slowly along a simple conveyor track in front of the assembly station and are slid onto side tables at each assembly stage. Finally the radio is tested, failures being passed back for reworking. Then they are packed and return to store.

2-band radios are slightly different to single band. There is a telescopic aerial to fit. Otherwise the additional components are carried on the printed circuit board. The cassette radio includes about three extra stages. It is likely that the line would run for several days on a single type of radio.

Nearly all supplies are imported. The plastic parts and fasteners are locally made but use imported raw materials. Only the carton and packaging is assumed to be wholly local, as shown below.

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PCS (tested) Headphone Loudspeaker Mains transformer Socket and switch Cassette tape mechanisms Aerial (short wave)	Imports
Case mouldings Screws and metal parts Tuning scale, pointer etc., Knobs	Local manufactured Imported materials
Carton and packaging	Local

The building requirement is 1070 sq. metres, consisting of 350 sq meters of stores, 350 metres of assembly, 70 sq meters of inspection and quality control areas, and the remainder offices.

The plant employes 59 people of when half are direct workers and half are indirects. The manning schedule is shown in Appendix B.

Assuming 1800 hours per hour per employee the direct labour content of the radios is 16 minutes. (An experienced and productive workforce working at a higher volume would complete the tasks in about 7 minutes).

The largest element of costs is the supplied components. These are shown in Table V/A.1. The imported items are based on ex-works prices in volume manufacturing countries, plus 12½ percent extra for containerised delivery to Addis Ababa. No tariffs of any kind are included. The operating costs for a full year are shown in table

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V A-2 production is assumed to be based on the following product distribution (this is not the same as that assumed in the recommended project later in this report):

	Sets sold per year
medium wave	100,000
MW/short wave	60,000
MW/SW/cassette	40,000

All radios are assumed to be ac-dc (i.e. battery/mains).

Capital investment amounts to 2.53 million Birr and is detailed in Table V A-3. In addition to the fixed investment there will be a large demand for working capital as shown below. The foreign currency element of the working capital is the same as the foreign currency component of the separate parts. It averages 84 percent overall.

	Million Birr
Stocks of supplies (3 months)	1.73
Stocks of finished goods (1 month)	0.62
Letter of credit (1 month)	0.55
Debtors (1 month)	0.62
Cash	0.05
	3.57

The comprehensive cost of a full year of production is shown in Table V A-4 and from this total annual cost the unit costs of the different models may be calculated. The unit costs of the different types of radio may be assumed to be in roughly the same relationship as the cost of parts of the different designs. Thus the simple medium wave radio costs 32 Birr and the two band radio is 35 Birr as shown below:

shown below:-

RADIO	ANNUAL COST MILLION BIRR	PRODUCTION THOUSANDS PER YEAR	UNIT COMPREHENSIVE COST BIRR
MW	3.195	100	32
MW/SW	2.095	60	35
Cassette	2.862	40	72
	8.152	200	

The cost of the 2-band radio (32 Birr) may be compared with the estimated prices of radios imported into Addis Ababa of around 30-32 Birr (before taxes) and with the estimate from chapter 2 for works cost plus transport for a SE Asian radio, of about 28 Birr.

TABLE V/A.1

MATERIALS COST IN ASSEMBLED RADIO

Item	Birr Per Set		
	Local Supplies	Imports	Total
Medium wave radio:			
Cartons & Packaging	0.41	-	0.41
Headphone	-	0.58	0.58
Case mouldings*	1.55	1.03	2.58
Screws & small metal Parts	0.27	-	0.27
Loudspeaker	0.11	2.09	2.20
Tuning scale,pointer&carriage	0.64	0.30	0.94
Knobs	0.27	0.07	0.34
Transformer	0.10	1.80	1.90
Socket & switch	-	0.54	0.54
	3.35	6.41	9.76
Printed circuit board	-	17.50	17.50
TOTAL MW radio	3.35	23.91	27.26
MW/short wave radio:			
Telescopic aerial, band switch, SW oscillator & coils	-	2.44	2.44
TOTAL 2-band radio	3.35	26.35	29.70
MW/SW cassette:			
Packaging (extra)	0.06	-	0.06
Larger case (extra)	0.23	0.15	0.38
Extra mouldings	0.91	0.43	1.34
Tape Mechanism	-	26.16	26.16
Pushbutton band switch	-	2.03	2.03
Electronic components (extra)	-	1.02	1.02
30% larger PCB (extra)	-	0.28	0.28
TOTAL cassette radio	4.55	56.42	60.97

* made locally

TABLE V/A. 2

SUMMARY OF OPERATING COSTS FOR RADIO ASSEMBLY

Item	MILLION BIRR PER YEAR		
	Local Currency	Foreign Currency	Total
Radio parts	0.718	5.918	6.636
Local transport imported parts	0.311	-	0.311
Manning (59 at 4022 Birr/year)	0.237	-	0.237
Other operating costs:			
Utilities	0.065	-	0.065
Maint. materials & sp.	0.032	0.032	0.064
Vehicle operations	0.027	0.027	0.054
Expenses	0.036	0.012	0.048
	1.483	5.989	7.415

TABLE V/A.3

CAPITAL INVESTMENT, RADIO ASSEMBLY

Cost Item	Thousand Birr		
	Local Currency	Foreign Currency	Total
Radio assembly equipment:			
Testing supplied components	8	85	93
Motorised conveyor	4	44	48
Product testing	6	64	70
Development/QA laboratory:			
Instrumentation	12	116	128
Drawing office	5	51	56
Humidity/heat chambers	6	58	64
Prototype workshop	3	30	33
	44	448	492
Jigs and tools	7	67	74
	51	515	566
Equipment installation	3	25	28
Office furn,eqpt. & fittings	81	82	163
Vehicles	29	296	325
Buildings 970 sq,m at 960 Birr	668	359	1027
	832	1277	2109
Project eng. & management	119	39	158
Preop. (mainly training)	53	213	266
	1004	1529	2533

TABLE V/A. 1

COMPREHENSIVE COST OF ASSEMBLED RADIOS

Cost Item	Million Birr			Percent
	Local Currency	Foreign Currency	Total	
Capital cost	1.004	1.529	2.533	
Working capital	0.558	3.012	3.570	
Annual capital charge* (15%)	0.151	0.229	0.380	4.7
Annual working capital* Charge (10%)	0.056	0.301	0.357	4.4
Operating costs:				
Radio parts	1.029	5.918	5.947	85.2
Manning	0.237	-	0.237	2.9
Other costs	0.160	0.071	0.231	2.8
T O T A L	1.633	6.519	8.152	100.0
		Percent		
	20	80	100.0	

* See Appendix A

2. Radio Manufacture

This profile is based on manufacture of 300,000 sets per year. The printed circuit boards are imported as large unprocessed boards. The boards are etched to prepare the circuits, holes are punched in them and around 50 electronic components are hand-inserted in to the holes. The undersides of the boards are automatically soldered. Thereafter the assembly proceeds as in the radio assembly profile. It is assumed that the transformer and coils used in the radio frequency side of the radio will be made in the plant and that the radio cabinets and plastic parts will be made locally but out side the plant.

The manufacture and sub-assembly of the printed circuit boards is described in detail as it is also appropriate to other electronic goods. A simple flow diagram of the operations is shown in Figure I/A.1 the incoming boards, made of pressed fibre clad with a film of copper are sheared into smaller pieces, probably about 25 cm square, each able to make about 6 radio PCBs. This is an appropriate size for the insertion and soldering lines. The boards are brushed clean. An enlarged master drawing of the printed circuit topology is photographed in a reduction camera. Such equipment will be available within the printing industry in Ethiopia and need not be purchased specially for this venture. It is very unusal for radio/TV manufacturers to do this themselves.

The photographic negative is used to make a silk screen image by means of contact printing on a copier. The resulting stencils are coated with printing ink and applied to the boards. The ink is transferred to the board and then cured under an ultraviolet lamp.

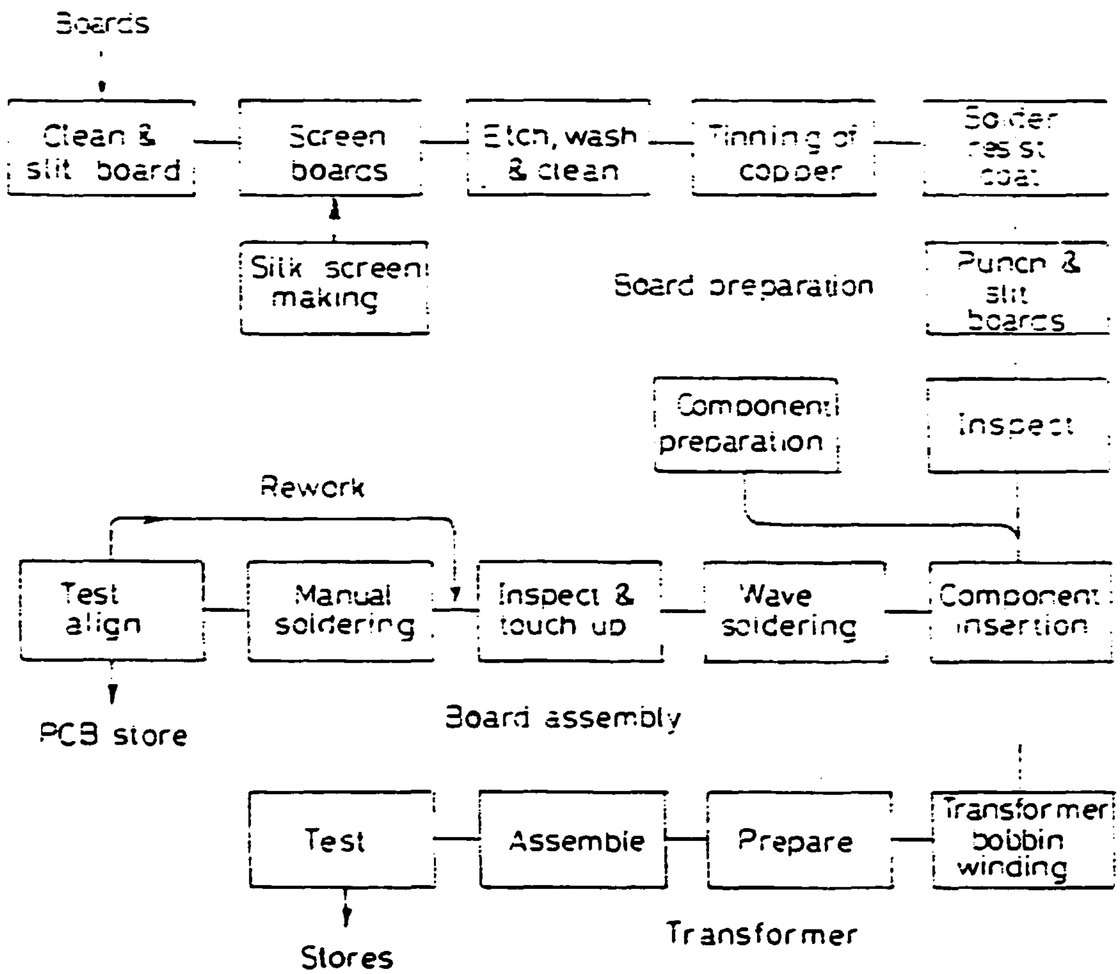

FIGURE VA-1 RADIO PCB AND TRANSFORMER MANUFACTURE

The parts of the board which are coated with protective ink will form the printed circuit. The remaining copper coating is then removed with a cupric chloride etchant. The etchant is washed off and the printing ink stripped from the board. Next the remaining copper circuit is fluxed and roller coated with tin to protect the copper and to improve the subsequent solderability of the components onto the copper circuits.

The tinned boards are again silk screened with a solder-resist. This ensures that when the component wires are soldered to the board the solder does not adhere except to the area immediately around the wires. This solder-resist is ultraviolet cured and the boards are punched with the holes for the component wires. Numerically-controlled drilling machines are often used in high volume practice. Drilled holes are of superior quality to multiple-punched holes but for simple radios and B/W televisions the cheaper punched hole is satisfactory. Finally the boards are slit to their final size (4-5 inches square) or partially slit so they can be cracked later.

The components are supplied with long pieces of wire sticking from the ends. There must be cropped to length and bent to exactly the correct spacing for insertion onto the PCB. In high-volume automatic insertion practice the components are supplied on a bandolier and the preparation is done automatically just before insertion. In manual practice the components will be supplied in boxes and dropped individually into a jig for automatic cropping and shaping of the wire.

The components and boards pass to the insertion line where a row of about 8 people each insert a limited

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number of components onto each board (limited to a sequence they can repeat quickly without mistakes, probably about 8 components).

The boards are placed onto a jig which carries them slowly over a molten solder bath. All those parts of the boards not coated with solder-resist will take up solder and the components will thus be soldered onto the board. About 4-5 components will be manually inserted and manually soldered afterwards for reasons of inaccessibility or unsuitability for automatic soldering. Each board is visually inspected and any defects taken off the line for manual touch-up. The boards then pass to the case assembly line as described in the assembly profile. In the assembly-only operation the boards are tested on a sample basis (about 5 percent). Where the boards are locally made they will be 100 percent tested using automatic equipment.

A separate line makes the transformers and RF coils. The transformer coils are wound on an automatic bobbin-winder. The smaller coils may be wound on small hand winders. The transformer consists of a winding around the laminated steel sheet core. The thin steel sheets can be imported and cropped to shape, assembled into standard packs and fixed together.

The plant employs 147 people of whom 54 are indirect workers; the remainder are employed directly at the production plants. The manning schedule is given in Appendix B.

The materials costs are shown in Table V A-5 and the operating costs for a full year of production are given in Table V A-6. The distribution of products remains the same as in the assembly profile.

The printed circuit board (fully assembled) costs 17½ Birr for the MW radio. The components now cost 11 Birr, and the comprehensive cost of the board is about 14½ Birr.

The capital investment requirement is given in Table VA.7. The plant needed for assembly of 200,000 radios is also sufficient for 300,000 (and more) the building remains the largest single element of capital cost. Space requirements are as follows:

Stores:	Goods inward	300
	Part finished	300
	Finished goods	250
Board making		300
Insertion etc.		300
Assembly		350
Inspection/QA/Dev.		150
Offices & aux. Services		550
		2500

The comprehensive costs are shown in VA.8. The unit cost of the different types of radio may be assumed to be roughly in the same relationship as the cost of the parts of the different designs. The units costs are then as shown below:

Radio	Annual Cost million Birr	Production thousands per year	Unit Comrehensive cost Birr
MW	3.993	150	26.6
MW/SW	2.683	90	29.8
Cassette	4.232	60	70.6
	10.908	300	

The 2-band radio costs 29.8 Birr compared to 35 Birr in the assembly - only version.

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The import price (before duties) of the 2-band radio was calculated in chapter IV as 23.2 Birr. The apparent prices in Ethiopia are slightly higher at 30-32. There does appear to be a case for consisting radio manufacture, although the imported price may be slightly below local manufacture.

TABLE VA.5

MATERIALS COST IN MANUFACTURED RADIO

Item	Birr Per Set		
	Local Supplies	Imports	Total
Medium wave radio:			
Printed circuit board:			
Board	0.39	0.48	0.87
Ferrite rod	0.04	0.77	0.81
Wires	0.52	-	0.52
Variable capacitor	0.08	1.53	1.61
Headphone socket	0.17	-	0.17
Solid state devices	0.10	1.99	2.09
Other electronics	0.25	4.72	4.97
	1.55	9.49	11.04
Transformer	0.27	1.31	1.58
Other parts (assembly profile)	3.25	4.61	7.86
Total MW radio	5.07	15.41	20.48
MW/short wave radio:			
Additional parts	0.12	2.32	2.44
Total 2-band radio	5.19	17.73	22.92
Cassette radio:			
Extras	1.20	30.07	31.27
Total Cassette Radio	6.39	47.80	54.19

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TABLE VA. 6

SUMMARY OF OPERATING COSTS FOR RADIO MANUFACTURE

Item	Million Birr Per year		
	Local Currency	Foreign Currency	Total
Radio Parts	1.611	6.769	8.380
Manning(147 at 3850Birr)	0.566	-	0.566
Other operating costs:			
Utilities	0.185	-	0.185
Maint. materials & spares	0.085	0.085	0.170
Vehicle operations	0.063	0.063	0.126
Expenses	0.030	0.090	0.120
	2.540	7.007	9.547

TABLE VA.7

CAPITAL INVESTMENT, RADIO MANUFACTURE

Cost Item	Thousand Birr			
	Local Currency	Foreign Currency	Total	
Radio assembly equipment:	51	515		566
Printed circuit board equip:				
Board cleaning	5	51	56	
Etching & stripping	16	162	178	
Roller tinning	6	56	62	
Printing	4	46	50	
Effluent treatment	2	21	23	
Automatic inspection	4	44	48	
Board punching press	4	43	47	
Chemical laboratory	9	88	97	
Jigs & fittings	7	78	85	
				646
PCB assembly:				
Component preforming	4	46	50	
Solder bath incl. preheat	9	88	97	
RF/IF alignment gear	9	95	104	
Cassette test gear	-	7	7	
Jigs & fixtures & small Pieces	8	83	91	
				349
Coil winding equipment:				
Bobbin winder	5	50	55	
Hand winders	4	41	45	
Vacuum impregnation	3	35	38	
Test equipment	1	13	14	
Jigs & fixtures	1	4	5	
				157
	152	1566		1718
Equipment installation	9	77	86	
Office furn. equip. fittings	122	182	304	
Vehicles	53	543	596	
Buildings 2500 sq at 960 Birr	1560	840	2400	
			5104	
Project eng. & management	287	95	382	
Preop. (mainly training)	132	528	660	
	2315	3831	6146	

TABLE VA. 3

COMPREHENSIVE COST OF MANUFACTURED RADIO

Cost Item	Million Birr			Percent
	Local Currency	Foreign Currency	Total	
Capital Cost	2.315	3.831	6.143	
Working Capital	0.878	3.512	4.390	
Annual capital charge (15%)	0.347	0.575	0.922	8.5
Annual working capital Charge (10%)	0.088	0.351	0.439	4.0
Operating Costs:				
Radio Parts	1.611	6.769	8.380	76.8
Manning	0.566	-	0.566	5.2
Other costs	0.363	0.238	0.601	5.5
T O T A L	2.975	7.933	10.908	100.0
	Percent			
	27.3	72.7	100.00	

* Stocks of supplies	2.10
Finished sets	0.80
Letters of credit	0.59
Debotrs	0.80
Cash	0.10
	4.39 Million

3. TELEVISION ASSEMBLY AND MANUFACTURE

1. Television Assembly

Television assembly is based on a volume of 15,000 black and white sets per year. At this volume a reasonably utilised assembly line can be established. A single screen size, 20 inches is assumed. The technical specification is given in Appendix C.

The TV set consists of a cabinet and speaker, picture tube, and chassis with printed circuit boards and controls and ancillaries such as transformers. The sequence of operations is shown below:

- sample checking of components
- prepare cabinet and fit speaker
- fit picture tube and chassis
- solder wiring and fit tuner controls
- mechanical inspection and warm-up (15 mins.)
- adjust focus, picture size and geometry
- quality control check
- close back and safety check.

Modern practice is to use plastic cabinets. These are large mouldings which will probably require the purchase of a new large injection moulding machine. A practice more appropriate to Ethiopia would be to use a wooden cabinet to which the various parts could be screwed.

The assembly and testing operation is carried out at a series of work stations served by a short length of roller conveyor on which the TVs resting on pallets are slid from station to station. At each station they are slid from the conveyor onto a side table. The pallets return on a slide beneath the conveyor. At 15,000 per year the line operates at 7 per hour. Allowing 1,500 effective hours per year the line will then operate at about 10 sets per hour. The minimum cycle time then being about 5-6 minutes. Such a line can be fully occupied on single shift working.

The only significant item of local manufacture is the cabinet. However, this is an important element of cost, amounting to about 14 percent of all supplies. Table V B-1 shows the list of parts. These total 148 Birr. Excluding the local transport element of imports the local supplies comprise 20 percent of the total. The picture tube and the PCBs together account for nearly three quarters of the total cost of parts.

Manning requirements are 14 direct and 18 indirect, totalling 32. The indirect employment is larger than the direct employment and could probably support a considerable increase in production volume without increasing numbers. Throughout the assembly line the work cycle is 5 minutes. There is as much inspection, testing and supervision as there is assembly work operating costs are in Table V B-2.

The direct labour content of each set is about 1 hour 40 minutes. In high volume practice it is about 20 minutes. Productivity is therefore very low.

Nearly all the equipment necessary for the assembly of radios (apart from the conveyors) is also needed to support TV assembly. This has been included as the second main heading in Table V B-3. In addition there is a requirement for a further 0.22 million Birr of instrumentation specifically for televisions. Allowance has been made for a minibus and three other vehicles.

TABLE V B-1

MATERIALS COST IN ASSEMBLED TV

ITEM	BIRR PER SET		
	Local* Supplies	Imports	Total
Cartons & packaging	2.2	-	2.2
Cabinet	20.33	-	20.33
Back	5.18	-	5.18
Tube (23 inch)	-	34.93	34.93
Deflection yoke	-	2.62	2.62
Earthing assembly	0.31	-	0.31
Loudspeaker	-	2.56	2.56
Knobs	0.31	0.15	0.46
Customer's controls	-	7.71	7.71
Printed circuit boards	-	71.03	71.03
Plastic escutchions	1.30	-	1.30
	29.63	119.00	148.63

* Excluding the local transport element of imported goods

TABLE V B-2

SUMMARY OF OPERATING COSTS FOR TV ASSEMBLY

15,000 per year

ITEM	MILLION BIRR PER YEAR		
	Local Currency	Foreign Currency	Total
TV parts	0.442	1.697	2.140
Local transport of imports	0.088	-	0.088
Manning(32 at 4300 Birr)	0.138	-	0.138
Other operating costs:			
Utilities	0.040	-	0.040
Maint.materials & spares	0.039	0.039	0.078
Vehicle operations	0.014	0.013	0.027
Expenses	0.021	0.007	0.28
	0.782	1.747	2.539

TABLE / B-3

CAPITAL INVESTMENT IN TV ASSEMBLY

COST ITEM	THOUSAND BIRR		
	Local Currency	Foreign Crurency	Total
TV assembly equipment:			
Signal transmission testing	6	50	55
Assembly test meters	2	24	26
QA lab measuring gear	7	74	81
Oscilloscopes	5	47	52
Conveyor	4	44	48
Jigs & tools	16	38	54
	40	286	326
Radio assembly equipment:	47	471	518
	87	757	844
Equipment installation	4	38	42
Office furn., equip. fittings	44	44	88
Vehicles	15	148	163
Buildings 920Sq.m. at 960 Birr	574	309	883
	724	1296	2020
Project eng. & management	38	114	152
Preoperating expenses	42	108	150
	804	1518	2322

The building requirement is 920 square metres. TV's are bulky items and storage areas are large.

Stores	450
Assembly	200
Inspection	70
Offices	200
	920 sq. metres

The various cost items are summed in Table V B-4. The total cost is equivalent to 2.05 Birr per set. Parts account for three-quarters of this. Foreign currency requirements are two-thirds.

A comparable 20 inch B/W TV made in South East Asia has an ex-works price of about $63 (131 Birr). To this may be added a selling company charge of about 17 percent and a retail price mark-up of about 30 percent giving a retail price of $91 (188 Birr). B/W TVs can probably be delivered to Addis Ababa with a selling company cost of around 25 percent and transport costs of about 25 percent; hence 196 Birr. Ethiopian assembled 20 inch B/W TVs will therefore have an ex-works cost some 60 percent higher than South East Asian TVs. However, they will be only about 10 percent more costly than comparable imported TVs.

TABLE V 3-1

COMPREHENSIVE COST OF ASSEMBLED TVs

COST ITEM	MILLION BIRR PER YEAR			Percent
	Local Currency	Foreign Currency	Total	
Capital cost	0.804	1.518	2.322	
Working capital	0.323	0.857	1.180*	
Annual capital charge (15%)	0.121	0.227	0.348	11.6
Annual working capital charge (10%)	0.032	0.086	0.118	3.9
Operating costs:				
TV parts	0.532	1.697	2.229	74.1
Manning	0.138	-	0.138	4.6
Other costs	0.114	0.059	0.173	5.8
TOTAL	0.937	2.069	3.077	100.0
		Percent		
	31.2	68.8	100.0	

*	Supplies	0.56
	Finished goods	0.22
	Letter of Credit	0.14
	Debtors	0.22
	Cash	0.04
		1.18 million

2. B/W TV Manufacture

This profile deals with manufacture at 20,000 B/W TV sets per year. Picture size is 20 inches. The plant is equipped with a printed circuit board preparation unit. The boards are then manually inserted with the electronic components. A B/W television has about 150 components. There are two PCB's in television. Manufacture therefore requires 2 x 20,000 = 40,000 PCB's per year. This amounts to only 150 boards per day. Such a level of production can be achieved in an hour or so of production. The plant would therefore be heavily underutilised if used only for low volume TV production. The manufacture of printed circuit boards was described in the profile on radio manufacture. The process would be identical for TV.

Because of the low volume of production, about 76 sets per day on average, it is unlikely that the plant would actually operate full time. The minimum convenient scale of operation in the manufacture and insertion of the PCBs is about 300 sets per day (around 200,000 per year). In this way the operation can proceed with a 30 second work cycle (note: work cycles of 20 seconds are common in high volume practice, where $\frac{1}{4}$-$\frac{1}{2}$ million sets are made in a year). Thus the plant could operate 1 day per 2 weeks or perhaps 2 days per month.

The testing and alignment of the PCBs could be undertaken on a 5 minute work cycle, equivalent to about 20,000 sets per year on 1 shift.

In the following sections of the profile the actual requirement for manpower, investment and services are reviewed, ignoring at first the fact that these resources would be heavily underutilised if not also used for other products.

In order to staff the plant when all parts are in operation, the direct labour force amounts to 66 employees. Such an operation would need 35 indirects if working full time 1 shift. The manning schedule is given in Appendix B.

The materials cost is shown in Table V B-5 and the operating costs are summarised in Table V B-6. The parts cost for the chassis and control amount to 64 Birr. In the assembly-only profile the chassis and control was purchased for 79 Birr.

Investment requirements are shown in Table V B-7. They amount to 6.056 million Birr compared to only 2.322 million Birr for the TV assembly plant. The main additional item of equipment over and above the PCB plant and the basic assembly plant, is the automatic PCB tester and the associated rigs. The building areas are as follows:

Goods inward store	220
Board preparation	300
QA/laboratory	70
Assembly shop	200
Assembly stores	600
Finished goods store	300
Offices and aux. services	420
	2110 sq. metres

The annual comprehensive cost is shown in Table V 3-4 as 4.643 million Birr. This is equivalent to 232 Birr per set. The assembly-only cost was 197.4 Birr. The effect of underutilising capital, labour and other resources in manufacture has been to increase the cost sharply. There is no question of considering television manufacture except as an extra to other volume manufacturing of PCBs.

TABLE V 3-5

MATERIALS COST IN MANUFACTURED TV

ITEM	BIRR PER SET		
	Local Supplies	Imports	Total
Chassis (PCB):			
2 integrated circuits	-	3.78	3.78
Tuners	-	14.55	14.55
132 misc. components	-	16.01	16.01
Mains transformer	1.29	7.27	8.56
Output transformer	-	8.73	8.73
7 power transistors	-	4.54	4.54
2 PCBs	1.17	1.31	2.48
Wiring	0.78	-	0.78
Tuning block	-	2.62	2.62
Mains switch	-	0.87	0.87
3 rotary controls	-	1.31	1.31
	3.24	60.99	64.23
Add assembly items (previous profile)	30.15	39.74	69.89
	33.39	100.73	134.12

TABLE V B-6

OPERATING COST TV MANUFACTURE

COST ITEM	MILLION BIRR		
	Local Currency	Foreign Currency	Total
TV parts	0.668	1.914	2.582
Local transport of imports	0.101	-	0.101
Manning (101 at 4000 Birr)	0.404	-	0.404
Other operating costs:			
Utilities	0.140	-	0.140
Maint. materials & spares	0.090	0.090	0.180
Vehicle operations	0.045	0.046	0.091
Expenses	0.066	0.021	0.087
	1.514	2.071	3.585

TABLE V 3-7

CAPITAL INVESTMENT TV MANUFACTURE

COST ITEM	THOUSAND BIRR		
	Local Currency	Foreign Currency	Total
TV chassis assembly equipment:			
PCB assembly autotester	11	118	129
Test rigs (3)	5	53	58
Additional jigs	24	56	80
Conveyors	5	45	5[illegible]
	45	272	317
TV assembly equipment:	40	286	326
Radio assembly & labs.	47	471	518
PCB equip. & coil winding	101	1051	1152
	233	2080	2313
Equipment installation	12	104	116
Office furn. equip. & fittings	158	159	317
Vehicles	37	372	409
Buildings 2110 sq.m at 960 Birr	1317	709	2026
	1757	3424	5181
Project eng. & management	97	292	389
Preoperating	97	389	486
	1951	4105	6056

TABLE V B-8

COMPREHENSIVE COST OF MANUFACTURED TVs

COST ITEM	MILLION BIRR PER YEAR			Percent
	Local Currency	Foreign Currency	Total	
Capital cost	1.951	4.105	6.056	
Working capital	0.447	1.043	1.490*	
Annual capital charge (15%)	0.293	0.616	0.909	19.6
Annual working capital charge (10%)	0.045	0.104	0.149	3.2
Operating costs;				
TV parts	0.769	1.914	2.683	57.8
Manning	0.404	-	0.404	8.7
Other costs	0.341	0.157	0.498	10.7
TOTAL	1.852	2.791	4.643	100.0
	Percent			
	39.9	60.1	100.0	

*	Stocks of supplies	0.67
	Finished goods	0.30
	Letters of Credit	0.16
	Debtors	0.30
	Cash	0.06
		1.49 million

3. Colour TV Manufacture

This profile is based on making 5000 colour TV sets of 20 inch size. The technical specification is given in Appendix C.

It is assumed that colour television would only be introduced to an established PCB-making and consumer electronic assembly plant. The costing in this profile is therefore based on allocations of use of an existing plant, except for final assembly which can be full-time.

The process of making a colour TV set is the same as for a black and white set except that there are some 300 hand inserted components instead of 100. The technology is more advanced, with greater use of ICs and of course the picture tube is more complex.

The minimum production rate on the set assembly is determined by the time required for a single operator to make all electrical adjustments to the receiver. This is about 15 minutes, thus permitting an effective production rate of about 25 sets per day or 6,600 per year.

At 15 minutes work cycle there are about 8 operators on the line giving a productivity of about 2 hours/set. With a 5 minute work cycle the work could still be undertaken with about 15 operations, equivalent to $1\frac{1}{3}$ hours per set. This gives a measure of the low productivity resulting from low production levels. Assembly could be considered a full time operation on 1 shift working.

The PCB assembly operation cannot be full-time. For accurate repeatability each manual insertion operator should be limited to 8-10 insertions (a 30 second cycle). Each set requires about 300 insertions before wave soldering. This requires a line of about 30 operators. Such a line can produce around 750 sets per day when only about 20 sets are needed.

With machine-aided manual insertion (with light spots to direct actions), a 1 minute work cycle could be introduced, with about 30 insertions in that time. Volume could be reduced further by arranging operators in work groups of 3-4 operators, each group having its own inspection. In this case the insertion rate will fall to around 20 per minute per operator. A combination of the two forms of PCB assembly (machine-assisted and manual) might be the most practicable solution, with work being undertaken on a 1 minute cycle as follows:-

4 operators (machine aided)	120 insertions
9 operators (manual only)	180
3 inspectors	-
16	300

The complexity of the colour PCB requires automatic inspection after the board cutting and touch-up operation. Alignment and picture test can be achieved by an operator in 8 minutes.

The manning requirement at full operation is 97 direct workers. This is shown in Appendix B. However the utilisation of facilities would be as follows:-

PCB making	- 3 days per month
PCB insertion	- 1 day per month
Set assembly/test	- full time

An allocation of labour on the above basis is made at the bottom of the Table in Appendix 3. The total full-time equivalent (direct and indirect) is 30 employees. The equivalent number of full-time directs is 19. This implies about 7 hours per set. An efficient high volume full time operation would require 2-3 hours.

The materials requirements are shown in Table V 8-9. More than half the cost is in the picture tube, which is over 4 times the cost of a 20 inch B/W tube. The operating costs are summarised in Table V 8-10.

The capital investment requirements are based on 12 percent use of the equipment in the B/W TV profile, but with the addition of special equipment essential to a colour assembly line. These costs are given in Table V 8-11.

The annual comprehensive costs are presented in Table V 8-12. The total cost of 1.90 million Birr is equivalent to 380 Birr per set.

The price of a 20 inch colour TV made in Europe and delivered to Addis Ababa will be about 460 Birr. This is considerably more than the 380 Birr estimated local manufacturing cost. But in any case the current price of a colour TV set in Addis Ababa is 2000 - 4000 Birr.

TABLE V B-9

MATERIALS COST IN COLOUR TV

ITEM	BIRR PER SET		
	Local Supplies	Imports	Total
Packaging	6.80	-	6.80
Cabinet	28.14	-	28.14
Back	5.17	-	5.17
Picture tube	-	142.55	142.55
Speaker	0.79	1.83	2.62
Degaussing coil & earth braid	0.78	1.46	2.24
Mains lead	-	0.87	0.87
PCBs	2.33	2.62	4.95
Integrated circuits	-	10.19	10.19
Transistors/nodes	-	12.34	12.34
Resistors - fixed	-	1.14	1.14
- variable	-	1.46	1.46
Capacitors- electrolytic	-	6.52	6.52
- ceramic	-	1.66	1.66
- other	-	5.24	5.24
Mains transformer	1.29	8.73	10.02
Flyback transformer	-	16.01	16.01
Drive transformer	0.52	1.75	2.27
Tuner	-	14.55	14.55
Customer controls	-	5.10	5.10
Miscellaneous	-	10.57	10.57
	45.82	244.59	290.41

TABLE V B-10

OPERATING COST COLOUR TV MANUFACTURE

COST ITEM	MILLION BIRR PER YEAR		
	Local Currency	Foreign Currency	Total
TV parts	0.229	1.111	1.340
Local transport of imports	0.058	-	0.058
Manning (equivalent 30 at 4000 Birr)	0.120	-	0.120
Other costs	0.041	0.019	0.060
	0.448	1.130	1.578

TABLE V 3-11

CAPITAL INVESTMENT IN COLOUR TV

COST ITEM	THOUSAND BIRR		
	Local Currency	Foreign Currency	Total
Special colour TV plant			
Semi automatic insertion(1)	3	29	32
Test rigs	5	53	58
Colour signal source	3	23	26
Meters	1	9	10
QA lab extras	1	15	16
	13	129	142
Allocation for on-costs(2)	169	200	369
12% of Mono TV investment	234	493	727
	416	822	1238

(1) Assign 10 percent of cost (insertion is. at 1 day/month) other plants can use it.

(2) Installation, fitments, building, engineering etc. based on the equipment/on-cost ratio in Mono TV, i.e. 2.6.

TABLE V B-12

COMPREHENSIVE COST OF COLOUR TV

COST ITEM	MILLION BIRR PER YEAR Local Currency	Foreign Currency	Total	Percent
Capital cost allocation	0.42	0.82	1.24	
Capital charge (15%)	0.06	0.12	0.18	10
Working capital charge*	0.02	0.07	0.09	5
Operating costs:				
TV parts	0.23	1.22	1.45	76
Manning	0.12	-	0.12	6
Other costs	0.04	0.02	0.06	3
	0.47	1.43	1.90	100
		Percent		
	25	75	100	

* Based on 5 percent of all other cost totals

C. MILITARY RADIOS

This profile is based on the following approximate demand.

Military transceivers:

- Hand held transceivers	2000-3000
- VHF/FM man packs	500-1000
- HF-SSB man packs	50-100

Some illustrative transceivers are described in Table V C-1. The hand held VHF-FM transceiver and the VHF/FM man pack are similar in technology although the man pack is heavier, has a higher transmitting power with more stable transmission and can use a large number of channels. This increased specification justifies a price nearly 50 percent above the hand held transceiver. The hand held transceivers can communicate directly or through a repeater, which receivers the weak transmission and re-broadcasts it at higher power. The VHF/FM man packs communicate directly.

The HF-SSB transceiver is a higher power transceiver with a much larger number of channels and a much more stable transmitter. This is used for longer-range transmission.

The military transceivers typically contain 10-20 printed circuit boards with 500-1000 discrete components and 20-30 integrated circuits. The hand held transceiver contains about 15 times as many components as a simple consumer radio. In general it is the transmission rather than the reception which introduces the complexity. Out of 15 printed circuit boards in a typical transceiver, about four might carry reception circuitry; the rest are for transmission.

TABLE V C-1

CHARACTERISTICS OF TRANSCEIVERS

	MILITARY TRANSCEIVERS		
	Hand Held VHF/FM	VHF/FM Man Pack	HF-SSB Man Pack
Frequency range (MHz)	any 10 in range 30-80	30-90	2-30
Number of channels	400	10 out of pos. 2000	28,000
Channel spacing(KHz)	25	25	1
Frequency stability of transmitter	±20 ppm	± 10 ppm	± 1-2 ppm
Power output of transmitter (watts)	½	5	20
Weight (kgs)	1½	4	11
Typically selling price in $US (at small volumes)	1300	1800	5500

The amount of direct labour for component insertion on the PCB and for transceiver assembly and testing varies from 15 - 35 hours (compared to 0.2 hours for radios) thus a hand held military transceiver consumes about 30 times the assembly and testing effort of a small consumer radio.

Military radios now use hybrid circuits, surface mounted components and in the latest designs, especially in hand held radios, the use of lasers for trimming of the active devices in order to align the radio characteristics of the circuits.

In general military radios are designed to withstand high levels of shock and vibration and are watertight. This adds substantially to the cost of the non-electronic materials but apart from this the component specifications and quality standards are similar to non military equipment. Military radios are often made on a small scale, say at rates of 100 per week. Assembly is nearly always manual although some 'pick and place' machinery is being introduced for the less expensive, higher volume 'squad' or hand held radios. This has especially been brought about because some of the modern PCBs now use surface mounted components (see Chapter IV). Military radios are also subject to extensive testing. There is a high level of manual inspection at every stage although the use of automatic test equipment cannot be justified at the small scale of manufacture usually appropriate to military radios.

The most difficult part of the transceiver manufacturing process is the making of the PCB. The total requirement is probably less than 1 square metre per day, amounting to around 250-300 finished boards. The standards for these boards is higher than for consumer equipment. They are made in environmentally controlled rooms. The boards will need to be NC drilled (rather than punched, which is practicable for small scale consumer products). The hand held transceivers are so small, with the boards so densely packed, that a high degree of drilling precision is needed. The technology may require some through-hole plating of the boards which connects both sides in a double sided PCB, and improves joint solderability, integrity and durability in both single and double sided boards.

All this equipment is likely to be highly underutilised in a plant making only 250-300 boards per day. (In the consumer radio profile the simple PCB plant makes about 1150 boards per day and is still underutilised.

The assembly and testing shops handle only about 17 sets per day and do not justify a conveyor line. Component insertion would be done by light-assisted gear in which a light simultaneously shines on the appropriate component hopper and through the appropriate hole in the PCB. In this way the operator conveys the correct component to the correct site on the board. The rejection and rework rates on military radios is much higher in consumer products.

The manning requirements of a military radio assembly plant have a higher requirement for skill than a consumer radio plant. The manning for assembly and testing of the 4100 sets (3000 hand, 1000 VHF/FM man packs, 100 SSB) would be:-

Direct labour:

Board preparation, stores, table	4
PCB insertion, wave soldering, manual soldering, carriers	13
Set assemblers	9
Foreman and reworking	3
	29
Inspection, testing, QA (on line)	22
	51

The indirect labour force, which in high volume consumer products may be only $\frac{1}{4}$ of the direct labour force will in this case be at least as high as the direct labour and will, most probably, be twice the direct labour. The administration requirements of military equipment manufacture are considerable. Later, the development of the models (both electronic and mechanical developments) will consume much time, as will discussion and review of specifications and performance. The total workforce amounts to 153.

The skill level in the direct workforce is higher than in consumer products as a result of the unusually high testing content. The weighted mean annual wage cost may therefore be taken at about 4600 Birr.

The materials cost in a hand held VHF/FM radio are shown in Table V C-2. These amount to 486 Birr per set. The other operating costs for the whole complex are shown in Table V C-3.

TABLE V C-2

PARTS COST IN MILITARY RADIO*

ITEM	BIRR PER SET		
	Local Supplies	Imports	Total
Printed circuit boards (16)	3	57	60
Integrated circuits (29)	5	105	110
Electronic components (535)	8	153	161
Mechanical components (220)	23	132	155
	39	447	486

* Hand held VHF/FM only

TABLE V C-3

OTHER OPERATING COSTS FOR MILITARY RADIOS

COST ITEM	MILLION BIRR PER YEAR		
	Local Currency	Foreign Currency	Total
Manpower	0.703	-	0.703
Consumable items	0.005	0.095	0.100
Maint. materials & spares	0.138	0.207	0.345
Utilities	0.140	-	0.140
Vehicle operations	0.054	0.054	0.108
Expenses	0.105	0.036	0.141
	0.145	0.392	1.537

Costs for the whole complex

Capital investment requirements are shown in Table V C-4. The plant items amount to 5.5 million Birr. This includes a plant for making printed circuit boards although this will be heavily underutilised. A major item of equipment is the numerically controlled drilling machine. This would be fully utilised; indeed it might not be possible to complete the drilling of 270 PCBs in a single shift. The test equipment is very costly, most of it being for the man packs.

The buildings amount to 4360 square metres, with 1510 square metres in assembly, work areas and laboratories; the remainder is stores, offices and services. The standard of building will be higher than for consumer products. The PCB section will be pressurised and dust free and the remaining areas are likely to be better fitted than a consumer factory. A development laboratory is included. The site itself will be larger, better equipped and more secure than consumer product plants. The project management and engineering costs will also be much higher than for a consumer product factory.

A comprehensive cost has been calculated for the hand-held VHF/FM transceiver. In order to allocate costs between the three types of transceiver, and hence to obtain an allocation for the hand held transceiver the weightings have been calculated. The hand-held transceiver is 58 percent of the total assembly/test man hours and 60 percent of the total retail value (see Tables 1 and 2 for the distributions). Thus 60 percent of the capital cost and operating cost has been assigned to hand held transceivers.

The comprehensive costs are shown in Table V C-5. 60 percent of the capital cost has been assigned to hand held transceivers. The cost per hand held set is thus 1653 Birr ($789).

TABLE V C-4

CAPITAL INVESTMENT IN MILITARY RADIOS*

COST ITEM	THOUSAND BIRR		
	Local Currency	Foreign Currency	Total
Plant and equipment:			
PCB plant	72	1371	1443
Special jigs & test equip.	137	2611	2748
Other plant	143	1292	1435
	352	5274	5626
Plant installation	28	253	281
Buildings	3260	1754	5014
Fittings, fixtures, office equp.	251	752	1003
Vehicles	49	492	541
Project eng. & management	1309	561	1870
	5249	9086	14335
Preoperating costs	58	775	833
	5307	9861	15168

* 3000 hand held transceivers, 1000 VHF/FM man packs and 100 SSB man packs (most items of equipment however have a capacity much higher than this).

TABLE V C-5

COMPREHENSIVE COSTS OF SMALL MILITARY RADIO*

COST ITEM	MILLION BIRR PER YEAR			Percent
	Local Currency	Foreign Currency	Total	
Capital cost (60% of total)	3.184	5.917	9.101	
Capital charge (17%)***	0.541	1.006	1.547	31.6
Parts	0.117	1.341	1.458	29.3
Manpower (60%)	0.422	-	0.422	8.6
Other operating costs	0.265	0.235	0.500	10.2
	1.345	2.582	3.927	
Working capital	0.047	0.110	0.157	3.2
Licences & technical support **	-	0.816	0.816	16.6
	1.392	3.508	4.900	100.0
		Percent		
	28.5	71.5	100.0	

* Hand held VHF/FM transceiver.

** Taken as 20 percent of total costs.

*** See Appendix A for explanation.

The retail price (at small volumes) of a hand-held military transceiver was shown in Table 1 as $1300. The cost structure of these retail prices is never disclosed but it can be surmised as follows:-

Hand held transceivers:	
Works cost (incl. financing)	850
Development charges	150
Selling mark-ups	300
	$1300 per set

It must be remembered that works cost for a defence-related product of this type in a developed country will include substantially higher financing charges, very much higher local manpower costs (perhaps five times those of Ethiopia), charges for land use, and a range of taxes, especially company taxation.

It is assumed that the bulk supply of military radios to Ethiopia would not include the full selling mark-ups shown above. For the purpose of direct comparison a figure of $1100 (2280 Birr) might be used. This is still greatly more than the probable cost of local manufacture. The overall savings and the local currency savings are large and make an overwhelming case for local manufacture. This is a product which can be made at well over the minimum economic scale of production. Furthermore the low cost advantages of South East Asian production is not fully realised since most of these products contain a large element of development country design labour and factory costs.

D. CABINETS SPEAKERS AND PHONES

1. Cabinets

Cabinets are needed for radios and televisions. Based on the assumptions in the radio and television profiles the cabinet making is assumed to be:-

radios	300,000
televisions	20,000

Local cabinets making is undertaken for almost every radio or television assembly operation. The technology, plastic moulding or wooden furniture making, is acquired early by all countries and so cabinet making does not pose technological problems. It has important economic advantages because cabinets themselves are low-value bulky items which are relatively very costly to transport.

Radio cabinets will undoubtedly be of injection moulded plastic, probably polystyrene or ABS (polystyrene is 2/3 the cost of ABS). The moulding typically would consists of:-

main box
front cover
handle (in one or more parts)
battery flap

The trim would be designed into the plastic items so that presentation parts would not need to be imported. Sometimes a name and instructions can be silk screen printed at the radio plant but this can be avoided by the use of an adhesive metal plate and of moulded-in lettering. The cassette radio, being around twice the price of the ordinary radio, probably justifies some appearance enhancement by the use of printed lettering and perhaps and adhesive

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coloured strip.

Television cabinets are usually now made by plastic injection moulding. This has the advantage of simplifying assembly because structural fixing points and fixings for presentation parts can be moulded in, thereby saving labour. However, the tooling costs for a large cabinets are high and a large injection moulding machine is needed Both of these items need high production volumes to become amortised. A wooden case is advisable in Ethiopia. This solution is still frequently adopted. Some televisions in developed countries are still made this way, and most were until a few years ago.

The wooden case consists of a long wooden strip with bevelled ends and three 'V' grooves cut across the strip. This can then be folded round into a rectangular box, open at front and back. An automatic glue dispenser coats the bevelled surfaces. Small wooden fillets and blocks are glued into the corners to stiffen the box. A longitudinal groove along the edge of the strip is also cut before folding. This forms the recess into which the wooden or plastic front panel is inserted and the case is folded around it. The front panel has cut-outs for the picture tube, speaker and controls. Additional glued wooden strips may be needed as a fixing for the fibre card back of the TV. The wooden case can be made of veneered plyboard or it can be of chipboard, around which a PVC veneer is machine wrapped and painted with a wood grain finsih. The former solution is usually more costly because of the higher real wood content.

The two plants, for plastic radio cases and wooden TV cases would be completely separate. Both plants have volumes sufficient to justify a separate shop for these products. However, both would obtain cost savings by being added to

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existing moulding or furniture making operations.

The radio cabinet parts would require probably two injection moulds, and two shots (injections) to complete the four pieces. This is 600,000 shots per year. With a 60 second cycle this is 10,000 machine hours. Taking roughly 1400 operating hours/machine/shift year and using two shifts we have a requirement for use of 3½ injection moulding machines working 2 shifts. (A half machine may be assumed if the production is added to a large works). The new area requirements are:-

Plastic moulding:

Raw materials & finished goods stores	300
Moulding shop	220
Offices & services	60
	580 Sq.metres.

The TV cabinet making is based around the following operations:-

- Plyboard slitting band saw
- Edge and long slot milling machine
- 'V' groove router
- Small cutting tools and band saws
- Pneumatic jigs for assembly
- Spray booth
- Sanders and polishers

A single line can cope with the volume of 75 cabinets per day. This is 5 minutes per cabinets. The areas are:-

TV cabinets:

Stores	240
Cutting shop	120
Cabinet shops	180
Offices & services	50
	590 sq. metres

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Both the plastic moulding and the wooden cabinet making would be added to existing operations. It is highly unlikely that new plants would be set up at the radio/TV factory. The construction of new plants would cost more and would also fail to make the fullest use of existing craft and technical skills in Addis Ababa.

Manning schedules are shown in Appendix B. The direct labour force for both radio and TV and the about the same, at 13 people. The radio cabinet making plant however works two shifts since it contains expensive machinery and tooling. Including tooling the investment is around 150,000 Birr per direct employee. The TV cabinet plant has less than half investment and works only one shift. In both plants the fact that the workshops can be added to existing works permits the addition of a relatively small number of indirect employees.

Materials costs are shown in the summary Tables VD.3 and 4 the plastic nibs for the radio cabinet must be imported. It is assumed that the materials for the TV cabinets, mainly plyboards, will largely be available from local resources.

Investment requirements are shown in Table VD.1 and 2. The high cost of injection moulding machines makes the radio cabinet machinery appreciably more expensive than the building. The reverse is true with TV cabinets.

The comprehensive costs are shown in Table VD.3 and 4. In both cases, the costs are comparable to the costs of similar articles in Europe. Radio cases are not of course made on a large scale but the estimate for Ethiopia is probably about 10 percent above the cost in Europe. Comparable TV cabinets have made in the UK recently at a cost of about

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20.7 Birr which makes the Ethiopian estimate in this profile about 8 percent higher. Both radio and TV cabinets would cost much more if imported into Ethiopia.

The cost/price and foreign currency situation is summarised below:-

	Radio Cabinet	TV Cabinet
	Birr	
Imported price estimate	2.5	26.9
Ethiopian cost	2.1	22.5
Foreign exchange in Ethiopian cabinets	1.6	4.0

The TV cabinet estimates exclude the back to the cabinet. This is a very heavy fibre card which is usually printed with warnings and slit so that it can be glued to the required shape. This is then screwed onto the wooden cabinet frame. This can probably be supplied entirely from local resources at a cost of about 5.2 Birr. It will be more appropriate in Ethiopia than the modern alternative of a plastic moulded back.

TABLE V D.1

INVESTMENT TV CABINET MAKING

Cost Item	Thousand Birr		
	Local Currency	Foreign Currency	Total
Machinery	15	155	170
Installation	17	-	17
Furniture & Fittings	12	13	25
Vehicles (part of)	4	46	50
Buildings 590 sq.m at 850 Birr	326	176	502
	374	390	764
Project eng. & management	28	29	57
Preoperating costs	7	-	7
	409	419	828

TABLE V D.2

INVESTMENT IN RADIO CABINET MAKING

Cost Item	Thousand Birr		
	Local Currency	Foreign Currency	Total
Machinery; moulding	61	617	678
Other (incl. spray booth)	7	58	65
Installation	7	30	37
Furniture & fittings	12	13	25
Vehicles (part of)	4	46	50
Buildings 580 sq.m 850 Birr	320	173	493
	411	937	1348
Project eng. & management	25	76	101
Preoperating costs	11	34	45
	447	1047	1494*

* Excludes 0.28 million Birr of tooling. This is added as a tooling charge to the operating costs.

TABLE V D.3

COMPREHENSIVE COST RADIO CABINETS

Cost Item	Million Birr Per Year			Percent
	Local Currency	Foreign Currency	Total	
Capital cost	0.447	1.047	1.494	
Working capital	0.039	0.053	0.092	
Capital charge (15%)	0.067	0.157	0.224	35.5
WC charge (10%)	0.004	0.005	0.009	1.4
Tooling charge	-	0.112	0.112	17.8
Operating costs:				
Materials	0.010	0.107	0.117	18.5
Labour(17 at 4000Birr)	0.068	-	0.068	10.8
Other costs	0.015	0.086	0.101	16.0
T O T A L	0.164	0.467	0.631	100.0
		Percent		
	26.0	74.0	100.0	

TABLE V D.4

COMPREHENSIVE COST TV CABINETS

Cost Item	Million Birr Per Year			Percent
	Local Currency	Foreign Currency	Total	
Capital cost	0.405	0.419	0.828	
Working capital	0.073	0.005	0.073	
Capital charge (15%)	0.061	0.063	0.124	27.6
WC charge (10%)	0.007	-	0.007	1.6
Operating costs:				
Materials	0.149	0.017	0.166	37.0
Labour(17 at 3600 Birr)	0.060	-	0.060	13.3
Other costs	0.092	-	0.092	20.5
T O T A L	0.369	0.080	0.449	100.0
		Percent		
	82.2	17.8	100.0	

2. LOUDSPEAKERS

These are assumed to be made for radio and TV at 320,000 per year. Typically the radio speakers are 3-4 inch diameter. TV speakers are 5-6 inch diameter but are often oval. Round speakers are easier to make and would be preferred in Ethiopia.

The loudspeaker are the moving coil type. The product range will be limited if the range of machinery is to be sensibly limited. Production volumes usually run into several millions (typically 2-3 million) at a single plant. There is for example, only one speaker manufacturer in the whole of the UK, and about four serving most of Europe.

The form of the loudspeaker is shown in Figure VD.5. A paper cone is fixed to a wound coil which is suspended over a metal pole piece and surrounded by a magnet. When the coil is energised by the electrical audio signal it moves to and from on the metal pole piece, thereby causing the paper cone to push the air outwards, causing sound waves.

The sheet metal bowl is cut, punched, pressed and finished. The magnet (unmagnetised) is attached to it and the work is cadmium plated. The voice coil is then attached by a light suspension and fitted over the pole piece. The clearance is about 0.001 inch. The voice coil itself is a precision item, wound in two layers around a paper tube using a lathe. The loudspeaker cone is then glued to the voice coil unit and the speaker metal bowl. Each glueing stage is followed by oven curing. Finally the magnet is magnetised. The assembly section must be maintained fairly dust free.

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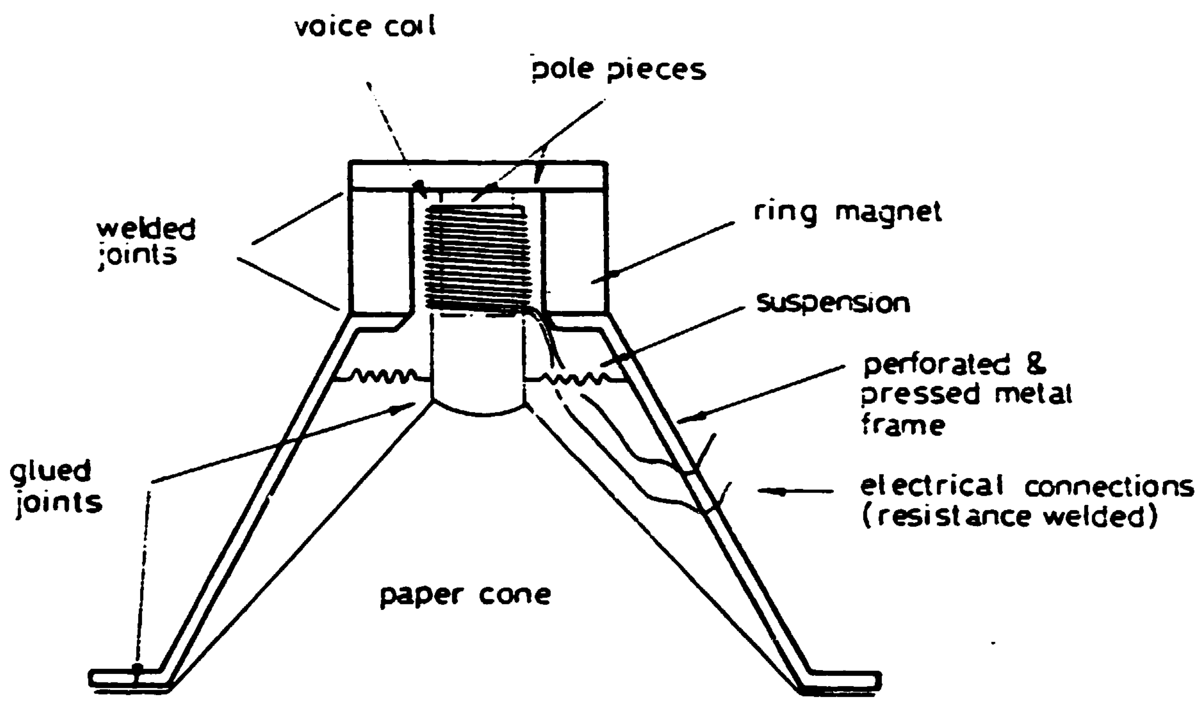

FIGURE V D-1 CONSTRUCTION OF A MOVING COIL LOUDSPEAKER

The steel for the bowl and the magnetics must be imported but can be machine pressed, punched, finished etc, locally. The voice coils and paper cones must be imported. They are precision items made in huge quantities.

A typical manning requirements is given in Appendix B. The 35 employees is equivalent to 12 minutes of work per loudspeaker. (in high volume, production with more mechanisation the figure falls to around 3 minutes. Work would best be carried out at a small number of work stations served by a conveyor belt.

The operating costs are summarised in Table VD.5 and the capital costs in Table VD.6. The largest them of capital cost is the building, the space requirements of which are:

Press shop & tool racks	160
Assembly shop(dust free-area)	200
Materials & product Stores	240
Offices	60
	660 sq. metres.

The comprehensive cost is presented in table VA.7. The annual sum of 1.228 million Birr is equivalent to 3.8 Birr per speaker. The ex-works cost of a speaker in S.E Asia is 2.2 Birr. This could be delivered to Addis Ababa for 2.75 Birr. The locally made speaker would cost 38 percent more than the import. Indeed the materials alone cost the same as the ex-works speaker from SE Asia.

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TABLE VD.5

SUMMARY OF OPERATING COSTS FOR SPEAKER MANUFACTURE

Item	Million Birr Per Year		
	Local Currency	Foreign Currency	Total
Purchased parts:			
Steel materials	0.03	0.35	0.38
Paper cones	-	0.03	0.03
Consumables	0.04	0.24	0.28
	0.07	0.62	0.69
Manning	0.14	-	0.14
Other operating costs:			
Utilities	0.07	-	0.07
Maint. materials &Spares	0.01	0.02	0.03
Vehicle operations	0.02	0.02	0.04
Expenses	0.02	0.01	0.03
	0.33	0.67	1.00

TABLE NO. 6

CAPITAL COST SPEAKER MANUFACTURE

Cost Item	Thousand Birr		
	Local Currency	Foreign Currency	Total
Plant & equipment(cif,Port):			
Shears & punches	-	26	26
500 tonne press	-	28	28
Welding & Riveting	-	4	4
Coil winding	-	17	17
Curing oven	-	30	30
Curing tunnel	-	46	46
Conveyors	-	40	40
Magnestisers/demagnetiser	-	60	60
Test gear & jigs	-	30	30
Tank & plating gear	-	8	8
	-	289	289
Freight in Ethiopia	26	-	26
Equipment installation	8	8	16
Office furn., equip.Fittings	20	20	40
Vehicles	17	168	185
Buildings660 sq.m at 1000Birr	429	231	660
	500	716	1216
Project eng. & Management	68	23	91
Preoperating expenses	2	13	15
	570	752	1322

TABLE VD.7

COMPREHENSIVE COST OF LOUDSPEAKERS

Cost Item	Million Birr Per Year			Percent
	Local Currency	Foreign Currency	Total	
Capital Cost	0.570	0.752	1.322	
Working Capital	0.160	0.130	0.290	
Capital charge(15%)	0.086	0.113	0.199	16.2
WC charge (10%)	0.016	0.013	0.029	2.4
Operating costs:				
Materials	0.070	0.620	0.690	56.2
Labour	0.140	-	0.140	11.4
Others	0.120	0.050	0.175	13.8
T O T A L	0.432	0.796	1.228	100.0
		Percent		
	35.2	64.8	100.0	

3. TELEPHONE SETS

This profile is based on 15000 per year. The two technologies for telephone handset manufacture are very different. The older rotary dial type is mainly electro-mechanical. The printed circuit board is small, with about 4 components, and the construction is essentially designed for manual assembly. The bell system is usually of the solenoid type with a clapper ringing two bells, and it needs a transformer. A substantial metal bridge carries the dialling mechanism and switch.

The modern lightweight digital telephone is based on printed circuit board technology. There are around 50 electronic components on the board, including several integrated circuits. The bell is a small loudspeaker. Dialling is digital.

The method of manufacture of the two types is completely different, and the cost structure is different. PCB based telephones have been introduced in Europe within the last few years but there are still more electro-mechanical rotary dial phones is use. Ethiopian telephones are almost entirely electro-mechanical and are expected to remain that way in the immediate future. It is however prudent to consider the relative costs of the two technologies. These are set out in Table VA. 8

The largest single cost item in the digital telephone is the assembled and tested printed circuit board estimated at 18 Birr when made in Ethiopia. It is assumed that the PCB is made at a radio manufacturing plant where over 300,000 PCBs, are being made and assembled for radios and hence some economy of scale is obtained. The largest single item in the rotary dial telephone is the dialling

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TABLE V D.8

COST COMPARISON OF TELEPHONE TECHNOLOGIES

Cost Item	Birr Per Set			
	Mod. PCB-digital		Rotary dial	
	Total	Foreign Currency	Total	Foreign Currency
Operating costs:				
Moulding*	12	9	10	7
PCB*	18	14	4	3
Dialling unit	-	-	16	16
Other parts	20	17	20	19
	50	40	50	45
Labour (assembly)	4	-	5	-
Other operating costs	4	3	5	3
Cap. charge (assembly)	6	4	7	5
	64	47	67	53

* Locally made, includes labour, capital chrges etc., The PCB is assumea to be made at the same scale as in radio manufacturing at 300,000 radios per year; it is thus more economical.

unit which would probably be imported completed at a cost of about 16 Birr.

When the PCB for the digital phone is made locally then there appears to be a small overall cost advantage in favour of digital phones. There is also a foreign currency cost advantage. If however the PCB is imported then these advantages are lost as the following figures show:-

	Birr/set	
	Total cost	Foreign currency
Rotary dial phone	67	53
Digital with local PCB	64	47
Digital with imported PCB	68	53

It is therefore important to note that the digital telephone is compatible with a modern consumer electronics plant but the older electro-mechanical dial-type phone is not compatible.

Telephone are normally made at volumes which permit full utilisation of moulding shops, effective use of PCB plants and allow assembly at rates approaching a 30 second time cycle. This suggests economies of scale at 200,000-300,000 per year. At this level modern hand sets were made with an ex-works cost of around $22 (46 Birr). These phones could be delivered in volume to Addis Ababa for around 65 Birr (excluding tariffs). This is comparable to the cost of local manufacture. Recently however Hong-Kong has established telephone handset manufacture on a large scale and costs seem to be falling again. It is likely that the cheapest sources will make handsets at $15-20 each, delivered to Addis Ababa at 50-60 Birr each. On this basis locally made phones would not compete with duty-free imports.

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VI - STRATEGY

A. Ethiopian Economic Development

1. Size of Ethiopian Industry

Ethiopia is a country with a large population but a very small industrial sector. In the World Bank 'World Development Report - 1984' Ethiopia is listed as the world's second poorest country (equal with Bangladesh, after Chad). This under-development has meant that industry in general has only emerged in recent years and that manufacturing industry is extremely small. In 1981 the value added in manufacturing industry was only $349 million (at 1975 prices). The economy as a whole did not grow during the period 1970-1982 although industry grew at 2 percent per year. Despite widespread poverty and foreign currency shortages the country is now making very serious efforts to develop the industrial sector and an ambitious plan exists for the next decade. Nevertheless, the very low starting point and the current economic problems will limit growth, especially in high technology areas.

It is pertinent to compare the Ethiopian industrial sector with that of other developing countries, especially with those whose electronics developments have aroused interest and admiration. Table VI A - 1 lists the GDP, industry and industrial growth for selected countries. The GDP of the industrial sector in Ethiopia was $640 million in 1982, having grown at 2.0 percent per year during the preceding 12 years. This industrial growth was better than that of some of the poorer countries (e.g. Zaire, Tanzania, Ghana, Zimbabwe) and was higher than some industrialised countries (e.g. UK and USA). But the present total size of industry is small compared to countries now making great strides in electronics :-

TABLE VI A - 1

INDUSTRIAL ACTIVITY IN SELECTED COUNTRIES

Country Country	Percent of GDP industry (1982)	Value of industrial GDP $Us billion (1982)	Annual growth industry 1970-82 16 percent
Bangladesh	14	1.53	8.7
Ethiopia	16	0.64	2.0
Zaire	24	1.20	-0.9
India	26	39.20	4.3
Tanzania	15	0.69	1.5
China	41	24.55	8.3
Guinea	23	0.40	na
Niger	30	0.47	10.8
Sri Lanka	27	1.19	4.2
Ghana	8	2.50	-2.4
Pakistan	25	6.17	5.9
Kenya	22	1.17	8.1
Sudan	14	1.30	5.8
Indonesia	39	35.16	10.7
Zambia	36	1.38	0.4
Egypt	34	9.00	8.3
Thailand	28	10.30	9.3
Philippines	36	14.35	8.0
Zimbabwe	35	2.07	-1.9
Nigeria	39	27.97	4.8
Morocco	31	4.56	5.3
Malaysia	30	7.76	9.2
Korea	39	26.68	13.6
Brazil	35	86.96	8.2
Portugal	44	9.37	4.4
Singapore	37	5.42	8.9
Ireland	35 *	5.15	na
UK	33	156.16	0.2
USA	33	993.17	1.9

Source: World Bank Development Report 1984

* Estimate

	Size of industrial GDP as a Multiplier of Ethiopian industry
India	61
China	38
Egypt	14
Thailand	16
Philippenes	28
Malaysia	12
Korea	41
Singapore	8
Ireland	8

Even in the 1960s when these and other developing countries began their electronics drive they were much bigger than Ethiopia.

There are opportunities in electronics for Ethiopia; and these opportunities can make an important contribution to Ethiopian industry. But the scale and range of the activity will reflect the low starting point.

The nature of Ethiopian industry can be seen from various data extracted from the Ministry of Industry Statistical Bulletin 1984, and shown in Table VI A - 2. Total permanent employment in industry in 1982 was 95,400, of which about 84 percent was in food and textile industries. Engineering industries form a very small part of the total.

Capital investment in industry amounted to 59.4 million Birr in 1981, equivalent to 620 Birr per person employed. Investment was 91 percent higher in 1981 than in 1980. Net book value of assets was 205 million Birr, equivalent to 2150 Birr per employee. Again food and textiles acccunt for around 85 percent of investment and assets. In traditional engineering industries with slow replacement the replacement value is typically about 4 times the book value.

TABLE VI A - 2

ETHIOPIAN INDUSTRY, 1981-1982

Sector	No. of employees 1982	Total capital investment in 1981 $ million	Book value of assets 1981 $ million
Food, beverages & tobacco	42,400	43.4	128.3
Textiles, fibres & leather	37,400	6.5	49.5
Wood	3,900	0.4	1.8
Paper & printing	2,400	0.6	3.5
Chemicals	2,300	0.4	5.8
Building materials	3,000	5.7	4.7
Engineering	2,000	0.7	3.8
Share companies	2,000	1.7	8.0
Total	95,400	59,4 *	205.4

Source: Worked up from Min. of Ind. Statistical Bulletin, 1984

Birr converted to $ at 2.07 Birr/$

All figures rounded

* 59 percent in foreign currency

If this figure is applied in Ethiopia then replacement value of assets is 8600 Birr per employee ($4150) which is very low, and indicates a very low technology industry.

Nearly 60 percent of capital investment was in foreign currencies. Since a high proportion of fixed assets is in buildings it may be expected that with increases in investment, proportionally more of future investment will be in machinery. This has a higher foreign content.

2. Planned growth of the economy

the 10 Year Perspective Plan forecasts 10.8 percent annual growth in output of the industry sector, as shown in Table VI A - 3. According to the Ministry of Industry the manufacturing element of industry is expected to grow at 7 percent/year overall and that part of industry which includes heavy industry and engineering (including electronics) is expected to grow at 12 percent per year. The main thrust of industrial development will however be in food and commodity industries. Nevertheless, as the Table shows, industry is expected to grow from 16 percent of GDP in 1984 to 24 percent by 1984. This is a most ambitious target and could only be achieved if every practicable project is siezed upon and implemented quickly. During the period 1970-82 such an industrial growth performance was achieved by very few countries. Out of the 70 or so low income and lower-middle income countries (World Bank classification) only Indonesia, Cameroon, Congo, Ecuador and Paraguay realised such growth. Of the upper-income countries only Jordan and Korea exceeded 10 percent industrial growth.

TABLE VI A - 3

PLANNED GROWTH OF SECTOR GDPs

Sector	GDP in Billion Birr (1982 vlues)				Annual growth percent
	1984	1986	1989	1984	
Agriculture	4.27	4.55	5.99	6.49	4.3
Industry	1.42	1.73	2.39	3.97	10.8
Services	3.15	3.50	4.31	6.13	6.9
Total	8.84	9.78	11.79	16.59	6.5
			(percent)		
Agriculture	48	46	43	39	
Industry	16	18	20	24	
Services	36	36	37	37	
Total	100	100	100	100	

Source:- Simplified and rounded from 10 Year Perspective Plan

Planned industrial investment is shown in Table VI A - 4. During the 5 year period to 1989 it amounts to 2.31 billion Birr, averaging 462 million per year, of which new projects account for 220 million/year.

The implication of the Plan is for fixed investment to increase from 11 percent to 28 percent of GDP, as Table VI A - 5 shows. At this level it considerably exceeds most industrialised countries.

3. Foreign exchange

Availability of foreign exchange is and will remain a Serious brake an economic growth. According to the 10 year perspective plan, foreign financing is intended to contribute 44.5 percent of the total investment requirement over the next ten years. Part of this foreign currency no doubt is expected to come from increased exports. These are planned to grow at 10.9 percent per year, which is appreciably faster than imports.

Ethiopia's foreign currency reserve position is extremely weak. In 1982 gross international reserves amounted is $277 million which was equal to only 3.6 months of imports (World Development Report 1984. The country had a balance of payment deficit of $196 million in 1982. A continuation at that level would have exhausted the foreign currency reserve early in 1984. The position is thought to be more serious now and imports are being cut still further. In this climate substantial industrial investment, a prerequisite of strong industrial growth, seems unlikely.

Opportunities to exist for business Joint Ventures. The proclamation of January 1983 sets out the conditions.

TABLE VI A - 4

FUTURE NATIONAL INVESTMENT

Sector	Million Birr per year (1982 values)					
	1983	1984 est.	Av. 1985/86	Av. 1987/89	Av. 1990/94	10-year Total 1985/94
Industry:						
State sector:						
Rehabilitation	41	63	79	47	55	572
Expansion	8	30	52	144	45	760
New projects	149	235	155	366	467	3742
Small scale	4	5	11	15	25	192
	202	333	297	572	592	5266
Agriculture	na	na	501	709	1003	8144
Energy	159	203	306	241	190	2283
Mining	51	65	176	362	114	2000
Transport & com.	na	na	391	515	290	3777
Water	54	114	201	258	245	2400
Constr. & housing	na	na	369	476	661	5475
Health & education	na	na	151	158	168	1617
Trade & tourism	na	na	49	114	98	929
Other			40	78	54	2203
			2481	3483	3415	34094
			percent			
Industry as percent of period total			12.0	16.4	17.3	15.4

TABLE VI A - 5

SOME NATIONAL ECONOMIC FORECASTS

	1984	1986	1989	1984
		Billion Birr (1982 values)		
Gross Dom. Product	8.84	9.78	11.79	16.59
Fixed investment	1.10	1.71	2.93	5.19
		(percent)		
Fixed investment as percent of GDP	11.3	15.8	22.5	28.3
		Billion Bir (1982 values)		
Exports	-	1.08	1.41	2.61
Imports	-	1.65	2.12	3.26
		Ratio		
Exports/imports		0.65	0.67	0.80
GDP/capita *	282	295	327	397

Source:- 10 Year Perspective Plan

* Equivalent to approximately 3½ percent per year. During the period 1970 - 1982 the GDP grew at 2.2 percent per year while the population grew at 2.0 percent (World Bank Statistics). This represents a decline in GDP/capita.

** Foreign financing will be 44.5 percent of the total.

These include a 5 year tax holiday and zero tariffs. Dividends can be remitted overseas with only 10 percent tax paid. The economic and political uncertainly has however discouraged prospective partners. It is interesting that at present there ar- no Joint Ventures, nor are there any discussions underway likely to lend to a Joint Venture.

4. Development Planning Criteria

At this point we most formulate the criteria against which the electronics projects, and other industrial development should be judged.

In discussions at the Ministry of Industry four essential criteria were mentioned :

1. Satisfy basic needs: at present even edible oil, flour, textiles, soap etc. still have unsatisfied demand.

2. Strengthen agricultural links: Industry has second priority to agriculture in the ten Year Plan. Anything that supports and improves agricultural output and food processing has very high priority.

3. Improve foreign currency balances. Forty percent of manufacturing current imports (excluding capital) are in foreign currencies. Industry consumes $400 million per year of foreign exchange. Exports of manufactured goods are less than $100 million. The main thrust of industry development will be to upgrade the resource based exports such as leather and textiles.

4. Links to future heavy industry. For example projects supporting the transport industries.

In discussion at National Metalworks Corporation a fifth criteria was suggested.

5. <u>Creation of employment</u>. There is substantial unemployment and also underemployment at work.

These observation provide a very good guide. A suggested listing of criteria is set out below and the electronics projects are measured against these criteria later in this chapter.

<u>Foreign exchange</u>

- volume of import substitution possible
- potential export earnings
- foreign exchange invested at outset compared to annual foreign exchange saving.

<u>Linkages</u>

- to agriculture
- to existing industry
- to future industry

<u>Project characteristics</u>

- Appropriateness of the product
- Appropriatness of the technology
- Size of the project (investment)
- Job creation
- Investment / job
- Ability of the project to be postponed

Performance

- Need for protection
- Profitability
- Security of demand for product
- Robustness of project against economic change.

B. INTERNATIONAL EXPERIENCE

1. Country Profiles

A study of electronics development in non-industrialised countries was made with the intention of extracting basic lessons which could be applied to Ethiopia. Some visits were made and a literature search was conducted. The main countries considered were:

Korea

Ireland

India

China

Philippines

Sri Lanka

Thailand

Taiwan

Experience in other countries has also been taken into account but the above eight countries serve to draw attention to the main messages. Brief accounts of their development are contained in the following pages.

KOREA

- Began in 1959 with radio manufacture (70,000 radios in 1961); exporting began in 1972.

- Foreign investment encouraged through tax reliefs, low duties and concessional financing. Free zones were tax free for 5 years.

- Component companies invested. Growth in the 1970's was 45 percent/year (general manufacturing was 18½ percent)

- By 1980, electronics was 4 percent of GNP, 12 percent of all exports, and employed 155,000 employees.

- Korea has exported electronics from the beginning. 1971 output was $138 m with 64 percent export. In 1980 it was $2.85 billion with 70 percent export. By 1983 it had risen to $5.5 billion. The export volumes are not though to have fallen.

- Production is concentrated in components and consumer electronics. 1983 figures are

components*	43	percent
consumer	40	"
industrial	17	"

* especially semiconductor devices. IC's were 22 percent of all components in 1980.

- By 1975 wholly owned foreign companies accounted for 51 percent of exports. Including also the Joint ventures, the total was 74 percent of exports.

- Foreign and JV companies accounted for 50 percent of exports in 1979, and 55 percent of production.

- By end-1977 foreign investment exceeded $156 m with 57 percent direct and 43 percent JV capital. Of the JV capital 60 percent was from Japan and 33 percent from USA.

- More than $\frac{2}{3}$ of foreign investment is in parts and components.

  The industry is not well linked. Value added was 29 percent in 1974 and is thought to be similar now. The companies (mostly foreign owned) are completely separate, not being integrated at all within Korea.

- Production includes 5 m B/W TV's and 4 m colour TV's. 76 percent were exported. Component volumes can be judged from Korean Electronics Company (KEC) with annual outputs of 960 m transistors, 120 m diodes, 60 m LCD's and 24 m IC's.

- Korean growth has been administered through a series of 5 year plans which have also embodied Electronics Development Plans. Early protection was covered in the 1969 'Electronics Industry Protection Law'.

- The latest Plan designates 31 electronic items of 'strategic' importance and 25 items of 'key' importance.

- A 5 - point strategy now exists

  . to acquire foreign technology
  . to prctect the home market
  . to reverse the 'brain drain' of Koreans
  . to pressure the local companies into using Korean chips
  . to use economies of scale in home markets to achieve export pentration.

- Already Korea finds that Japanese companies are reluctant to hand over technology.

- But Korean companies are developing their own technology. Samsung is setting up a design and prototyping facility in California.

- The Korean - owned companies are mostly conglomerates and often electronics is only a part of the total. Hyundai, lucky Gold Star, Dae Woo and Samsung, the big four, will spend $2 bn in the next five years to develop the 256 K dram (memorychip).

- The Korean Government will invest $28 m in semiconductor development in 1985-87. It monitors individual company performance closely, through the Ministry of Commerce and Industry, apply selective incentives and disincentives.

- Government policy is now to develop technology–intensive industrial electronics; to diversity exports and exploit domestic markets (to buffer the world trade movements). They plan to sustain growth, develop component (chip) industries, increase research, and new product development, and achieve orderly linkages between the successful large firms and the smaller companies.

IRELAND

- Electronics began in 1960's. Some consumer product assembly plants were established by UK and continental firms but local market was too small.

- During 1970's, especially late 1970's, the IDA (Irish Development Agency) actively sought foreign investment, not very successfully at first. They put together a small electronics team for this purpose.

- Initially the companies were small, state-of-the-art, and cash-hungry. They were attracted by the incentives. Cash grants, in some cases up to 60 perce t, grants to cover 100 percent of training and part of R & D, tax free profits (now 10 percent of new investments) and a range of administrative support to start up. Until recently none of the top 5 USA companies were there. Now they have most, including IBM.

- Current production is nearly all exported (over $0.9 billion). Employment is 20,000 (it was 5000 in 1972).

- All manufacturing industry is around 100,000 people. Electronics is about $\frac{1}{5}$ of manufacturing.

- Output is concentrated in office machines and data processing. Recently this has grown faster than other areas due to investment by USA computer companies.

Office machines & dp	63	percent
Telecommunications	10	"
Components & equipment	10	"
Prof. scientific and control	17	"

- IDA strategy is now to concentrate on end-products but with a small number of IC plants to support them.

INDIA

- Began with radios in 1960's and TV's around 1970. First efforts in private sector.

- Foreign investment not encouraged (repatriation of divendents not permitted)

- Exports represent very small proportion of production (1975-4.6 percent; 1978 - 7.1 percent; 1980 - 5.3 percent).

- Production grew at 16.7 percent/year in 1970's to $995 million in 1980.

- India quickly moved into communications equipment, components and control, instrumentation and industrial electronics.

- 1980 split is

consumer**	27	percent
communications	23	"
components*	21	"
control/ind.	17	"
aerospace/defence	8	"
computers	4	"

* tubes 12%; SC devices 19%; passive comp. 32%; electromechanical, eg. tape mechanisms, 37%.

** including 980,000 radios and 400,000 TV's

- Structure is 150 'organized' companies and 2000 small scale industries. $\frac{3}{4}$ of component companies are Govt. owned because of capital intensity and need for economies of scale. Most of the 10 computer firms are private, some are public/private.

- Early technology was E. Bloc. Some Russian technology now in computers. Only 2 computer firms have foreign technology support. There is discussion of USA telecommunications support. Govt (Dept. of Electronics) funded 18 Electronics Test and Development Centres, and encouraged Functional Industrial Estates (now 11).

- Govt. has now established a National Centre of Development of Telematics, and is setting up a National Silicon Facility, which may also export to E. Bloc.

- 50 - 60 percent of TV components are imported. Small firms pay high prices. Govt. is to bulk-buy under a new 'Materials, Technology, Brand Name' scheme.

CHINA

- With China's huge market manufacture began in the 1950's, with complete projects imported from USSR and East Germany.

- In the 1960's China imported complete production lines for semiconductors etc. from Japan, UK, France and Switzerland.

- In the late 1970's development had progressed to the point where 11 contracts were signed with western countries for specified packages of production equipment/technical support (total $240 m).

- In 1980 the China Electronics Import and Export Corporation was established. This now buys equipment and technology (600 equipment contracts in 1982, and 36 technology contracts).

- In 1979 the 3000 companies began to be rationalised. By 1981 there were 2400 companies employing 1.3 million people.

- In 1982 China made 15.6 million radios, 3.3 million cassette recorders and 5.7 million TV's. Radios increased by only 30 percent from 1979 but TV's increased nearly 12 times.

- Consumer products and broadcasting equipment are still the main element of manufacture but other areas are growing fast. In 1981 the split was

Broadcast TV, radio audio	37 percent
Radio, telecoms, instruments	26 "
Components	21 "
Semiconductors	12 "
Vacuum devices	4 "

- There is substantial foreign investment in China although the amount in electronics is not specified. Joint Ventures are now common. Japanese companies are providing microprocessor and logic chip technology after USA companies were banned from doing so. Japan is also now providing TV and VTR technology.

- Joint ventures have all import duties waived and pay no taxes for 2 years. Taxes are reduced to ½ in next three years.

- Electronics is administered through the Ministry of Electronics Industry. Then there are 4 Administrations-Radar Industries, Telecommunications and Broadcasting, Computer Industries, and Electronic Component and Device Industries. There is also a National Electronic Device Corporation.

- China has ambitious electronics plans. These include further strong growth in consumer electronics and an attack on the capital products market especially in computers (where a substantial capability already exists)

- Exporting has been undertaken on a small scale for some years but is not growing fast.

PHILIPPINES

- Impetus to growth came in 1950's with import restrictions caused by foreign exchange shortages. Assembly of consumer products began.

- By 1981 production reached 282,000 B/W TV's and 25,000 colour TV.

- The main thrust of development has been components. Assembly and packaging of semiconductor devices began in 1970 (about 8 years after Hong Kong, Singapore and Korea).

- In 1982 exports of semiconductors reached $811 million. In 1981 Philippines exported 20 percent of world merchant semiconductor business. Exports of other components were only $18 m (capacitors, speakers, tubes, radio parts, TV chains).

- Semiconductor exports grew from only $188 m in 1978. The multinationals were attracted by the Export Incentives Act and by later incentives introduced in 1982.

- Employment in export activities is 34,600. A further 4,200 people are engaged in making products for the local market.

- The components are made entirely by foreign owned companies. Even on consumer products there is hardly any Independent Filipino involvement of 10 TV companies 7 are Japanese Joint Ventures, 1 USA, 1 Filipino. Of 14 stereo companies, 13 have foreign partners.

- Total electronics production is estimated to be about $ 0.7 bn in 1984. This is 1.8 percent of GDP.

- There is no R & D effort although most semiconductor companies now do the final testing in Philippines.

- There appears to be no Electronics Authority as such. The Ministry of Trade and Industry established policy and the Board of Investments implements it.

- In 1975 the Electronics Local Content Programme was established to encourage local manufacture. Among other benefits the registered companies were totally protected and even local competition was regulated.

- The local consumer product industry is very heavily protected. Imported products carry a 60 percent tariff. The industry is considered to be overprotected. It is probably significant that there is only one exporter of consumer products.

SRI LANKA

- Industry was built initially on consumer products. In 1976 there were 8 approved radio companies assembling 80,000 sets (with capacity for 170,000 but no foreign exchange to import parts). Also 8 approved suppliers of most of the parts including selected capacitors and resistors, ferrite rods and speakers.

- The consumer product industry is considered to be inefficient and high cost due to the small size of individual units.

- In 1977 the import restrictions were eased and efforts made to attract foreign investment mainly through tax concessions. The higher the employment the longer the tax holiday, up to 5 years and in special cases up to 10 years. The Export Development Board was established in 1979 and offers concessionary loans for export projects.

- Joint Ventures were then set up to make IC's (2) and magnetic heads, floppy disks and semiconductors (3). A further semiconductor venture is proposed. These ventures are regarded as successful.

- The 1981 domestic market is of course largely mass media equipment:

Mass Media	60	percent
Telecommunications	13	"
Other products	27	"

THAILAND

- Electronics actively promoted since early 1960's when import substitution was the criterion. From 1972 an aggressive policy to attract foreign investment through incentives.

- In 1980 there were 19 factories making radios but only 2 making over 100,000/year. 14 factories made TV's but only 1 over 100,000/year.

- Most consumer product factories are relatively small scale assemblers. 1 large plant, Tanin, has 75% of radio market, 35 percent of B/W TV and 10% of colour.

- Of 20 companies setting up in 1970-78, 14 were foreign owned or JV, only 6 Thai. The foreign companies are mainly export orientated.

- There are 9 companies making consumer components and 5 making IC's ($425 million, all exported).

- Employment is split roughly half radio/TV equipment and half IC's

Radio	1400	employees
TV	4155	"
Transceivers*	2367	
Phones	35	
	7957	
IC's	8939	

* Average/year 1977-80 HF/SSB 23,000.;
VHF/FM: 38,000

TAIWAN

- Taiwan is the principal Japanese offshore manufacturing area. In 1979 Japanese companies employed 230,000 people in Taiwan.

- Production began with USA investment in the late 1960's, but this grew slowly. Activity was mainly TV sub-assemblies for export. Still, Taiwan is a preferred location for USA investment.

- With the growth of Japanese offshore investment in the 1970's production built up rapidly, particularly in colour TV, calculators, phones and computer peripherals.

- Taiwan offered tax incentives and loans at 2 percent below commercial rate.

- In 1983 exports of electronic goods were around $3.8 bn. having grown 24 percent on 1982. Electronics exports account for $\frac{1}{6}$ of all Taiwanese export.

- Electronics development has been overseen by ESRO (Electronics Research and Service Organization) In 1976 they sent 20 engineers to RCA for training in chip design and manufacture.

- The Govt. has established Hsinchu Science Park, an area where companies are encouraged to locate. 37 companies there exported $100 m on 1983.

- Taiwan is the world's 7th largest maker of industrial robots, and has drawn up plans for rapid expansion in this area (10,000 in 1990).

- A Taiwanese owned company, United Microelectronics is to set up R & D of IC's in California and will hire 40 top level specialists.

2. Summary of Experience

A summary of some of the main lessons is shown in Table VI B-1. There are two main forms of development and these are illustrated in Figure VI B-1. The developing countries with very large markets, namely India and China have both concentrated on supplying local markets, first with consumer products and later as they expanded their technology, with industrial and professional goods. In neither case was the industry dependent on foreign investment although in both cases they acquired foreign technology to start with. In both cases the early technology came from the E. Bloc. Both countries, but especially China acquired western technology later.

India's growth rate has been modest around 16 percent. China's growth in the early years was slow but has now accelerated. Both countries, in the absence of large foreign companies have built a substantial small scale electronics industry (although there are large companies as well). There is some evidence that these industries are commercially weak. India has taken steps to strengthen its small scale industries; China rationalised the industry in 1979-81. Consumer products and broadcasting have remained the largest sector in both the Indian and Chinese industry. Now however both countries are expanding strongly into data processing and industrial electronics. Exports are at a low level in both countries.

Countries which do not have vast consumer product markets find that the consumer product industry soon begins to satisfy the market without becoming a large and powerful economic force. Often protection is still needed and the country begins to take other steps to develop electronics opportunities. Most countries embark on detailed planning of electronics and other industrial opportunities. They identify foreign investment as a vehicle for further growth.

TABLE VI B.1

SOME INTERNATIONAL LESSONS

- Nearly every developing country has started in local market comsumer products.
- Where small scale assembly plants are set up the industry is usually weak and high cost.
- Only the huge markets of India and China have retained their concentration on the domestic market.
- Successful countries display a strong planning element in their approach.
- Only India has gone for near-total self reliance in technology. But even there they bought technology to start, and are still buying.
- Most countries have gone for growth and exports through attracting foreign investment.
- Foreign investment is nearly always export orientated.
- In general the JV's are strong ventures.
- Foreign companies need to be attracted by incentives; in some case the incentives are enormous.
- Incentives range from capital grants to tax relief, training and R & D support, technology centres, science parks, and protection.
- Political and economic stability is counted highly by USA companies. Labour performance rates very highly with the Japanese.
- Foreign technology must be acquired at the outset. No self development schemes have been identified.
- Most foreign investment is in semiconductor manufacture
- Linkage is not necessarily essential in the early stages of electronics development, but most strategies concentrate on it eventually.

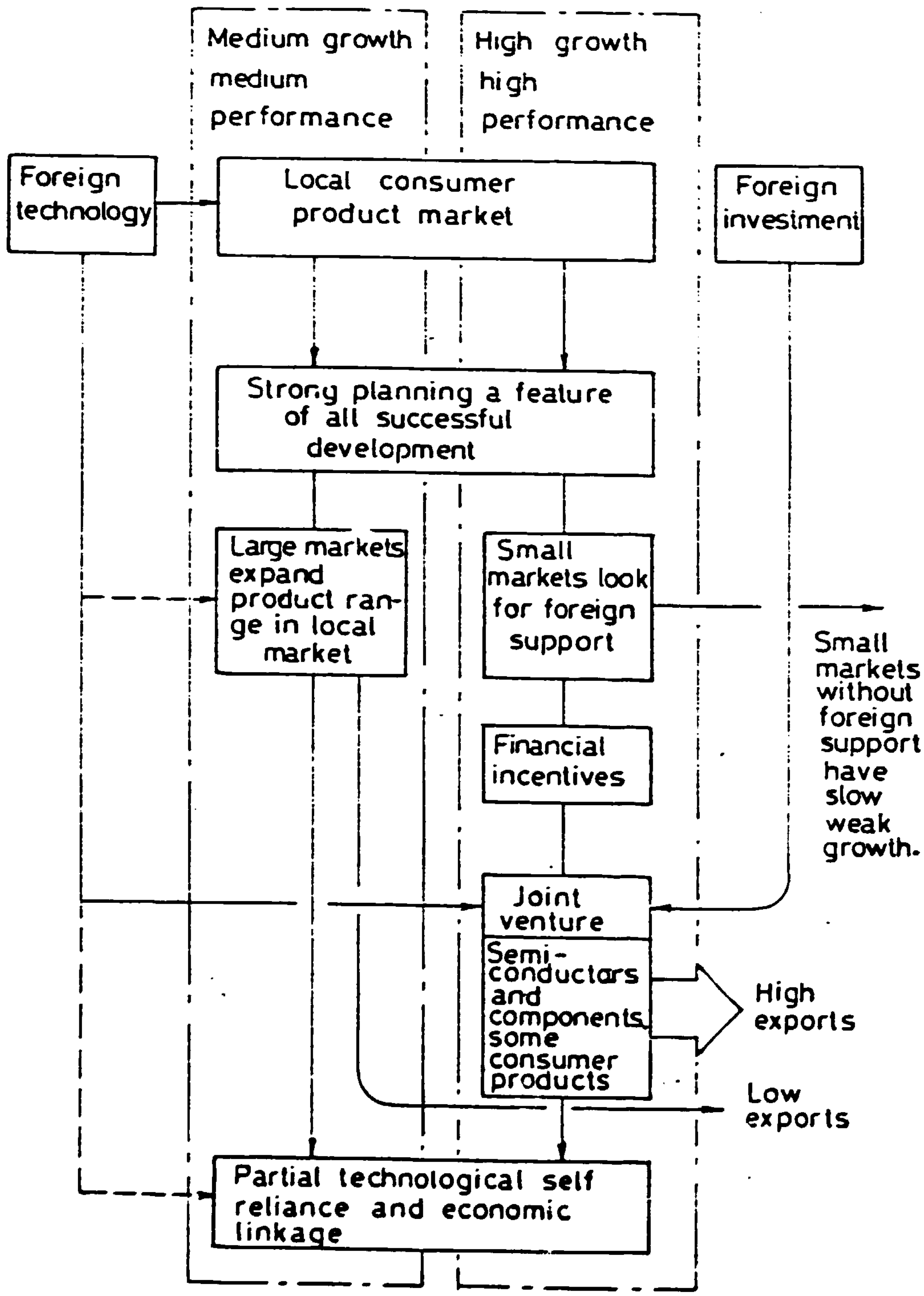


FIGURE VI B-1 TYPICAL ELECTRONICS DEVELOPMENT

Before attending further to foreign investment it should be noted that strong planning has been an important element in the development of electronics nearly everywhere. Electronics has usually formed an important part of periodic national plans. Most countries have also established some form of electronics council to oversee the development of electronics and ensure its well-being. The planning sometimes takes the form of strong central planning and execution. But often it consists of a centralised decision-making with speedy, flexible policy formation left to the industry itself. Korea is a good example of this, although they still monitor individual company performance closely.

The foreign investment boom in developing country electronics was not just a matter of developing countries choosing to offer incentives. Both Japan and the USA were looking for offshore opportunities. The USA had embarked on the space-race and was overwhelming its local electronics industry, much of which was required to up-rate its technology. They needed to place part of the huge expansion in electronics offshore. Japan was in a similar situation but more so in consumer and industrial products. Both countries were also looking for cheap labour.

The developing countries merely had to make a reasonable offer to attract interest. All the countries which have enjoyed large Japanese and USA investment have offered financial incentives. In every case there have been tax incentives, at least at first. In most cases there has been concessionary financing, usually the availability of loan finance at slightly less than the normal commercial rate. In some cases, more recently, there have been offers of large capital grants. Ireland, which has suddenly been hugely successful in attracting USA investment after a slow start, has offered cash grants of up to 60 per-cent of the project cost, plus other incentives as well.

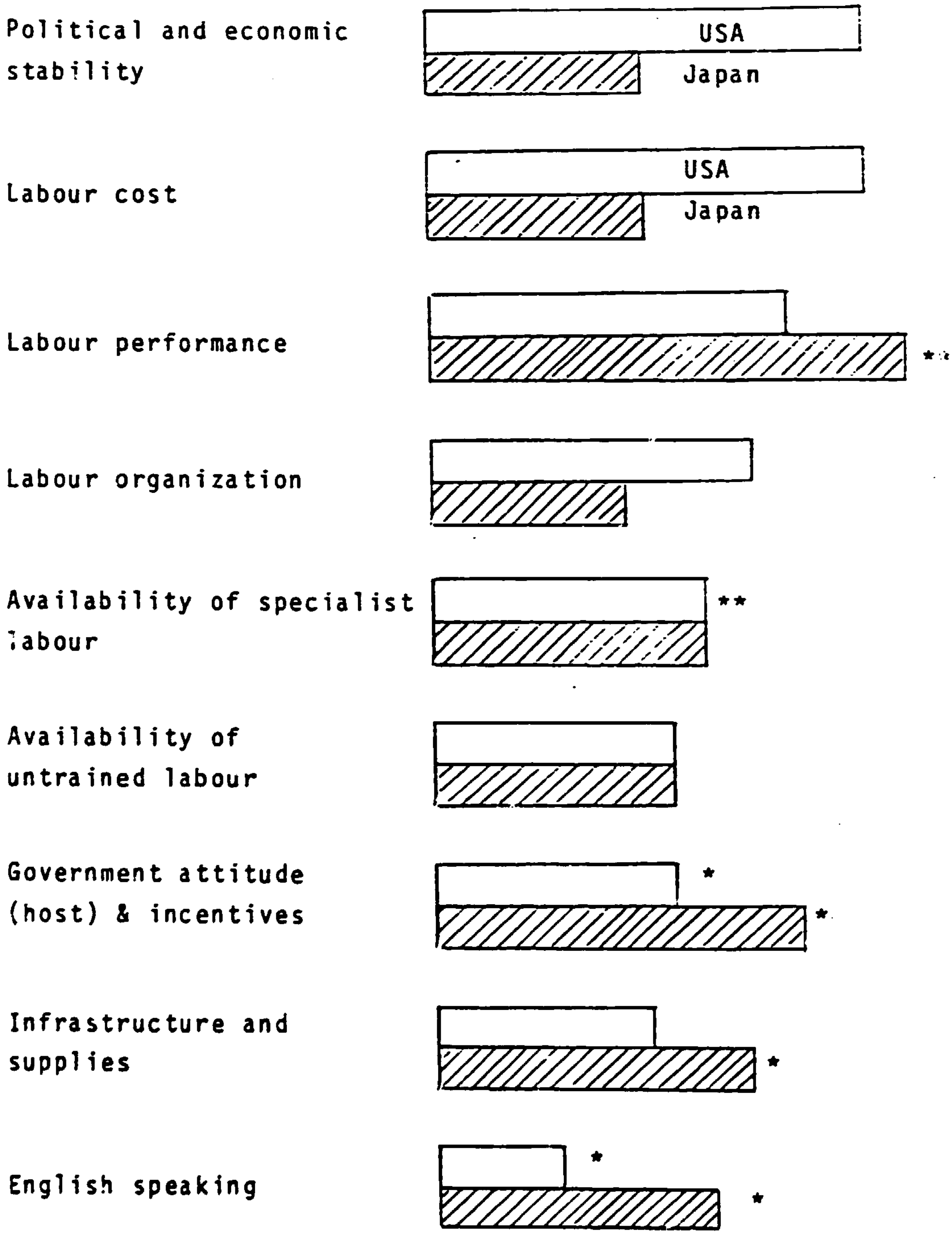
In most cases, and especially in recent years, foreign investment has been concentrated in component manufacture, particularly semiconductor devices. Almost the whole of the production from this foreign investment is then exported.

The countries which have received this foreign investment have noted that there is very little integration. Often companies with common activity do not collaborate at all. Value added remains low because all parts are imported. But these ventures do generate employment and they lead to wealth creation. In the end linkages are established as Governments (becoming less dependent on the foreign partners) are able to advance their own plans. Technology does also transfer to local companies in the end. In the country profiles presented earlier, the accounts of both Korea and Taiwan end with statements about locally owned companies setting up high technology operations in the USA.

The fastest growth and the highest business performance is obtained in countries which invite foreign involvement. Countries which proceed on their own, without huge local markets to support them, and with small, heavily protected electronics industries do not perform well.

The majority of electronics investment comes from Japan and the USA. An indication of the investment criteria of Japanese and USA companies can be seen in Figure VI B-2. The notes are self explanatory. The USA regards political and economic stability very highly, as it does labour performance and a positively encouraging attitude on the part of the host country.

Bars refer to relative importance of location criteria for companies locating overseas in 1978. Stars show special importance attached to subsequent locations.
Source: Financial Times Quoting Booz Allen & Hamilton



USA/JAPAN LOCATION CRITERIA

Figure VI B - 2

The preferred locations for USA companies are shown in Table VI B-2. With the exception of Mexico (close to the USA, and politically stable) and Taiwan (already the principal Japanese offshore electronics manufacturer) the first eleven countries are well developed western nations.

The messages do seem very clear, as enumerated Table VI B-1. A foreign Joint Venture is the ideal way to develop in the absence of a huge local market, but in any case foreign technology is essential.

TABLE VI B - 2

PREFERRED LOCATIONS FOR USA ELECTRONICS FIRMS

Country	Preference Votes in 1983	Ranking in 1983	Ranking in 1982
United Kingdom	71	1	1
West Germany	51	2	2
Ireland	44	3	3
France	31	4	7
Mexico	28	5	5
Canada	25	6	4
Taiwan	21	7	6
Netherlands	19	8	12
Italy	18	9	9
Japan	17	10	8
Spain	15	11	11
Singapore	14	12	10
Philippines	13	13	14
Belgium	12	14	16
Australia	11	15	15
Barbados	11	16	28
Switzerland	10	17	31
Austria	9	18	13
India	9	19	34
Hong Kong	8	20	33
Jamaica	8	21	35
Malaysia	8	22	17
Sweden, Brazil, Costa Rica, Portugal, South Korea, Morocco, Sri Lanka, Egypt, Israel, New Zealand, Norway - 57 votes			
17 other countries - 32 votes			

263 companies indicated 543 preferred countries

Source: Electronics Location File 1983.

C. THE PROPOSED PROJECT

It is clear that all the separate projects reviewed in Chapter V show, at best, marginal performance and at worst commercial failures. The matter will be reviewed further in the next section of this report. The reason why these projects do not succeed is that they are underutilised. The economies of scale in Chapter IV show that there are appreciable economies of scale to be obtained after 300,000 radios per year, and great economies of scale in televisions over 20,000 per year.

The PCB plant could certainly make the boards for both radios and TV's. The radio sub-assembly should be able to improve its performance substantially after 1-2 years. Only the final assembly lines need to be established separately for each product. The merging of radio, B/W and colour TV onto a single line is very unusal but there is no technical reason at all why it cannot be done. It looks a promising option for Ethiopia because the radio demand is at such a level that it leaves a suitable margin of plant capacity for TV manufacture.

A practical programme of development is shown in Figure VI C-1. The start of construction has been delayed to the end of 1986 in order to reflect the current economic situation. Under free-market demand conditions, and free from project foreign currency difficulties the project could go ahead sooner but that is probably not a realistic assumption.

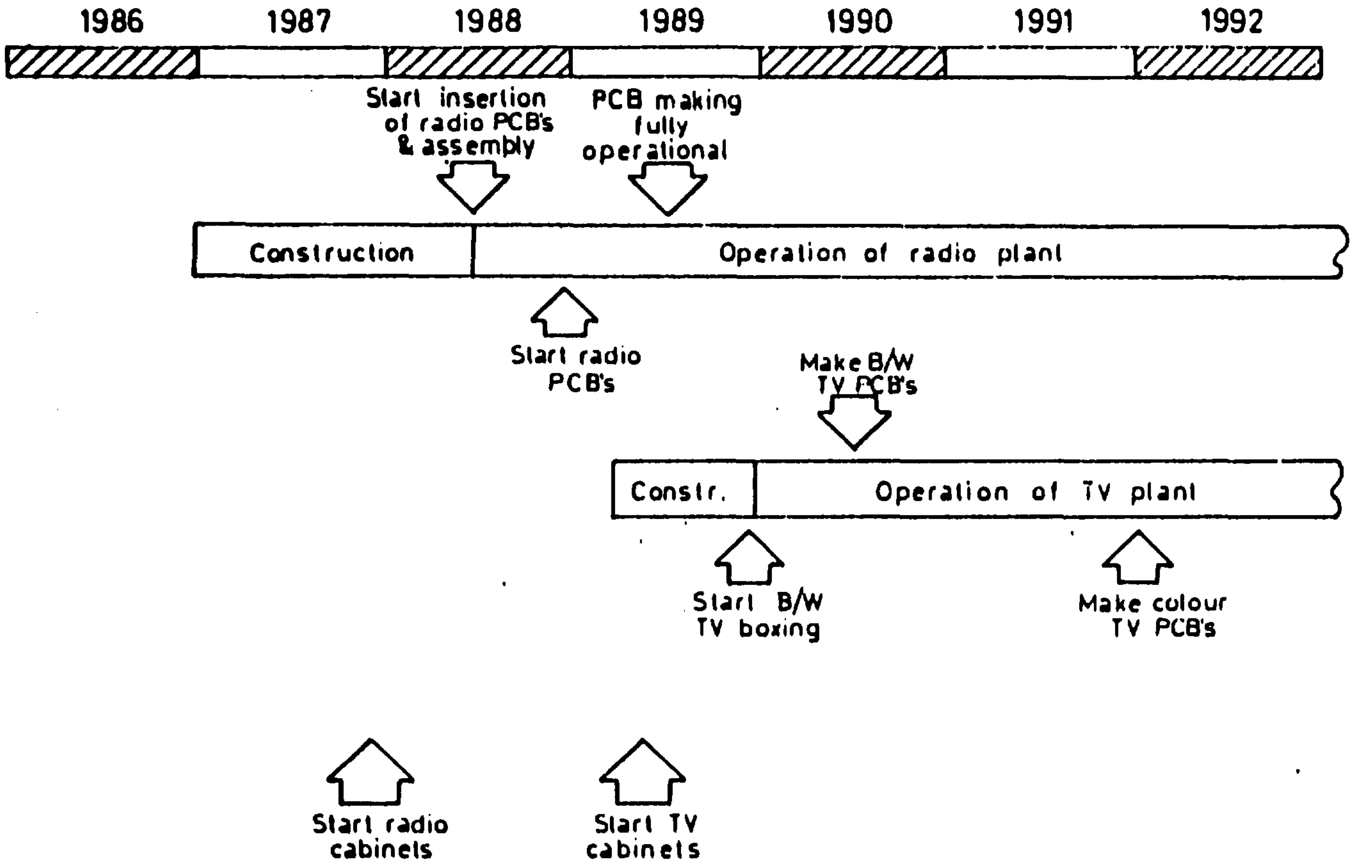


FIGURE VI C-1 A POSSIBLE CONSUMER PRODUCT DEVELOPMENT PROGRAMME

Radio sub-assembly (printed circuit board assembly) could begin in mid 1988 and the manufacture of PCBs could begin at the end of 1988. Eighteen months is then allowed to ensure full and successful operation of the radio plant before introducing B/W TV's. A further eighteen months elapses before colour TV is introduced. This is the fastest technologically practicable programme bearing in mind the amount of training and experience needed in a wholly unskilled workforce.

A possible market demand is shown in Table IV C-1. This is based on the medium growth forecasts. Growth of production of radios could take place as follows:

Year 1	Q 1	50/day	
	Q 2	150	
	Q 3	250	
	Q 4	450	
Average for year 1			60,000 radios
Year 2	Q 1	750	
	Q 2	950	
	Q 3	1050	
	Q 4	1100	
Average for year 2			253,000 radios

At the end of year 2 the workforce should be capable of making 300,000 radios per year, although the market has not reached that level. Coincidentally the 1989 market is 253,000 radios. So from the second year of operation the plant would be market limited.

TABLE VI C-1

POSSIBLE SALES OF RADIO & TV

YEAR	SALES THOUSAND SETS PER YEAR		
	RADIOS	B/W TV	COLOUR TV
1985	153	6	1
1986	163	7	1
1987	227	8	1
1988	238	9	2
1989	253	10	2
1990	267	12	3
1991	293	12	3
1992	319	13	4
1993	354	15	5
1994	397	17	6

Medium growth cases for each product

Television would be introduced in 1990 when the demand would be about 12,000 B/W sets. It should be possible to meet that demand in the first year. Likewise the demand for 4000 colour sets in 1992.

If the full output of the plant is taken as 300,000 radios, 20,000 B/W TVs and 5000 colour sets (it should in practice be more than this) then the suggested programme implies the following utilization:

1988	15 percent
1989	65 "
1990	78 "
1991	88 "
1992	93 "
1993	100 "

It is assumed that contribution at full output is based on share of revenue, ie. approximately radio 77%, B/W TV 16%, colour TV 7%.

The capital recovery factor for this growth rate (other assumptions as in Appendix A) is 16.5 percent.

The capital cost of the plant is shown in Table IV C-2. It is based on the radio manufacturing project, with additions for assembly of TV's. The fixed investment is 9.3 million Birr of which 45 percent is accounted for by the buildings. The plant layout is presented in Figure IV C-2, together with the flow of materials.

The factory would employ 188 people. This is made up of the 147 people in the radio manufacturing project profile plus the final assembly B/W TV (14) and the final assembly colour TV (11). A further 16 indirect workers have been added as follows:

TABLE VI C-2

CAPITAL COST OF JOINT PROJECT

COST ITEM	THOUSAND BIRR		
	LOCAL CURRENCY	FOREIGN CURRENCY	TOTAL
Printed circuit boards	57	589	646
PCB sub assembly	30	319	349
Coil winding	14	143	157
Radio final assembly	51	515	566
TV chassis equipment	45	272	317
B/W TV final assembly	40	286	326
Colour TV test and assembly	13	129	142
	250	2253	2503
Equipment installation	13	112	125
Offices, equipment etc.	297	297	594
Vehicles	25	225	250
Buildings (4350 sq.m)	2714	2002	4176
	3299	4889	7648
Project eng. & Management	144	430	574
Preoperating expenses	76	1009	1085
	3519	6328	9307

For details of plant and equipment see Chapter V.

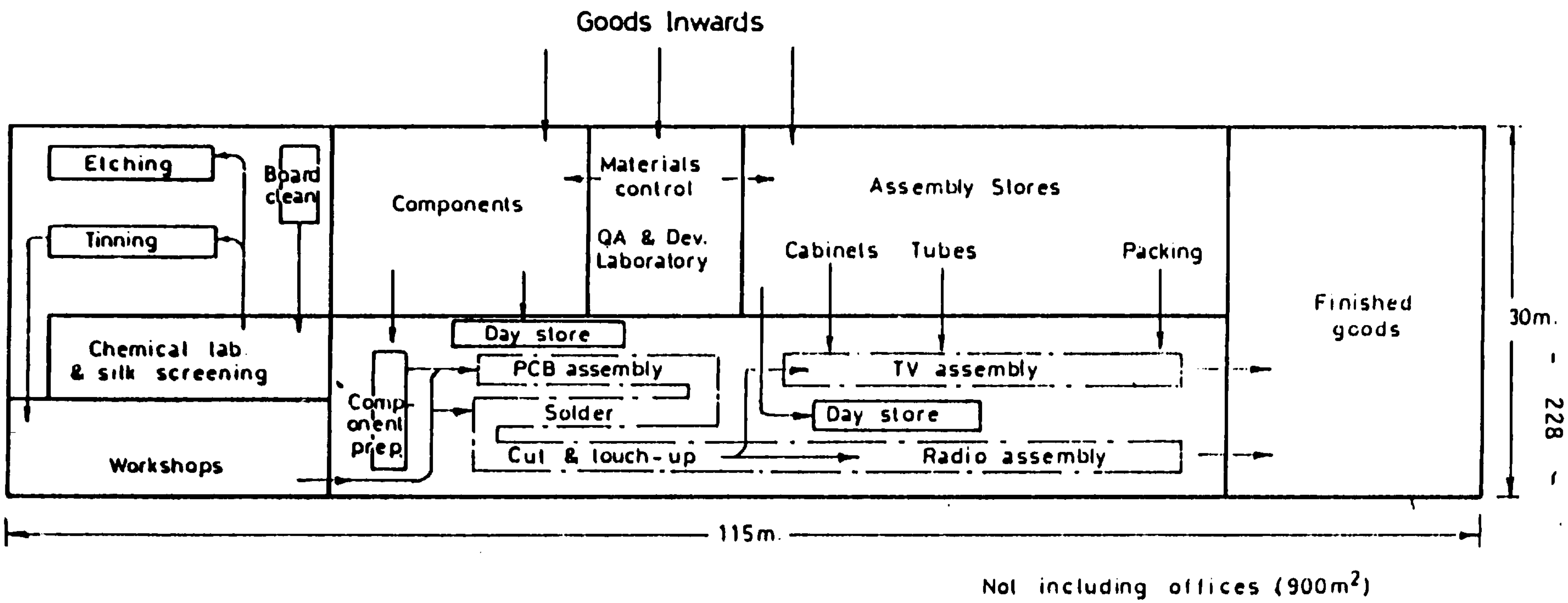


FIGURE VI C-2 CONSUMER ELECTRONICS PLANT LAYOUT

2 electronic engineers	(grade A/B)
1 plant engineer	(B)
2 managers	(B)
5 clerical staff	(3C, 2D)
3 site & security	(E)
2 cleaners/messengers	(F)
1 driver	(D)

The weighted mean wage cost of the 188 staff is 3890.- Birr/year. It should be noted that the indirect workforce of 70 is nearly 60 percent of the direct workforce. The most efficient operations (admittedly, at higher volume) run at 25-30 percent. The grades and numbers of employees are, for convenience, summarised in Table VI C-3.

The comprehensive annual cost is summarised in Table IV C-4. Other operating costs are built up as follows:

Utilities	0.299
Maintenance matls. & spares	0.184
Vehicle operations	0.103
Expenses	0.183
	0.769 million Birr

Working capital amounts to 6.54 million Birr as follows:

Stock (average 3 months)	3.29
Finished goods (1 month)	1.22
Letters of Credit (1 month)	0.71
Debtors (1 month)	1.22
Cash	0.10
	6.54 million Birr

TABLE VI C-3

EMPLOYEES IN JOINT PROJECT

	NUMBER OF EMPLOYEES						
	A	B	C	D	E	F	TOTAL
Direct workers:							
PCB Plant	1	4	17	19	-	5	46
Coils	-	-	2	7	-	-	9
Radio assembly	-	3	5	26	-	4	38
TV assembly	-	1	5	6	-	2	14
Colour TV	-	-	7	-	1	3	11
							118
Indirect workers	3	11	3	29	14	10	70
	4	19	39	87	15	24	188

TABLE VI C-4

COMPREHENSIVE COST - JOINT PROJECT

COST ITEM	MILLION BIRR PER YEAR			
	Local Currency	Foreign Currency	Total	Percent
Parts				
300,000 radios	1.64	7.40	9.04	
20,000 B/W TV	0.67	2.01	2.68	
5000 colour TV	0.23	1.22	1.45	
	2.54	10.63	13.17	78
Manning	0.73	-	0.73	4
Other operating costs	0.48	0.29	0.77	4
Capital charge	0.58	1.04	1.62	10
Working cap. charge	0.15	0.50	0.65	4
TOTAL	4.48	12.46	16.94	100

The comprehensive annual cost of 16.94 million Birr must now be compared with the import prices. In Chapter IV the prices of radios (duty free) delivered from SE Asia were estimated as follows:

MW	25.8 Birr
2 band	28.2 "
Cassette radio	59.0 "

The model price of a B/W TV was also calculated in the same excercise as 196 Brir. The price of a colour TV imported duty-free was estimated in the project profile as 460 Birr. Using these prices the equivalent import cost becomes:

Radios:

MW only	(75,000)	1.935
2 band	(150,000)	4.230
cassette	(75,000)	4.425
		10.590
B/W TV	(20,000)	3.920
Colour TV	(5,000)	2.300
		16.810 million Birr

This cost is almost exactly the same as the comprehensive annual cost of 16.94 million Birr. The clear indication is that the project can compete with import prices (duty free) and still achieve a 10 percent return on investment. Furthermore the foreign currency content of the comprehensive cost is only 12.6 million Birr, a saving of 4.35 million Birr on imports.

D. MERITS OF THE PROJECTS

In this section the attributes of the project profiles are reviewed, together with the proposed joint project described in the previous section.

1. General Observations on Performance

A summary of project characteristics is given in Table VI D-1. All the separate radio and B/W TV projects show a net less compared to import prices. The joint project breaks even.

	Local cost above imports
radio assembly	16 percent
radio manufacture	3 "
B/W TV assembly	5 "
B/W TV manufacture	18 "
Joint radio/TV	-

But all these projects achieve a saving in foreign exchange.

The colour TV profile assumes that colour TV is added to an existing radio and TV plant. It therefore shows a 17 percent overall saving compared to imports.

Cabinets are attractive projects; both showing worthwhile savings.

Loudspeaker manufacture is simply at too small scale and results in a net loss compared to imports of 40 percent.

Telephones show a net loss compared to imports of 17 percent. However, it is the electro-mechanical rotary dial phone which is costed. The printed circuit board phone is considered in outline. It would be slightly cheaper (if a PCB plant already exists) but would still show a small loss.

TABLE VI D-1
PROJECT CHARACTERISTICS

Characteristic	Radio Assemb	Radio Manu.	B/W TV Assemb.	B/W TV Manu.	Colour TV	Cabinets		Loud-Speakers	Phones (Rotary dial type see Interim Report)	Military Radios	Joint Project
						Radio	TV				
Million Birr											
Fixed investment	2.53	6.15	2.32	6.06	1.24	1.49	0.83	1.32	0.62	15.17	9.31
Working capital	3.57	4.39	1.18	1.49	0.90	0.09	0.07	0.29	0.42	2.62	6.54
Total Capital	6.10	10.54	3.50	7.55	2.14	1.58	0.90	1.61	1.04	17.79	15.85
Cost when imported	7.05	10.59	2.94	3.92	2.30	0.75	0.54	0.88	0.90	10.92	16.81
Comprehensive cost	8.15	10.91	3.08	4.64	1.90	0.63	0.45	1.23	1.05	7.82	16.94
Total saving	(1.10)	(0.32)	(0.14)	(0.72)	0.40	0.12	0.09	0.35	(0.15)	3.10	(0.13)
Foreign exchange	6.51	7.93	2.07	2.79	1.43	0.47	0.08	0.80	0.80	5.59	12.46
FX savings	0.53	2.66	1.01	1.13	0.87	0.28	0.44	(0.08)	0.10	5.33	4.35
Employment:											
Manning	59	147	32	101	30	17	17	35	15	153	188
Percent of total cost:											
Local cur. costs	20	27	31	40	28	26	82	35	25	29	26
Fixed cap. manpower	8	14	16	28	16	46	41	28	16	40	14
Total capital invested per job ('000 Birr):											
Cap. intensity	103	72	109	75	71	93	53	46	69	116	84
Implicit exchange rate:											
Birr spent to save $1 of FX	6.3	2.3	2.3	3.4	*	*	*	FXloss	5.2	*	2.1

* Index not appropriate (both foreign exchange & local currency are saved).

Military radios is an attractive project with an apparent 28 percent saving.

2. Investment and Manpower

None of the consumer projects have high fixed investments but it is noticeable that the radio and TV projects have substantial working capital requirement associated with storage of imported parts. The military radio plant has quite a high capital investment.

Investment (capital plus working capital) per job is around 75,000 - 100,000 Birr. It is higher in the assembly-only projects mainly because these, although simple operations, have high storage costs.

The projects do not, in general, create large number of jobs. The largest separate projects are consumer radios and military radios, each at around 150 people.

3. Foreign Currency

Only the loudspeaker project fails to save foreign currency. On most projects there is a substantial saving of foreign currency. Even the B/W TV assembly project (at 15,000 sets per year) saves over 1 million Birr per year of foreign exchange.

One way of looking at foreign currency savings is to determine the penalty which has to be carried in extra local currency in order to save $1 of foreign exchange. Thus, in the radio assembly project the overall loss is 1.1 million Birr. The foreign exchange saved is 0.53 million Birr ($0.26 million). Therefore the cost of saving $0.26 million is 1.1 + 0.53 = 1.63 million Birr. In this case the project values the Birr at 6.3 Birr per dollar.

Such a high implicit exchange rate is not worth considering. However the figure of 2.3 Birr/dollar is worthy of consideration in the case of radio manufacture and TV assembly.

4. Project summary

A summary is presented in Table VI D-2. The most attractive project in commercial terms is the military radio project. The joint radio and TV project shows an adequate commercial performance and good foreign exchange savings. Cabinets should then made. Speakers should not. Telephones may be justified in due course when PCB manufacture is established.

5. Further Review of the Recommended Joint Project

The recommended project may now be measured against the criteria set out earlier in this Chapter. Table VI D-3 lists the criteria and the project valuation. The import substitution effect is good and the foreign exchange invested in fixed and working capital is recovered in 2½ full years of operation. Because of the underutilization of the plant in the early years the actual time to recover the initial foreign currency outlay will be about 4 years.

One aspect of the foreign currency consideration is that the free market demand for radio and TV is much more than current imports. Imports in 1984 were probably around 3 million Birr of radios and 2 million Birr of TVs; about 5 million Birr in total. The foreign currency is therefore about 5 million Birr. With demand at the free market level the imports would be closer to 15 million

TABLE VI D-2

PROJECT SUMMARY

Radio assembly	Net loss, inadequately compensated by foreign currency saving; low employment, relatively high investment requirement. Inadvisable
Radio manufacture	Very small net loss. Large foreign exchange saving; high employment; introduces and justifies PCB manufacture which underpins all other electronics development. Advisable but with television (see joint project).
TV assembly	Small net loss, compensated by foreign exchange saving; low employment, high capital requirement. Inadvisable if any other consumer product manufacture is to be established
TV manufacture	As a separate venture it shows a large net loss, inadequately compensated by foreign currency savings. Inadvisable as a separate venture but can show advantages when merged with radio (see below)
Colour TV	When associated with full scale consumer electronic production it shows big net savings and foreign exchange savings; but project is small. Savings may be large enough to justify introduction as soon as technically practicable after B/W TV, even though volume low. Advisable.
Cabinets	Substantial advantages. Advisable
Loudspeakers	High cost, net loss and FX loss. Inadvisable
Telephones	Unsatisfactory commercial performance and small FX saving. But a PCB-based phone would be slightly cheaper. Borderline
Military radios	A successful project with big net savings and FX savings associated with acquisition of high technology. Although demand is small it is well above minimum economic volume. (Non-military radios would probably continue to be cheaper to import.
Joint project	Successful project which competes with imports and saves foreign currency. It is the largest project in employment terms and introduces a range of technology.

TABLE VI D-3

EVALUATION OF PROJECT AGAINST DEVELOPMENT CRITERIA

ASPECT		VALUATION
Foreign exchange:		
- Import substitution	good	over 95% of imports
- Exports	poor	zero in medium term
- Savings	good	$ 4.2 m/year, but only 26% of cost
- FX invested per FX saved	good	56,000 Birr invested per job 23,000 Birr saved per year
Linkages:		
- to agriculture	poor	
- to existing industry	fair	cabinets, transport, packaging, printing (20% of materials)
- to future industry	fair	but good in long-term
Project Characteristics:		
- product	good	satisfies basic need
- technology	fair	very challenging
- investment	good	low at 9 m. Birr but also high working capital, 6 m. Birr
- employment	poor	low at 188
- fixed inv./job	good	50,000 Birr below average
- postponability	poor	could easily be delayed
- separability	poor	not practicable in stages
Performance:		
- profitability	good	achieves 10% ROI
- protection	good	product competes with import:some protection needed
- demand resilience	fair	requires active support
- growth rate	good	
- robustness	good	economic problem could depress market but project not highly sensitive
- flexibility	poor	can only make radio/TV

Birr. Substitution of these imports by local manufacture would save foreign exchange. But the foreign currency for the manufactured free-market sales will still be twice the present restricted imports. The question of whether to continue to restrict public access to broadcasting facilities is a political matter. There is a very strong case to be made for assuming that radio and B/W TV are an essential part of today's social fabric, and that after food and health care they are essential. They should not be considered as luxury goods.

Given the criteria set out in this Chapter there is a strong case for going ahead with the radio/TV project, despite the present serious foreign currency shortage. Certainly if restrictions on radio and TV importing are to be eased or lifted in 1-2 years time, thereby increasing sales, there is a very strong case indeed for local manufacture.

A final excercise to check the advisability of the joint radio/TV project is to ascertain its sensitivity to failure of sales volume. Such a high percentage of the total cost is imported parts that the unit cost rises relatively slowly with falling volume.

Figure VI D-1 shows a breakeven chart. If budgeted output is reached in the manner described earlier in this Chapter then the project makes a 10 percent return on investment (comprehensive costs include fixed capital charges based on a 10 percent discount factor, and the comprehensive cost equals the import price). We may assume the fixed and variable costs to be as follows:

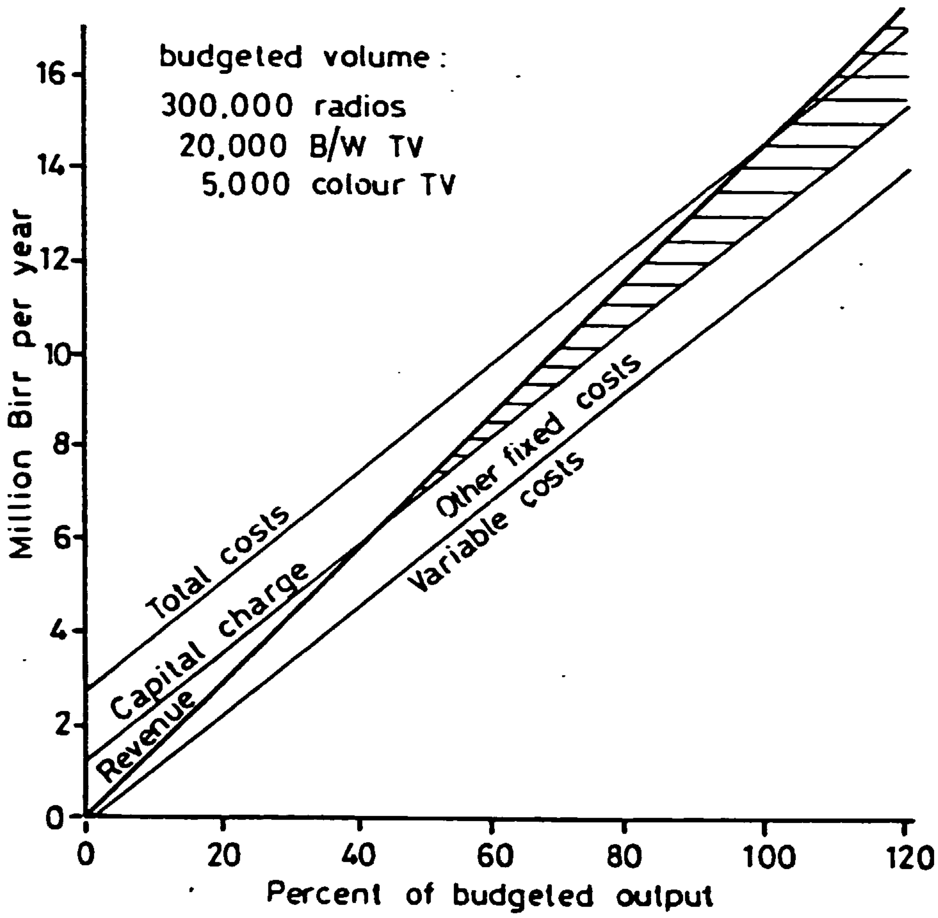


FIGURE VI D-1 A BREAKEVEN CHART FOR THE JOINT RADIO/TV PROJECT

Parts	-	variable
Manning	-	fixed
Other Operating Costs	-	2/3 fixed*
Capital Charge	-	fixed
Working Cap. Charge	-	variable

* Utilities, maintenance materials, vehicle operations and company expenses.

In this case the total costs decrease as shown in Figure VI D-1. The revenues of course decrease linearly with volume. The plant continues to cover a part of its capital charges down to about 50 percent of budgeted output. Thus the venture is not highly sensitive to market volume.

E. STRATEGY

1. The Course of Action

The appropriate course for electronics development in Ethiopia seems very clear. A summary of conclusions is set out in Table VI E.1.

Ethiopia should follow the example of nearly all developing countries and build on its local consumer product market. As quickly as possible a product circuit board capability should be established. This will be a basis for further product development later. Professional and industrial electronics have hardly any opportunity in view of the small scale of the economy. Ethiopia is not in a position to export and must prove a capability before that becomes possible.

The opportunity is for a substantial radio manufacturing plant onto which is placed a small TV manufacturing requirement. It would make sense to restrain television demand until the local plant is able to satisfy the considerable suppressed demand.

Once colour TV is introduced the plant will be able to make more or less than this volume, according to market requirements, without difficulty. The unit cost should not change much because the plant will be used for other product if it is not making colour TVs. A decision on supply of colour TV could also be made on foreign currency grounds since each colour TV supplied incurs on extra foreign currency requirement of 120-130 Birr for imported parts.

Military radios appears to be an attractive project. It should be established with a fixed capital investment making only those components where the economy of scale justifies the investment. A joint PCB plant with the radio/TV plant would be appropriate.

TABLE VI E.1

STRATEGY

Products

- Build on consumer product demand
- Develop a PCB capability for longer-term opportunities
- Concentrate on profitable and FX-saving activities
- Ignore unprofitable components
- Look for exports in the longer-term
- Adopt the latest technology
- Clasify intentions regarding technology aquisition
- Establish an ongoing source of technical and production skills, preferably via a joint venture
- In medium term concentrate an applications rather than new product development

Business Climate

- Create confidence through a well-ordered approach to industrialisation
- Establish an authority to promote the interests of an electronics industry and related activities
- Try to attract foreign investment

Training

- Establish centres of expertise in electronics technology & production
- Develop relevant technical & production courses
- Offer subsidised training schemes

Support the Electronics Venture

- Secure the product demand
- Arrange appropriate protection
- Permit commercial semi-autonomy
- Waive taxes, FX-restrictions etc

Some other products might be justified after a more detailed study, e.g phones. The wider consideration of electronics should, for the time being be limited to the application of electronics to industry and commerce, rather than to small scale and high cost manufacture of industrial and professional goods.

There has been previous discussion of the possibility of adopting some appropriate, intermediate electronics technology. This idea should be rejected. The only practicable course is to adopt the latest technology. The source of technology is a complex issue. If a joint venture with a foreign partner could be arranged this would be by far the best solution. Foreign technology is essential. It is however, critical that Ethiopia makes it clear where its preference lies, and embarks with enthusiasm on a search for a western foreign partner if that is the chosen course. Any lack of commitment will cause failure.

An integral part of the strategy should be to create a feeling of confidence about business development. This requires a well ordered plan and Government actions which will convince potential foreign partners that Ethiopia is determined to go ahead with such a venture and in business-like way. There is no point in talking to potential partners until there is a sense of commitment and of direction. This report mentions some of the organizational issues.

The problems facing the establishment of an electronics venture are the same as will be encountered in future light, precision engineering industry. The absence of a heritage of industrial skill is a serious disadvantage which can only be overcome by extensive technical and operator training. Subsidised or free training is one of the incentives Ethiopia can offer local and foreign business.

An electronics venture will succeed if it is able to sell at a volume determined by a largely free market demand; and if restriction on operation, availablity of foreign currency, etc. are removed. Some import protection would be needed, but less than at present.

2. Contribution of Electronics Manufacturing

A very approximate idea of the contribution of electronics manufacturing to overall industrial growth can be gained by comparing the tentative proposals from the profiles with the expectations of the 10 Year Plan.

According to the Ministry of Industry the employment in industry will increase by 80,000 in the next 10 years. At a constant growth this means around 36,000 additional employees in the 5 years 1987-1991. The tentatively suggested consumer electronics developments, plus military radios would account for around up to 400 people in that time, i.e. around 1 percent.

During the period 1987-1991 consumer electronics industries and military communicators will probably reuire some 25 million Birr of fixed investment, averaging around 6 million Birr/year. This is about 3 percent of industrial investment.

VII. IMPLEMENTATION

A. TECHNOLOGY ACQUISITION

1. Requirement for Technology

The production and technical know-how needed to support a modern electronic industry has been acquired in the industrialised countries through many years of experience as industry has evolved both in scale and sophistication of product. The basic principles of both design and production can readily be transferred through further education courses but the translation of these principles into successful product manufacturing requires experience. It is also important that product design engineers appreciate the needs of production processes.

Ethiopia does not enjoy a heritage of industrial engineering and production skills. There are few, if any, production units in the country which pose the same complex production problems as the proposed electronics venture. In this respect it is important to understand that the main technical and production problems will lie, not in the electronics circuitry but in the management of high volume short cycle production operations, and in materials control and scheduling. There is also a need for a detailed understanding of other production processes outside the electronics complex, plastic moulding, tool design, precision metalwork, printing, packaging etc.

The electronics complex should not therefore be regarded as unusual in the normal industrial development of Ethiopia. Most of the design,production and industrial engineering skills necessary for successful implementation of a consumer electronics industry will be directly relevant to part of existing industry and to most manufacturing industry which will follow in coming years.

There are essentially five ways in which the technology can be acquired in Ethiopia:

- Joint Venture in association with a foreign partner. This has been the preferred approach in most developing countries which have established electronics industries. Part of the investment required comes from a foreign partner, who also provides all the know how, probably finances the plant supply and who also gives preference to his own sources of supplies. Where the venture is majority-owned by the foreign partner then usually it is managed by representatives of that foreign partner. The nature of the technical support is comprehensive over the whole range of the agreed products and the product will carry the foreign partner's brand name.

- A variation on the Joint Venture approach is for the foreign partner to have a minority holding and to provide all necessary support but to allow local management to run the factory.

- The third approach is to seek a licence from an established producer. This arrangement can extend from simply paying for a proven design and for a given level of technical support (specified perhaps in man-months), up to a full assistanee programme and even perhaps a brand name. The latter arrangement is rarely, it ever, adopted in electronics in developing countries.

- The purchase of design technology and plant from an Eastern bloc supplier is similar in some ways to the licensing approach but is more embracing. The deal is usually made with a State Export Corporation of same form. Poland, E. Germany, Czechoslovakia, Bulgaria etc. offer such packages in a wide ranging of engineering products. The deal includes a standard plant (not usually closely tailored to local requirement), a loan financing package and a know-how and training agreement together with product designs. Sometimes this scheme is described as supply of a 'project'.

- Finally we have the Self Development approach. It is possible to form a small team of foreign experts who will prepare product and factory designs, manage the operations and teach local engineers and technologists. Such an approach, while possible in principle, probably has no precedents in practice. It is also attended by some commercial disadvantages.

2. Merits of the Schemes

The five schemes vary widely in their advantages and disadvantages. In many cases the assessment of their strengths and weaknesses has to be highly subjective and hence any comparison is bound to be subjective. Table VII A-1 lists the main aspects to be considered in choosing a scheme for technology acquisition. The relative strengths of each scheme are also indicated. In the following paragraphs each of the attributes is considered in more detail.

TABLE VII A-1

TECHNOLOGY ACQUISITION ALTERNATIVES

● high

○ low

Attribute	RELATIVE VALUATION				
	JV Foreign Manag.	JV Local Manag.	Licence	E.Bloc Package	Self Dev.
Proven design	●	●	●	◒	○
Appropriate plant	●	●	◒	◓	●
Technical support	●	●	◒	◒	◓
New product development	●	◒	◓	◓	○
Help with foreign suppliers	●	●	◒	●	◓
Help to local suppliers	●	◒	○	◓	◒
Brand name	●	●	◓	○	○
Export market help	●	◒	◓	◓	○
Independent securing	○	○	◓	○	●
Business independence	○	◒	◒	◒	●
Local training help	●	◓	◓	◒	●
Overseas training	●	●	◒	●	○
Acquisition of skills	◒	●	◒	●	◒
Rate of output growth	●	◒	◒	◒	○
Precedents	●	●	◒	●	○
Low risk	●	◒	◒	◒	○
Financial help	●	◒	○	◓	○
Cost/performance	●	◒	◓	◓	○
Ease of achievement	◓	◒	◓	●	●

Proven Design: Proven designs are available from all except the Self Development scheme. Joint Ventures or licences from Western or Far Eastern partners will incorporate full design information on-up-to-date models with a limited but carefully designed and economical product range. The design in an East Bloc Package will also be comprehensive from a production point of view but might not be of the most fashionable design or of the latest technology. It might, for example, be based on the use of discrete components, with more circuit board assembly stages. This is not in itself a marketing disadvantage, but might have a marginal cost disadvantage, and is not generally conducive to establishing a high reputation as a producer of electronic goods.

The Self Development scheme brings no product designs. They would have to be copied from existing designs marketed elsewhere. This is quite practicable with simple radios, but poses progressively increasing problems as the venture moves, first into black and white television, and then into colour. It would not be at all practicable to attempt the design of communications products or industrial and professional goods in this way. A much larger development team would be needed for such products than the four specialists incorporated into the Self Development scheme.

Production Support: Joint Ventures have the merit of a complete range of technical support. Even when the venture is locally managed, the foreign partner provides essential help at short notice,and is motivated to do so by his investment in the project. The Licence arrangement includes a technical support agreement although persistent problems might not be treated with the same sense of urgency as in Joint Ventures. Likewise with an E.Bloc Package, the skills might not be readily available during the several years the venture moves through radio to colour TV, although no doubt efferts would be made to solve the problems. The Self Development scheme would have a few experienced employees available, but they have no company expertise to fall back on when they themselves encounter problems.

Plant Design: It is suggested in this report that the plant should be designed mainly for radios, but that the PCB and sub-assembly lines should incorporate black and white and colour TV. Consideration might also need to be given to the possibility of later incorporation of telephone PCB's or even radio communicators etc. The plant will need to be carefully tailored to these requirements and will need to reflect other aspects such as extra large stores, sample testing of components etc. Such a plant can be so tailored within a Joint Venture without difficulty. It can also be tailored in the same way by the specialists in a Self Development scheme. It is more of a problem in a licence arrangement since this may not cover all the products of interest, and cannot really take adequate account of possible future products, but the same flexibility can be maintained. The E. Bloc Package is likely to be a standard plant without much modification for the particular local market size and conditions, and with consideration of future products deferred until the time arises. Often the plant is agreed in a simple, high level protocol and subsequent change is very difficult to arrange.

New Product Development: In time it will be desirable to modify, improve and extend the designs of the existing product range. New product opportunities will also arise in the medium to long term. An alert Joint Venture partner, who is also undertaking his own research, will be able to make these changes, and seize new opportunities.

This will be specially true of a Joint Venture Partner who has staff permanently seconded to the venture. Both the Licence arrangement and the E. Bloc Package offer poor support in this respect, particularly with regard to new products as opposed to improvements. The Self Development scheme offers virtually no such support; the specialists will be involved in managing production and quality control and will not be able to contribute much to development.

Modern electronics companies spend a substantial sum on research and product development. Companies working on the most advanced products spend up to $\frac{1}{4}$ of revenue on R & D. In the USA, electronics companies as a whole spend about 9 percent of revenue on R & D. If government research is added to this it becomes 12½ percent of product revenue. Eleetronics represents 20 percent of all USA research (excluding defence and NASA etc. research). For longer term electronics development in Ethiopia a source of high technology is essential.

Help with Foreign Suppliers: Most of the parts will come from overseas and, especially with televisions, may come from different suppliers. There will also be a need for communication with suppliers over component specifications, modifications and quality problems. A Joint Venture or an E. Bloc package will arrange the entire supply of parts and should be able to deal effectively with any quality problems. In the E. Bloc package the provider of the components may actually be drawing them from a variety of sources and might therefore find occassional problems in dealing speedily with quality problems. In a Licence arrangement there might not be the same possibility of support on components for products not covered by the Licences. The Self Development scheme relies solely on the past experience of its few specialists and this is a poor substitute for a technical contact overseas.

Support to Local Suppliers: The providers of cabinets, mouldings, presentation parts, electro-mechanical or mechanical components will also encounter their own problems. They will of course have a contractual responsibility to meet the quality specifications and volume deliveries. But if they are unable to resolve their problems speedily then, contract or not, the electronic goods plant will be inconvenienced. It is customery to take an interest in, and to support, the suppliers. Joint Ventures with foreign management will usually be able to deal with all suppliers problems on the spot. Where they cannot they can still call on other expertise. A Self Development scheme has the same local expertise but does not have recourse to other experts in the few cases this becomes necessary. The Licence arrangement offers no support to local suppliers. The E. Bloc Package may be able to provide same guidance through its Local or visiting specialists, but is less likely to take a strong interest outside the electronics venture.

Brand Names: The use of an established foreign brand name on the consumer product will be a strong marketing advantage in local markets and probably will be essential in export markets. Joint Ventures will make brand names available. The Licence arrangement probably will not, at least in the early years (when it is most important). The E. Bloc Package and the Self Development scheme offer no established brand names.

Export Market Help: It is highly desirable to be able to export. If Local manufacture can compete with imports then same exports can probably be achieved. The extra transport cost can probably be offset by incremental costing of the extra production. That is to say, if there is very little extra manpower, capital, etc. needed to achieve the extra output, then it is not necessary to charge the average cost of these fixed cost resources to the extra production. The price can then be below average cost.

All large foreign campanies have some foreign sales of their own. Such companies may be able to place well-priced production from an Ethiopian business interest into export markets. Ethiopia might eventually be seen as having an advantage within any future preferential tariff structure in African States. It might also be possible to exploit Gulf markets with an established brand name. A foreign managed Joint Venture will be most alert to such possibilities but locally managed ventures or licence arrangements (with brand name) still have important advantages. The E. Bloc package could only find outlets in the E. Bloc countries and probably will not wish to do this; they have numerous consumer product plants. The Self Development scheme offers no assistance whatever in exports.

Financial Help: Joint Ventures by definition involve provision of equity. The Licence arrangement and Self Development scheme offer no equity or loan finance contribution. The E. Bloc Package will offer loan financing usually on a soft loan basis. This will cover all the plant supply and quite possibly part of the building costs as well. This soft loan is sometimes compensated by a relatively expensive plant.

Availability of Scheme: The E. Bloc Package and the Self Development forms of technology can be acquired without difficulty. Of the remaining three forms, the foreign minority Joint Venture will local management is probably the likeliest opportunity in Ethiopia but less likely than the other two. A foreign managed Joint Venture and a comprehensive Licence arrangement will probably be very difficult to acquire, although the former has sufficient attractions to make it worthwhile pursuing.

Local Training Help: The greatest contributions to local training will come from the foreign managed Joint Venture and the Self Development scheme. Both have a group of experienced foreigners in charge of operations or, in the case of Self Development, partly managing and partly advising on management. In fact the Self Development scheme probably offers the best of all prospects for Local training. The E. Bloc Package will send specialists to assist in training and management in the early stages but they will not be permanently in post or even permanently available for consultation. The locally managed Joint Venture and the Licence arrangement both have local management with some foreign support. Some local training is available,but less than the other schemes.

Overseas Training: It is essential that key Ethiopian employees have the opportunity to spend time in similar operations overseas. There is no substitute for this. All Joint Ventures offer this, and so does the E. Bloc package, in adequate measure. The Licence arrangement will afford probably slightly less chance. The Self Development scheme,none at all - a serious disadvantage.

Management/Technical Skills: The ventures in which local nationals actually manage the operation will be the ones which most quickly acquire the skills Locally. The locally managed Joint Venture and the E. Bloc Package are best. The Licence arrangement, because of the lower level of foreign support is not as good. The other two approaches offer the opportunity to understudy expatriates in the medium term. The transfer of skills will depend much on the level of mutual understanding and cooperation.

Independent Sourcing: The Self Development scheme offers the best opportunity for independent sourcing. The Licence arrangement offers some scope though probably not much in a comprehensive technical support arrangement. Joint Venture and the E. Bloc Package will be tied to the partner's sources of supply.

Business Independence: The existence of a foreign Joint Venture partner's management team (and, in this case, probably his majority shareholding)removes may prospect of business independence. More autonomy is achieved with the locally managed, Local majority Joint Venture, and a little more still with Licensing. The equity-free schemes, E. Bloc Package and Self Development, allow complete business independence, unless the E. Bloc contract removes some of this independence by making the Loan package contingent on approval of changes in plan.

Growth Rate: The ability to reach the forecast radio market quickly and quickly to enter television is greatest with a foreign managed Joint Venture and slowest in the Self Development scheme, which may be at least 2 years slower in moving into colour TV. The locally managed schemes, supported by a broad range of foreign technology, should all show an adequate growth in output.

Precedent: Joint Ventures and E. Bloc package schemes are well demonstrated. The Licence arrangement is also well tried but not in the circumstances of Ethiopia. There is no heritage of industrial skill on which to build the electronics venture. No precedents are known for the Self Development scheme in consumer electronics, and where no previous experience exists.

Risk: The risk of failing to achieve the planned output and performance is greatest the Self Development case. The other schemes have foreign support and do carry high risks. The lowest risk will be associated with the foreign managed Joint Venture.

Costs: Overall performance will be highest with a foreign managed venture, slightly lower with a locally managed Joint Venture and lower still with Licensing or the E. Bloc Package. In the latter two cases there will be a lower level of technical support. The nature of the plant may also not be ideal for the full range of products planned. This will reduce performance. Performance will be lowest with Self Development.

3. Recommendations on Technology Acquistion

The advantages and disadvantages discussed in the previous pages were summarised in Table VII A-1. It is possible, since all the attributes are separately ranked, to give an overall ranking to the five schemes. It would be possible to weight the attributes; for example to double the importance of say'proven design' but to leave certain other attributes unweighted. Experiments with such procedures have not changed the overall ranking which is:

First - Joint Venture foreign management: This scores uniformly highly on design, technical support and business performance.

Second - Joint Venture local management: This is a close second, failing slightly only because local managers, however first they learn will not bring the experience of foreign managers from an existing company.

Third - E. Bloc Package: It is clear from the table does that this offers nowhere near the advantages of a Joint Venture using western technology. It has few serious drawbacks but also few strong advantages. This is not to be recommended if there is any prespect whatever of a Joint Venture being established

Fourth - Licensing: A licence fails to give adequate support in any area except proven design.

Fifth - Self Development: A very weak scheme.

Unfortunately it is not merely a matter of selecting the appropriate scheme. It is equally important for Ethiopia to make itself attractive to prospective Joint Venture partners. This matter was dealt with in Chapter VI B International experience. Ethiopia does not have the political and economic climate likely to attract western (including developed SE Asian/Japanese) partners. They also usually require financial incentives, which Ethiopia is not in a position to provide, except for tax reliefs, provision for which exists in the Joint Venture Proclamation.

What Ethiopia does have to offer is an attractive, growing local consumer product market, cheap (but unskilled) labour, and a useful geographical location between Africa and the Arab region. These are advantages. If these were to be combined with a well organised and comprehensive effort to establish consumer product manufacture and a genuine, determined effort to attract a foreign investor, then a Joint Venture might still be possible.

B. ORGANISATION

1. Management

The purpose of discussing organization structure is to establish the scope for local management, the cost of expatriate supoort and the amount of training needed for the local staff. Figure VII B-1 shows an appropriate management structure for the consumer product joint radio/TV project. It is suggested that all the 14 posts could be filled with graduates, although in practice the foreman (sub-assembly) and the foreman (final assembly) might be technicians with 2-3 years training in electronics or light electrical engineering.

A scheme must be devised for filling the key posts with Ethiopian nationals as quickly as possible consistent with the need to maintain quality standards and volume output at the plant. There will be a need for the presence of experienced electronics engineers at the plant for some time.

If the plant is a foreign managed Joint Venture then of course the key posts will be filled with expatriates. Table VII B-1 shows these five key posts. The General Manager would be an expatriate. The Finance and Administration Manager would be an Ethiopian national and would be the Deputy GM in this case.

If the plant is to be managed by Ethiopians then some posts will need to be supported by expatriate technical advisors. It is suggested that the post of Manager-Development and Quality Assurance should be so supported for 4 years, in order to see the plant through the introduction of all products up to manufacture of colour television sub-

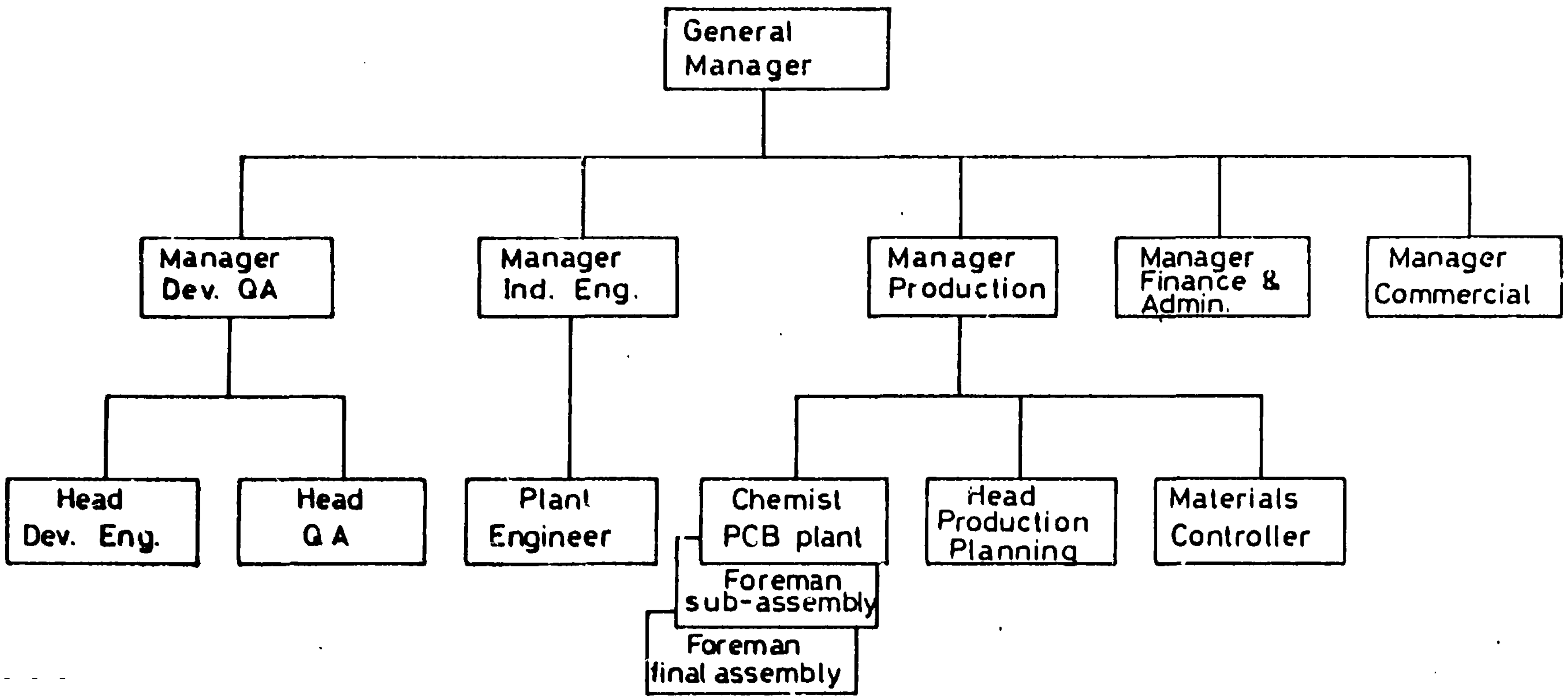


FIGURE VII B-1 PERMANENT ORGANIZATION OF MANAGEMENT AT THE CONSUMERS PRODUCT PLANT

TABLE VII B-1

FOREIGN MANAGEMENT/SUPPORT

	JV Foreign Manag.	Local Management	Self Development
Gen. Manager	✓		
Mgr.Dev/ QA	✓	assisted 4 years	✓
Mgr. Ind. Eng.	✓	assisted 2 years *	✓
Mgr. Production	✓	assisted 1 year	✓
Mgr. Fin. & Admin.			
Mgr. Commercial			
Head Dev. Eng.	✓	assisted 2 years	} ✓
Head QA			
Plant Engineer			
Head Prod. Plan.			
Materials Cont.			
Chemist			
Foreman Sub-Assem.			
Foreman Final Assem.			

* Plus an expert for 6 months each time a new product is introduced.

assemblies. In this way there will be a continuing source of technical skill available, not only to the development and quality assurance functions, but also to other parts of the plant.

During the first two years of operation the position of Head-Development Engineering must be supported by an expatriate. There would therefore be two expatriates in the development/quality assurance function during these two years. The electronics engineer supporting the Head of Dev. Eng. would also be able to help the Head of Quality Assurance; indeed he would probably divide his time between the two.

The production manager should be supported for one year, up to the point when radio manufacture is fully established. The Manager Industrial Engineering should be supported for ? years, up to the point when B/W TV PCB's are being produced. It will also be necessary for specialist industrial engineering expertise to be re-introduced for about six months each time a new product is introduced (eg colour TV, telephones etc.). In this way the production line operations can be changed most effectively and the correct introduction and use of new machinery, jigs and tools can be ensured.

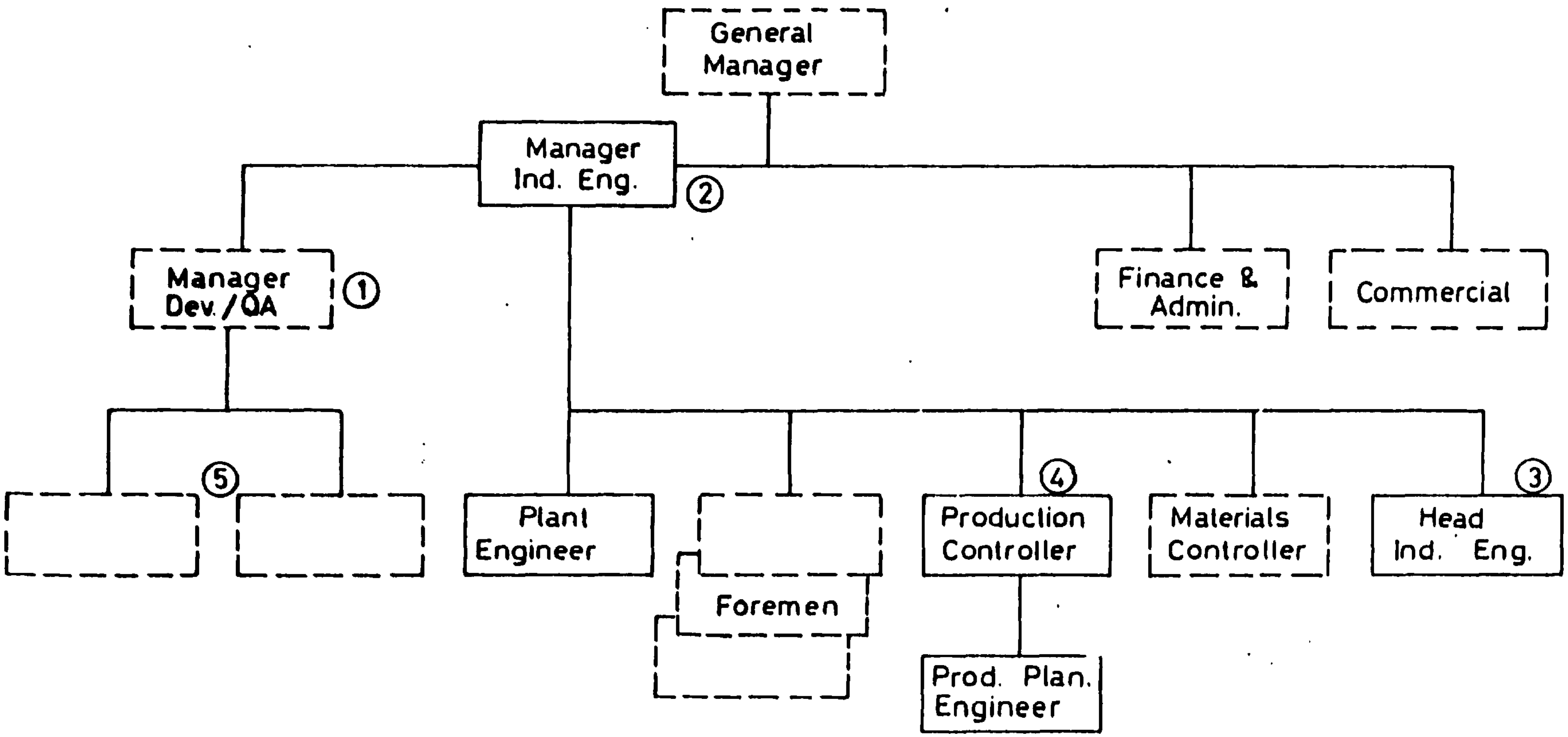
The production manager needs be supported for only 1 year. It will be a matter for the detailed project arrangement whether the posts described above are actually filled, or merely advised, by expatriates. In this report it is assumed that, with one exception discussed below, the expatriates are advisors and that Ethiopians are recruited for these management posts well before production begins.

It will probably not be possible for Ethiopians of suitable calibre to be found for all the electronics management jobs. Some career development must be arranged. Nor is it likely that the General Manager will be able to assume full technical responsibility at the outset. It is suggested therefore that the plant begins with the interim arrangement shown in Figure VII B-2. The notes explain the nature of the interim arrangement.

The Manager Industrial Engineering will in effect control all operations and will support the Ethiopian General Manager. This arrangement would probably be needed for 1-2 years. The expatriate concerned would be a very senior and experienced man who would leave within this time. In any Joint Venture discussion every effort should be made to secure agreement to the provision of such a man. When he leaves,the post would revert to the scope usual for an industrial engineering manager. The formal reporting lines of the production and technical functions would also then revert directly to the General Manager. The Head of Industrial Engineering, an Ethiopian, would then occupy the post, having had 1-2 years of in-job experience.

While the senior expatriate is running the plant there might be no production manager as such. The Production Controller, an Ethiopian, would meanwhile be groomed for the post. He could assume it at any time he becomes competent to do so.(In practice the production manager could be one of the other section heads or foremen if such a man proved better suited).

As the section heads succeed to the management jobs so engineers beneath them would fill their place.



① Expatriate stays 4 years

② Expatriate stays 1 year

③ Local; succeeds Manager Ind. Eng. but with reduced scope

④ Local; becomes Production Manager

⑤ Locals; one will succeed Manager Dev./QA.

dotted boxes same as permanent structure.

FIGURE VII B-2 INTERIM MANAGEMENT CHART

If it is decided to introduce military radio manufacture soon after the consumer plant starts then the consumer plant might well be regarded as a 'forcing house' for management, supervision and skilled workers for the more difficult military project.

The preoperating costs make provision for a total of 8 man-years of expatriate support (although much of this comes after operation starts). This is considered to be the minimum necessary to assure full realisation of technical and sales plans.

2. Direction and Regulation

More critical than the way in which the consumer product factory is internally organised is the way the the venture is established, encouraged and controlled within the Ethiopian economy as a whole.

The international experience section of this report draws attention to the successful electronics sector development which results from well-ordered national and sectoral planning and control. This helps the electronics companies directly; it helps them indirectly by improving the industrial and commercial climate in which they operate; and it is obviously attractive to potential foreign partners of one sort or another.

There are three essential direction and control features needed for any future electronics Joint Venture or semi-autonomous state company.

1. The venture needs a substantial degree of autonomy. Some industrial ventures are well suited to government control. The consumer product industry is not one of these. It needs to be responsive to the market. Rigid external control over its prices, distribution systems, production volume or product types can do serious damage to its business prospects. Strategy can be formulated centrally but operational policy must be left to the company. This is not a 'western' approach to business; it is a 'commercial' approach.

2. The venture should come under the control of an organization which has or will have responsibility for other ventures of a similar sort. There is very little light and precision, high technology engineering in Ethiopia. Such industries have different problems to most of present industry. There will be benefits from linking such future industries under one controlling body. The existing organizations and institutions do not seem well fitted to the task. A new body is probably needed. The existence of an appropriate controlling body, probably a new corporation, would also help to convince prospective foreign investors or technology suppliers of the determination of Ethiopia to make this and future ventures succeed.

3. There needs to be a high level body able to influence all the parts of Government which can affect the current fortunes and long-term development of an electronics venture (again, the same will be true of related sophisticated industrial activity). Among the matters which will require periodic review are:

- financial conditions and incentives
- taxation
- foreign exchange availability
- protection against imports (and gradual removal of protection)
- import tariffs
- training at all levels
- links to broadcasting authorities
- links to telecommunications
- links to defence electronics
- research and development arrangements
- national standards
- foreign travel
- Ethiopianization of management

Most successful electronics nations have some form of electronics council with wide-ranging representation including high level government representatives. Something of this form should be established in Ethiopia. In view of the present economic crisis and of the small scale of the proposed electronics venture, it would not be appropriate to establish an Electronics Council as such. But there must be a forum for discussion of all key issues in this venture and related engineering activities. The chairman must be of sufficient stature to be able to precipitate action when it is needed. One possibility is an Interministerial Committee, meeting perhaps Quarterly. This could always expand to fuller representation in time. Once again, such coordination, if genuine, would help to impress foreign investors and technology suppliers.

C. RECRUITMENT AND TRAINING

1. Overseas Training

The organisation of management indicates the type and amount of management and supervisory training needed. Figure VII B-3 sets out an appropriate amount of overseas training, also included in the project pre-operating costs.

There are important advantages to be gained from incorporating into the project team some future members of the operating management. Thus the chart shows three members of the local management team having 1 month of overseas training as the project starts. Thereafter they can play a part in the detailed design and progressing of the project. This will include paying special attention to incorporation of maintenance requirements at the project stage and monitoring the performance of local and foreign contractors. The General Manager will be in overall charge of preparing for eventual staffing of the plant. This will include timely recruitment of other training schedules. This early 3 man-months overseas is counted as part of the project management cost.

There follows a total of 3½ man-years of overseas training for eight key staff. The production controller, industrial engineer, production planner and Quality assurance technologist should each spend 3-6 months overseas. They return 3-6 months before start-up, enough time to assist with local training matters and to prepare for production (equipment testing, stock build-up etc).

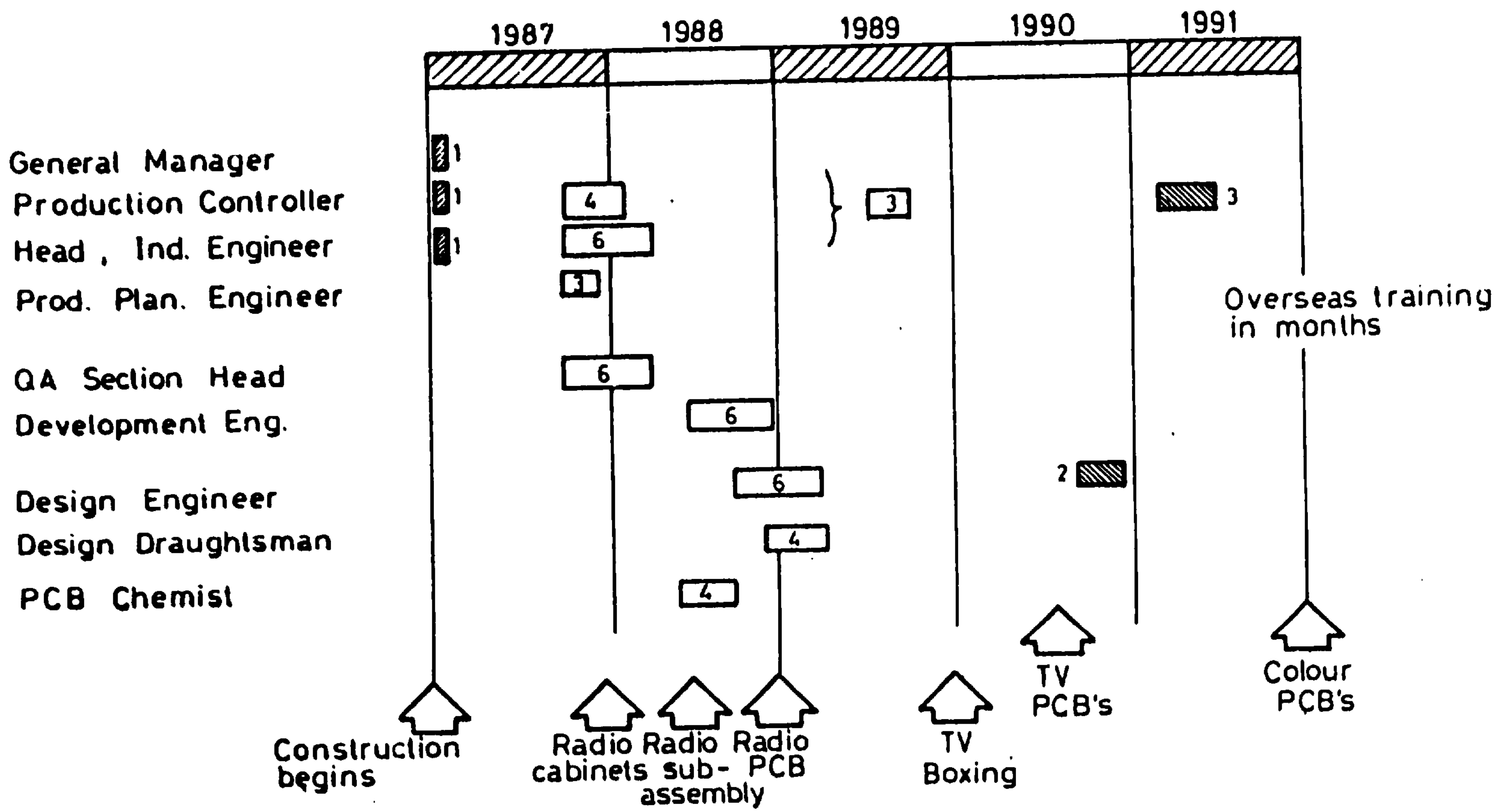


FIGURE VII B-3 OVERSEAS TRAINING

The development engineer, design staff and chemist can be recruited shortly before production starts, and go overseas then. The chemist is not needed until late 1988 when the plant prepares for PCB manufacture. The development and design staff will not be needed until radio manufacture is established and the company begins to consider the wider product possibilities.

2. Academic Training

The qualifications needed by professional and technical staff are shown in Table VII C-1. Out of 188 employees, the consumer product plant will need 12 graduates of whom about 6 would need electronics degrees. A further 10 need about 3 years of technician training, mainly in electronics. The junior technicians will number only about five. The qualified staff make up 14 percent of the workforce.

The qualifications required in the military radio plant make an interesting comparison. Although there would be fewer employees overall, the skill requirement is higher. There are twice as many technical staff. The 42 qualified staff are more than a quarter of the workforce.

3. On-Site Training

There are three main areas of on-site training. These are shown in Table VII C-2. The bulk of the operators go through the second course, assembly and testing. The nature of these courses is basic to electronics assembly but the approach will have much in common with other light industries to be established in future (ie. the emphasis on job instructions, procedures, safety, use of tools, etc).

TABLE VII C-1

MANNING BY ACADEMIC LEVEL

Level	CONSUMER PRODUCTS		MILITARY RADIOS
Degree	Development	2	3
	QA	1	6
	Production	2	1
	Ind. Eng.	2	2
	Gen. Mgr.	1	1
	Mat. Cont.	1	1
	Chemist	1	-
	Commercial	1	1
	Financial	1	1
		12	16
Technician 2-3 yrs.	QA	5	7
	Ind. Eng.	3	4
	Foremen	2	2
		10	13
Technician 1-2 yrs.	All types	5	13
TOTAL		27	42

TABLE VII C-2

ON SITE TRAINING COURSES

Fault Finding and Quality Assurance (4 weeks)

- Basic electronics and tolerancing
- Fault Finding Procedure
- Presentation of information and reporting
- Repair work
- Technical specifications
- Reading drawings
- Parts and component testing
- Appreciation of QA principles
- Elementary workshop practice
- Safety

Assembly and Testing (2 + 2 weeks)

- Use of hand tools
- Soldering
- Handling components and materials
- Wire stripping
- Reading job instructions
- Instrumentation
- Parts recognition (codings etc.)
- Procedures and their purpose
- Housekeeping
- Safety

Printed Circuit Boards (2 + 2 weeks)

- Silk screen practice
- Use of chemicals
- Visual inspection of boards
- Machine shop practice on PCB's
- Safety

First course is 4 weeks. Other are 2 weeks basic for operators, plus further 2 weeks for testers. Screening is made on basis of eyesight, dexterity, reliability, intelligence and potential.

The application of these courses is shown in Figure VII C-1. Unskilled workers are screened in the assembly and the PCB courses. The basic operators and assemblers undergo a 2-week initiation course. Those with more potential progress to the second half of each module and become testers, as well as having assembly skills. It is suggested that if possible all the fault-finding and quality assurance staff should have a technician qualification. This may not however be possible. Furthermore all foremen and fault-finders/QA staff should go through the advanced operator training courses, preferably before completing the fault-finding course.

It would be useful to establish at the new Institute some common-base courses such as programmes for storemen and foremen. The nature of these courses could be appropriate to a wide range of industry but the emphasis would be on scientific and systematic approaches to the type of work concerned. There is a serious need to build a stock of engineering industry skill.

Electronics assembly, especially consumer products is much more about control of shop floor practice than it is about electronic circuitry. This being so the skills needed to make a successful electronic assembly plant are very appropriate to a wide range of other engineering industries, many of which Ethiopia will wish to build in future. The final section of this Chapter deals with maintenance of quality. It is important that those who will be responsible for progressing electronics developments in Ethiopia know the kind of industry they will be dealing with.

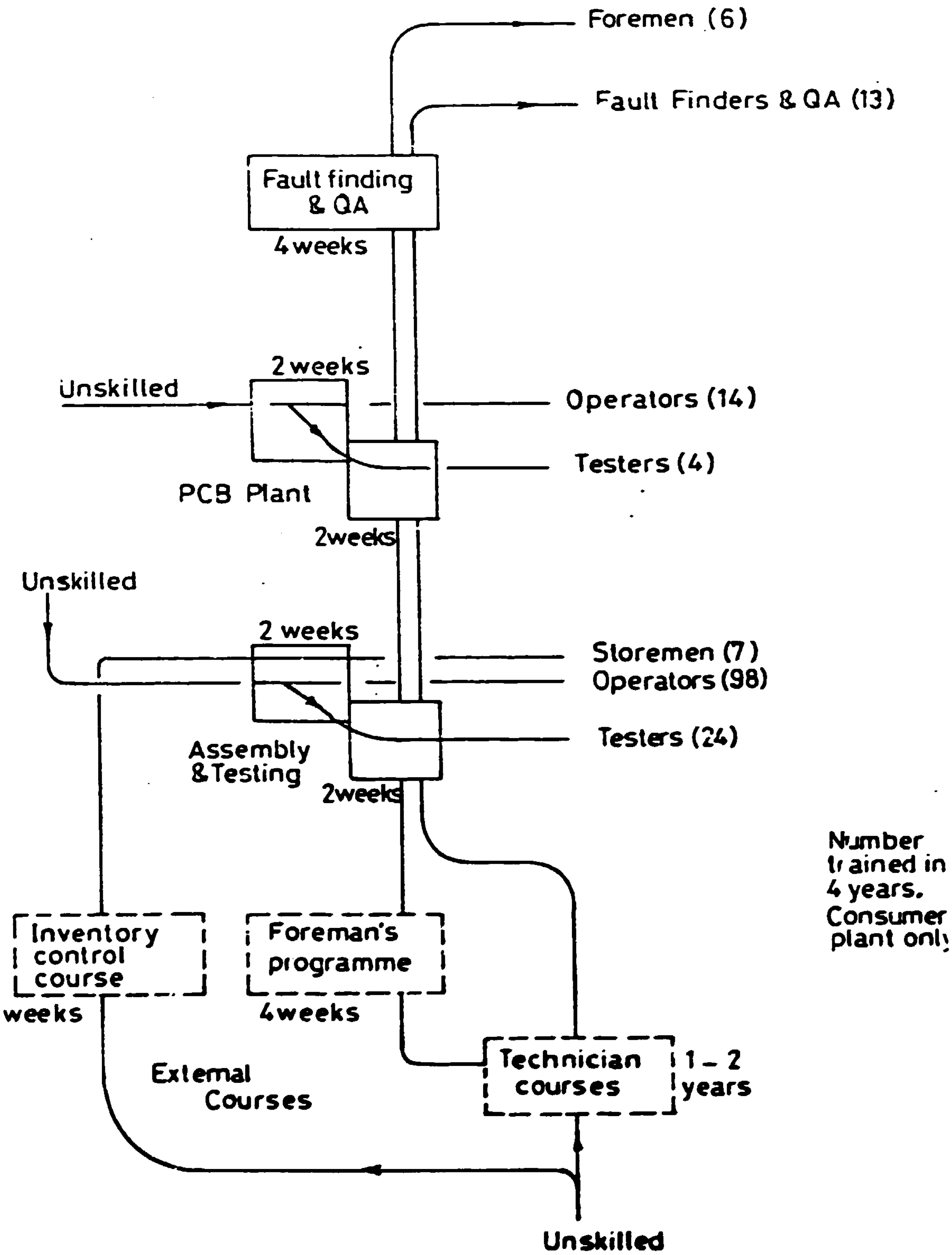


FIGURE VIIC-1 ON SITE TRAINING PROCEDURES

Figure VII C-1 also shows the number of staff who will have to undergo on-site training during the four year build up of consumer product manufacture. It totals 166. The way the numbers are built up is shown in Table VII C-3. This deals only with consumer products. The requirement in a military radio plant might be less but the level of training more advanced.

It is assumed that there will be a substantial failure rate, bearing in mind the absence of a heritage of industrial skill. Also that there may well be some transfers of skilled workers to other, related operations outside the factory. For these reasons a 20 percent per year failure/turnover rate has been assumed.

Substantial numbers of employees require training for a consumer product venture. A high degree of training organization will be needed to make such a scheme work.

TABLE VII C-3

NUMBER (INDICATIVE) FOR ON SITE TRAINING

COURSE	1987	1988	1989	1990
Employees in-post:				
Fault finders & QA	4	6	7	8
Assemblers & testers	50	68	68	74
PCB plant	8	10	10	10
Foremen	2	3	3	3
Storemen	3	4	5	5
	71	91	93	100
Training requirement:				
Fault finders & QA	5	3	2	3
Assemblers & testers	60	28	14	20
PCB plant	10	4	2	2
Foremen	3	2	1	0
Storemen	3	2	2	0
	81	39	21	25

Fault finders and QA (ie. technicians) assumes 25 percent annual turn-over or transfer. Other activities assume 20 percent turn-over, transfer or failure.

Consumer products only

D. QUALITY AND EFFICIENCY IN CONSUMER ELECTRONICS

The keys to success in consumer electronics manufacture are the same as in most light engineering, especially precision engineering. The secret is less in deep and widespread understanding of the technology than in an absolutely rigid control of production engineering procedure. South East Asian labour forces have excelled in this rigid adherence to carefully established procedure. The lessons learned in consumer electronics are highly relevant to most of Ethiopia's future engineering development. Some general and specific comments regarding quality and efficiency are made below.

1. All Products

Control of inventory is critical. Material is 55-85 percent of product cost, therefore wastage through loss, damage and acceptance of poor quality material is critical.

Minimise material on factory floor by working to planned production schedules, issuing material against the minimum practicable lots, if possible daily. Ensure regular reconciliations of issues against use.

Accept material only to specification and conscienciously pursue causes of deviation back to source. Regular checking of measuring equipment is necessary to ensure standards are maintained.

2. Handling of Material in Factory

Avoid component damage during handling, for example during component preforming.

Maintain machines (damage is not always obvious).

Careful handling of solid state devices (some are easily damaged by static electricity). Follow suppliers advice.

Maintain solder bath operating conditions (too little heat can lead to poor joints; excessive heat can damage the PCB).

Faulty assemblies requiring rectification are good stock and should be handled carefully during rework cycle. Plan rectification cycle to be in line with production. Avoid build-ups of rework stock.

Establish salvage system for assemblies damaged beyond repair, to allow good components to be reclaimed.

It is particularly important to ensure items affecting the product appearance are adequately protected, during manufacture and assembly. Avoid scratching or marking and ensure that packaging is adequate for product transit.

Operator awareness of these and other points mentioned later must be ensured during their training and the job instructions should also take account of such points. Each operator should have a clear, concise, printed job instruction card for the particular operation and should be regularly checked for his/her understanding and adherence to the procedure, and that he has had the training required for that operation.

3. Factory Installations

Care must be taken to ensure safety of operators, particularly in the test and adjustment stages of both mono and colour TV. These adjustemnts have to be made on 'live' receivers without backs and on the circuit board itself. The power supplies to each stage should be isolated from one another.

Colour TV receivers are particularly sensitive to local magnetic fields, even changes in the earth's magnetic field produce noticeable effects on the picture. Final adjustment of the picture tube elements should take place within an area where the earth's field is equivalent to that of the geographical area where the receivers will be used.

Before adjustment the receiver should be thoroughly degaussed (demagnetised) and from that point until the end of test magnetic material should not be used on benches, tracks etc.

Stability of the supply voltage during test and measurement of TV is important.

4. Quality Assurance

The function of quality assurance is to ensure that the product made and despatched is to the standard of performance, appearance, and reliability laid down as required by the market. Whilst the achievement of the goal is the responsibility of all, QA must interpret the market requirement into standards and specifications from each process stage, they must monitor the performance at various stages to ensure maintenance of standards; finally they must initiate the corrective or preventative action necessary to maintain standards.

It is essential therefore that there is clear understanding of the material specification required by the design authority, by both the suppliers and the user and that there is no misunderstanding of the quality levels to which the supplier undertakes to deliver. Sampling at goods inwards stores must be adequate to ensure that agreed standards are maintained. Procedures to be adopted in the case of unsatisfactory material must be agreed between supplier and user before decision to purchase. (Ethiopia is a long way from most component suppliers). Factory visits to suppliers will be necessary.

It is very necessary during production to have agreed procedures for handling situations of non-achievement of specification.

Statistical information should be taken at key points on the production chain to determine trends and to allow preventative actions to be taken before corrective ones become necessary. This information should form the basis of a regular (monthly) report to all management and supervision so that there is an all-round awareness and involvement in quality levels and improvement. Local products must be of a quality to justify the exclusion of imports and all product leaving the factory is effectively subject to a final inspection - by the customer.

APPENDIX A

CAPITAL RECOVERY FACTORS

1. The Principle

It is useful during the early stages of project identification and evaluation to be able to combine the capital and operating costs into a comprehensive cost. Such a 'comprehensive cost' can be expressed as an annual cost or a cost per unit of production, and can be compared to the price in order to obtain a rough assessment of performance. It is even more useful if the method of annualising the capital cost can be made sensibly independent of the size of the project.

The annuity method of cashflow analysis permits the real irregular cashflow of the investment which precedes production, to be converted into a notional regular cashflow throughout the production life of the project. In essence this is done by adjusting the level of the regular annual cashflow until it has the same present value as the real irregular cashflow. The transformation of the irregular cashflow into a regular annual sum is achieved by discounting.

The regular annual sum we call the annual capital charge. This can be added to the operating costs in order to produce a comprehensive cost.

The annual capital charge can be based on a capital recovery factor. The comprehensive cost (T) is then calculated as follows:-

$$T = P + rC$$

where P = annual operating cost

C = total capital cost

r = capital recovery factor

The capital recovery factor is based on a given set of assumptions about the project (construction period and phasing of investment, learning period, project life, etc). Provided these assumptions remain constant, the capital recovery factor remains constant, regardless of the actual level of investment. In some cases it is also possible to take into account, in calculating capital recovery factor, financing conditions and taxation.

2. Factors Used in Chapter V

The capital recovery factor of 15 percent used in the project profiles in Chapter V is calculated according to the assumptions given below. The calculation is given in Table A-1. The assumptions are considered appropriate to a small electronics venture in Ethiopia.

- Project life : 15 years of operation
- Construction period : 2 years
- Phasing of investment cashflow:

First year of construction::	33 percent
Second year of construction:	62 "
First year of operation :	5 "
Residual value after 15 years:	zero

- Production growth:

First year	: 33 percent of full output
Second year	: 78 percent of full output
Third year	: 95 percent of full output
Fourth year	: 100 percent of full output

(Note: This implies that at the end of year 1 production is an annual rate of 65 percent; at end of year 2 it is at 90 percent).

- Project rate of return : 10 percent

  (Note: This implies that if the whole of the finance were provided as equity then there would be a real return to equity of 10 percent.

The capital recovery factor for the above case is 15.2 percent. This means that on the basis of the given assumptions, including a 10 percent project rate of return, the comprehensive cost during a full year of production will consist of the annual operating costs plus 15.2 percent of the original investment.

3. Sensitivity of Capital Recovery Factor

The calculation is sensitive to project life and discount factor as follows:-

At discount factor* - 10 percent

Project life in years	Capital recovery factor percent
10	19.3
15	15.2
20	13.7

At project life - 15 years

Discount factor* percent	Capital recovery factor percent
5	10.7
10	15.2
15	20.6

* Note: The discount factor is also the Internal Rate of Return for the project in this case. Thus a 10.7 capital recovery factor and a 15 year project life implies a 5 percent IRR.

4. CRF in the Military Radio Profile

A capital recovery factor of 17 percent was used for fixed investments in military radios in Ethiopia. This was based on a shorter project life (12 years operation); investment phasing - year 1 : 35%; year 2 : 60 percent; year 3 : 5 percent. A residual value after 12 years operation of $\frac{1}{3}$ of the building cost; and finally a slower build up of production from year, as follows: 50%, then 75, 85, 90, 95 and 100%. A 10 percent discount factor was used. The CRF was 16.6 percent, rounded to 17 percent in the profile.

5. Working Capital Charges in the Profiles

The same principle can be applied to the working capital. In this case the working capital is assumed to build up with production, i.e 33 percent in year 1 of operation and 67 percent in year 2. Since this working capital is constantly maintained it must all be credited to the project at the end of the financial life, i.e in year 16 of operation. Using a 10 percent discount factor the working capital charge may be calculated as 9.7 percent, rounded to 10 percent for use in the Ethiopian projects.

TABLE A-1

CAPITAL RECOVERY FACTOR CALCULATION

Year	Investment (units)	Operating surplus	Discount factor 10%	Present Value	
				Investment	Operating surplus
-2	33	-	1.21	39.93	-
-1	62	-	1.10	68.20	-
1	5	0.33x	1.00	5.00	0.33x
2		0.78x	0.91	-	0.71x
3		0.95x	0.83	-	0.79x
4		1.00x	0.75	-	0.95x
5		1.00x	0.68	-	)
6		1.00x	0.62	-	)
7		1.00x	0.56	-	)
8		1.00x	0.51	-	)
9		1.00x	0.47	-	) 4.87x
10		1.00x	0.42	-	)
11		1.00x	0.39	-	)
12		1.00x	0.35	-	)
13		1.00x	0.32	-	)
14		1.00x	0.29	-	)
15		1.00x	0.26	-	)
	100			113.13	7.45x

If x is the operating surplus in a full year of output then for the present value of both investment and operating surplus to be equal :-

$$x = 113.13/7.45 = 15.2 \text{ units}$$

and expressed as a percentage of initial investment (before financing) x = 15.2 percent.

APPENDIX B

MANNING COSTS AND SCHEDULES

The manning schedules for the projects in chapter V are contained in this appendix. The levels of manning have, for simplicity, been grouped into the following six groups.

	Total cost Birr/year
Grade A (General manager, electronics engineer	12,000
Grade B (Engineer, department manager, accountant etc. foreman)	8,000
Grade C (Storeman, inspector)	4,500
Grade D (Machine operator, clerical staff, drivers)	3,500
Grade E (Security staff)	2,000
Grade F (Labourers)	900

These grades include the normal social benefits - working men's compensation 3 percent of payroll; medical expenses, health premium, 50 percent. Some housing. Total social cost 25 percent of wage.

The weighted mean wage cost in the project profiles in then around 4,000 Birr per year. This is high compared to the annual wage costs per employee in the various Corporations which range from 1460 Birr to 3690 Birr, and average 2430 Birr. The higher wage cost industries are characterised by their requirement for craft skill and their use of process/technology based industries. Fringe benefits vary from 10 to 45 percent of basic wages, averaging 26 percent. They tend to be slightly higher in the lower paid corporations. The data for the corperations is summarised in the following Table.

INDUSTRIAL WAGE COSTS IN EHTIOPIA, 1982

Corporation	Basic annual salary '000 Birr	Fringe benefits percent of salary	Total wage cost per employee '000 Birr
Sugar	2.71	36	3.69
Nat. Metal Works	2.94	15	3.39
Nat. Chemical	2.92	13	3.29
Share companies	2.75	17	3.21
Wood works	2.89	11	3.20
Building materials	2.08	45	3.02
Tobacco & matches	2.19	25	2.73
Beverage	2.11	26	2.65
Printing	2.27	10	2.49
Leather & shoe	1.89	21	2.30
Food	1.59	18	1.87
Textile	1.47	28	1.87
Fibre works	1.22	34	1.64
Meat	1.21	21	1.46
All corporations	1.92	26	2.43

Increase of wage cost per employee 1981-1982 was less than 1 percent.

Source: Ministry of Industry, Statistical Bulletin 1984, worked up from Tables 5a and 6.

TABLE B - 1

MANNING OF RADIO ASSEMBLY 200,000/ YEAR

Activity	Skill level	Number of employees	
Direct employees:			
Stores	C	2	
Incoming materials inspection	C	1	
Carriers & cleaners	F	3	
Front panel assembly	D	1	
Transformer & socket fitting	D	1	
Prepare wiring	D	2	
Solder connect PCB	D	2	
Fit PCB in case, fit scale	D	2	
Solder the case connections	D	1	
Test connected PCB	D	4	
Fit back, check labels	D	1	
Test radio	C	1	
Packing	D	1	
Final stores	C	1	
QA lab & troubleshooters	B	2	
Line foremen	B	1	
Prepare cassette & flap	D	1	
Fit cassette & solder	D	2	
Test cassette	D	1	30
Indirect employees :			
General manager	A	1	
Electronics engineer	A	1	
Plant engineer	B	1	
Accountant	B	1	
Administrator	B	1	
Supplier manager	B	1	
Sales manager	B	1	
Accounts staff	D	3	
Administrative staff	D	4	
Supplies staff	D	2	
Site & security	E	6	
Cleaner & messengers	F	4	
Drivers	D	3	
			29
			59

TABLE 5 - 2

MANNING OF RADIO MANUFACTURE

300,000/year

Activity	Skill level	Number of employees
Direct employees - assembly:		
Stores	C	2
Incoming materials inspection	C	1
Carriers & cleaners	F	4
Front panel assembly	D	1
Transformer & socket fitting	D	1
Prepare wiring	D	2
Solder PCB	D	3
Fit PCB in case, fit scale	D	3
Solder case connections	D	2
Test connected PCB	D	5
Fit back, check labels	D	1
Test radio	C	1
Packing	D	1
Final stores	C	1
QA lab & troubleshooters	B	2
Line foreman	B	1
Cassette fitting	D	7
		38
Direct employees - PCB :		
Assembly stores	C	1
Carriers & cleaners	F	3
Chemist & manager	A	1
Board slitting & piercing	D	2
Sild screen machine operator	C	1
Etch, wash & strip	D	1
Roller tinning	D	1
Inspectors	C	2
Track feeders	F	2
Component preparation	D	3
Insertion	D	11
Wave solder machine	D	1
Visual inspect/touch up	C	2
Manual soldering	C	2
Testing & alignment	C	9
Troubleshooters/repair	B	3
Line foreman	B	1
		46
Direct employees - transformer :		
Bobbin winder/tester	D	2
lamination	D	3
Assembly	D	2
Testing	C	2
		9

Continued overleaf

Radio assembly - continued

Activity	Skill level	Number of employees	
Indirect employees :			
General manager	A	1	
Electronics engineer	A	1	
Plant engineers	B	2	
Accountant	B	1	
Admin/personnel supervisors	B	2	
Supplies manager	B	1	
Sales manager	B	1	
Accounts staff	D	5	
Admin/personnel staff	D	11	
Supplies staff	D	3	
Site & security	E	11	
Cleaners & messengers	F	8	
Drivers	D	7	
			54
GRAND TOTAL			147

TABLE 3 - 3

MANNING OF TV ASSEMBLY 15,000/YEAR

Activity	Skill level	Number of employees	
Direct employees:			
Stores	C	1	
Inspection/quality assurance	C	1	
Assemble & solder	D	2	
Inspect/signal adjustment	C	1	
Focussing	C	1	
Line QC	C	1	
Fit back	D	1	
Safety check	D	1	
Clean & package	D	2	
Foreman	B	1	
Carriers & cleaners	F	2	
			14
Indirect employees:			
Manager (inc). sales)	A	1	
Electronics engineer	A	1	
Plant engineer	B	1	
Supplies manager	B	1	
Bookkeeper	C	1	
Administrator	B	1	
Clerical staff	D	5	
Site & security	E	3	
Cleaners & messenger	F	2	
Drivers	D	2	
			18
			32

TABLE B - 4

MANNING OF TV MANUFACTURE 20,000/Year

Activity	Skill level	Number of employees	
Allocation of employees for PCB/ winding*	Av D		10
Direct employees (manufacture):			
Quality assurance	B	3	
Component preforming	D	5	
Board assembly (simi-automatic)	D	12	
Solder baths	D	2	
Board cutting & touch up	D	3	
Automatic inspection	C	2	
Foreman	B	1	
			28
Hand assembly & solder	C	2	
Inspection	C	1	
Align RF/IF	C	1	
Picture check	C	1	
Packing	E	1	
Rectification	C	2	
Carriers & cleaners	F	3	
			11
			49
Extra chemical lab staff			3
Assembly (see profile)			14
			66
Indirect employees :			
Manager	A	1	
Electronics engineers	A	2	
Plant engineers	B	2	
Supplies manager	B	1	
Sales manager	B	1	
Accountant	B	1	
Administration manager	B	1	
Clerical staff	D	10	
Site & security	E	7	
Cleaners & messenger	F	5	
Drivers	D	4	
			35
			101

* The radio manufacturing profile has approx. 10 directs & 6 indirects on PCB making. 2/3 of these are considered necessary for making TV boards.

PCB manufacture in 2 stages:

- Automatic section at 800/day (up to $\frac{1}{4}$m/yr) but operating 2 days per month
- Manual finishing & alignment/checking, operation ful time 1 shift.

TABLE B - 5

MANNING OF COLOUR TV MANUFACTURE

AT 5000 PER YEAR

Direct employment	Skill level	Number of employees	
One day per month (insertion):			
Stores		1	
Component preparation		5	
Machine aided insertion		4	
Hand assembly on board		9	
Inspection		3	
Solder bath		2	
Cut and touch-up		4	
Automatic testing		1	
Hand assembly & soldering		5	
Alignment & testing		1	
Rectification		2	
Carriers & cleaners		3	
Foreman		1	
QA/troubleshooters		2	
			40
3 days per month (PCB shop):			46
Full time (assembly):			
Stores	C	1	
Carriers & cleaners	F	2	
Cabinet prep. & tube fitting	D	2	
Chassis fitting	D	1	
Tube parameter adjustment	C	1	
Check & QA	C	1	
Rectification	C	1	
Packing (&other tasks)	D	1	
Foreman	B	1	
			11

Number of directs allocated to manufacture of 5,000 sets/year is:

11 ± (o.13 x 46) ± (0.05 x 40) =	19
Indirects allocated	11
Total full time equivalent	30

TABLE B - 6

MANNING REQUIREMENTS FOR CABINETS

Activity	Grade	No.of employees
Radio cabinets (2 shifts)		
Stores	C	1
Moulding machines 2x3	C	6
Finishing	D	1
Carriers & cleaners	F	3
Chargehands	B	2
Total	B	13
Additional indirects	B	4
Total		17
TV cabinets (1 shift)		
Stores & despatch	C	2
Machine shop	C	5
Carriers & Cleaners	F	2
Assembly shop	D	2
Finishing shop	D	2
Total direct employees		13
Additional indirects	2B, 2D	4
Total		17

TABLE 3 - 7

MANPOWER FOR SPEAKER MANUFACTURE

AT 320,000/YEAR

Activity	Skill level	Number of employees
Direct employees:		
Sheet metal work:		
Shearing, punching, pressing		4
Linishing		1
Plating		2
Assembly:		
Assemblers & machine operators		7
Carriers & cleaners		2
Checking & testing:		
Assembly check		2
Magnetising		1
Electrical test		2
Carriers & cleaner		2
Packing & stores:		
Packing		1
Stores		2
Supervision:		
Foreman & QA technician		2
		28
Indirect employees:*		
Superintendent		1
Administration		1
Clerical staff		2
Site & security		2
Cleaners & messengers		1
Drivers		1
		8
		35

* Indirect employees are at alow level since it is assumed that the activity would be added to an existing radio plant.

APPENDIX C

Technical specification of radios and televisions

Radio specification

The information in the Ministry of Industry report on radio production (1980) indicates that the national transmissions can be satisfactory received on radios having bands with internationally agreed coverage of:-

520-1610 KHz (MW)
and 3.2-12.2 MHz (SW)

Components are produced worldwide for these bands. It is strongly recommended that this specification is adopted for the products under consideration.

For the same reason, and also to take maximum advantage of experience available in other countries, the performance standards of signal processing areas, and in consequence their design format, should follow current international practice.

The primary source of power for radios should be dry batteries, incorporated within the radio housing, to allow portability and use in rural areas. For little extra cost, however, the additional feature of mains operation can be added.

The design should allow for the use of batteries, widely available throughout the country.

The appearance and construction of the receiver housing is important for the following reasons :-

- ruggedness to permit handling and use in adverse environmental conditions
- market need for variety of appearances and for price classification.

- rationalisation of design of major sub-assemblies is required to minimise the effect of variety on productivity and set-up costs.

Plastic mouldings are likely to form the greater part of the enclosure and presentation but a combination with local materials wood for example, could give more opportunities for variety.

A suggested general technical specification is as follows:-

Wave bands: As above

Circuit: Internal ferrite rod aerial for MW with
telescopic SW aerial (where SW fitted)
5 stages of selectivity
7 transistor functions incorporated

Push pull audio output

Sensitivity: Typically MW 350 mV/m at 20 dB s/N
typically SW 150 mV/m at 20 dB S/N

Output power: 200 mW at 10 percent THD

Loudspeaker: 4 inch round

Power supply: mains 240V AC 50 Hz
batteries 6V 4 x 1.5V

Receiver size, knob arrangement and number of controls will be dependent of local market requirements, but are unlikely to be significantly different from similar specification models marketed elsewhere.

Monochrome television specification

20" table model	. 19V picture tube 110 degrees deflection angle.
Power requirements	. 220-240V 50 HZ 50W (typically)
Presentation	. Wooden cabinet made and finished with mainly local materials.
	Customer controls for TV
	Channel selection picture brightness, picture contrast and sound volume.
	Aerial input socket of coaxial type to accept 75 ohm antenna with unbalanced lead.
Circuitry	. Solid state active devices, stabised power supply with VHF tuner covering Bands I and III. Preset adjustment by dealer to allow customer instant selection of station.
	Receiver circuitry designed to requirements of national transmission standard 625 lines, 50 HZ
	Sound output - approximately 2 watts at 10 percent THD.
Loudspeaker	. 8 ohm 5" circular (or 6" x 4" elliptical).
	approx.dimensional of cabinet width 24" Height 16" Depth 15"

Colour television specification

20"table model	. 19V picture tube (colour) 90 degree deflection angle PIL construction
Power requirements	. 220-240V 50 Hz. 75 watts typical.
Presentation	. Cabinet as for monochrome. Customer controls for TV. Channel selection, picture brightness, picture controls, picture colour and sound volume. Aerial input socket of coaxial type to match 75 ohm antenna with unbalanced feeder.
Circuitry	. Solid state active devices, stabilised power supply, VHF tuner covering. Bands I and III, preset by dealer to allow customer instant selection of station Circuitry design to requirements of the national transmission standard 625 lines 50 Hz. Pal System G(?)
Sound output	. Approx. 2 watts @ 10 percent THD
Loudspeaker	. 8 ohm 5" round or 6" x 4" elliphical approximate dimensions Width 24" Height 16" Depth 20"

APPENDIX D

BUILDING COSTS

In all the Ethiopian building cost estimates for radio and TV manufacture a unit cost of 960 Birr/square metre has been used.

The buildings will be mainly of 15m bay width, with eaves 4.5 metres high, suspended ceilings in some areas but no air conditioning. Structure will be of locally made painted steel frame with reinforced concrete ground floor construction, blockwork walls and uninsulated metal sheet roof. Internal services will be to normal European standards.

The plant should be on a site which allows a plot radio of at least 1:3, building to total plot size. It should allow for expansion. The buildings cost includes all associated site works such as surfacing, fencing, lighting, garage facilities for works vehicles etc. The main cost assumptions are:

Foundation works	1450	Birr/sq.metre
Steel work	90	Birr/sq.metre
Roofing	1500	Birr/sq.metre
External walls	1200	Birr/sq.metre

A contingency of 10 percent is added to all costings.

The distribution of cost is then as follows:

	percent
Concrete works	12
Frame & cladding	14
Walls, windows, etc...	20
Finishing	15
Mechanical & elec. serv.	20
Outside works	19
	100