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(ETHIOPIAN CENTRE FOR TECHNOLOGY)

BACKWARD LINKAGES IN THE ETHIOPIAN AUTOMOTIVE INDUSTRY

FINAL REPORT -
Project opportunity profiles

[illegible] International

May 1987

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May 1987

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Date 14th May 1987

United Nations Industrial Development
Organisation (UNIDO)
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Dear Sir

Backward Linkages in the Ethiopian Automotive Industry
Project No. DU/ETH/84/001

We have pleasure in submitting our Final Report on backward linkages in the Ethiopian automotive industry.

The objective of the study was to identify automotive components which could be manufactured in Ethiopia, and to prepare project opportunity profiles for each of them. The 10 viable projects which have been identified are summarised in the first section of the report "Summary of Project Opportunity Profiles".

The assignment was greatly facilitated by the co-operation and assistance of staff at Development Projects Study Agency, for which we would like to express our thanks.

Yours faithfully
for and on behalf of
WS Atkins International

D B Butcher
Director

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INTRODUCTION

This is the Final Report on the Study of Backward Linkages in the Ethiopian Automotive Industry.

The Interim Progress Report (February 1986) identified ten automotive components as suitble for immediate manufacture in Ethiopia.

They are:

* exhaust systems
* rubber extrusions
* rubber mouldings
* engine and power train re-make
* wiring harnesses
* radiators
* friction materials
* automotive body pressings
* shock absorbers
* windows and windshields.

This Final Report contains Project Opportunity Profiles on each of these ten automotive components. In addition it contains two project opportunity profiles (automotive foundry and forge) not recommended by the Consultants but commissioned by UNIDO as an addendum.

The project profiles are preceeded by a Summary of the main characteristics of all twelve projects. Assumptions used in the project opportunity profiles are set out in an Appendix A.

SUMMARY OF PROJECT OPPORTUNITY PROFILES

The main characteristics of the twelve projects are summarised in the following table. The most significant conclusions are as follows:

* projects 1-10 all appear to be viable investment opportunities, which will contribute to the building backward of linkages in the Ethiopian automotive industry

* projects 11 and 12 (automotive foundry and forge) are not viable on the basis of forecast 1990 vehicle production of 2,000 trucks and buses and 2,900 tractors. They should be postponed until vehicle output has reached at least double this level, with manufacture (not just assembly) of engines and gearboxes carried out in Ethiopia

* projects which depend principally on the after market are more secure than those which rely substantially on original equipment demand from the vehicle assemblers. There are six such projects, namely

  - Project 1 - exhaust systems
  - Project 2 - rubber extrusions
  - Project 3 - rubber mouldings
  - Project 4 - engine and power train re-make
  - Project 7 - friction materials
  - Project 9 - shock absorbers

* priority should be given to carrying out full feasibility studies on these projects with a view to immediate implementation

SUMMARY OF PROJECT OPPORTUNITY PROFILES

	1 Exhaust Systems	2 Rubber extrusions	3 Rubber mouldings	4 Engine & power train remake	5 Vehicle wiring harnesses	6 Radiators	7 Friction materials	8 Body press shop	9 Shock absorbers	10 Windows and windshields	11 Automotive Foundry	12 Automotive Forge
Planned 1990 output	12,200	62.4t	42.5t	8,200	6,000	7,400	140.0t	52,000	89,600	23,500	5,964t	2,164t
Planned 1990 capacity	30,000	165.0t	330.0t	-	8,600	9,600	220.0t	100,000	200,000	74,000	7,500t	4,000t
Technology licence	No	No	No	No	No	Yes	Yes	No	Yes	No	No	No
Project Schedule (months)	12-18	18-24	18-24	12-18	12-18	6-9	24	12-18	24	12-18	24	24
Manpower	40	38	70	232	49	25	82	38	84	18	278	233
Building area m^2	1,160	1,625	1,500	4,608	440	280	1,800	2,000	1,200	2,576	15,200	12,500
Investment - Total B'000	3,530	3,544	3,908	10,923	703	1,525	6,595	8,144	6,491	5,220	104,500	73,291
- Foreign B'000	1,277	1,058	827	3,112	20	397	2,368	3,749	2,684	1,677	58,094	41,121
- Local B'000	2,253	2,486	3,081	7,811	683	1,128	4,227	4,395	3,807	3,543	46,406	32,270
Capital structure												
supplier credits %	25	25	15	20	-	20	25	30	30	35	35	29
bank loans %	35	35	45	40	60	40	35	30	30	25	25	31
equity %	40	40	45	40	40	40	40	40	40	40	40	40
Production Costs B'000	1,000	1,162	1,196	6,313	470	1,785	2,463	2,730	3,104	979	32,921	22,517
- labour B'000	124	115	194	816	175	90	275	132	310	54	1,050	866
- materials B'000	279	512	464	3,780	183	1,470	1,085	1,167	1,650	130	11,601	7,139
- overheads B'000	105	88	88	359	36	43	212	256	234	114	3,514	2,406
- depreciation B'000	291	245	227	735	36	95	515	711	540	384	10,800	6,602
- interest B'000	201	202	223	623	40	87	376	464	370	297	5,956	5,504
Net sales revenue	2,376	2,433	2,845	9,452	823	2,629	5,836	5,337	6,135	2,227	31,270	16,220
Operating profit B'000	1,577	1,473	1,872	3,762	393	931	3,749	3,071	3,401	1,545	4,310	(-790)
Gross profit B'000	1,366	1,271	1,649	3,139	353	844	3,373	2,607	3,031	1,248	(-1290)	(-6290)
Net profit B'000	688	635	824	1,569	176	422	1,686	1,303	1,515	624	(-1290)	(-6250)
Rate of return %	25.2	23.6	26.8	20.1	30.7	33.4	31.3	21.7	29.0	17.5	4.5	nil
Repayment period years	3.0	3.2	3.1	3.7	2.8	2.5	2.6	3.3	2.7	4.0	6.7	12.6
Cost per job B	88,250	93,263	65,133	47,080	14,347	61,000	80,426	214,351	77,274	292,666	375,900	314,978
FX per job B	31,925	27,800	13,783	13,413	408	15,880	59,915	98,657	31,592	93,166	208,956	176,487
Total FX saving per annum B'000	1,117	885	756	3,073	429	1,371	2,091	4,027	1,568	477	(-120)	(-7300)

* the remaining four projects depend to varying degrees on the expansion and deletion plans of the vehicle assemblers

* two of the projects - Project 5 : Wiring Harnesses and Project 6 : Radiators are small projects with low plant costs, which can be operated profitability on a wide range of outputs. They hardly justify a full feasibility study. They should be implemented in the near future if suitable project sponsors can be found amongst existing metal fabrications in Ethiopia

* the two remaining projects - No. 8 Body Press Shop and No. 10 Windows and Windshields, are larger and more capital intensive. Implementation of these projects should be timed to coincide with the realisation of forecast 1990 output by the vehicle assemblers.

1. EXHAUST SYSTEMS

1.1 The Product

Exhaust systems for vehicles are essentially made up of three components:

* the front pipe from the engine to the silencer

* the silencer (muffler) unit

* the tail pipe leading from the silencer.

There are also several fixing brackets which attach the exhaust system to the vehicle.

The three components of the exhaust system can be replaced separately, but the modern tendency is to replace the entire exhaust system as a single operation.

1.2 Market Demand, Capacity and Output

Exhaust systems are required both as original equipment (OE) for installation on vehicles assembled in Ethiopia, and as spare parts for the after-market (AM).

There is normally one exhaust system per vehicle. OE demand is therefore equal to the number of vehicles assembled (See Table 1.1).

AM demand depends upon the size of the vehicle fleet and the replacement rate per vehicle. Replacement rates are very variable, depending upon driving practices, vehicle maintenance, road conditions and climatic factors. The major cause of wear is internal corrosion resulting from acid bearing moisture produced by the combustion process in the engine. Some of this condenses in the exhaust system, particularly under cold conditions on start-up or when a vehicle fords a river, and attacks the steel. But external damage can also be caused by uneven and poorly surfaced roads. Garages report that it is quite common for exhausts to require attention after one year, but they will often be repaired rather than replaced. Five years can be taken as an average life for an exhaust system for all types of vehicles.

The estimated OE and AM demand is shown in Table 1.1. Planned output is based on the assumption that the project would be able to offer a product range covering 100% of OE demand and 50% of AM demand in Ethiopia. This gives a planned output of 11,500 units in 1990. Plant capacity at 30,000 units per year is determined essentially by the minimum scale of output.

TABLE 1.1 - MARKET DEMAND, PLANNED CAPACITY AND OUTPUT
('000 units)

	1990		1995		2000	
	Low	High	Low	High	Low	High
Vehicles assembled[x]	4.9	4.9	7.6	8.3	9.3	10.7
OE demand for exhausts	4.9	4.9	7.6	8.3	9.3	10.7
Vehicle fleet	73.9	73.9	96.0	96.0	111.8	111.8
AM demand for exhausts	14.7	14.7	19.2	19.2	22.4	22.4
OE + AM demand	19.6	19.6	26.8	27.5	31.7	33.1
Planned output	12.2	12.2	17.2	17.9	20.5	21.9
Planned capacity	30.0	30.0	30.0	30.0	30.0	30.0

x excluding trailers

1.3 Raw Materials

The raw materials for exhaust systems are steel sheet and tube, welding rods, electric power and aluminium paint. Steel sheets are normally medium drawing grade of 1-2mm thickness, and are used for the silencer. Steel tube is thin walled 30-50mm diameter and 1-2mm wall thickness, used for the front end and tail pipes of the system.

Steel sheets will have to be imported. Thin wall tubes formed from imported steel strip could probably be supplied by Kaliti Steel Industries in Addis Ababa.

1.4 Location

Exhaust systems are not easily or economically transported. They are long and light, in awkward shapes, and are easily distorted if not properly supported. The manufacturing project should therefore be located in the Addis Ababa region, near to the vehicle assembly operations, and to the major centre of vehicle population.

A suitable project sponsor would be a company familiar with metal forming and fabrication, and with the requirements of the automotive industry, such as a unit within State Metalworks Corporation.

1.5 Project Technology

The front and end pipes of exhaust systems are made by cutting steel tube to correct lengths on pipe cutters or mechanical hacksaws, and then shaping them on pipe bending machines. The ends of the tubes may then be swaged to achieve a fit to the adjacent part of the system.

The silencer is made from formed sheet. The sheet may first require flattening, after which it is sheared to a size appropriate to each model of exhaust system. The body of the silencer is roll formed into a cylinder, on which the seam is edge pressed and seam welded.

The ends of the silencer are stamped on a blanking press, and welded on to the cylindrical body of the silencer. Internal baffles in the silencer, if required, can also be made on the blanking press. Attachment brackets are similarly stamped, bent and welded to the exhaust system at suitable points. Finally, the three parts of the system are assembled, painted with aluminium paint and labelled.

1.6 Availability of Technology

Plant and equipment to manufacture exhaust systems can readily be obtained from many sources. There is no need to enter into any transfer of technology agreement. Acceptable designs can be developed in-house by copying existing products, and in co-operation with the vehicle assemblers.

1.7 Project Engineering

A generalised layout for a plant to produce 30,000 units per annum on one shift is proposed in Figure 1.1. The project requires 1100m^2 of light industrial building, and some 60m^2 office space.

The work flow is from raw material storage at one end of the building to finished goods at the other end. There are two parallel production streams, for silencers using flat sheets, and for front end and tail pipes, using steel tube. The two streams come together in the assembly, painting and inspection area.

1.8 Project Scheduling

The implementation period is 12-18 months, if a light industrial building has to be constructed on a greenfield site. If an existing building is used the implementation period could be reduced to 6-9 months, for specifying, purchase and installation of machines and recruitment and training of staff.

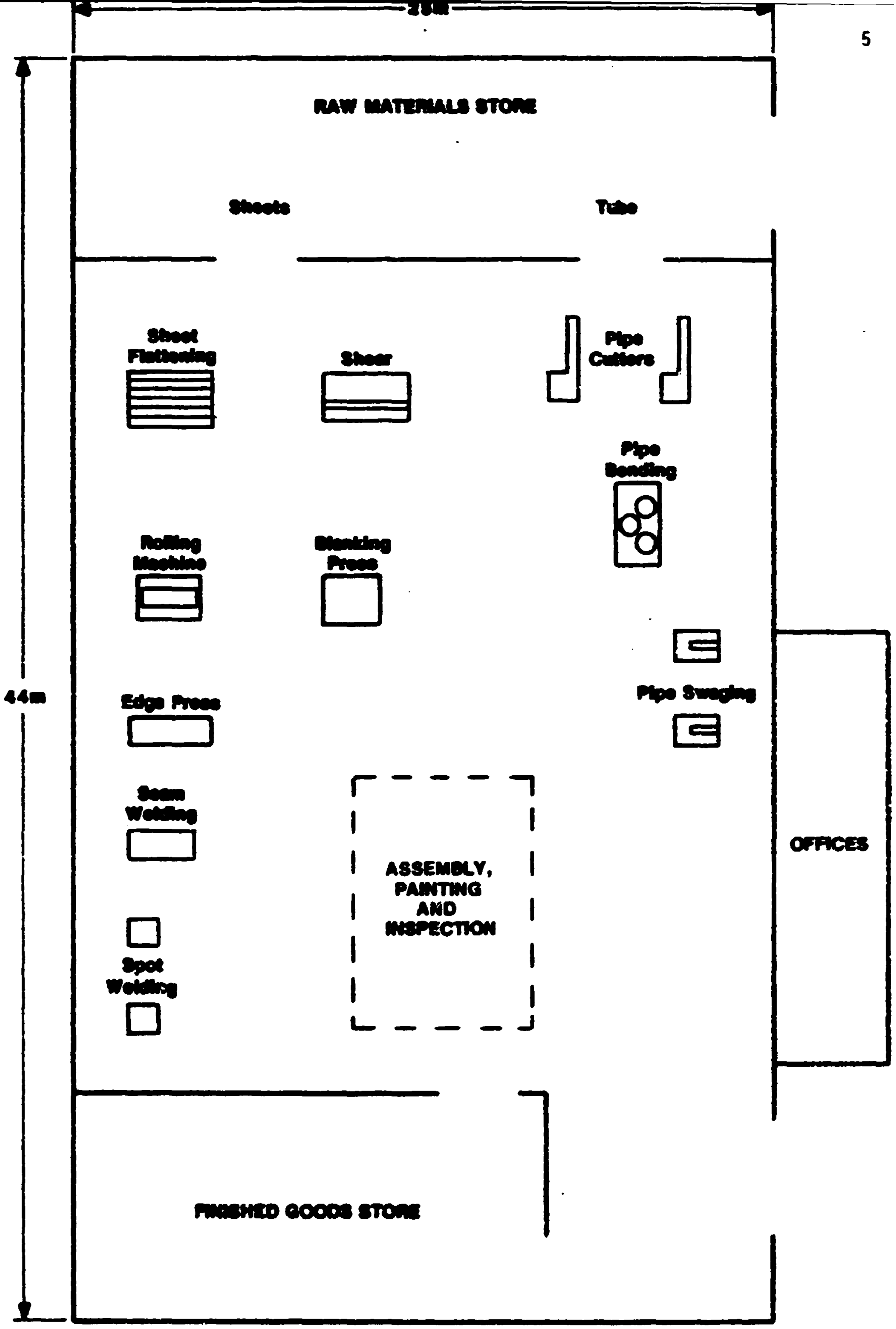

FIGURE 1.1 LAYOUT FOR MANUFACTURE OF EXHAUST SYSTEMS

1.9 Manpower, Organisation and Training

The following manpower is required to achieve planned 1990 output of 19,100 exhaust systems per year on single shift operation.

unskilled	14
semi-skilled	13
chargehands	2
drivers	3
security	4
administration	3
manager	1
Total	40

An organisation chart from the project is presented in Figure 1.2.

The required knowledge of metal forming and welding already exists in Ethiopia. It should therefore be possible to recruit qualified staff and key employees in Ethiopia, and to train additional employees within a period of several months in the plant.

1.10 Investment

The following is the required investment for the planned capacity of 30,000 units per year on single shifts:-

	Foreign	Local (Birr '000)	Total
Buildings	-	1,044	1,044
Services	42	10	52
Vehicles	-	140	140
Racks, tables, etc.	-	15	15
Plant and equipment	1,235	370	1,605
Initial tooling	-	80	80
Total investment	1,277	1,659	2,936
Working capital	-	594	594
Total cost	1,277	2,253	3,530

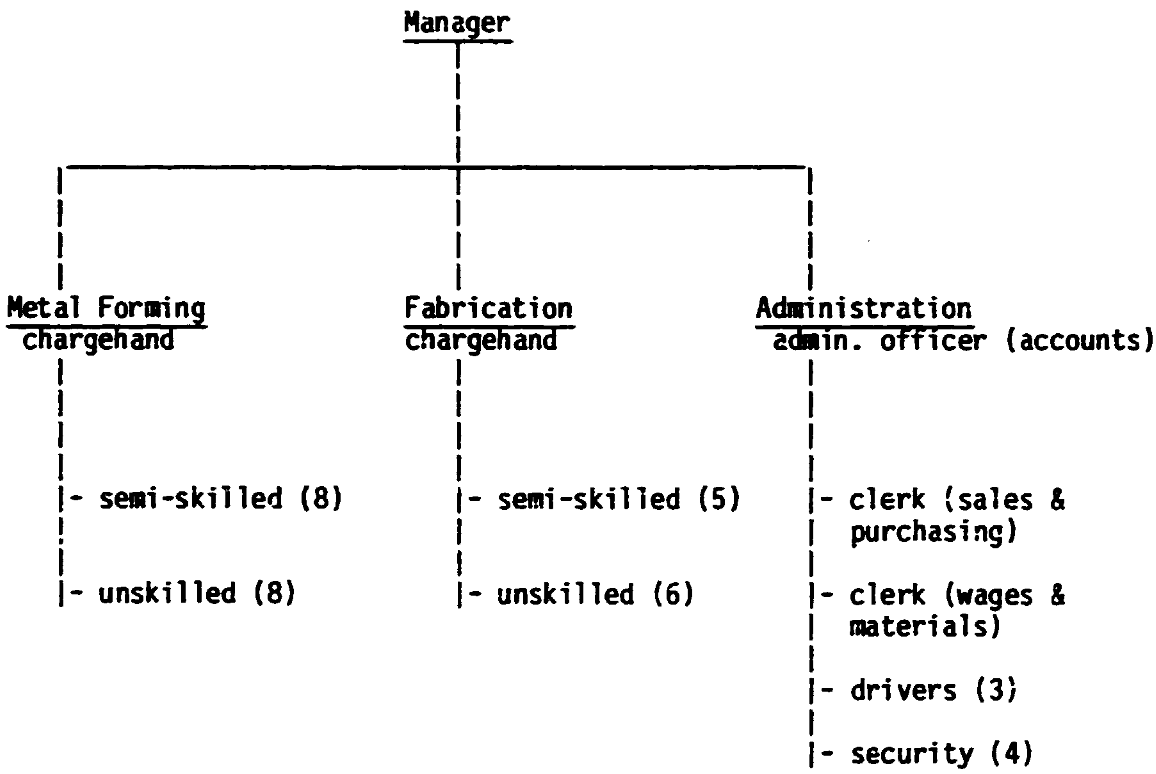

FIGURE 1.2 - ORGANISATION OF EXHAUST SYSTEM PROJECT

A appropriate financing arrangement would be:

supplier credits	25%
bank loans	35%
equity	40%
	100%

1.11 Production Costs

Estimated production costs in 1990 for an output of 12,200 units per year on one shift are as follows:

	Birr '000
Labour	124
Materials	279
Overhead expenses	105
Depreciation	291
Interest	201
Total production costs	1,000

1.12 Sales Revenue

The net sales revenue in 1990 is forecast at Birr 2.376m as follows:

Sector	Output ('000 units)	Unit ex-works price (Birr)	Sales revenue ('000 Birr)
O.E.			
Trucks and buses	2.0	188	376
Tractors	2.9	63	183
A.M.			
Trucks and buses	2.1	650	1365
Tractors	1.0	170	170
Cars and pick-ups	4.2	233	489
Total	12.2		2583
less 8% transaction tax			207
Net sales revenue			2376

1.13 Commercial Profitability

	Birr '000	Birr '000
Net sales revenue	-	2,376
Operating costs	508	
Depreciation	291	
Operating profit		1,577
Interest	201	
Gross profit before tax		1,376
Corporation tax	688	
Net profit		688

$$\text{Rate of return} = \frac{\text{net profit + interest}}{\text{total cost of project}} \times 100$$

$$= \frac{688 + 201}{3530} \times 100 = 25.2\ \%$$

$$\text{Repayment period} = \frac{\text{total cost of project}}{\text{net profit + interest + depreciation}}$$

$$= \frac{3530}{688 + 201 + 291} = 3.0 \text{ years}$$

1.14 National Economic Benefit

$$\text{Total cost per job created} = \frac{3,530,000}{40} = 88,250 \text{ Birr}$$

$$\text{Foreign exchange cost per job created} = \frac{1,277,000}{40} = 31,925 \text{ Birr}$$

Annual foreign exchange savings =

	Birr '000	Birr '000
import substitution	-	1,513
depreciation of plant	154	
interest on plant	117	
imports of materials	125	
Total FX saving		1,117

2. RUBBER EXTRUSIONS

2.1 The Product

The main rubber extrusions on a vehicle are hoses and weatherstrips.

Hoses may be classified by shape and dimension, and by type of reinforcement, as follows:

* shape
  - straight
  - shaped
  - complex shapes, such as T's and junctions
  - corrugated flexibles
* reinforcement
  - plain
  - reinforced
  - fabric
  - braided (wire/yarn)
  - knitted
  - reinforced with wire spiral

Automotive radiator hoses are usually shaped and sometimes have junctions. They may be plain or reinforced. Corrugated flexible hoses can be used as replacement parts; because of its flexibility the same hose can be fitted to a wide variety of vehicles, but it would not be as durable as the shaped hose specified as original equipment. Spiral wire reinforcement is not used for radiator hoses; it is required to prevent collapse of hose for suction applications.

There are a number of other hoses in use on vehicles. There may be small diameter hoses connecting the radiator to an overflow reservoir. If the vehicle is heated there will be similar water hoses connecting the engine and heater unit. There may also be lightweight rubber corrugated hoses conveying air at certain points, although in general these are made of aluminium foil and kraft paper. There are high pressure hydraulic hoses for brakes and other services. Most of these applications require a hose of different specification and manufacturing technology. There may be opportunities for sales of these types, but this project is aimed at the radiator hose market. It excludes high pressure hydraulic hose, such as brake hose, where there is a risk to health and safety and corresponding product liability and quality requirements.

Weatherstrip is the extruded rubber beading which surrounds doors and windows on vehicles. It is not reinforced.

2.2 Market Demand, Plant Capacity and Output

Original equipment demand for rubber extrusions is related to the number of vehicles assembled in Ethiopia, and their make-up in terms of trucks, buses and tractors. There is also a large spare parts after-market for radiator hose, but very little for weathership.

Table 2.1 sets out the estimated rubber extrusion market demand, planned capacity and output. Original equipment demand for hoses is based on two hoses per vehicle assembled. The after market for hoses assumes replacement every two years. Cars have been included in the after market because tooling costs for hoses are low, and it will pay to supply hoses for most common car models, even though there is no car assembly, and therefore no car hose original equipment market.

Weathership OE demand is calculated on various lengths for trucks and buses. In future the tractors assembled in Ethiopia will not have cabs, and therefore will not require weathership. The weathership after market is negligible.

TABLE 2.1 - MARKET DEMAND, PLANNED CAPACITY AND OUTPUT

	1990		1995		2000	
	Low	High	Low	High	Low	High
Vehicles assembled* ('000)	4.9	4.9	7.6	8.3	9.3	10.7
OE demand for hoses ('000)	9.8	9.8	15.2	16.6	18.6	21.4
(tonnes)	3.3	3.3	5.1	5.5	6.2	7.1
OE demand for weathership (tonnes)	6.0	6.0	9.3	10.2	11.4	13.1
Vehicle fleet* ('000)	73.9	73.9	96.0	96.0	111.8	111.8
AM demand for hoses ('000)	73.9	73.9	96.0	96.0	111.8	111.8
(tonnes)	24.6	24.6	32.0	32.0	37.3	37.3
Total demand for extrusions (tonnes)	33.9	33.9	46.4	47.7	54.9	57.5
Planned output of automotive extrusions (tonnes)	31.4	31.4	43.2	44.5	50.9	53.8
Planned out of industrial extrusions (tonnes)	31.0	31.0	43.0	44.0	51.0	54.0
Total planned output (tonnes)	62.4	62.4	86.2	88.5	101.9	107.8
Planned capacity (tonnes)	165.0	165.0	165.0	165.0	165.0	165.0

* excluding trailers

Planned output of rubber extrusions is set at 100% of OE demand and 90% of AM demand. Because tooling costs are low the project should be able to offer hoses and weathership to meet this high proportion of market demand.

There is significant industrial (non-automotive) demand for rubber extrusions. Examples are industrial hoses for water, chemical, food and petroleum plant, and rubber profiles for miscellaneous applications in industry, suchas edges on conveyor belts. Output of industrial extrusions has been estimated at approximately the same as automotive.

Planned capacity is determined by the smallest unit of plant available, rather than by market demand, and is much greater than planned output, even on single shift.

2.3 Raw Materials

The principle raw materials and services required for extrusion manufacture are:

* natural rubber (e.g. raw smoked sheets)
* synthetic rubber polymers
* additives and chemicals for compounding
* polyester yarn for braiding
* cotton duck for reinforcement and for curing cloth
* fuel oil for steam raising
* water
* power.

The constituents of a typical natural rubber mix, suitable for automotive hoses, would be as follows:

	Parts by weight
Natural rubber	100
Carbon black (reinforcement)	40
Zinc Oxide (activator/filler)	5
Processing aid (e.g. Renacit VII)	0.5
Processing aid (e.g. CBS)	0.5
Sulphur (Vulc. agent)	4
Suplhur Acid (activator)	1
Antioxidant (e.g. Nunox BL)	2
Oil Softener (e.g. Dutrex R)	4
	157

2.4 Location

Location of the project is not critical. Rubber extrusions are relatively light, and easily transportable with the minimum of packing. Raw materials are mostly bulk commodities imported without packing or in plastic sacks. After-market demand will exceed OE demand for many years, so that market considerations would if anything suggest a location in the main centre of population.

If the project were located at Addis Tyre there would be some saving of capital costs (about 20% of plant costs) by utilising existing rubber compounding and mixing facilities. There would also be some benefit in having access to knowledge of rubber technology. However, if Addis Tyre acts as project sponsor, the rubber extrusion activities should be organisationally separate from the bulk tyre activities.

2.5 Project Technology

The process of rubber extrusion begins with compounding and mixing of the rubber, as for any other rubber product. Thereafter there are two main methods of forming hose, by extrusion or by building.

In the extrusion method a tube is extruded, cooled and coated with antitack chemicals or talc, and coiled in a suitable way. In the case of non-reinforced hose, this extrusion is then cured on a mandrel, to form the finished hose.

Reinforcement can be done in three ways:

* by wrapping with fabric on a building machine, as below

* by feeding through a circular knitting machine. The hose is inflated with compressed air to keep it rigid, and then coiled again

* by blowing on to a mandrel and passing through a braiding machine.

The inner hose and reinforcement is then passed through a crosshead extruder to apply the outer hose cover.

The uncured hose can then be cut to length and placed on shaped mandrels, with an outer wrapping of curing cloth, and cured in an autoclave or cured as straight lengths; or partially cured and then cut to length, placed on shaped mandrels, and T's and junctions made up with rubber cement if required, then finally cured. (The purpose of curing cloth is to exert pressure on the hose during curing. It is removed after curing).

The extrusion methods can be more or less capital intensive depending upon the volume of production and quality requirement.

In the building method the hose is built up on a mandrel from layers of calendered sheet, reinforcement fabric (impregnated with rubber or spreading or by friction calendering), outer layers of calendered sheet, and finally curing cloth. They may be built individually on shaped mandrels, or in long lengths, then precured, cut and placed on shaped mandrels if needed. Normally they will be built up on long straight mandrels on a 3-roll building machine, which rotates the mandrel as the layers are laid on.

These methods are more intensive, and do not give as good a quality product as extrusion. The outer surface of the hose may be irregular in apperance, and built reinforced hoses tend to be less flexible.

Weathership is made by simple extrusion of a profile through a die, followed by autoclave curing.

2.6 Availability of Technology

The technology for manufacture of rubber extrusions is widely understood and readily available. There is no difficulty in buying suitable plant or expertise.

2.7 Project Engineering

A generalised layout of the rubber extrusion plant is presented in Figure 2.1.

The plant is installed in a light industrial building of 1625m^2 (25m x 65m). The project has capacity to manufacture hose by both extrusion and building methods. The extrusion method is necessary to provide a product of sufficient quality, and it is therefore prudent to provide for manufacture by this method as well, especially for short production runs and non-standard dimensions.

The bias cutter and calendar, together with the three roll machine, provide this reserve capacity to produce hoses by build-up methods, in the event of failure of the extrusion and braiding machines, or for short production runs and non-standard dimensions.

For reinforced hoses the extruded inner on a straight mandrel is fed through the braiding machine, which braids on a yarn reinforcement mesh. The outer rubber is then either wrapped on, on a three roll machine or extruded on using a crosshead on the extruder. Braiding machines are simpler to operate than knitted reinforcement machines.

The overall capacity of the plant is about 165 tonnes per annum on single shift, determined by the mill capacity. The extruder and braider have greater capacity, which is more than sufficient for planned output even though hoses may pass through the extruder twice.

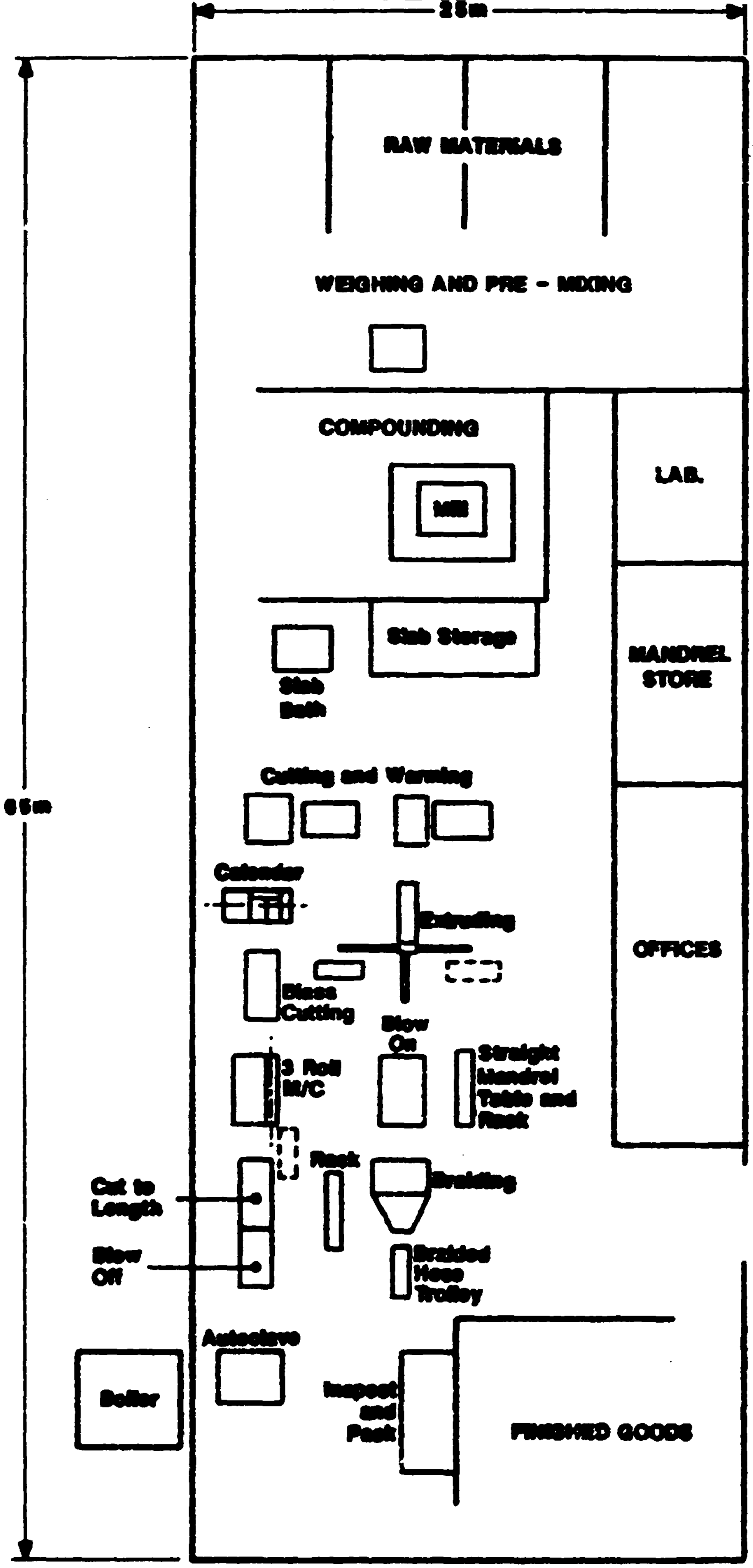

FIGURE 2.1 LAYOUT FOR RUBBER EXTRUSIONS

2.8 Project Scheduling

Implementation period is 18-24 months, with specification and manufacture of plant running in parallel with construction of the factory building.

2.9 Manpower, Organisation and Training

The manpower required for planned output on single shift is as follows:

unskilled	19
semi-skilled	6
chargehands	2
administration	3
security	4
driver	1
rubber technologist	1
production manager	1
general manager	1
	38

An organisation chart for the project is presented in Figure 2.2.

There is considerable knowledge to be acquired of rubber formulations suitable for every application, and of the extrusion, braiding and curing plant and processes. This knowledge must be held by the production manager, rubber technologist, and the two production chargehands. Suitably qualified and experienced employees can perhaps be recruited from the existing rubber industry in Ethiopia, (Addis Tyre) but further training may be necessary.

The rubber technologist should have attended a European technical institute. The production manager and chargehands should receive training from suppliers either in Ethiopia or at the plant suppliers own factory.

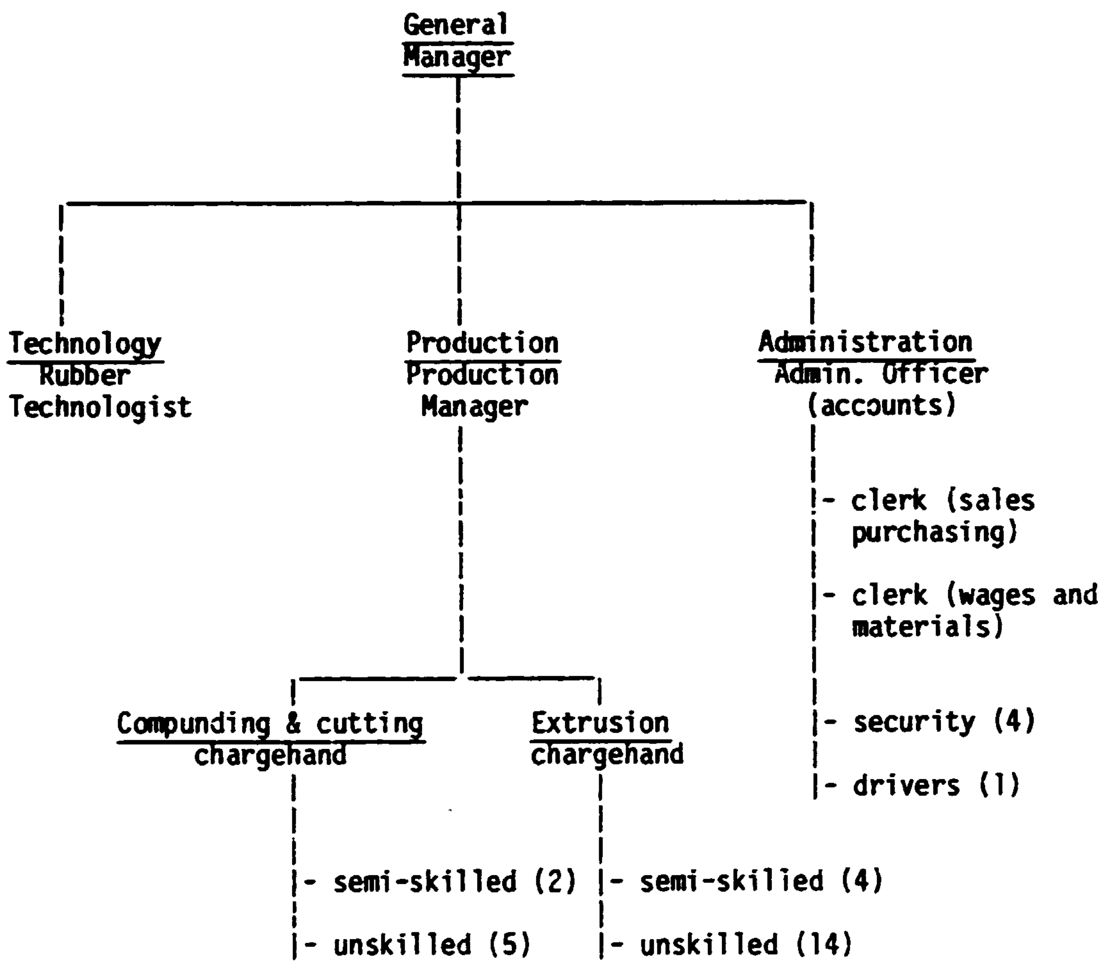

FIGURE 2.2 - ORGANISATION OF RUBBER EXTRUSION PROJECT

2.10 Investment

The following is the estimated foreign and local current investment required for the project:

	Foreign	Local (Birr '000)	Total
Buildings (1625m² x 900 Birr)	-	1,462	1,462
Services	58	15	73
Vehicles	-	70	70
Racks, tables etc.	-	20	20
Plant & equipment	1000	301	1301
Initial tooling	-	10	10
Total investment	1,058	1,878	2,936
Working capital	-	608	608
Total cost	1,058	2,486	3,544

An appropriate financial structure will be:

	%
Supplier credits	25
Bank loans	35
Equity	40
	100

2.11 Production Costs

Estimated production costs are as follows:

	Birr ('000)
Labour	115
Materials	512
Overhead expenses	88
Depreciation	245
Interest	202
Total production costs	1162

2.12 Sales Revenue

The net sales revenue in 1990 is forecast at Birr 2.433m as follows:

Sector	Output ('000 units)	Unit ex-works price (Birr)	Sales revenue ('000 Birr)
O.E.			
Trucks and buses	4.0	19	76
Tractors	5.8	7	41
Weatherstrip ('000 kg)	6.0	20	120
A.M.			
Trucks and buses	19.3	63	1216
Tractors	9.5	16	152
Cars & pick-ups	37.8	11	416
Total automotive			2021
Industrial extrusions ('000 kg)	31.0	20	620
			2644
	less 8% transaction tax		211
	net sales revenue		2433

2.13 Commercial Profitability

	Birr '000	Birr '000
Net sales revenue		2,433
Operating costs	715	
Depreciation	245	
Operating profit		1,473
Interest	202	1,271
Gross profit before tax	636	
Net profit		635

$$\text{Rate of return} = \frac{\text{net profit \& interest}}{\text{total cost of investment}} \times 100$$

$$= \frac{635 + 202}{3544} = 23.6\%$$

$$\text{Repayment} = \frac{\text{total cost of investment}}{\text{net profit and interest and depreciation}}$$

$$= \frac{3544}{635 + 202 + 245} = 3.2 \text{ years}$$

2.14 National Economic Benefit

Total cost per job created $\frac{3,544,000}{38} = 93,263$ Birr

Foreign exchange cost per job created $\frac{1058,000}{38} = 27,800$

Annual foreign exchange savings:

	Birr '000	Birr '000
import substitution	-	1335
depreciation of plant	125	
interest on plant	95	
imports of materials	230	
Total FX saving		885

3. RUBBER MOULDINGS

3.1 The Product

Vehicles contain a large number of rubber mouldings, such as:

* engine and gearbox mountings
* suspension bushes and rubber buffers
* shock absorber bushes
* grummets, plugs, seals, pedal covers
* gaiters
* mats and mudflaps.

There are typically 40-60 of these in a vehicle. Most moulded rubber components are small (eg 20 grams) but some are several kilos in weight.

Some components are rubber-to-metal (R/M) bonded, such as for example engine/gearbox mountings. In these carefully prepared metal inserts are inserted in the press along with the rubber, and are bonded in the vulcanising process.

Prestressed R/M components are moulded oversize or in a distorted shape, then compressed to size and shape in a suitably designed rig in a press. The component is then fastened in shape with a clip or band, which is released after the component is fitted in the vehicle.

3.2 Market Demand, Plant Capacity and Output

Original equipment demand for rubber mouldings is related to the number of vehicles assembled. There is also a large spare parts after-market for some rubber components, particularly those which are highly stressed in use, such as suspension and shock absorber bushes.

Table 3.1 sets out the estimated market demand for rubber mouldings in Ethiopia, and the planned capacity and output of the project.

TABLE 3.1 - MARKET DEMAND, PLANNED CAPACITY OUTPUT

	1990		1995		2000	
	Low	High	Low	High	Low	High
Vehicles assembled ('000)	5.4	5.4	8.2	8.9	10.0	11.4
OE demand for mouldings ('000)	270.0	270.0	410.0	445.0	500.0	570.0
Vehicle fleet ('000)	76.8	76.8	99.5	99.5	115.4	115.4
AM demand for mouldings ('000)	384.0	384.0	497.5	497.5	577.0	577.0
OE + AM demand ('000)	654.0	654.0	907.5	942.5	1077.0	1147.0
Planned output ('000)	538.8	538.8	758.3	793.3	903.9	973.9
of auto mouldings (tonnes)	21.5	21.5	29.1	29.8	34.2	35.6
Planned output of non-automotive mouldings (tonnes)	21.0	21.0	29.0	30.0	34.0	36.0
Total planned output (tonnes)	42.5	42.5	58.1	59.8	68.2	71.6
Planned capacity (tonnes)	330.0	330.0	330.0	330.0	330.0	330.0

Original equipment demand is based on an average of 50 mouldings per vehicle assembled. After market (AM) demand is based on the size of the vehicle fleet and an average replacement rate for rubber components of 5 per year. It will be seen that, at the present stage of development of the automotive industry, AM demand is greater than OE demand.

Planned output has been taken as 100% of OE demand, and 70% of AM demand, because there will be some models for which it is uneconomic for the project to tool-up. This gives a planned output of 538,000 automotive mouldings (21.5 tonnes) in 1990.

There is also a large non-automotive demand for moulded rubber components, such as soles for shoes, rubber trolley wheels, and miscellaneous industrial washers, seals, buffers, and couplings. R/M bonded components are used for industrial and marine transmission couplings, railway suspension systems and anti-vibration mountings. This non-automotive demand for rubber components is usually of the same order of magnitude as automotive demand. Output of non-automotive components has therefore been estimated at approximately the same tonnage as automotive, that is 21.0 tonnes in 1990. Non-automotive components would also improve the product mix, because the average piece weight tends to be greater than for automotive components, and some, such as trolley wheels (about 5kg), are very heavy.

It is proposed to instal a capacity to make 330 tonnes per annum with some two shifts working. This is much greater capacity than is required in volume terms, but for small components the capacity constraint is in volume terms. The installed capacity will handle about 800,000 components which should be sufficient for 1990 planned output, depending on product mix. If greater output is required the press shop can operate on three shifts.

3.3 Raw Materials

The principal raw materials and services for the manufacture of moulded and rubber-to-metal bonded components are:

* natural rubber in the form of raw and smoked sheets

* synthetic rubber polymers

* additives and chemicals such as carbon black, zinc oxide, sulphur and proprietary additives

* moulds

* bonding agents for R/M components

* metal inserts for R/M component

* fuel oil for steam raising

* cooling water

* electric power.

Good quality moulds are important for a successful project; they could probably be supplied by the proposed design centre and toolmaking project sponsored by National Metal Works Corporation. Metal inserts for R/M bonded components could be supplied by the Light Presswork and Fabrication Project (Project No. 8). All other raw materials will require to be imported, with the exception of water and electric power.

3.4 Location

Location of this project is not critical. Rubber automotive components are small and easily transported with the minimum of packaging, e.g. plastic bags.

As noted above the project would require tool making skills to produce moulds, and there is therefore a case for it to be reasonably near to the proposed design and toolmaking project, to facilitate close co-operation in the development of mould designs.

If it were located at Addis Tyre it could share compounding and mixing facilities which would reduce plant costs by some 20%, but it should be organisationally separate from the bulk tyre activities.

If the rubber extrusion and moulding projects (Projects 2 and 3) were combined there would be a saving in labour costs of 5%-10%.

3.5 Project Technology

Moulded rubber components are the simplest of rubber products and can be made on a small scale with relatively simple equipment. A product which is dimensionally acceptable is easily made, but achieving the right chemical and mechanical properties in the rubber is more difficult. Compounds can be made with a wide range of properties, in terms of mechanical strength, elasticity, hardness, oil resistance, temperature resistance, flame resistance, colour.

The basic process stages are:

* weighing and premixing of ingredients. This can be done in any appropriate way from totally manual weighting of ingredients into skips or buckets, to fully automated weighing from hoppers and tanks with skips on a conveyor

* mixing - the ingredients are blended and masticated on a mill, usually in 40-50kg batches. There are two main types of mill

  - open mill with two horizontal rollers. This is cheap and labour intensive but dirty, and can be difficult for some types of rubber

  - internal (Banbury) mixer, which is more expensive, but is quicker, cleaner and can be properly controlled. With a Banbury mixer the mixed compound is normally dropped down in batches on to an open mill on the floor below to produce convenient sized strips of slab rubber

The slab rubber is then cooled and left for a time to rest and mature. Mixing generates a lot of heat; the equipment is water cooled, and the speed of mixing has to be carefully controlled to maintain the mix at a workable temperature without scorching or curing taking place.

* preparation of blanks. The slab rubber is cut to size/shape to fill the moulds. Shaped blanks may be formed on an extruder and cut to length. The blanks are placed in the open mould, ideally after preheating

* moulding - normally a hydraulic press is used, having a number of steam heated platens (separated by "daylights") between which one or several moulds are placed. They are then closed by the press, forcing rubber into the mould cavity, and held for the predetermined time at the necessary pressure and temperature for the rubber to vulcanise (cure). The moulds are machined from steel plate, and for good surface quality and life need to be hard chrome plated. Moulds may have a single or multiple cavities. They may be simple two-part compression moulds, or two-or-more part transfer moulds, in which the blank is loaded into one cavity and is then extruded into the shaped cavity, when the mould is closed in the press

* finishing - after the curing period, moulds are removed, opened and stripped. The moulding is cooled, flashing trimmed off, and if necessary ground smooth.

For rubber-to-metal bonded (R/M) components, additional equipment is needed to form the metal inserts (by stamping and/or machining), which then must be cleaned and degreased, and proprietary bonding compounds applied. This can be done on a fully automated line, but for small runs can be done with a solvent degreasing bath, shot blaster and brush or spray painting, in a dust free atmosphere, with careful handling.

In the moulding operation, more complex moulds will be needed, with an arrangement, using magnets if necessary, to hold the metal inserts in position while the rubber is flowing into the mould cavity.

3.6 Availability of Technology

Rubber moulding and ancillary equipment is readily available from a large number of manufacturers worldwide, and both high technology, high volume equipment and labour intensive, low volume equipment can be obtained. In addition, because the rubber industry is in decline in Europe, and there is rationalisation and reinvestment in new technology by major producers, there is a healthy trade in second hand equipment. There are firms specialising in the refurbishment and sale of secondhand rubber and plastics machinery, and equipment can often be obtained at around one third of the cost of new equipment.

3.7 Project Engineering

A generalised layout for the rubber moulding project is shown in Figure 3.1. The project requires 1500m^2 (60 x 25m) of light industrial building.

The heart of the project is the three moulding presses, each capable of producing 132000 pieces, or 55 tonnes per year on single shifts. It is proposed to operate the three presses on two shifts, giving the planned annual capacity of 792,000 pieces or 330 tonnes.

The mixing mill will have more than adequate capacity to match the moulding presses on one shift. The insert preparation section-containes equipment for cleaning and painting steel inserts for the R/M bonded mouldings. The prestress press and thread running bench are also required for R/M bonded mouldings.

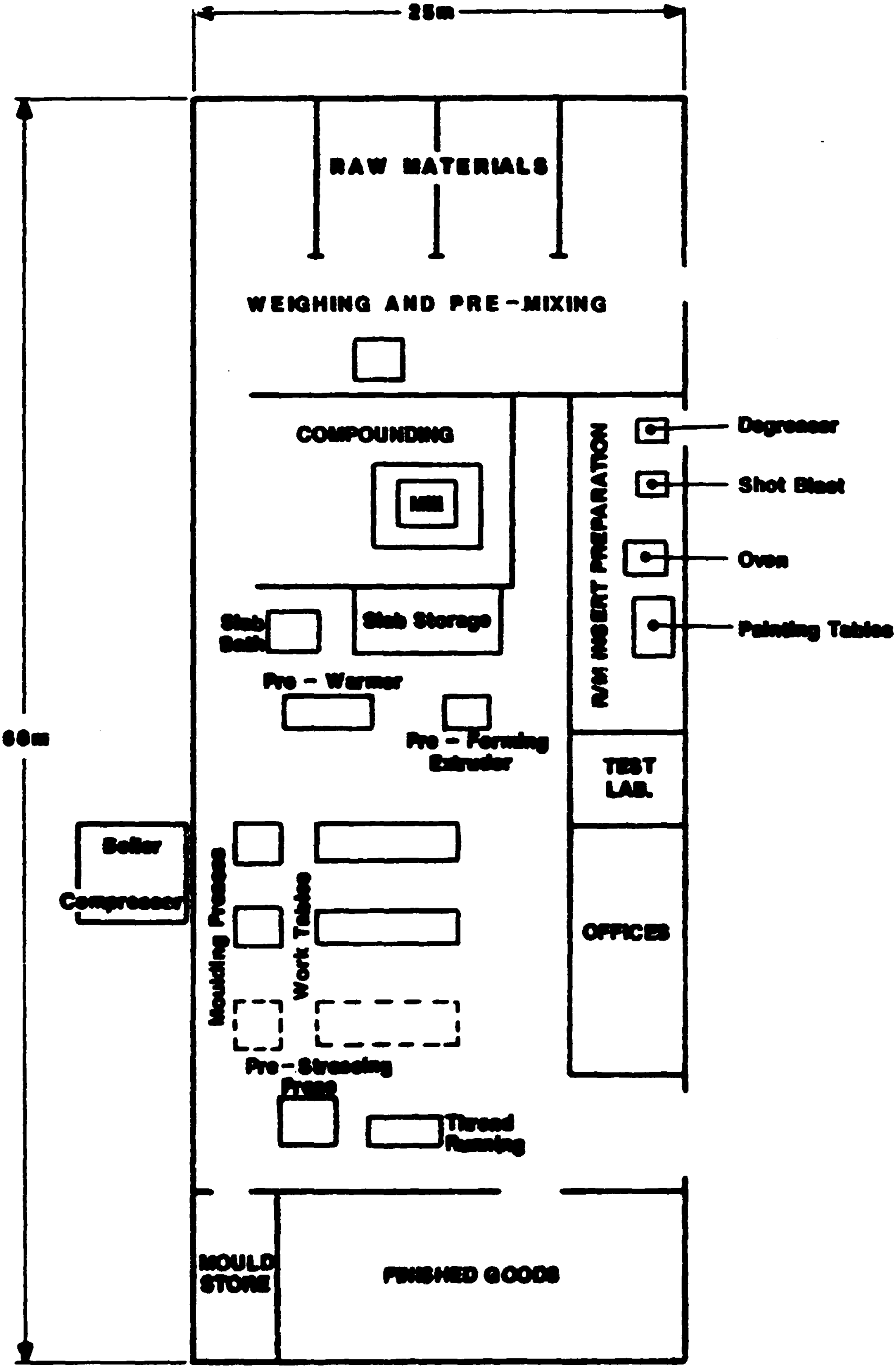

FIGURE 3.1 LAYOUT FOR RUBBER MOULDING

3.8 Project Scheduling

The total implementation period is expected to be 18-24 months. Critical activities are the specification and manufacture of plant, which will run concurrently with erection of a light industrial building.

3.9 Manpower, Organisation and Training

Manpower required to achieve the planned 1990 output is as follows, assuming single shift working in weighing, pre-mixing, compounding, administration and laboratory, and double shift working in other departments:

unskilled	39
semi-skilled	16
chargehands	3
shift manager	1
production manager	1
general manager	1
administration	3
security	4
driver	1
technologist	1
	70

An organisation diagram for the project is presented in Figure 3.2.

A rubber factory producing a range of products will have to develop many different formulations. These are the company's trade secrets which enable it to meet any customer's performance specifications in a cost effective way. Many formulations are given in text books, or in chemical supplier's catalogues, but they usually need to be

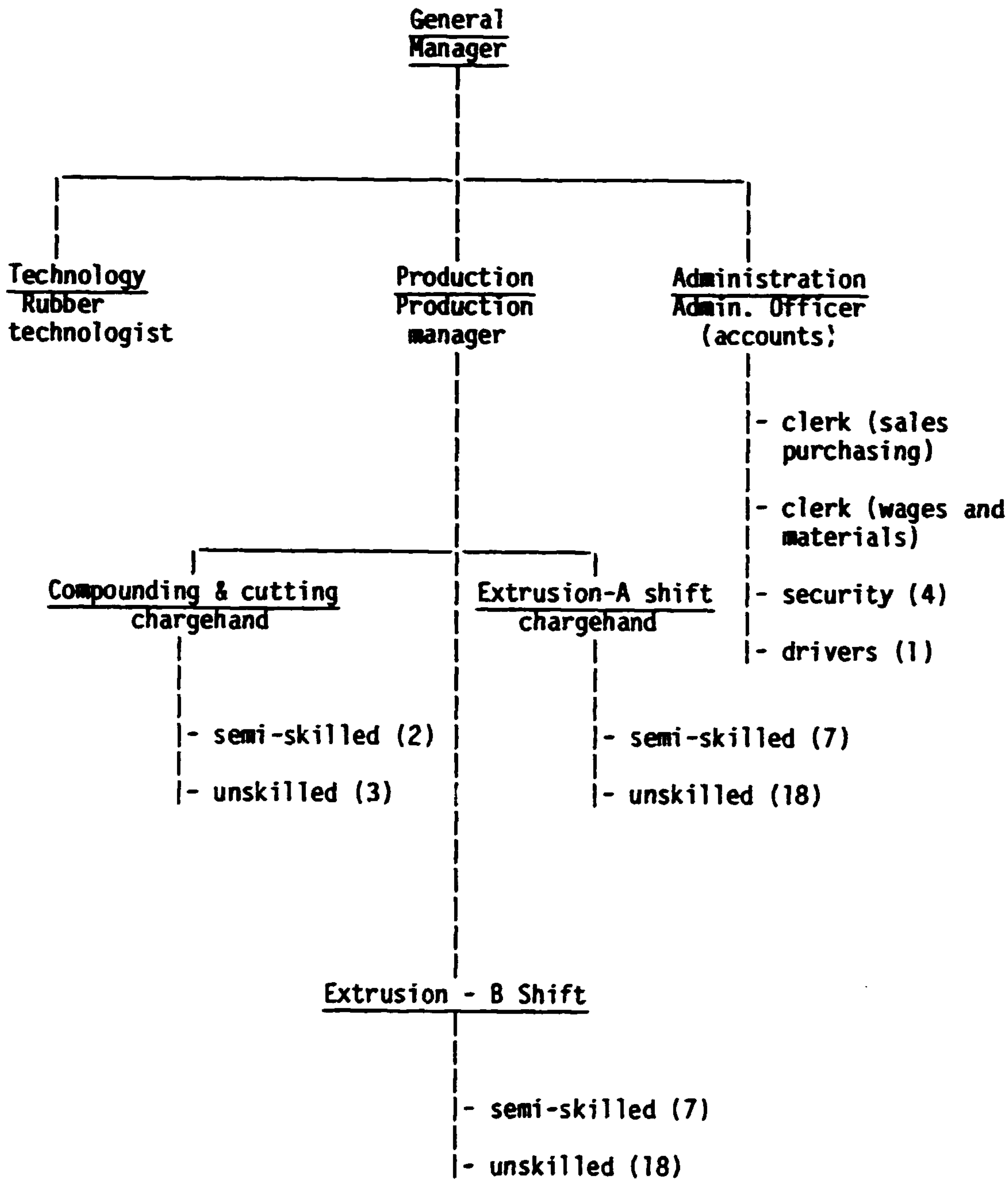

FIGURE 3.2 - ORGANISATION OF RUBBER MOULDING PROJECT

adapted to special circumstances, and the necessary processing times, sequences, pressures and temperatures for each compound need to be learned. There is thus a significant know-how to be acquired.

The project will therefore have to recruit a qualified rubber technologist. The production manager, shift manager, and chargehands will require training on the operation and maintenance of the compounding and moulding equipment, thus training should be provided by the plant supplier.

3.10 Investment

The following is the investment required for a plant with an annual capacity of 330 tonnes partly on 2 shift working:

	Foreign	Local (Birr '000)	Total
- Buildings (1500m² x 900 Birr)	-	1,350	1,350
- Services	54	14	68
- Vehicles	-	70	70
- Racks, tables etc	-	15	15
- Plant and equipment	773	232	1,005
- Initial tooling	-	200	200
Total investment	827	1,881	2,708
Working capital	-	1,200	1,200
Total cost:	827	3,081	3,908

An appropriate financing package will be:

suppliers credits	15%
bank loans	45%
equity	40%

3.11 Production Costs

The estimated production costs for a 1990 output of 42.5 tonnes are as follows:

	Birr ('000)
Labour	194
Materials	464
Overhead expenses	88
Depreciation	227
Interest	223
Total production costs	1,196

3.12 Sales Revenue

The net sales revenue in 1990 is forecast at Birr 2.845m as follows:

Sector	Output ('000 units)	Unit ex-works price (Birr)	Sales revenue ('000 Birr)
O.E.			
Trucks and buses	100.0	4	400
Tractors	145.0	2	290
Trailers	25.0	4	100
A.M.			
Trucks and buses	74.9	13	974
Tractors	36.8	4	147
Cars & pick-ups	147.0	2	294
Tractors	10.1	13	131
Total Automotive			2336
Non-automotive ('000 kg)	21.0		756
Total mouldings			3092
less 8% transaction tax			247
net sales revenue			2845

3.13 Commercial Profitability

	Birr ('000)	Birr ('000)
Net sales revenue	-	2,845
Operating costs	746	
Depreciation	227	
Operating profit	-	1,872
Interest	223	
Gross profit before tax	-	1,649
Corporation tax	825	-
Net profit	-	824

$$\text{Rate of return} = \frac{\text{net profit + interest}}{\text{total cost of investment}} \times 100$$

$$= \frac{824 + 223}{3,908} \times 100 = 26.8\%$$

$$\text{Repayment period} = \frac{\text{total cost of investment}}{\text{net profit + interest + depreciation}}$$

$$\frac{3,908}{1,274} = 3.1 \text{ years}$$

3.14 National Economic Benefit

$$\text{Total cost per job created} = \frac{3,908,000}{60} = 65,133 \text{ Birr per job}$$

$$\text{Foreign exchange cost per job} \quad \frac{827,000}{60} = 13,783 \text{ Birr per job}$$

Annual foreign exchange savings:

	Birr '000	Birr '000
- import substitution	-	1,136
- depreciation on plant	97	-
- interest on plant	74	-
- imports of materials	209	-
Total FX saving		756

4. ENGINE AND POWER TRAIN REMAKE

4.1 The Product

The output of this project is re-made engines, gearboxes, rear axles, wheel hubs, brakedrums and discs. It is an activity which in developed countries is carried out on a large scale by assemblers, original equipment manufacturers and re-make specialists.

Used components for re-make are bought from the motor trade, and are sold back after re-make, not necessarily to the same garage. It is therefore essentially a different activity from motor servicing, in which a component is removed from a vehicle for repair then returned to the same vehicle, for a service charge.

Because the project is making a business out of re-make it can afford to have a far greater range of equipment and skilled employees than a general purpose garage could possibly justify.

4.2 Market Demand and Planned Output

Table 4.1 shows forecast demand for trucks, buses and tractors, planned local production, and the planned output of re-made components from this project.

The demand for re-made components is somewhat unpredicatable; it depends on the attitudes of fleet operators, as well as on demand, and the availability of new vehicles. It is proprosed therefore that the planned output of the project (in terms of the 1,600 vehicles put back on the road with re-made engines) should represent less than one fifth of 1990 demand for truck, buses and tractors, and a smaller proportion in later years, and fill part of the gap between demand and local production. Re-made output will not therefore compete with local assembly projects. (see Table 4.1).

TABLE 4.1 - MARKET DEMAND, LOCAL PRODUCTION AND PLANNED OUTPUT OF RE-MADE COMPONENTS ('000 units)

	1990		1995		2000	
	Low	High	Low	High	Low	High
Annual demand for trucks, buses and tractors	8.9	8.9	11.5	11.5	13.7	13.7
Local production	4.9	4.9	7.6	8.3	9.3	10.7
Planned re-made output:-						
- engines	1.6	1.6	1.6	1.6	1.6	1.6
- gear boxes	1.6	1.6	1.6	1.6	1.6	1.6
- clutches	0.8	0.8	0.8	0.8	0.8	0.8
- prop. shafts	0.6	0.6	0.6	0.6	0.6	0.6
- hubs	0.8	0.8	0.8	0.8	0.8	0.8
- brake drums	0.4	0.4	0.4	0.4	0.4	0.4
- electrical instruments	2.4	2.4	2.4	2.4	2.4	2.4
	8.2	8.2	8.2	8.2	8.2	8.2

The planned output of 8,200 units per year is on one shift and can easily be increased by two shift working in all or part of the plant. Also, the capacity of a jobbing shop of this type is flexible; it can for example be increased by taking in components requiring less meanhours to restore them to as-new condition.

There will also be considerable demand for some types of re-made components for cars and trailers which could be supplied by this project if necessary, although no account has been taken of this demand when planning project output.

There will also be non-automotive demand for example for re-made stationery diesel engines. Again, this potential demand has not been included in planned project output. The revenue forecasts are therefore considered to be conservative.

4.3 Raw Materials

The major raw material for the project is a supply of used components for re-make.

As a matter of policy it is intended that the average age of vehicles should be reduced to five years, so that approximately one fifth of the fleet will be scrapped each year. This gives the following forecasts for annual scrapping of vehicles.

	1990	1995 (units '000)	2000
fleet of trucks, buses and tractors	31.9	47.4	55.4
annual scrapping	6.4	9.5	11.1

In fact in the early years the numbers of vehicles being scrapped will be greater than this, because the 1986 fleet is substantially older than 5 years on average, and there will have to be heavy scrappings in order to get down to an average five years life. There will therefore be no shortage of components for re-make.

Other raw materials include local or imported spare parts, such as friction materials (See Project No. 6) or bearings, steel and phosphor bronze bars and flats, and welding consumables.

4.4 Location

In order to ensure a good supply of components for re-making and easy delivery to customers it is important that the project should be at the centre of the road transport network of the country, that is in the Addis Ababa region. In this location the transport costs of heavy engine and power train components, can be produced by moving some of them as part loads, or as return loads on otherwise empty vehicles.

The project could be developed in association with a sponsoring company with existing knowledge of automotive repair and reconditioning, such as Agricultural Equipment and Technical Services Corp.

4.5 Project Technology

The technology required by this project is general machine shop and tool room skills as applied to automotive engineering. These include:

* line boring for restoration of worn main bearings and damaged thrust bearing seats of engine blocks and repair of worn gearbox bearing seats

* restoration of worn connecting rod parent bores

* regrinding of crankshafts and camshafts

* crack repairs on cylinder heads and blocks by metal stitching and welding

* crankshaft journal rebuilding and finishing with associated straightening, crack testing, stress relieving and dynamic balancing

* low temperature eutectic welding of cast iron, aluminium alloy, and alloy steel parts

* heat treatment for hardening, tempering, annealing, case carburising

* degreasing, descaling and shot blasting for thorough cleaning of dismantled engine block heads and other components

* testing and running of overhauled engines on dynamometer - test beds

* overhauling and calibration of diesel fuel injection pumps, and reconditioning of injectors and nozzles

* rebuilding of clutch cover assemblies with testing under simulated conditions, and dynamic balancing

* resleeving of brake drums

* reclaiming rear axle housings with broken or worn out ends, spigot bearing seat wear, and spring pad seat damages

* straightening and aligning front axle beams

* oversizing or resleeving at king pin bores

* retrieval and dynamic balancing of propeller shafts

* straightening and trueing of wheel rims for light vehicles, and restoration of worn out holes on truck rims

* restoration of threaded holes in various components by use of helioil inserts

* reclaiming bearing seats and stud locations for hubs

* overhauling and testing of starter motors, dynamos, and alternators

* rewinding starter and dynamo armatures

* servicing calibration and repair of dashboard instruments, including voltage regulators and cut outs for dynamos.

4.6 Availability of Technology

Technology is unrestricted and widely available in general courses on automotive engineering, maintenance and operation.

4.7 Project Engineering

A generalised layout of the engine and power train re-make plant is presented in Figure 4.1. The plant is installed in a light industrial building of 4608 m^2 (48m x 96m).

Engine and power train components returned by garages or fleet operators are first stripped and degreased. The condition of each component is then inspected, and decisions taken on the work required to restore it to as new condition.

There are two main machine shop areas within the plant, one with general purpose machine tools, and the other with specialised automotive machine tools. The general machine shop contains facilities for lathe work up to 700mm swing and 3000mm length, shaping, slotting, milling, internal and external cylindrical grinding, centreless grinding, surface grinding, tool cutter grinding, drilling and bench fitting.

The automotive machine shop can undertake such specialist automotive tasks as cylinder block boring, honing and re-sleeving, crankshaft grinding, surfacing, head insert fitting and valve seat cutting, valve grinding, flywheel and pressure plate facing, drum and disc skimming or grinding.

There is also an electrical and instrument shop for refurbishing alternators dynamcs and starter motors.

All components pass through a final inspection and testing facility, including dynamometer test beds for engines, before moving to the finished goods store or direct to customers.

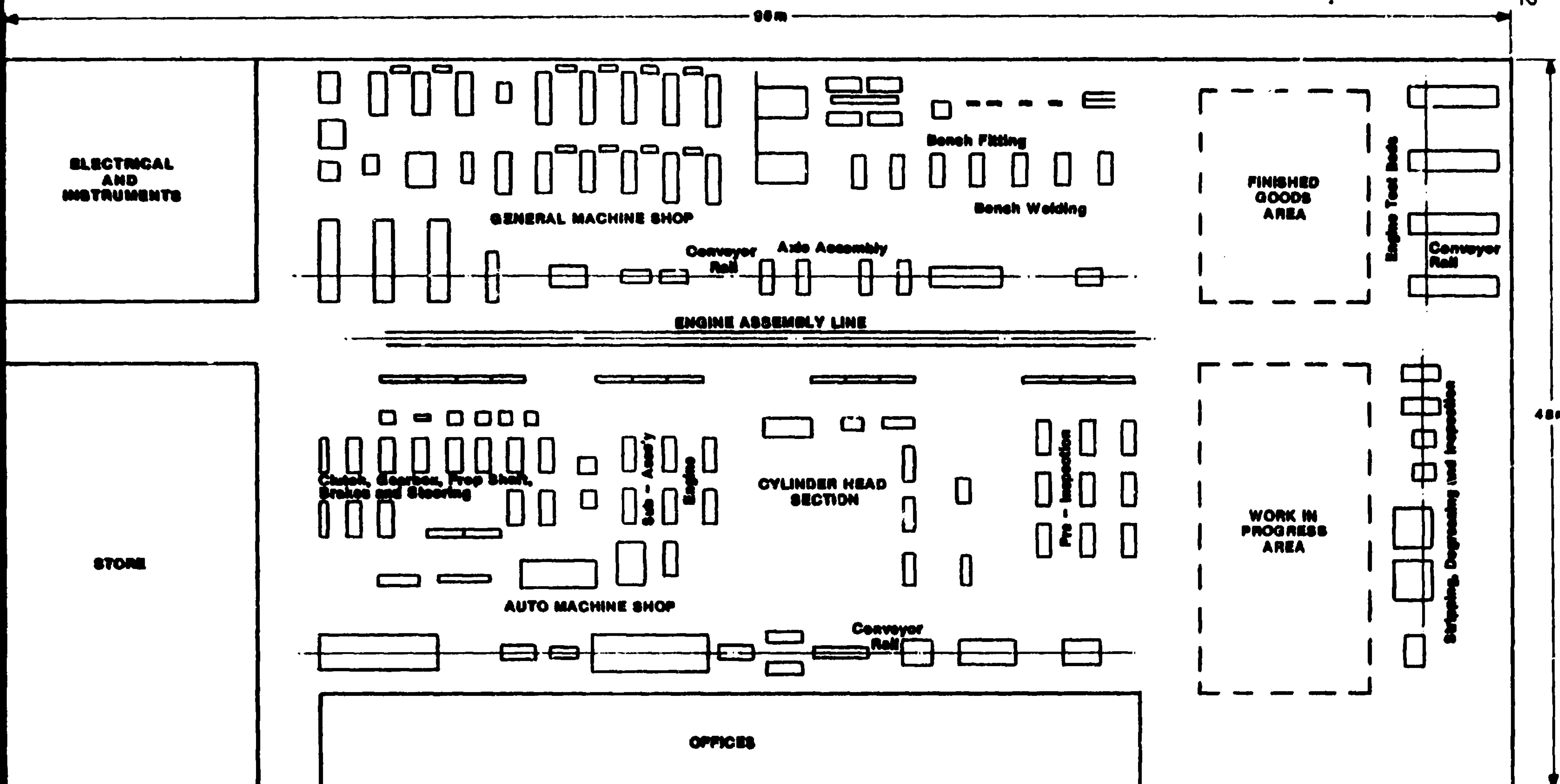

FIGURE 4.1 LAYOUT FOR ENGINE AND POWER TRAIN RE-MAKE

4.8 Project Scheduling

The implementation period will be 12-18 months, if a building has to be constructed. If use is made of an existing building implementation could be reduced to 6-9 months, for specifying, purchase and installation of machine tools, and recruitment and training of key staff.

4.9 Manpower, Organisation and Training

The following manpower is required to obtain the planned output on single shift operation:

unskilled	34
semi-skilled	62
skilled	53
chargehands etc	16
security	36
drivers	4
clerks	9
assistant managers/department officers	11
managers/financial controller	5
general manager	1
director	1
	232

An organisation diagram for the project is presented as Figure 4.2.

Key managers and personnel can be recruited from qualified people in Ethiopia, but a substantial training programme will also be required. This will amount to 100-150 man weeks of overseas training of operatives. In addition on site training by overseas experts will amount to some 100-125 instructor weeks.

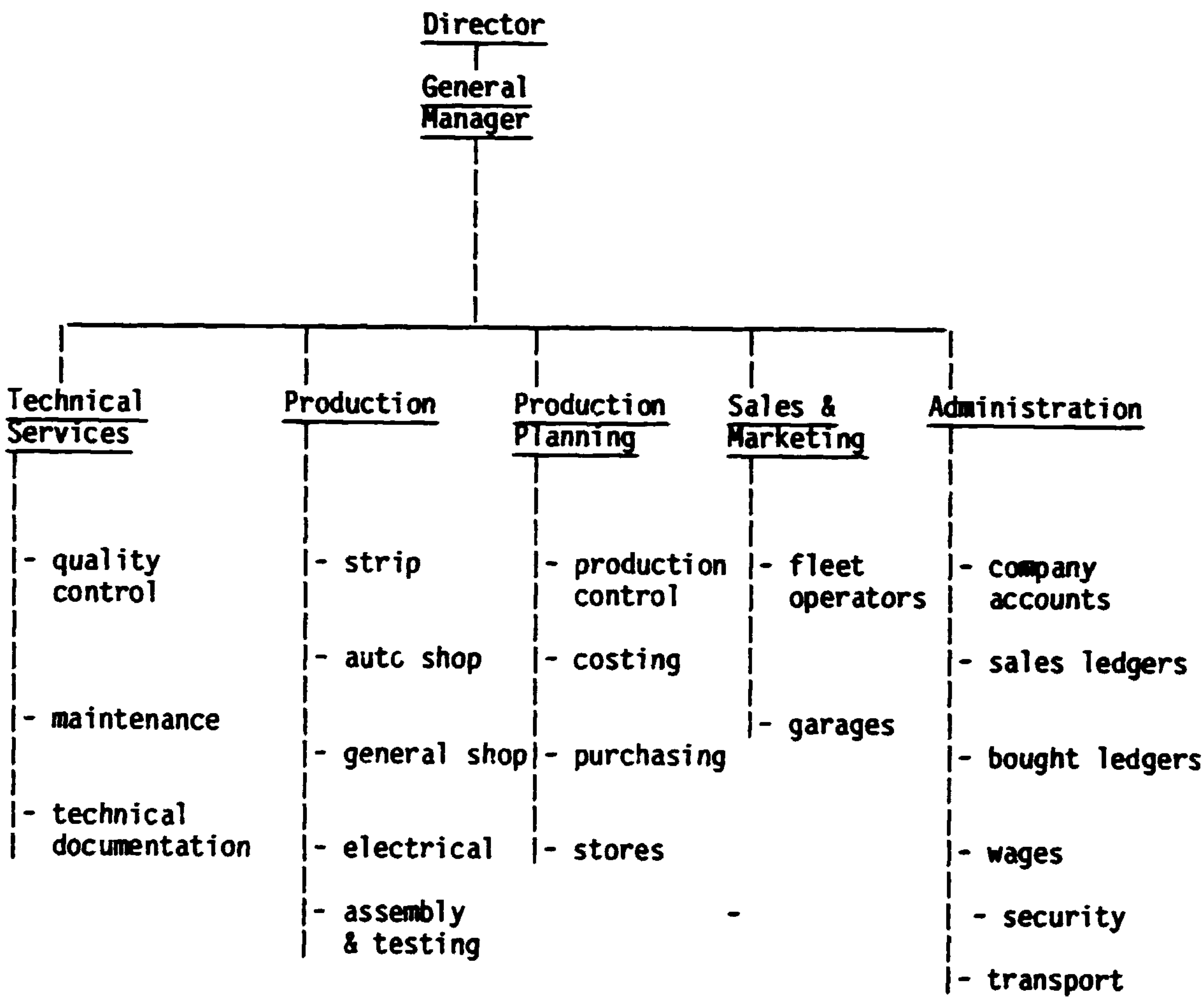

FIGURE 4.2 - ORGANISATION OF ENGINE AND POWER TRAIN RE-MAKE PROJECT

4.10 Investment

The following is the investment required to install the planned capacity:-

	Foreign	Local (Birr '000)	Total
Building	-	4,147	4,147
Services	166	41	207
Vehicles	-	280	280
Racks, tables etc.	-	100	100
Plant and equipment	2,678	800	3,478
Initial tooling	268	80	348
Total capital	3,112	5,448	8,560
Working capital	-	2,363	2,363
Total cost	3,112	7,811	10,923

A suitable financial structure for the project would be:-

supplier credits	20%
bank loans	40%
equity	40%

4.11 Production Costs

Production costs for the planned output will be as follows:-

	Birr '000
Labour	816
Materials	3,780
Overhead expenses	359
Depreciation	735
Interest	623
Total production costs	6,313

4.12 Sales Revenue

Sales revenue is estimated on the basis of an average price per job of 1,250 Birr as follows:

		1000 Birr
8,200 units x 1,250 Birr	=	10,250
less 8% transaction tax	=	798
		9,452

4.13 Commercial Profitability

	Birr '000	Birr '000
Sales revenue	-	9,452
Operating costs	4,955	
Depreciation	735	
Operating profit		3,762
Interest	623	
Gross profit before tax		
		3,139
Corporation tax	1,570	
		1,569

Rate of return $= \dfrac{\text{net profit + interest}}{\text{total cost of project}} \times 100$

$= \dfrac{1569 + 623}{10,923} \times 100 = 20.1\ \%$

Repayment period $= \dfrac{\text{total cost of project}}{\text{net profit + interest + depreciation}}$

$= \dfrac{10,923}{1569 + 623 + 735} = 3.7$ years

4.14 National Economic Benefit

Total cost per job created = $\frac{10,923,000}{232}$ = 47,080 Birr

Foreign exchange cost per job created = $\frac{3,112,000}{232}$ = 13,413 Birr

Annual foreign exchange savings:

	Birr '000	Birr '000
import substitution		4,253
depreciation on plant	368	
interest on plant	280	
imports of materials	532	
Total FX saving		3,073

This project is particularly attractive in terms of foreign exchange saving because there is a relatively small imported content in its raw material.

5. VEHICLE WIRING HARNESSES

5.1 The Product

Wiring harnesses are the assemblies of insulated wiring supplied to motor manufacturers as original equipment for incorporation in the vehicle during assembly.

The harness interconnects the major items in the vehicle electrical system, such as the alternator, starter motor, battery, voltage regulator, instrument panel, lights, windscreen wipers and washer, fans, horn, radio and any other electrical services. Most of the wiring harness is normally 12 volt, except for the high tension system from the coil. There are also heavy duty leads connecting the battery to the starter motor, and to the bodywork.

Although the wiring harness is one interconnected system when in use, for convenience in vehicle assembly it may be delivered as several separate harnesses. There are in this sense an average of three harnesses per vehicle, but it is convenient to plan this project in terms of harness sets, ie one harness set per vehicle.

In addition to wiring the harness contains snap connectors for joining to electrical components, earth connectors for attachment to earthing bolts on the bodywork, and junction box terminals where two or more wires connect. In some cases there may also be fuse holders incorporated in the wiring. It is also normal to thread rubber grommets on the harness during manufacture, so that they are in position to be fitted into holes in the bodywork where the wiring runs through body panels.

5.2 Market Demand, Plant Capacity and Output

Wiring harnesses are mainly an original equipment market, installed when a vehicle is assembled, or completely rebuilt. It is relatively rare for a wiring harness to be fitted as a spare part, although this may happen for example when a vehicle has been on fire. The Ethiopian market for wiring harnesses therefore depends principally on the number of vehicles being assembled in the country, and to a small degree on the size of the truck and bus fleet.

Forecast market demand, and planned capacity and output are summarised in Table 5.1. Original equipment (OE) demand is one harness set per vehicle assembled. After market (AM) demand is calculated on the basis of 1 in 100 of the truck and bus fleet being rewired each year. Planned output is 6,000 units, calculated at 100% of OE demand plus 80% of AM demand, on the assumption that the project could not supply harness for all models in use in Ethiopia; some models are present in the fleet in such small members that it would not be worth producing them. An initial capacity of 8600 sets per annum is proposed, which is sufficient for planned output in 1990. After 1990 it is proposed to expand capacity by one third to 11500 harness sets per annum.

TABLE 5.1 - MARKET DEMAND, PLANNED CAPACITY AND OUTPUT ('000 harness sets)

	1990		1995		2000	
	Low	High	Low	High	Low	High
Vehicles assembled	5.4	5.4	8.2	8.9	10.0	11.4
OE harness demand	5.4	5.4	8.2	8.9	10.0	11.4
Vehicle fleet	76.8	76.8	99.5	99.5	115.4	115.4
AM harness demand	0.8	0.8	1.0	1.0	1.2	1.2
OE plus AM harness demand	6.2	6.2	9.2	9.9	11.0	12.4
Planned output	6.0	6.0	9.0	9.7	11.0	12.4
Planned capacity	8.6	8.6	11.5	11.5	11.5	11.5

There is some non-automotive demand for wiring harnesses (e.g for domestic appliances) in developed countries, but it is not significant for the viability of this project in Ethiopia, and has therefore been ignored.

5.3 Raw Materials

The raw materials for manufacture of wiring harnesses are insulated wires, connectors, terminals, rubber grommets and electric power. Insulated wires could be made by Ethio Plastics, which already makes similar wires for other applications. Rubber grommets could be made by the Rubber Mouldings Project (Project No 3).

Connectors and terminals would initially be imported; they are made in very large quantities by the suppliers to the assemblers of the same models of vehicles in developed countries. To obtain a reasonable price the harness project would have to buy connectors and terminals in quantities which might represent many months production in Ethiopia. It would therefore be preferable for connectors and terminals to enter Ethiopia as part of the vehicle kit, and then to be given on free issue to the harness manufacturer by the vehicle assembler, who would in due course get them back as part of the complete harness.

5.4 Location

Wiring harnesses and their constituent parts have low weight in relation to their value. They are not easily damaged in transit, and require only the minimum of packaging, typically plastic bags. Transport costs are therefore low, and location is not a major issue.

However, with the motor industry everywhere moving to a just-in-time delivery policy, it would be preferable for a harness project to be located reasonably near to the major vehicle assemblers, that is in the Addis Ababa/Nazareth area, particularly if connectors and terminals are to be delivered to the project in kits via the assemblers.

There is no obvious project sponsor in Ethiopia, but a small and straightforward project of this type can be set up as a new organisation.

5.5 Project Technology

Except in the case of the largest motor manufacturers, harnesses are normally made by hand. Harness manufacturers are given either a sample or a wiring diagram, of the required harness. This specifies the wires, colour codes, lengths, junctions, wrapping, grommets and terminals.

The manufacturer first turns this specification into production instructions, indicating a certain number of lengths of wire of each diameter and colour code. Wire can be conveniently stored on a creel arrangement so that the required length can be drawn off through a hole in a board which indicates the wire specification. A stock of typically 25-50 different types of wire is required. The wire ends are next stripped of insulation, and codes are printed on if required. Stripping and printing are done by small hand-fed bench mounted machines. Terminals are crimped on to each end of the cables, and in some cases insulated covers are shrink wrapped around the cable and terminal by the application of heat. Battery leads are prepared in the same way using heavy cable and the appropriate terminals.

Assembly begins once all the cables required for a batch of harnesses have been cut to length and fitted with terminals. The harnesses are assembled by hand one at a time, on a board (1.5m x 2.0m) standing vertically into which nails have been inserted to control the route of each cable. There is thus a board for each model of harness which the manufacturer is able to supply. Instructions can be printed on the boards, or a sample harness left in place, on top of which the new harness is laid up.

When assembly is complete the harness is removed from the board, and junctions may be dipped in hot solder. The harness is then taken to a second board for testing. Again this board is unique to each model of harness being supplied. All terminals are plugged into the board, and each circuit is tested with a low voltage current and a series of indicator lamps. A one hundred percent test of harnesses is required, because the cost of rectification once it is in the vehicle is prohibitive. Fault rates may be 1-10 percent depending on the quality of labour and supervision. If no faults are found the harness is then wrapped in plastic tape and grommets threaded on to the appropriate positions.

5.6 Availability of Technology

There is no difficulty in obtaining the information needed to manufacture wiring harnesses. The motor manufacturers will provide the specification of cables, connectors and terminals, and indicate acceptable sources of supply.

5.7 Project Engineering

A generalised layout is proposed in Figure 5.1, requiring $440m^2$ (20 x 22m) of floor space.

Harness manufacture can be carried out on a scale as small as 100 units per month. It can accommodate great diversity of models within this total, with individual orders as low as one or two off once boards have been set up, but typically 50 off.

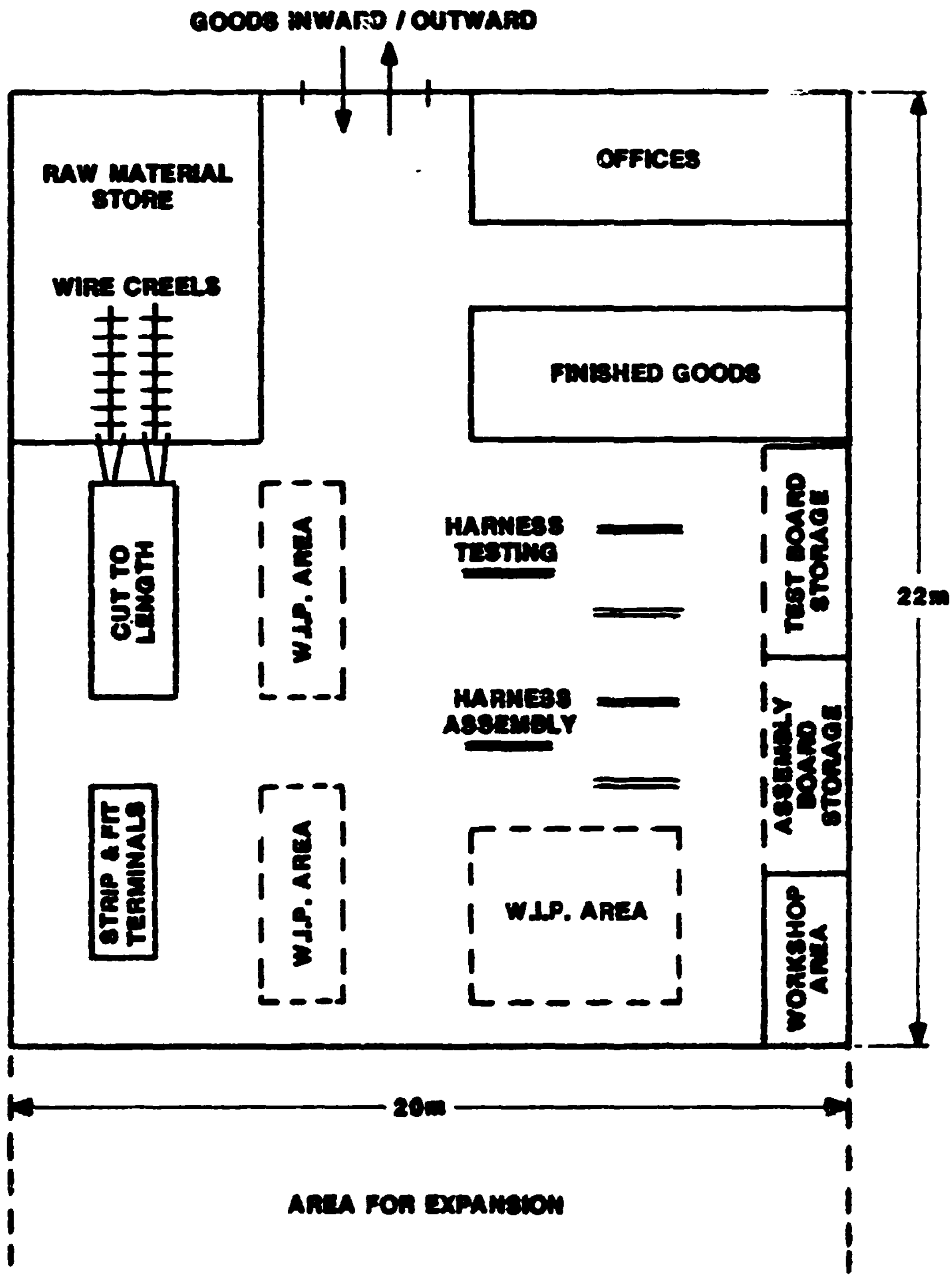

FIGURE 5.1 LAYOUT FOR WIRING HARNESS MANUFACTURE

Harness sets are laid up on a board at a rate of about six per shift, that is 30 per week on single shift, or 1440 per year. The planned 1990 capacity of 8600 harnesses per year will be achieved by having three work stations working on two shifts (1440 x 3 x 2 = 8640).

Since the equipment for assembling harnesses consists of simple tables, racks and boards there is no difficulty in increasing production at short notice if necessary. The only constraint is total floorspace, and in the proposed layout there is provision for expansion of the building in one direction.

It is visualised that capacity would be increased to 11500 in 1995 by having four work stations.

5.8 Project Scheduling

Total implementation period is 12-18 months. The critical item is the construction of a light industrial building. If any existing building were available, the implementation schedule could be reduced to the 3-6 months, required to recruit and train staff, and to set up assembly and test boards for each model of harness to be manufactured.

5.9 Manpower, Organisation and Training

The following manpower is required to achieve planned 1990 output of 6000 harness sets per year, on two shifts:

unskilled	12
semi-skilled	20
charge hands	4
drivers	2
security	4
administration	4
shift manager	2
manager	1
Total	49

An organisation diagram for the wiring harness project is presented in Figure 5.2.

There is significant managerial skill in understanding the auto-assemblers wiring diagrams, and in keeping up-to-date with numerous modifications. Effective production planning and control is also required to achieve orderly management of work in progress.

The manager and shift managers would therefore require to receive several weeks training at an existing wiring harness plant, and at auto-assemblers.
They would then be able to train the workforce of the project over a period of 2-3 months.

5.10 Investment

The following are the investment requirements for an annual capacity of 8600 harnesses on two shifts.

	Foreign	Local (Birr '000)	Total
- Buildings (440m² x 900 Birr)	-	396	396
- Services	8	2	10
- Vehicles	-	70	70
- Racks, tables, boards etc.	-	6	6
- Stripping, printing and crimping machines	12	3	15
Total investment	20	477	497
Working capital	-	206	206
Total cost	20	683	703

It will be noted that the foreign exchange requirement is very small, and the major investment cost is the building.

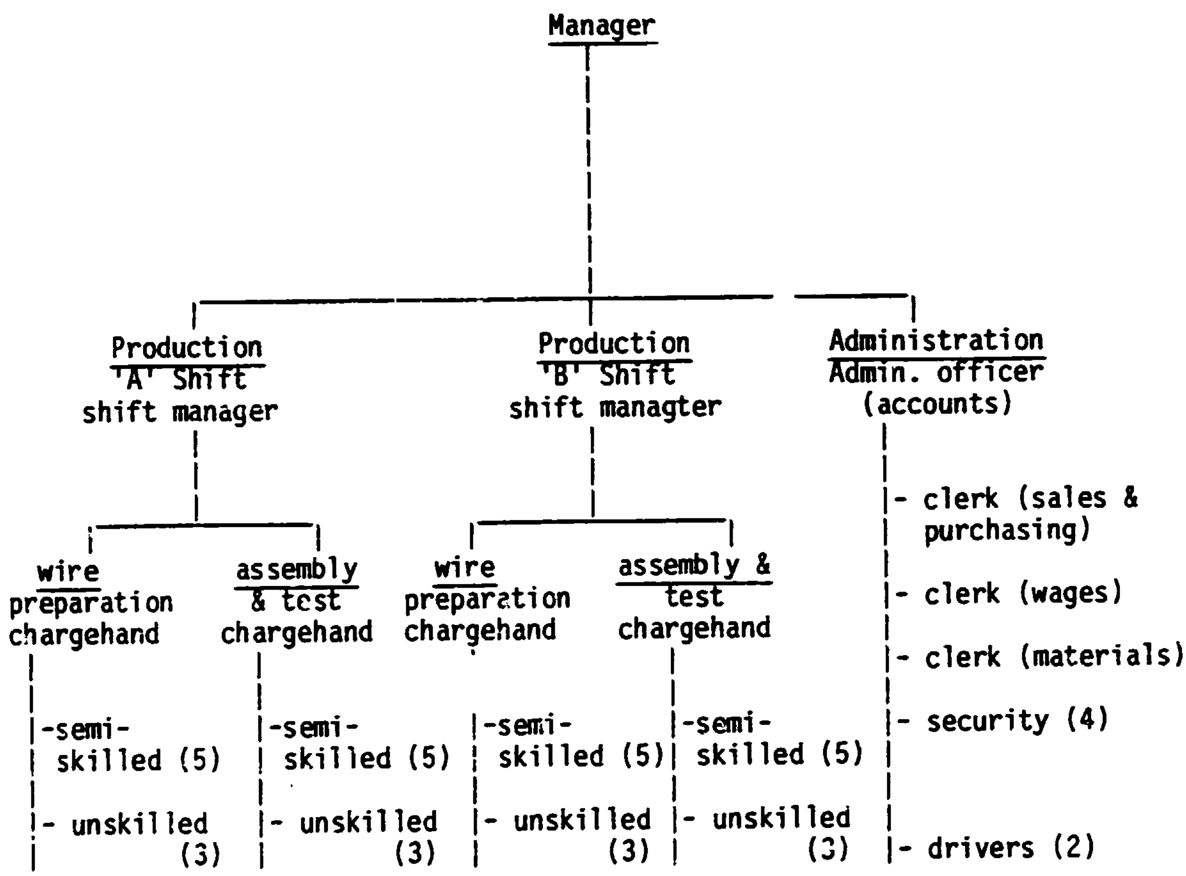

FIGURE 5.2 - ORGANISATION OF WIRING HARNESSES PROJECT

An appropriate financial structure would be:

	%
Bank loan	60
Equity	40
	100

5.11 Production Costs

The following are the production costs for 6000 harness sets per year:

	Birr '000
Labour	175
Materials	183
Overhead expenses	36
Depreciation	36
Interest	40
Total production cost	470

5.12 Sales Revenue

The net sales revenue in 1990 is forecast at Birr 823,000 as follows:

Sector	Output ('000 units)	Unit ex-works price (Birr)	Sales revenue ('000 Birr)
O.E.			
Trucks and buses	2.0	245	490
Tractors	2.9	43	125
Trailers	0.5	33	16
A.M.			
Trucks and buses	0.2	842	168
Tractors	0.1	113	11
Cars & pick-ups	0.3	280	84
Trailers	neg	111	-
TOTAL			894
	less 8% transaction tax		71
		Net sales revenue	823

5.13 Commercial Profitability

	Birr '000	Birr '000
Sales revenue	-	823
Operating cost	394	
Depreciation	36	
Operating profit		393
Interest	40	
Gross profit before tax		353
Corporation tax (50%)	177	
Net profit		176

$$\text{Rate of return} = \frac{\text{net profit + interest}}{\text{total cost of investment}} \times 100$$

$$= \frac{216}{703} \times 100 = 30.7\%$$

$$\text{Repayment period} = \frac{\text{Total cost of investment}}{\text{net profit + interest + depreciation}}$$

$$= \frac{703}{252} = 2.8 \text{ years}$$

5.14 National Economic Benefit

$$\text{Total cost per job created} = \frac{703{,}000}{49} = \text{about 14347 Birr per job}$$

$$\text{Foreign exchange cost per job} = \frac{20{,}000}{49} = \text{about 408 Birr per job}$$

Annual foreign exchange savings:

	Birr '000	Birr '000
import substitution	-	514
depreciation on plant	2	
interest on plant	1	
imports of raw materials	82	
Total annual FX saving		429

The above assumes that all raw materials are directly imported without backward linkage; the foreign exchange saving on materials would be greater if suitable insulated wires were made locally and bought by this project.

6. RADIATORS

6.1 The Product

The function of the radiator is to transfer heat from the water coolant to the atmosphere. There is normally one radiator per water cooled engine. There may also sometimes be a smaller oil cooler radiator serving a similar purpose in relation to the oil circulation.

Radiators usually consists of top and bottom tanks connected by many small bore oval brass tubes, attached to copper foil sheets to increase the effective cooling surface.

There have been some recent developments in radiator technology using plastic header tanks, and aluminium tubes.

6.2 Market Demand, Plant Capacity and Output

The forecast demand for radiators in Ethiopia is set out in Table 6.1, together with the planned output and capacity of the project.

OE demand is equal to the number of vehicles produced in Ethiopia, that is 4900 in 1990. AM demand depends on the vehicle fleet and the annual replacement rate of radiators. Modern radiators have a relatively long life and may well outlast the vehicle. A fifteen year life is assumed which gives an after market of 5000 radiators in 1990.

TABLE 6.1 - MARKET DEMAND, PLANNED CAPACITY AND OUTPUT
('000 units)

	1990		1995		2000	
	Low	High	Low	High	Low	High
Vehicles assembled*	4.9	4.9	7.6	8.3	9.3	10.7
OE demand	4.9	4.9	7.6	8.3	9.3	10.7
Vehicle fleet*	73.9	73.9	96.0	96.0	111.8	111.8
AM demand	5.0	5.0	6.4	6.4	7.5	7.5
OE + AM demand	9.9	9.9	14.0	14.7	16.8	18.2
Planned output	7.4	7.4	10.8	11.5	13.1	14.5
Planned capacity	9.6	9.6	19.2	19.2	19.2	19.2

* excluding trailers

Planned output assumes that the project would supply all the radiators for the limited range of vehicles assembled in Ethiopia, that is the 4900 OE market in 1990. It further assumes that the project could supply half the models in the more diverse after market, that is 2500 units in 1990. Total planned output in 1990 is therefore 7400 units.

Minimum capacity on single shift is 9600 radiators per annum which is sufficient to cover 1990 output. By 1995 it will be necessary to increase output by introducing a second shift. Full two shift working lifts capacity to 19200 radiators per year, sufficient to cover planned output in 2000.

There are diverse non-automotive applications for radiators, where heat transfer is required in industrial plant. Supply and refurbishment of industrial radiators may provide some additional revenue for the project, but has not been assumed in the following profile.

6.3 Raw Materials

The major raw materials for radiator cores are brass tubes coated externally in solder, and cadmium copper foil strip. Even large European manufacturers tend to buy in the thin walled oval tube, manufacture of which is a specialised sector of the non-ferrous metal industry. The project will import this tube in 4m lengths. Copper foil will be imported as coiled strip and formed into fins on site.

Top and bottom tube plates are 70:30 brass, which can be imported flat and formed on site. Side plates are lead coated mild steel. Header tanks can often be recovered in the after market, but OE demand could be met using imported 20-gauge brass sheet. Solder will also be imported.

6.4 Location

The radiator project should be located reasonably close to the vehicle assembly plants so that OE radiators can be delivered to the assemblers with the minimum of protective packaging. This will also be a conveniently central location for servicing the after market.

6.5 Project Technology

Radiators are made by assembling a core of water tubes separated by copper finning. The tubes enter tube plates at top and bottom, and the top and bottom tanks are attached to the tube plates. Side plates are soldered to the outer tubes to provide lateral support and protection.

Water tubes are first cut to length from 4m stock. Copper foil strip is perforated and corrugated to form the finning packs. Top and bottom tube plates and side channels are formed on a press. Tanks are formed on a Dualform machine, which is capable of making its own tooling from sample pieces, and is therefore ideal for low cost production of a diverse range of pieces.

Radiators are assembled in a jig in a horizontal position, that is with the top and bottom tube plates at either side and the water tubes lying horizontally. A sideplate is laid on the jig first, followed by the first row of water tubes and finning and then successive layers of tubes and finning until the core is complete.

The water tubes are coated externally with solder and are bonded to every corrugation of the finning by baking in an oven. This ensures good heat transfer. The core then undergoes an end-dip in silver solder which coats the tube plates and enables new or recovered tanks to be bonded to them.

6.6 Availability of Technology

The project should enter into an agreement with a technical partner for supply of technology, raw materials, a packaged manufacturing plant and training. The cost of this technology transfer is included in plant and material costs. The agreement should also provide for continuing support in technology updating and extending the product range.

6.7 Project Engineering

A generalised layout of the project is presented in Figure 6.1. The project requires approximately 280 m^2/(14 x 20m) of light industrial building.

Side plates and tube plates are formed on the guillotine and open front press. Header tanks, of required, are made on the Dualform press. There are two Pac machines which transform copper foil strip into corregated fin packs. Assembly of the radiators is a manual operation carried out on four building jigs. The assembled cores are then dipped in flux and baked, which causes the fins to fuse to the tubes. Tube plates are then dipped in molten solder, and tanks are soldered on by hand, if required. Fume extraction is required from the baking oven and the solder dip bath.

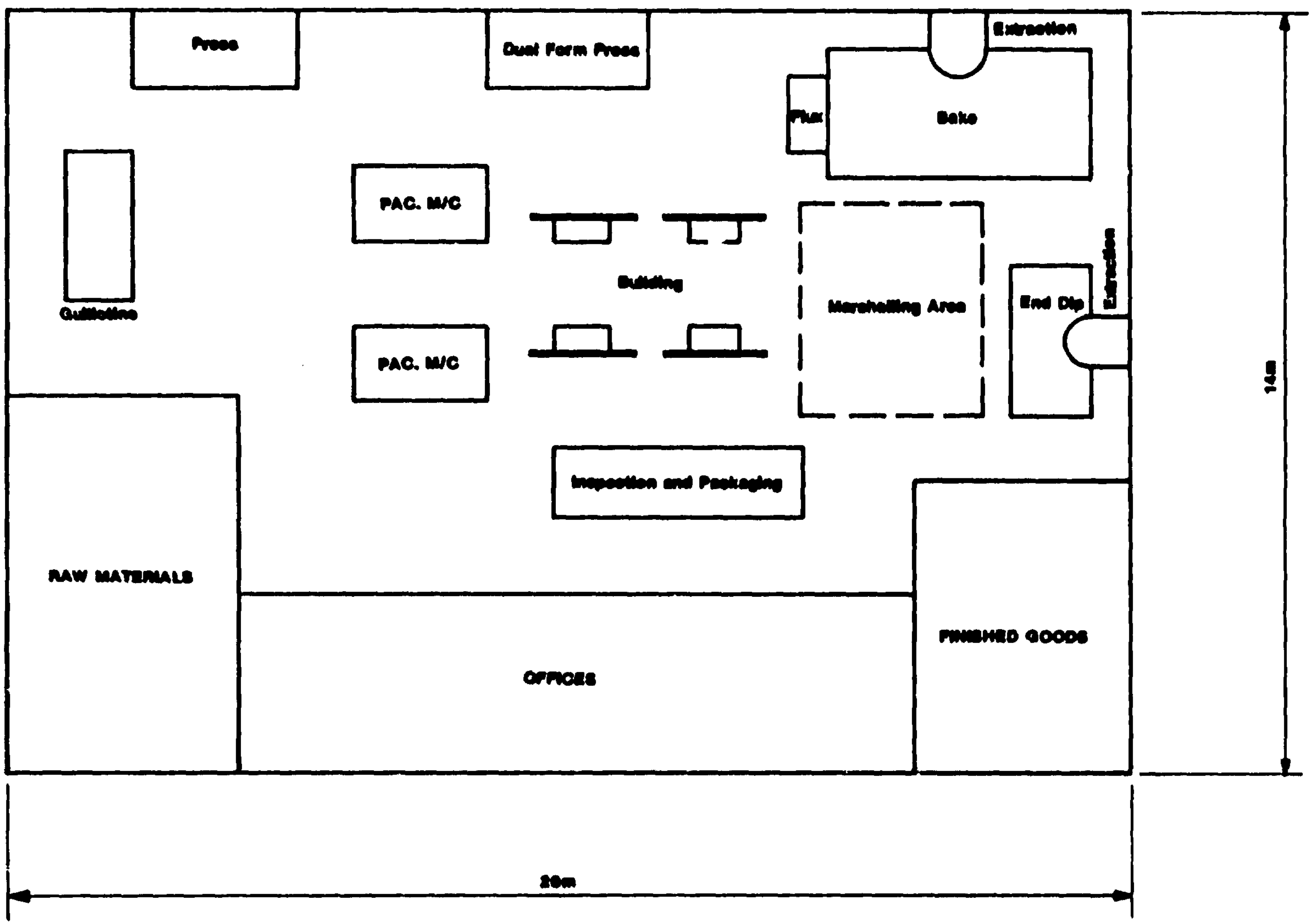

FIGURE 6.1. LAYOUT FOR RADIATOR MANUFACTURE

6.8 Project Scheduling

The project could be implemented in 6-9 months using an existing building. If a new building has to be built then the implementation schedule is likely to be 12-18 months.

6.9 Manpower Organisation and Training

The manpower required for the project is as follows:

Unskilled	5
Semi-skilled	10
Foreman	1
Administration	3
Security	4
Driver	1
General Manager	1
	25

An organisation chart for the project is continued in Figure 6.2.

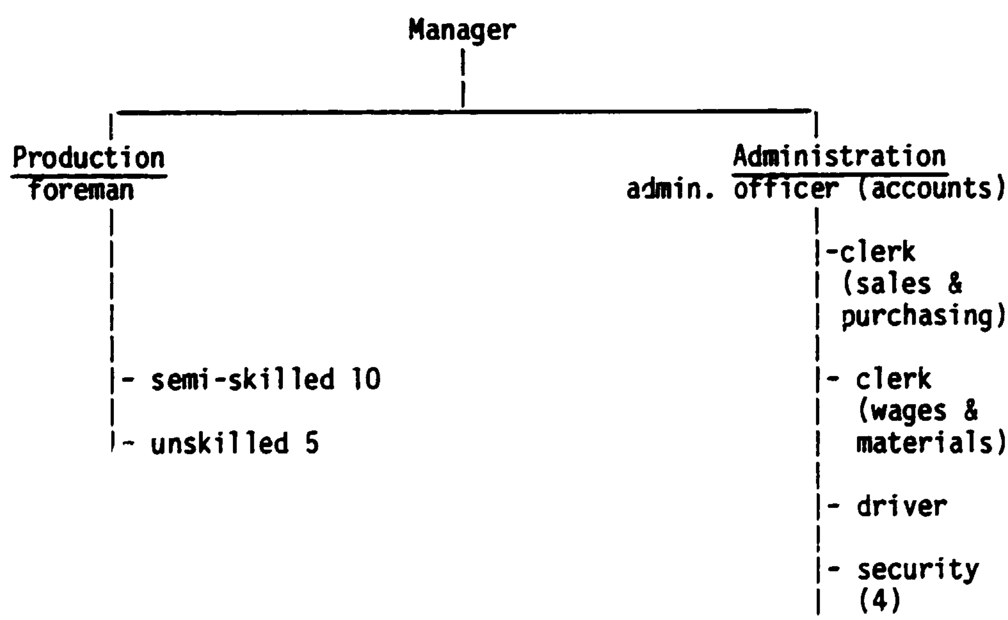

FIGURE 6.2 ORGANISATION OF RADIATOR PROJECT

Training will be provided by the technical partner. The general manager and foreman should visit the works of the technical partner for 2 weeks. The technical partner would provide further on site training at the time of commissioning, lasting 2-3 weeks.

6.10 Investment

The following is the required investment to achieve the planned capacity of 9600 radiators per annum on single shift:

	Foreign	Local (Birr '000)	Total
Buildings (280m² x B900)	-	252	252
Services	10	3	13
Plant equipment	387	116	503
Racks, tables etc	-	30	30
Vehicles	-	70	70
Total investment	397	471	868
Working capital	-	657	657
Total cost	397	1,128	1,525

An appropriate financing structure is:

	%
- supplier credits	20
- bank loans	40
- equity	40
	100

6.11 Production Costs

Estimated production costs for a single shift output of 7400 radiators in 1990 are as follows:

	(Birr'000)
Labour	90
Materials	1,470
Overhead expenses	43
Depreciation	95
Interest	87
	1,785

6.12 Sales Revenue

The net sales revenue in 1990 is forecast at Birr 2.629m as follows:

Sector	Output ('000 units)	Unit ex-works price (Birr)	Sales revenue ('000 Birr)
O.E.			
Trucks and buses	2.0	347	694
Tractors 2.9	2.9	106	307
A.M.			
Trucks and buses	0.7	1182	827
Tractors	0.4	284	114
Cars and pick-ups	1.4	654	916
Total	7.4		2858
	less 8% transaction tax		229
		Net sales revenue	2629

6.13 Commerical Profitability

	Birr'000	Birr'000
Sales revenue	-	2,629
Operating costs	1,603	-
Depreciation	95	-
Operating profit		931
Interest	87	
Gross profit before tax		844
Corporation tax	422	
Net profit		422

$$\text{Rate of return} = \frac{\text{net profit + interest}}{\text{total cost of project}} \times 100$$

$$= \frac{422 + 87}{1525} \times 100 = 33.4\%$$

$$\text{Repayment period} = \frac{\text{total cost of project}}{\text{net profit + interest + depreciation}}$$

$$\frac{1525}{422 + 87 + 95} = 2.5 \text{ years}$$

6.14 National Economic Benefit

$$\text{Total cost per job created} = \frac{1,525,000}{25} \quad \text{Birr } 61000$$

$$\text{Foreign exchange cost per job created} = \frac{397,000}{25} \quad \text{Birr } 15880$$

Annual foreign exchange savings:

	Birr'000	Birr'000
Import substitution	-	2117
Depreciation of plant	48	-
Interest on plant	37	-
Imports of materials	661	-
Total FX saving		1371

7. FRICTION MATERIALS

7.1 The Product

Friction materials in vehicles are designed to generate maximum friction between two surfaces, and to withstand the heat and wear which the friction generates. They have essentially two applications; in brakes as brake linings and pads, and as clutch plate facings.

A large number of part numbers are required to supply friction materials for the complete fleet of vehicles in most countries, but some of these are made from the same material and differ only in respect to dimensions and rivet holes.

7.2 Market Demand, Plant Capacity and Output

As with many automotive components there is both an original equipment (OE) and after market (AM) demand for brake linings, pads and clutch plates.

The estimated demand for friction materials is set out in Table 7.1. In the case of OE demand all the vehicles assembled are trucks, buses, tractors and trailers (not cars), and use drum brakes with linings, rather than disc brakes with pads. The average number of wheels per truck, bus or trailer assembled is calculated at 5, because some of these commercial vehicles have more than four wheels. There are normally two brake shoes per wheel. On some commercial vehicles each lining is divided into two half linings on each shoe for greater efficiency.

TABLE 7.1 - MARKET DEMAND, PLANNED OUTPUT AND CAPACITY ('000 units)

	1990		1995		2000	
	Low	High	Low	High	Low	High
Original Equipment Brake linings						
Vehicles	5.4	5.4	8.2	8.9	10.0	11.4
Wheels	24.1	24.1	36.8	40.3	44.3	51.3
Linings	48.2	48.2	73.6	80.6	88.6	102.6
Clutches						
Vehicles assembled*	4.9	4.9	7.6	8.3	9.3	10.7
Clutch plates	9.8	9.8	15.2	16.6	18.6	21.4
After Market Brake linings						
Fleet	76.8	76.8	99.5	99.5	115.4	115.4
Wheels	331.5	331.5	427.9	427.9	492.6	492.6
Replacement linings	369.0	369.0	515.6	515.6	590.4	590.4
Clutches						
Fleet*	73.7	73.7	96.0	96.0	111.8	111.8
Replacement clutches	52.9	52.9	71.7	71.7	83.6	83.6
Brake pads						
Fleet of cars	42.0	42.0	48.6	48.6	56.4	56.4
Replacement pads	42.0	42.0	48.6	48.6	56.4	56.4
OE & AM Planned output						
Linings	306.0	306.0	434.5	441.5	501.9	515.9
Clutches	46.8	46.8	65.4	66.8	79.2	82.0
Pads	29.4	29.4	34.0	34.0	39.5	39.5
	382.2	382.2	533.9	542.3	620.6	637.4
Tonnes output	140.0	140.0	195.0	199.0	227.3	233.0
Planned capacity	220.0	220.0	220.0	220.0	220.0	220.0

* excluding trailers

In the case of the after market both brake linings for commercial vehicles, and linings and brake pads for cars have to be considered. Cars usually have linings on the rear wheels and pads on front wheels. It is assumed that brake linings on high mileage commercial vehicles are replaced once per year. On cars it is assumed that brake linings and pads are replaced only every four years. Clutches are estimated to be replaced every two years on commercial vehicles, and every four years on cars.

Output of the project is planned at 100% of OE demand and 70% of AM demand. This gives total planned output of 382,000 pieces in 1990. This equals about 140 tonnes.

The planned capacity of the project is approximately 220 tonnes of friction material per annum on single shift, and is determined by the minimum cale of operation.

There are non-automotive applications for friction materials, for example, on railway rolling stock and mining equipment. These might provide some additional revenue for the project but have not been included in this profile.

7.3 Raw Materials

Friction materials are manufactured from proprietary chemical compounds which are the outcome of years of research and experienc These compounds would be imported by the project. In the long term they would be formulated in Ethiopia. Adhesives for bonding of linings and pads would also be imported. Copper rivets could be made locally.

The other major raw material is brake shoes and backplates for brake pads. These would mainly be obtained as trade-ins from the motor trade, but a proportion of new shoes and backplates would be required. These are made in vast quantities in Europe, which justifies the high cost of tooling and automatic forming equipment. Shoes and backplates could be fabricated by the metal indusry in Ethiopia, bbut there would be a considerable cost penalty.

7.4 Location

Location is not critical for this project. Both the raw materials and finished products are easily packed and transported. There is however, a preference for the project to be located centrally on the transport network, because the after market is larger than the original equipment market, and the project will take b ed brake shoes from the market for re-lining.

7.5 Project Technology

Manufacture of friction components of all the above types involves a number of sequential operations. The dry powder has first to be preformed to the appropriate shape. It is then baked to form the finished abrasive component. The material has then to be precisely ground to the finished surface shape required by each application. Finally the lining has in some cases to be fixed to a brake shoe. This operational sequence varies in detail with each type of friction component.

7.5.1 Brake Linings

Friction material for car brake linings is made in continuous sheet then baked into rigid form, curved in one direction with a diameter corresponding to the finished diameter of the brake lining. Pieces corresponding to individual linings are then cut off these curved sheets. In the case of large linings and ½ blocks for commercial vehicles linings are baked individually.

The linings are then finished by cutting precisely to size and grinding to ensure exact alignment with the shoe (for bonded types) and the brake drum. The linings are then drilled and rivetted, or bonded to the prepared brake shoes, which may be either new or trade-in parts from garages.

There is an alternative process route for brake linings, using flexible sheet in roll form, which is highly economic and able to cope with a wide range of shoe specifications. It can be sold to garages and workshops in sheet form for fitting to brake shoes when required.

7.5.2 Brake Pads

Brake pads are mounted on backplates which may be either new or trade-ins. Old pads are burnt off and shot blasted while new backplates are degreased. New pads are then preformed in dies on the prepared backplates before being press cured in a 100 ton hydraulic press. The pads are then ground to specified dimensions, painted and stencilled with part identification numbers.

7.5.3 Clutch Facings

These are made on similar equipment to brake pads, but without backplates. Clutch facings are preformed from a powder mix which is weighed into dies and pressed to the basic clutch facing shape. The dies are then cured in a multi-platten electrically heated hydraulic press. Finally they are baked in an oven, ground to size and drilled for rivetting to the clutch plates.

7.6 Availability of Technology

Brake linings are critical components in a vehicle, carrying serious liability in the event of failure. A great deal of research has therefore gone into the development of friction materials, and the resulting technology is held by a small number of companies worldwide.

The Ethiopian project would require to enter into a technology transfer agreement with one of these companies, covering the supply of plant, training and raw materials. The agreement should also provide ongoing support covering trouble shooting, and information on the latest developments in friction technology.

7.7 Project Engineering

A generalised layout for the project is presented in Figure 7.1. The project requires a light industrial building of 1,800m^2 (30x60m).

The major production areas are:

* a mixing area in which material is blended for manufacture of friction components in flexible and rigid form

* flexible roll manufacture, which is then fed to the finishing area (see below) for cutting to length and width and surface grinding

* parallel areas for ½ blocks for commercial vehicles, and rigid full linings which are each cut to make several linings in the finishing area

* a clutch facing area, which uses the baking oven also used for ½ blocks and full linings, and the thickness grinder in the flexible roll area

* a brake pads production area

* a shoe and backplate preparation area where components returned by garages are stripped of friction material and refurbished prior to assembly with new friction material. New shoes and backplate are also degreased and painted in this area

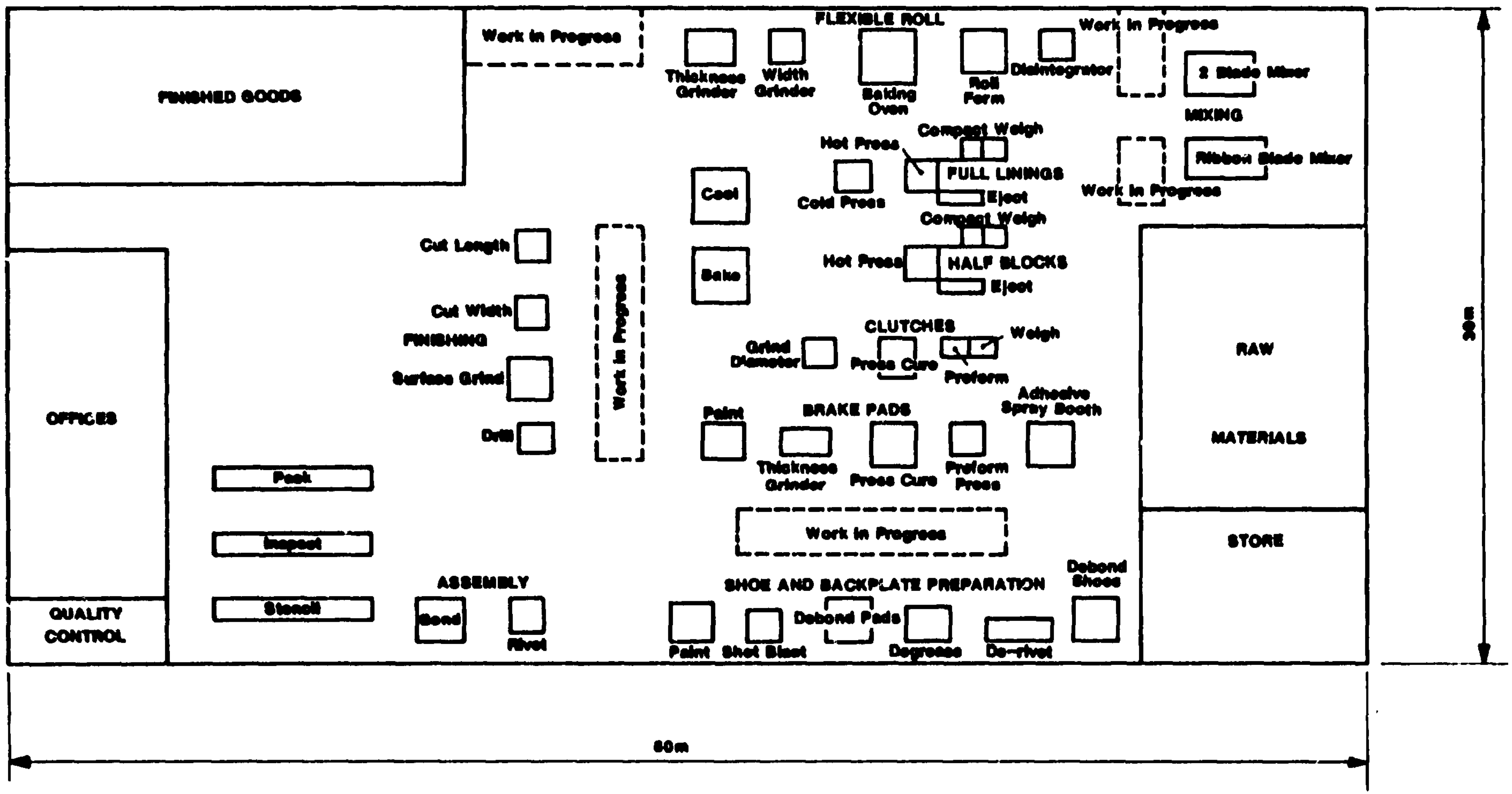

FIGURE 7.1. LAYOUT OF FRICTION MATERIAL PROJECT

* finishing area where linings are cut to length and width, surface ground and drilled for rivets

* assembly area where new linings are fitted to new or trade-in shoes. (Some linings are sold loose for rivetting by garages)

* stenciling, packing and inspection.

A dust extraction system is required with ducts to many of the plant units.

7.8 Project Scheduling

The required implementation period is 24 months, assuming 8 months for negotiations with the licensor, and 16 months for equipment manufacture, shipment and installation. Construction of a suitable building and training of key personnel at another of the licensor's plants, would run in parallel with these activities.

7.9 Manpower, Organisation and Training

The planned output could be achieved with the following labour force, on single shift operation:-

unskilled	7
semi-skilled	51
chargehands	6
quality control inspectors	1
maintenance	2
works manager	1
administration	5
drivers	2
security	6
general manager	1
	82

An organisation chart for the project is presented in Figure 7.2.

Most of the operations in the plant are semi-skilled, requiring only a few weeks instruction and practice to become a fully competent operator.

Training will be provided by the technical partners. Two key personnel would spend 2 weeks at another plant operated by the technical partners, and after commissioning the technical partners will be on hand for 2-4 weeks to assist in further training of personnel.

7.10 Investment

The following estimated foreign and local currency investment is required for the project:

	Foreign	Local	Total
		(Birr '000)	
Buildings ($1800m^2$ x 900B)	-	1,620	1,620
Services	65	16	81
Plant equipment	2,303	921	3,224
Racks, tables & containers	-	71	71
Vehicles	-	140	140
Total investment	2,368	2,768	5,136
Working capital	-	1,459	1,459
Total costs	2,368	4,227	6,595

A suitable financial structure will be:

	%
supplier credits	25
bank loans	35
equity	40

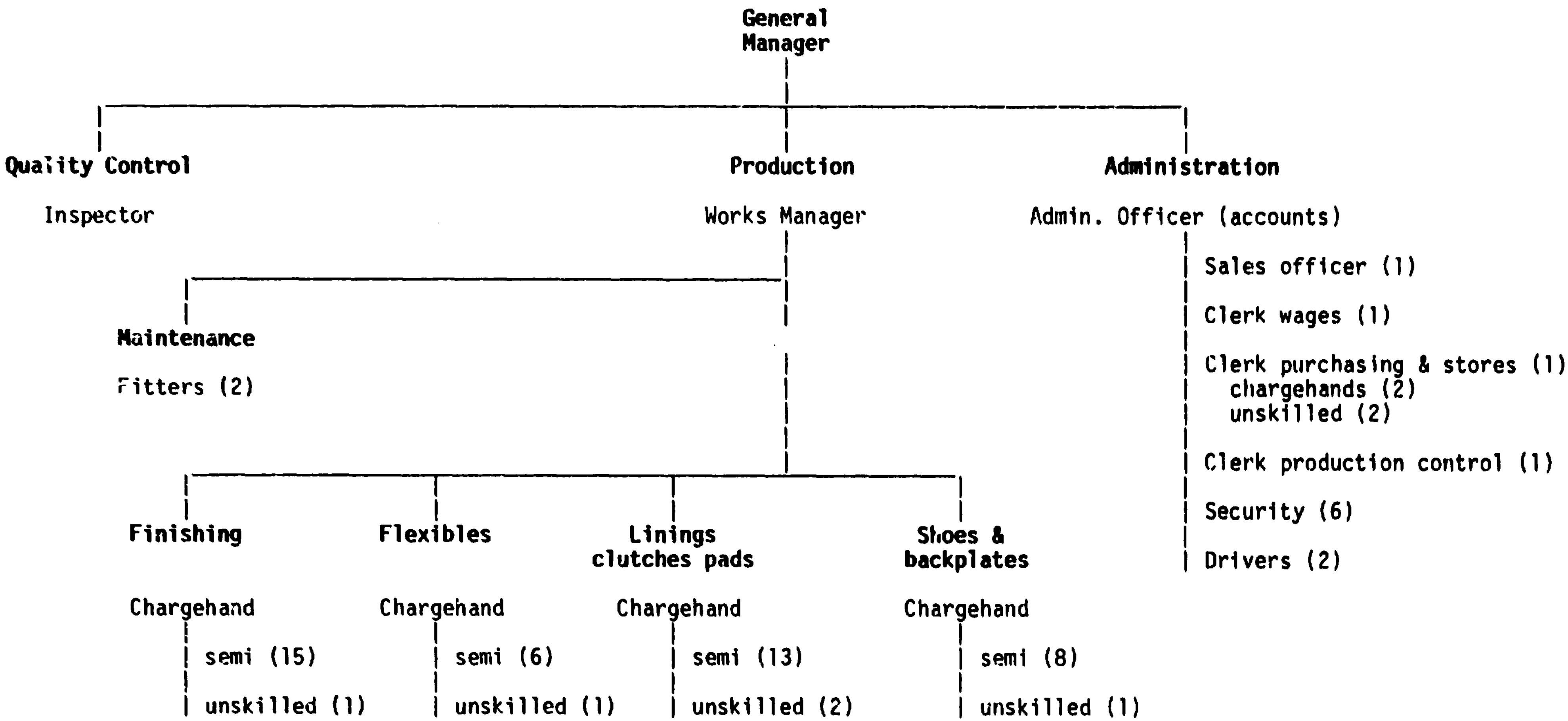

FIGURE 7.2 - ORGANISATION OF FRICTION MATERIAL PROJECT

7.11 Production Costs

Estimated production costs for the planned output of the project are as follows:

	Birr '000
Labour	275
Materials	1,085
Overhead expenses	212
Depreciation	515
Interest	376
Total production costs	2,463

7.12 Sales Revenue

The net sales revenue in 1990 is forecast at Birr 5.836m as follows:

		Output ('000 units)	Unit ex-works price (Birr)	Sales Revenue ('000 Birr)
O.E.				
Trucks and buses	- linings	20	6	120
	clutches	4	6	24
Tractors	linings	23	6	138
	clutches	6	6	36
Trailers	linings	5	6	30
A.M.				
Trucks and buses	- linings	150	21	3150
	clutches	15	21	315
Tractors	linings	59	16	944
	clutches	8	16	128
Trailers	linings	20	21	420
Cars	linings	29	17	493
	clutches	15	17	255
	pads	29	10	290
Total		383		6343
	- less 8% transaction tax			507
	Net sales revenue			5836

7.13 Commercial Profitability

	Birr '000	Birr '000
Net sales revenue	-	5,836
Operating costs	1,572	
Depreciation	515	
Operating profit		3,749
Interest	376	
Gross profit		3,373
Corporation tax	1,687	
Net profit		1,686

$$\text{Rate of return} = \frac{\text{net profit + interest}}{\text{total cost of investment}} \times 100$$

$$= \frac{1686 + 376}{6,595} \times 100 = 31.3\%$$

$$\text{Repayment period} = \frac{\text{total cost of investment}}{\text{net profit + interest + depreciation}}$$

$$= \frac{6,595}{2,785} = 2.6 \text{ years}$$

7.14 National Economic Benefit

Total cost per job created $\frac{6,595,000}{82}$ = 80,426 Birr

Foreign exchange cost per job created $\frac{4,913,000}{82}$ = 59,915 Birr

Annual foreign exchange savings:

	Birr '000	Birr '000
Import substitution	-	3,086
Depreciation of plant	288	
Interest on plant	219	
Imports of materials	488	
Total FX saving		2,091

8. AUTOMOTIVE BODY PRESS SHOP

8.1 The Product

Trucks and buses consist of an engine, transmission and mechanical parts mounted on a chassis, on top of which a fabricated body unit is fixed. In tractors, the cab body is supported by the engine and transmission and small sub-frames.

In an integrated manufacturing facility all these items are manufactured and assembled on one site, but the technologies are different and manufacture on several sites is quite possible.

The body parts consist of sheet metal pressings made in a press shop. They are sturdy items which can be stacked on suitable pallets and transported without much difficulty. Their manufacture can thus be conveniantly separated from the assembly facility. Such a press s ɿp could also undertake work for other industries, gaining wider experience and building an expertise which will benefit all users.

A bus body has a metal frame to which sheet metal panels are attached, and rubber items, glass windows and interior trim are added to produce a finished body. The frame forms a skeleton and provides the attachment points for the body/chassis joints, doorways, windows, roof rack, and internal fitments such as luggage racks and the drivers instrument panel.

Truck cabs are smaller than bus bodies, and because of their short length are subjected to less bending and torsional stresses. The configuration of the cab is such that it can be constructed from panels without a frame, but some parts of the cab act as stiffening members.

Tractor cabs are similar, but of a simpler construction. They are mounted directly on the engine and transmission assembly of the tractor. In Ethiopia it is planned to supply tractors without cabs, and therefore no further consideration need be given to this application.

8.2 Market Demand, Plant Capacity and Output

Vehicle bodies are predominantly an original equipment (OE) market. There is also an aftermarket for crash repairs, carried out by body repair shops, using replacement panels from the OE manufacturer.

Typically a bus body contains about 2 tonnes of metal parts consisting of:

* 100 Body panels - 80% flat panels needing no forming
* 20 Small sheet pressings
* 30 Pressed steel brackets.

A truck cab contains approximately 1 tonne of metal parts consisting of:

* 30 Body panels
* 30 Small sheet pressings and
* 100 Pressed steel brackets.

Estimates have been made of the OE demand for panels in Ethiopia, based on the production plans for trucks and buses. It is assumed that the press shop would plan to make 90% of the small sheet pressings required for these vehicles.

In the case of the after market for repair panels, demand has been estimated at one half of one percent of the panels in the fleet of trucks and buses in Ethiopia per annum. The project would plan to supply only a small part of this demand (20%) owing to the diversity of vehicles in the fleet, and the high tooling costs of short runs.

Market demand planned output and capacity are shown in Table 8.1. Capacity at 100,000 units per annum is determined by minimum output from key plant items on single shift operation, and can be increased if necessary in later years by double shift working.

TABLE 8.1 - MARKET DEMAND, PLANNED CAPACITY AND OUTPUT ('000 UNITS)

	1990		1995		2000	
	Low	High	Low	High	Low	High
Vehicles assembled*	2.0	2.0	3.4	4.1	3.6	5.0
OE panels demand	57.0	57.0	98.0	119.0	103.0	145.0
Trucks & bus fleet	21.4	21.4	26.4	26.4	27.4	27.4
AM panels demand	3.1	3.1	3.8	3.8	3.9	3.9
OE + AM demand	60.1	60.1	101.8	107.9	106.9	148.9
Planned output	52.0	52.0	88.9	88.9	93.4	131.3
Planned capacity	100.0	100.0	100.0	100.0	100.0	100.0

* excluding tractors and trailers

8.3 Raw Materials

Body panels are usually manufactured from steel sheet. Aluminium is sometimes used to reduce body weight and increase payload, but is more expensive. Steel sheet is usually 1.2 - 3.0mm in thickness, and up to 2.0 x 4.0m in width and length. Deep drawing quality is required for deep pressings. Steel sheets would be imported for this project.

8.4 Location

The automotive press shop should be located reasonably near to the main truck, bus and tractor assembly facilities in the Addis Ababa area. This will enable the press shop to give a just-in-time-service to the assemblers, and will reduce handling and transport costs of finished pressings.

Raw materials in the form of flat steel sheets will have to be transported from the port of entry, but they are easily handled and are delivered in strong export packing.

8.5 Project Technology

The processes involved in a body press shop include:

* storage of raw material in sheet form
* marking-off the sheets to sizes indicated on customers orders or engineering drawings
* cutting sheets to size
* hole cutting
* bending and pressing the sized sheets
* handling the sheets through each stage of the process
* packing and despatch.

Orders for body pressings will probably be accompanied by an engineering drawing which will specify the detailed shape of the finished product. Orders for simple pressings may have details indicated on the order document itself. Occasionally a sample of the finished product will be received by the press shop for copying.

On receipt of an order the requirements will be interpreted to determine the size of flat sheets needed to produce the finished form. Instructions to the workshop in the form of a works order will include the drawing when necessary and the size and number of flat sheets to be withdrawn from store.

Marking-off will employ the traditional chalk line, scriber and punch but template and pre-set machines can be employed for large orders of identical sheets. The flat sheets will be placed upon waist high benches, and the cutting dimensions and bend positions marked off from the drawing or template.

Sheet cutting will be carried out using electrically powered mechanical shears, and niblers. Holes may be cut or drilled before or after the forming operation depending upon the job. When multiple sheets are required they may be cut to size in groups. The sized sheets are then deposited at the bending or forming press for working into the finished shape.

Two types of press are employed for sheet forming. A press brake is employed when two dimensional bends are required, and a forming press when three dimensional forms have to be produced. Some jobs may require a combination of forming operations. Some customers may require de-burred edges but generally the sheets will be delivered in the as-cut state.

Finished pressings will be grouped according to their shape, and will be packed in nesting piles on pallets for delivery.

8.6 Availability of Technology

Sheet metal technology is widely available, and is already understood in Ethiopia. The motor manufacturers will provide fully detailed specifications of material and finished sheet form with their order, but the press shop personnel will need to design the cutting requirements of the raw material to minimise waste and maximise yield.

8.7 Project Engineering

A generalised layout of a press shop is shown in Figure 8.1. This requires 2000m^2 of light industrial buildings, without overhead cranes, and with provision for expansion in one direction.

The main items of equipment are as follows:

* manual shears for small items
* mechanical punching and shearing machine
* mechanically driven squaring shears for large body panels
* plate rollers to produce panels with large radius bends in one plane
* press brake (controlled movement of the platten) to produce panels with multi bends in one plane
* open fronted press to produce pressing with two dimensional bends.

8.8 Project Scheduling

The estimated implementation time is 12-18 months, assuming installation in a purpose built factory. The machines are standard models available from many suppliers in Europe, USA, Japan and East bloc countries, but tooling would be required to suit the model range assembled in Ethiopia.

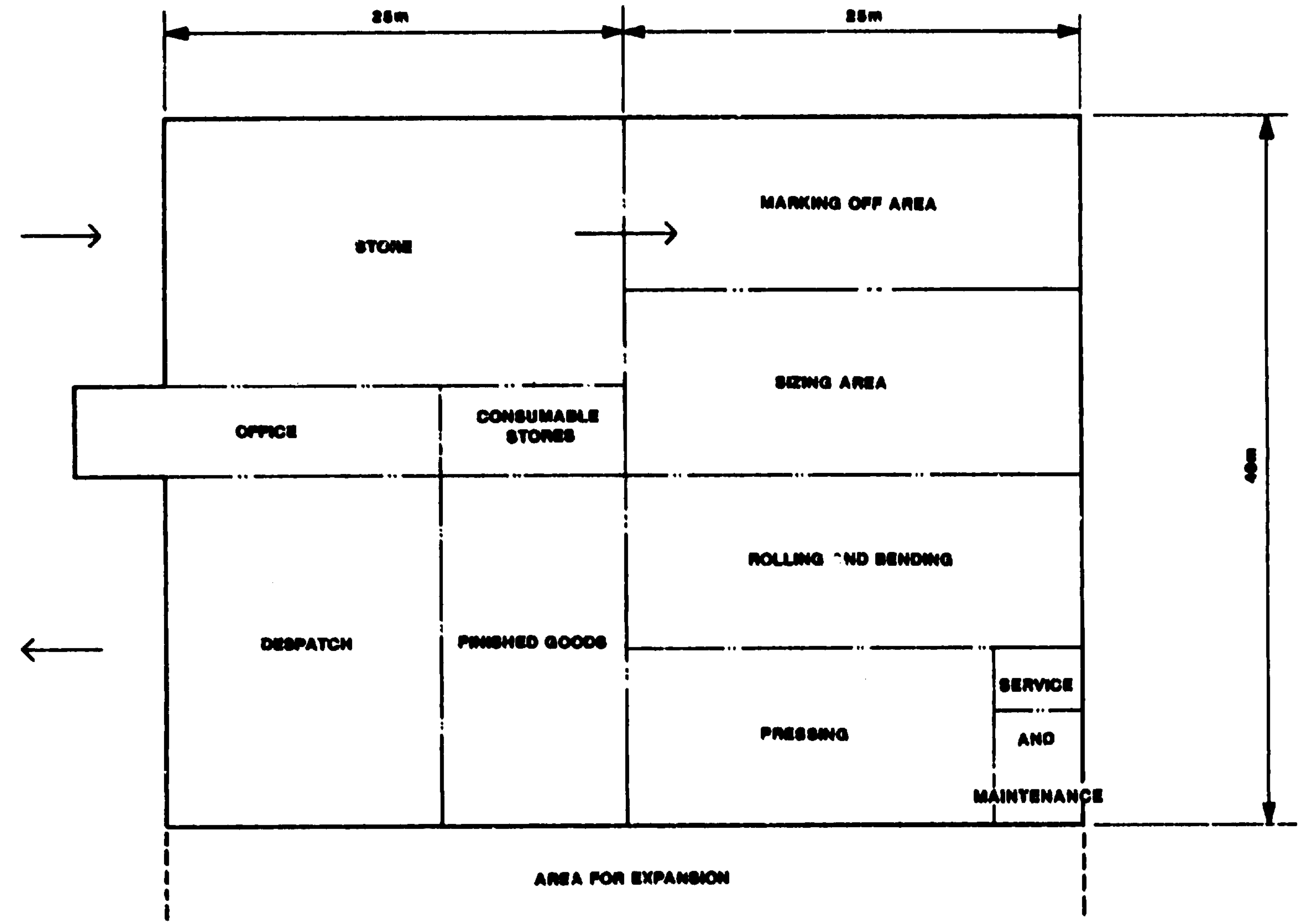

FIGURE 8.1. LAYOUT OF AUTOMOTIVE PRESS SHOP

8.9 Manpower, Organisation and Training

The following manpower is required to achieve the planned output of pressings per year on single shift:

skilled plate workers	2
skilled machinists	5
semi skilled	7
unskilled	11
inspector	1
foreman	1
drivers	2
security	4
administration	4
manager	1
	38

An organisation chart for the project is presented in Figure 8.2. The skills necessary for sheet metal work are usually gained through an apprenticeship, but there are skilled craftsmen available in Ethiopia, and further training can be given in the shop.

A quality control inspector will be needed to ensure that the finished goods are to specification, particularly with regard to dimensional accuracy.

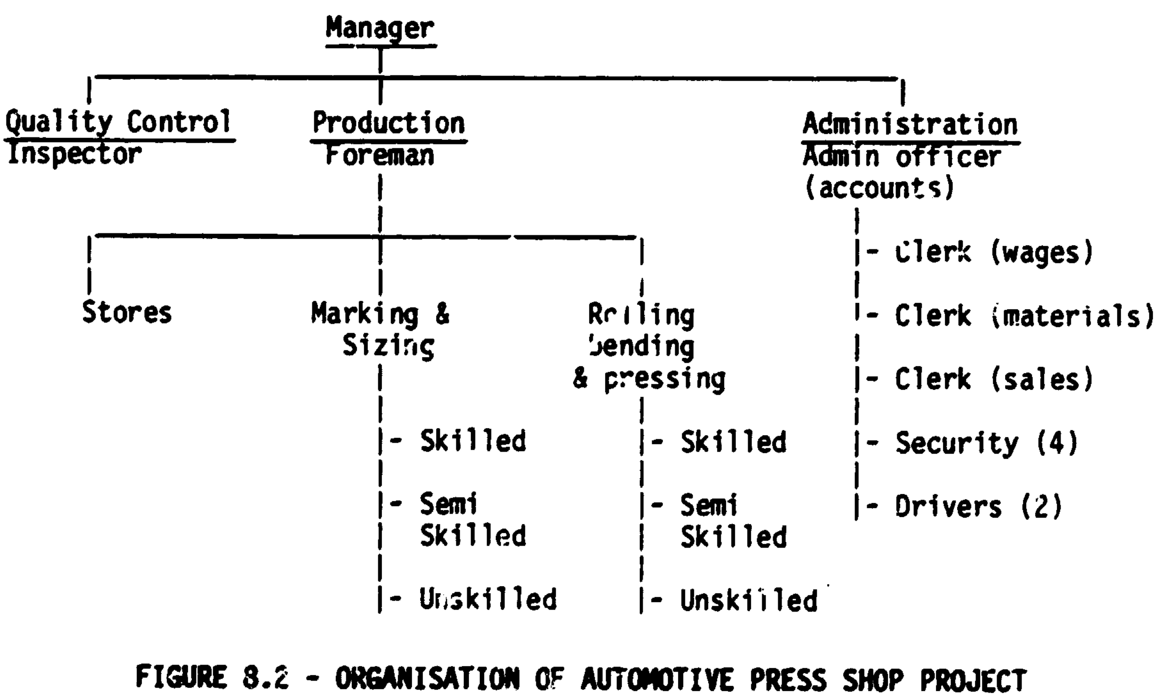

FIGURE 8.2 - ORGANISATION OF AUTOMOTIVE PRESS SHOP PROJECT

8.10 Investment

The following are the investment requirements for an annual capacity of 100,000 panels per year operating the shop on one shift:-

	Foreign	Local	Total
		(Birr '000)	
- Buildings (2000m^2 x 900 Birr)	-	1,800	1,800
- Services	34	11	45
- Vehicles	-	140	140
- Machine tools	1,494	446	1,940
- Tooling	2,040	610	2,650
- Miscellaneous Equipment	181	54	235
Total Investment	3,749	3,061	6,810
Working Capital	-	1,334	1,334
Total Cost	3,749	4,395	8,144

A suitable financial arrangement will be:

	%
- Supplier credits	30
- Bank loans	30
- Equity	40

8.11 Production Costs

Estimated production costs for the planned output of pressings per year on one shift are as follows:

	Birr '000
Labour	132
Materials	1,167
Overhead expenses	256
Depreciation	711
Interest	464
Total production costs	2,730

8.12 Sales Revenue

The net sales revenue in 1990 is forecast at Birr 5.337m as follows:

Sector	Output ('000 units)	Unit ex-works price	Sales revenue
O.E.			
Trucks	45.9	108	4,957
Buses	5.4	108	583
A.M.			
Trucks	0.6	373	224
Buses	0.1	373	37
Total	52.0		5,801
	less 8% transaction tax		464
		Net sales revenue	5,337

8.13 Commercial Profitability

	Birr '000	Birr '000
Net sales revenue	-	5,337
Operating costs	1,555	
Depreciation	711	
Operating profit		3,071
Interest	464	
Gross profit		2,607
Corporation tax	1,304	
Net profit		1,303

$$\text{Rate of return} = \frac{\text{Net profit + interest}}{\text{Total cost of project}} \times 100$$

$$= \frac{1304 + 464}{8144} = 21.7\%$$

$$\text{Repayment Period} = \frac{\text{Total cost of project}}{\text{Net profit + interest + depreciation}}$$

$$= \frac{8144}{1303 + 464 + 711} = 3.3 \text{ years}$$

8.14 National Economic Benefit

Total cost per job created = $\frac{8,144000}{38}$ = 214,351

Foreign exchange cost per job created = $\frac{3,749,000}{38}$ = 98,657

Annual foreign exchange savings =

	Birr '000	Birr '000
import substitution	-	5,092
depreciation of plant	307	
interest on plant	233	
imports of materials	525	
Total FX saving		4,027

9. SHOCK ABSORBERS

9.1 The Product

The function of the shock absorber is to damp the oscillations of the vehicle suspension system. There are three basic types of shock absorber.

9.1.1 Telescopic twin tube

These are the most widely used type. They are oil-filled, having an inner cylinder and an outer casing forming an oil reservoir. There are a variety of different lengths and end fitments according to the make of vehicle. Some have an outer coil spring attachment. There are 3 basic sizes according to the inner cylinder diameter: 1", $1\frac{3}{8}$" and $1\frac{5}{8}$", although some other diameters are also met.

9.1.2 Integral struts

These are used on a few makes of cars - notably on Peugeots' front suspension - and have a stub axle or axle attachment. There is a tendency for new models, particularly Japanese cars, to use integral struts. The McPherson strut, as used on Peugeots, has a replaceable damper cartridge which fits inside the strut, which is similar in construction to the normal telescopic shock absorber.

9.1.3 Monotubes

These, instead of having an outer tube with an oil reservoir, have a floating piston separating the oil from a pressurised gas reservoir. They are for high performance use, having rapid response damping and rapid heat dissipation. They are not necessary for normal Ethiopian conditions.

The project is designed to manufacture the first two of the above types.

9.2 Market Demand, Plant Capacity and Output

Demand for shock absorbers comprises two elements:

* original equipment (OE) demand, which depends on the numbers and types of vehicles being assembled in Ethiopia, and the acceptance of locally produced shock absorbers as components.

* after market (AM) demand for shock absorbers as spare parts. The size of this demand depends upon the number of vehicles in use, and the average replacement rate for shock absorbers per vehicle per year.

Table 9.1 shows estimated OE and AM demand for shock absorbers, assuming an average of four shock absorbers per vehicle assembled, and a replacement rate of 1.5 shock absorbers per vehicle per year.

TABLE 9.1 - MARKET DEMAND, PLANNED CAPACITY AND OUTPUT ('000 units)

	1990		1995		2000	
	Low	High	Low	High	Low	High
Vehicles assembled*	2.5	2.5	4.0	4.7	4.3	5.7
OE demand	10.0	10.0	16.0	18.8	17.2	22.8
Vehicle fleet*	66.3	66.3	78.5	78.5	87.4	87.4
AM demand	99.5	99.5	117.8	117.8	131.1	131.1
OE + AM demand	109.5	109.5	133.8	136.6	148.3	153.9
Planned output	89.6	89.6	110.2	113.0	122.1	127.7
Planned capacity	200.0	200.0	200.0	200.0	200.0	200.0

* excluding tractors

The project is assumed to offer a product range covering all OE demand, plus 80% of AM demand, so that planned output in 1990 is 89,600 units.

The planned capacity of approximately 200,000 shock absorbers per annum on single shift is less than the minimum unit capacity of most items of specialised equipment required for shock absorber manufacture. Output could therefore easily be expanded if necessary.

9.3 Raw Materials

The principal raw materials required are steel tubes, various pressed and machined end mountings and fittings, internal components, piston rods, oil and paints. Tubes, oil and paints, can progressively be obtained from Ethiopian manufacturers, but initially most materials will be imported.

9.3.1 Welded steel tubes

Initially these will be imported in container loads in 6 metre lengths. Later some tubes can perhaps be obtained from Kaliti Steel, if adequate dimensions, tolerances and qualities can be assured. Longitudinally welded tube of 2.5mm maximum wall thickness is required, in various diameters from 1" ID up to about 3".

For the dust cover, finish and specification is not critcal. For the reservoir tube, however, a smooth finish is required and the weld fin must be removed internally and externally. The cylinder tube must be cold drawn and accurately straightened. Additional equipment would be needed at Kaliti Steel.

9.3.2 Piston rods

These are special steel rods, case hardened, ground to very high tolerances and surface finish (2 micron) and hard chrome plated, with precision machined end. Suitable equipment for manufacturing these components is not available in Ethiopia, and would add some 2.75 million Birr to the equipment cost with minimal savings in imported materials. It is therefore recommended that piston rods be imported as finished components from the licensor.

9.3.3 Mountings and end fittings

A variety of end mountings and top and bottom caps are required. The end mountings are unique to each vehicle model and may be rings, eyes, threaded studs, forks, flattened tubes, or special arrangements. The manufacture of these mountings requires a range of stamping, welding and machining operations. These could be made in Ethiopia from suitable plate and bar stock, but to do so in small batch sizes would not always be economical.

These end mountings are normally supplied with special fittings, including nuts and washers (for screw mountings) and rubber bushes and mountings. When adequate quality has been achieved and good rubber-to-metal bonding facilities installed, the rubber components could be obtained from the proposed Rubber Mouldings Project (Project No. 3).

9.3.4 Internal components

A shock absorber contains a number of precision internal components, such as sintered iron valve parts, rubber seals, flexing plates, and turned parts. All of these must be made to fine dimensional tolerances. Many of them are bought-in even by large volume shock absorber manufacturers in Europe. In Ethiopia they would be supplied as part of the kit of parts from the licensor.

9.3.5 Hydraulic oil and paint

The oil is specially formulated for shock absorber applications, and would initially be purchased from the licensor. It could however be supplied by any lubricating oil blending plant. It should also be possible to obtain suitable quality paints in Ethiopia.

9.4 Location

Location is not critical to the project, but in the interests of regional industrial development, there is a case for having this project nearer to the port of importation of raw materials. Tubulars are relatively low value and bulky, whereas the finished shock absorbers can be transported more easily and economically to vehicle repairers throughout the country, who will make up 85%-90% of total demand.

The project would benefit from having a sponsor familiar with the demands of the automotive industry, such as Ethiopian Spring M.B.Sh.Co.

9.5 Project Technology

9.5.1 Tube preparation

Steel tubes for the inner cylinder, outer tube, and dust cover are cut to length and deburred.

The outer tube is given identifying codes in a roll making machine. The ends are shaped by inserting each end manually into a swaging press which reduces the diameter as required. The end cap is then inserted into the tube in a press, and then seam welded into place in an automatic seam welding machine. The completed outer tube assembly is tested for leaks. Satisfactory units are then washed in a dunking type washing machine, and the bottom end mountings and outer tubes are welded together in a projection welding machine.

Cylinder tubes coming off the rotary saw/deburring section are passed to the cylinder end facing machine, where the ends into which the foot valve assembly and top seal/guide assemblies will fit are turned to shape so that a precise fit is achieved. The internal bore of the cylinder is then accurately sized and straightened in a ball sizing machine which presses a tungsten-carbide ball down the tube.

The dust cover tube is cut without further processing and is fitted onto the top cap of the complete shock absorber at the end of the assembly process.

9.5.2 Valve and guide assembly

The valve and guide assembly operations are carried out in clean-room conditions away from the main assembly areas, and all small components are cleaned in an ultransonic cleaning bath, before assembly.

There are a large number of small parts required for assembly of the range of sizes and types of valves and guides. These parts must be carefully labelled, stored and allocated to work stations according to the daily schedule of production. Careful control of the valve assembly operations is required to ensure that the correct components are inserted in the correct orientation and the right sequence.

Small bench presses are provided for the assembly of the foot valves, capsule valves, seal assemblies and bush/guide assemblies, in the clean room.

The seal assemblies and bush/guide assemblies are then assembled into the top cap, and spot welded if necessary. These top assemblies are then fitted onto the piston rod. The top end mountings are projection-welded onto the rod, and the weld tested in a hydraulic pull-test machine. The piston rod sub assemblies are then return to the clean room for assembly of the piston and piston valves.

9.5.3 Final assembly

Completed piston rod assemblies are inserted into the inner cylinders, the cylinder is filled with oil, and the foot valve assembly is fitted.

The outer tube is cleaned, and partially filled with oil, and the cylinder/piston rod inserted into it and top cap pressed home. The shock absorber is now substantially complete except for the top cap welding and the dust cover. Before these are done, the complete unit is tested. Each unit is mounted on the torque test machine which imposes a programmed load and a horizontal motion. A pen attachment should then follow a predetermined motion path. The programmed load includes both rapid and slow oscillations. If the shock absorber does not perform it can then be stripped down and the valve assemblies checked.

Satisfactory units now pass for the final operations. The top cap is seam welded to the outer casing, and the dust cover spot welded on to the top mounting.

The units are opened out fully, washed, and painted using electrostatic spray equipment. After drying, they are closed up again, end fittings added, labelled, and after a final general inspection are boxed for despatch.

9.6 Availability of Technology

There are relatively few manufacturers of shock absorbers worldwide. Designs and equipment are proprietary to the manufacturing companies, and a new entrant to the industry would be unable to develop either the product designs and know-how, or the specialised manufacturing equipment. This project is therefore conditional upon a satisfactory licensing agreement being reached with one of the major shock absorber manufacturers. A number of plants have been set up on this basis in developing countries, for example in Iran, Trinidad and Kenya.

The agreement should cover:

* exclusive rights to use proprietary designs within a specified territory

* transfer of manufacturing technology

* supply of a turnkey equipment package

* supply of tooling and designs for any new models of shock absorber which the project wishes to sell in Ethiopia

* technical and training assistance in setting up and operating the plant

* a troubleshooting service on demand

* regular up-dates on new shock absorber designs and technology

* assistance in negotiating supply contracts with vehicle assemblers in Ethiopia

* supply at favourable prices of shock absorbers not manufactured by the project so that the project can offer an extensive range.

The costs of this licensing agreement are covered in the estimates of capital costs and raw materials.

9.7 Project Engineering

The proposed layout of a plant to manufacture 200,000 shock absorbers per year on single shift is presented in Figure 9.1. This is for assembly from imported kits supplied by the licensor, with increasing local content in later years.

The project requires 1200m^2 (32x37.5m) of light industrial building with standard concrete floor and no overhead cranes. The work flow is U shaped, starting with tube cutting and cylinder sizing, followed by piston rod and foot valve assembly, than final assembly in the return direction.

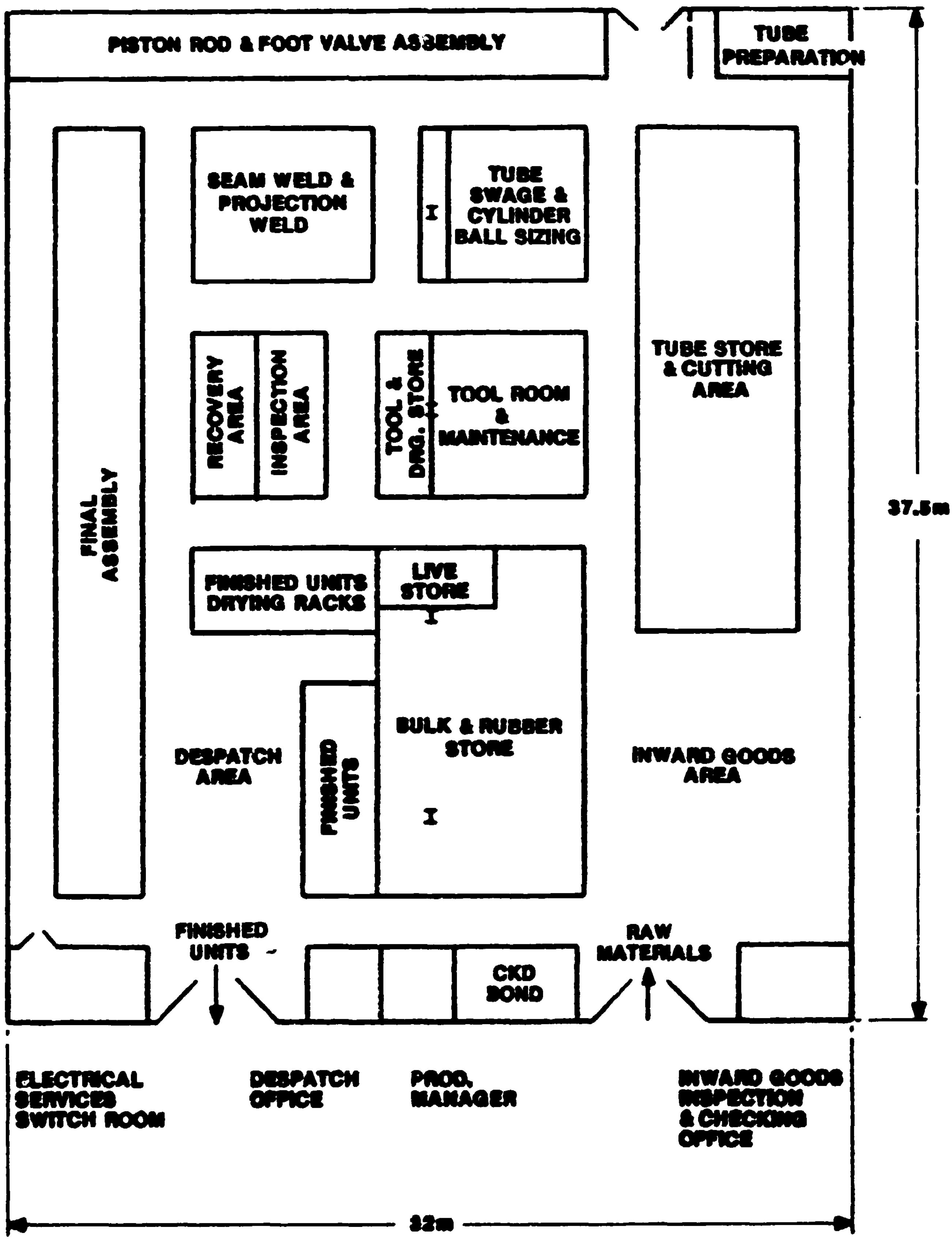

FIGURE 9.1 LAYOUT FOR MANUFACTURE OF SHOCK ABSORBERS

Most of the equipment is dedicated specialist plant, manufactured to the licensor's specifications, and supplied as a complete package. Some additional equipment could be bought locally, such as racks, stillages, trolleys, benches, furniture and hand tools.

9.8 Project Scheduling

The required implementation period is 24 months, allowing 8 months for detailed negotiations with the licensor, and 16 months for equipment manufacture, shipment and installation. Construction of a suitable building, and training of key personnel at another of the licensor's plants, would run in parallel with these activities.

9.9 Manpower, Organisation and Training

Most of the items of production equipment have capacities well in excess of the planned plant capacity of 200,000 units per year. In many cases, the machine loading is only around 3 hours per week per 100,000 units of production. For this reason a flexible manning system is required, in which one skilled operator carries out more than one related operation, wherever physical proximity of the machines in the layout permits it. There are buffer stocks of work in progress between each operation, in stillages or trolleys, so that operations can be programmed accordingly.

The total manpower required for the planned output is as follows:

skilled operators & fitters	24
semi-skilled production assistants	9
unskilled labourers	9
chargehands	3
inspectors	2
maintenance engineers	2
sales, personnel and purchasing officers	3
secretary	4
clerks and storekeepers	7
drivers	2
messengers	3
security	12
managers	3
general manager	1
	84

There are 22 skilled operators plus 2 skilled maintenance fitters. In addition, assistants are assigned to each group of operations: these will carry out less skilled operations to relieve temporary bottlenecks as required and act a pool of apprentices who can take over skilled operations when required.

An organisation diagram for this project is presented in Figure 9.2.

Shock absorber manufacture requires precision mechanical engineering. Some personnel with an engineering background can be recruited in Ethiopia, but all levels of manpower and management will require training in the product and manufacturing technology. This training programme should include:-

* secondment of technical assistance personnel from the licensor for commissioning and for a period of at least 6 months thereafter

* regular visits by the licensor's technical assistance personnel during the first 2-3 years

* visits by 8-10 key management and supervisory staff to the licensor's plant for periods of 2 weeks, ie 16-20 man weeks of training in total.

9.10 Investment

The capital cost of a project with capacity to manufacture 200,000 units per year on single shift is as follows:

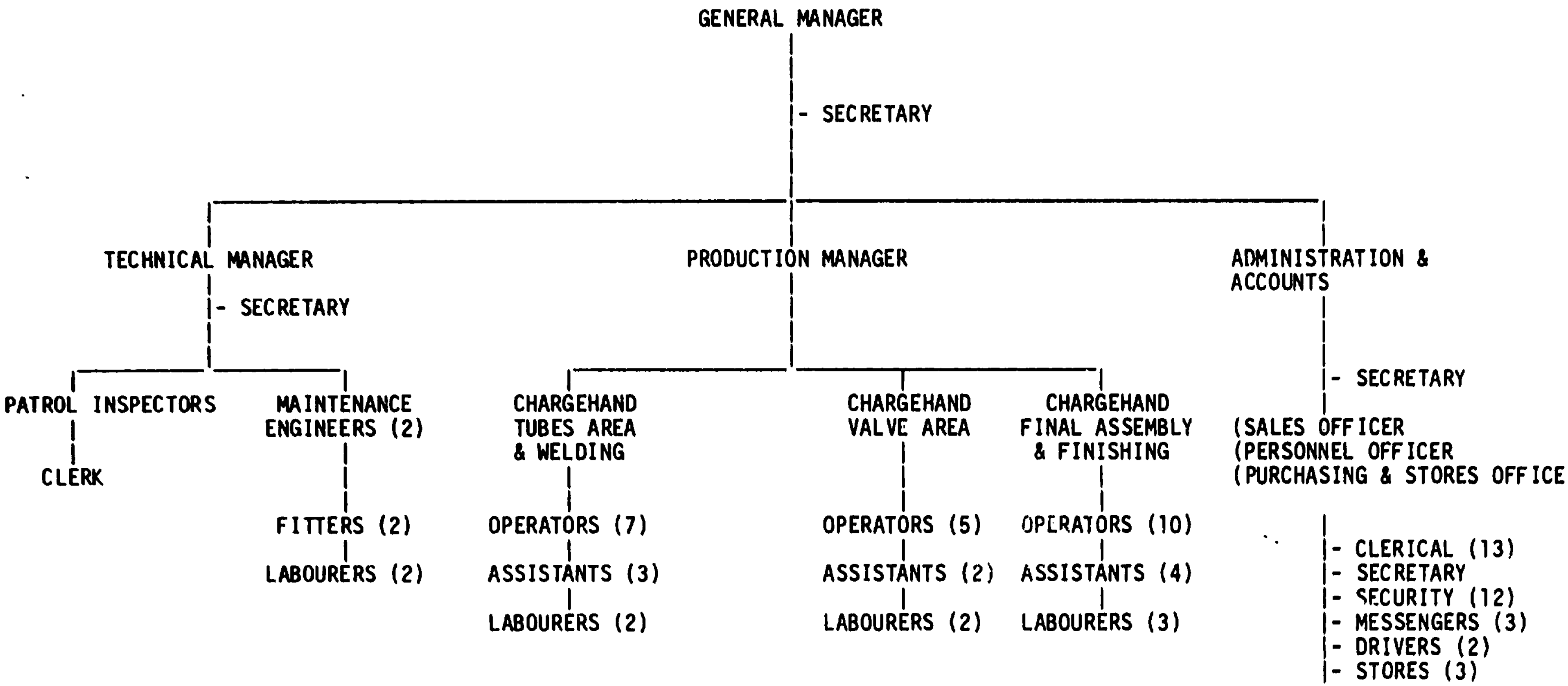

FIGURE 9.2 - ORGANISATION OF SHOCK ABSORBER PROJECT

	Foreign	Local (Birr '000)	Total
Buildings	-	1,080	1,080
Services	43	11	54
Vehicles	-	140	140
Racks, tables etc.	-	250	250
Plant equipment & tooling	2,641	792	3,433
Total investment	2,684	2,273	4,957
Working capital	-	1,534	1,534
Total cost	2,684	3,807	6,491

The proposed financial structure is as follows:

- supplier credits 30%
- bank loans 30%
- equity 40%

9.11 Production Costs

Production costs for the planned 1990 output of 89,600 units are as follows:-

	Birr '000
Labour	310
Materials	1,650
Overhead expenses	234
Depreciation	540
Interest	370
Total production costs	3,104

9.12 Sales Revenue

The net sales revenue in 1990 is forecast at Birr 6.135m as follows:

Sector	Output ('000 units)	Unit ex-works price (Birr)	Sales revenue ('000 Birr)
O.E.			
Trucks and buses	8.0	32	256
Trailers	2.0	32	512
A.M.			
Trucks and buses	25.7	109	2799
Cars and pick-ups	50.4	54	2723
Trailers	3.5	109	379
Total	86.9		6669
	less 8% transaction tax		534
		Net sales revenue	6135

9.13 Commercial Profitability

	Birr '000	Birr '000
Sales revenue	-	6,135
Operating costs	2,194	
Depreciation	540	
Operating profit		3,401
Interest	370	
Gross profit before tax		3,031
Corporation tax	1,516	
Net profit		1,515

Rate of return $= \frac{\text{net profit + interest}}{\text{total cost of project}} \times 100$

$= \frac{1515 + 370}{6491} \times 100 = 29.0\%$

Repayment period $= \frac{\text{total cost of investment}}{\text{net profit + interest + depreciation}}$

$= \frac{6491}{1515 + 370 + 540} = 2.7$ years

9.14 National Economic Benefit

Total cost per job created $= \frac{6,491,000}{84} =$ Birr 77,274

Foreign exchange cost per job created $= \frac{2,684,000}{84} =$ Birr 31,592

Annual foreign exchange savings:

	Birr '000	Birr '000
import substitution	-	2,890
depreciation of plant	330	
interest on plant	250	
imports of materials	742	
Total FX saving		1,568

10. WINDOWS AND WINDSHIELDS

10.1 The Product

This project is designed to supply all the glass required in vehicles. Vehicle glass can be either tempered (toughened) or laminated.

Tempered glass is made by heating and rapid cooling of float glass, to produce a toughened outer skin which resists impact. On severe impact the inner tensile stresses are released and the glass shatters instantly across the entire surface into many granular fragments.

Laminated glass consists of two or more sheets of float glass, interlayered with sheets of PVB (polyvinylbutyral). The resulting laminate is more resistant to impact, and does not collapse if the outer layer is cracked.

Laminated glass is in general 2-3 times the price of tempered glass, because of the cost of the PVB interlayer, and higher plant costs. For this reason tempered is normally used for side and rear windows. In some countries laminated is specified for windscreens because of its greater impact resistance, but other countries allow either laminated or tempered. In Ethiopia both types are used, and AMICE has said it would have no objection to tempered windscreen in its trucks and buses. It is therefore proposed that the project should initially produce tempered only, but with factory space for laminated at a later date.

10.2 Market Demand, Plant Capacity and Output

Market demand, planned output and plant capacity for glass manufacture are set out in Table 10.1.

TABLE 10.1 - MARKET DEMAND, PLANNED CAPACITY AND OUTPUT ('000 units)

	1990		1995		2000	
	Low	High	Low	High	Low	High
Vehicles assembled:						
trucks	1.7	1.7	3.0	3.7	3.1	4.5
buses	0.3	0.3	0.4	0.4	0.5	0.5
OE demand for glass:						
trucks	13.6	13.6	24.0	29.6	24.8	36.0
buses	6.0	6.0	8.0	8.0	10.0	10.0
total	19.6	19.6	32.0	37.6	34.8	46.0
Vehicle fleet:						
trucks	19.2	19.2	23.6	23.6	24.0	24.0
buses	2.2	2.2	2.8	2.8	3.4	3.4
cars	42.0	42.0	48.6	48.6	56.4	56.4
AM demand for glass:						
trucks	3.0	3.0	3.8	3.8	3.8	3.8
buses	0.6	0.6	0.8	0.8	0.9	0.9
cars	4.2	4.2	4.9	4.9	5.6	5.6
total	7.8	7.8	9.5	9.5	10.3	10.3
OE + AM demand	27.4	27.4	41.5	47.1	45.1	56.3
Planned output	23.5	23.5	36.7	42.3	39.9	46.0
Capacity	74.0	74.0	74.0	74.0	74.0	74.0

It has been assumed that on average a vehicle contains the following number of pieces of glass:

	Windscreeen	Windows
Buses	2	18
Trucks	2	6
Cars	1	5

The AM demand estimates assume that each year windscreens are replaced on 5 percent of the fleet, and side windows are replaced in 1 percent of the fleet. This excludes tractors, which in future will not have cabs. It also excludes trailers.

Planned output assumes that the project would supply all the glass for vehicles asssembled in Ethiopia, but only 50 percent of the replacement glass for the diverse range of vehicles in the fleet.

There is also a non-automotive market for tempered safety glass for doors in buildings. This is not included in the planned output in Table 10.1, but might generate some additional revenue for the project.

10.3 Raw Materials

The major raw material for the project is high quality float glass, which would be imported until a float glass plant is operating in Ethiopia. Sheets will be 1-2m wide, 2-4m long and 4-12mm thick as delivered.

10.4 Location

Glass is heavy and fragile, and requires adequate crating for transport. Finished windscreens and side windows are also easily scratched or shattered and are mainly used by assemblers. The project should therefore preferably be located close to the assembly plants, or alternatively close to the future float glass plant.

10.5 Project Technology

Glass for tempering has first to be cut to the finished size and shape of the vehicle windscreen or window, using templates.

Tempering is achieved by heating the cut pieces in a tempering furnace to about 700°C, followed by rapid chilling to 80-60°C by air blowers.

10.6 Availability of Technology

A number of companies in Europe, USA or Japan are able to supply complete production units for tempered and laminated screens, together with training in their operation.

10.7 Project Engineering

A generalised factory layout for the project is presented in Figure 10.1. It requires a single floor light industrial building of 2,576 m^2 (46 x 56m). All plant is floor mounted and no overhead cranes are required. Space has been reserved for laminating equipent when required.

From the glass store flat glass sheets move anti-clockwise to the cutting, grinding, washing and powdering machine which produces shaped pieces as required. These pieces pass either to the tempering furnace, or to the serial bending machine in the case of laminated windscreens. Pairs of screens emerge from the bending furnace and pass into the air conditioned clean room for lamination with PVB interlayer. They then move first through the vacuum box and on to the autoclave where lamination is completed. There is template storage, a mould store, compressor room for the autoclave, test laboratory and offices.

10.8 Project Scheduling

Plant of this type is available 10-12 months from order. Total implementation time is therefore approximately 12-18 months, including selection, specification, manufacture and commissioning of plant, in parallel with construction of a suitable building.

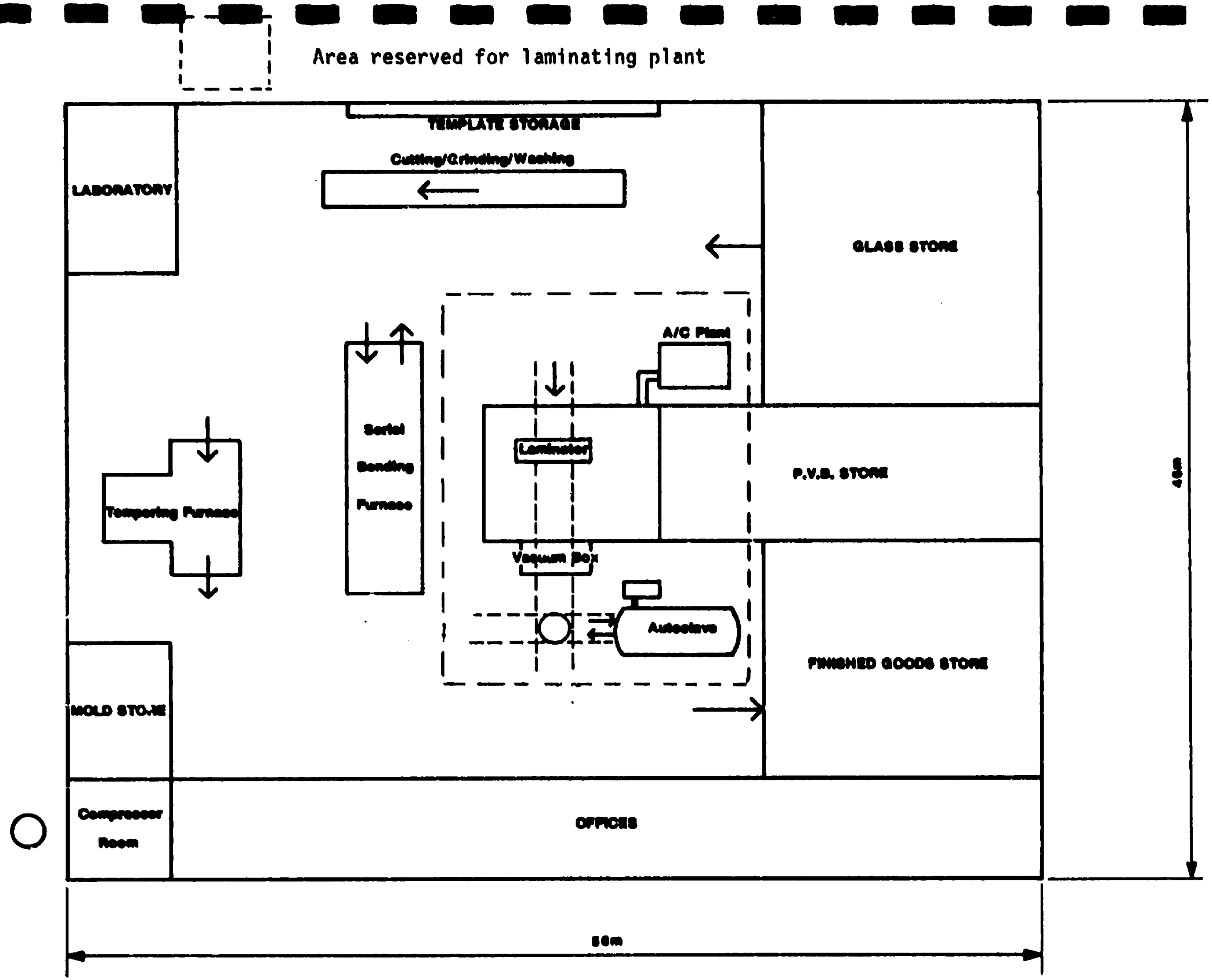

FIGURE 10.1. LAYOUT FOR MANUFACTURE OF AUTOMOTIVE WINDOWS AND WINDSHIELDS

10.9 Manpower, Organisation and Training

The following manpower is required to achieve the planned output in 1990 on a single shift basis:

unskilled	10
semi-skilled	3
foreman	1
driver	1
security	4
administration	4
laboratory technician	1
manager	1
	18

An organisation chart for the project is presented in Figure 10.2.

Training will be provided by the plant suppliers, over a period of 2-4 weeks. This will include training of a laboratory technician to carry out standard tests, agreed within the industry, on sample pieces.

10.10 Investment

The following investment is required to install the above plant, with an effective capacity under normal operating conditions of 74,000 tempered pieces per annum on one shift. This capacity is determined by the minimum output of key plant items; it could readily be increased by two shift operation.

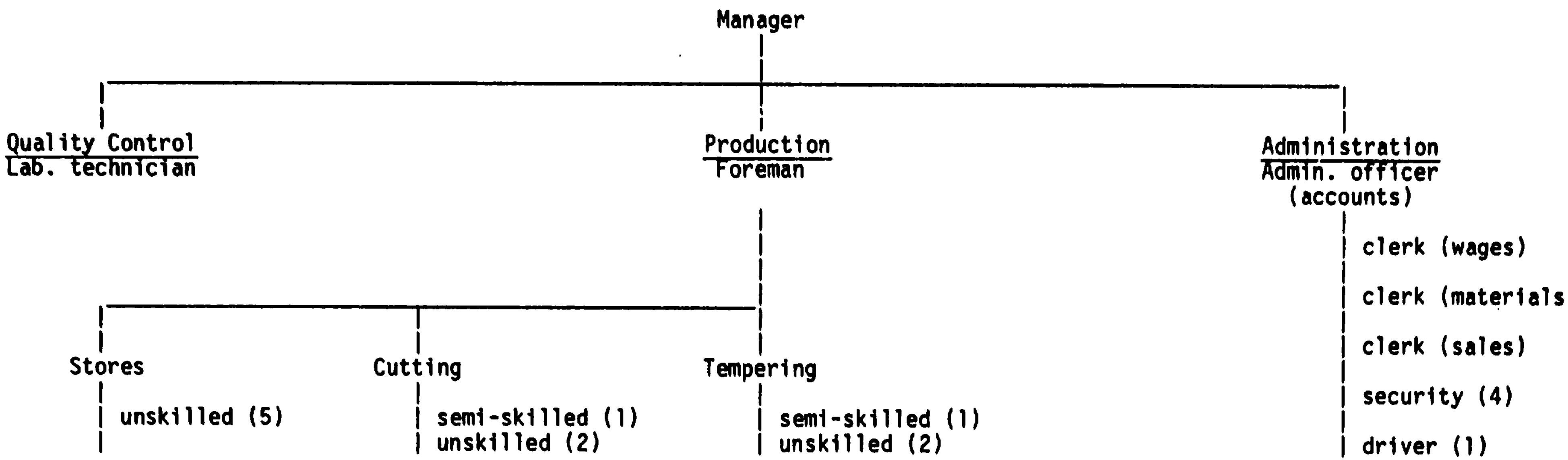

FIGURE 10.2 - ORGANISATION OF WINDOW/WINDSHILED PROJECT

	Foreign	Local	Total
Buildings (2,576m² x900 Birr)	-	2,318	2,318
Services	93	23	116
Vehicles	-	70	70
Plant equipment & spares	1,584	475	2,059
Miscellaneous equipment	-	100	100
Total investment	1,677	2,986	4,663
Working capital	-	557	557
Total cost	1,677	3,543	5,220

A suitable financial structure is:

	%
suppliers credits	35
bank loans	25
equity	40

10.11 Production Costs

Estimated production costs for the planned 1990 output of tempered pieces are as follows:

	Birr '000
Labour	54
Materials	130
Overhead expenses*	114
Depreciation	384
Interest	297
	979

10.12 Sales Revenue

The net sales revenue in 1990 is forecast at Birr 2.227m, as follows:

Sector		Output ('000 units)	Unit prices ex-works (Birr)	Sales ('000 Birr)
Original equipment				
Trucks and buses	w/s	4.0	81	324
	side	19.6	42	655
After market				
Trucks and buses	w/s	2.1	279	586
	side	1.6	143	229
Cars	w/s	2.1	187	393
	side	2.1	111	233
				2420
	less 8% transaction tax			193
	Net sales revenue			2227

10.13 Commercial Profitability

	Birr '000	Birr '000
Sales revenue	-	2,227
Operating costs	298	
Depreciation	384	
Operating profit		1,545
Interest	297	
Gross profit		1,248
Corporation tax	624	
Net profit		624

$$\text{Rate of return} = \frac{\text{net profit + interest}}{\text{total cost of project}} \times 100$$

$$= \frac{624 + 297}{5,268} \times 100 = 17.5\%$$

Repayment period = $\frac{\text{Total cost of project}}{\text{net profit + interest + depreciation}}$

$$= \frac{5,268}{624 + 297 + 384} = 4.0 \text{ years}$$

10.14 National Economic Benefit

Total cost per job created = $\frac{5,268,000}{18}$ = Birr 292,666

Foreign exchange cost per job created = $\frac{1,677,000}{18}$ Birr 93,166

Annual foreign exchange saving:

	Birr '000	Birr '000
import substitution		1,309
depreciation of plant	440	
interest on plant	334	
imports of materials	58	
Total FX saving		477

11. AUTOMOTIVE FERROUS FOUNDRY

11.1 The Product

The foundry will manufacture a range of iron castings (grey iron, SG iron) for:

* Fiat (IVECO) truck and bus engines and transmission
* Belarus tractors
* Fiat tractors (proposed project)
* ad hoc spares for other vehicles.

Non-automotive castings have not been included in the product mix because the Spare Parts Project caters for the production of steel, grey iron and non-ferrous castings of spare parts for the textile, sugar, cement and metal working and railway industries.

There is no significant demand for steel castings for the automotive industry. At a later stage it would be possible to include a steel foundry, which would be able to produce castings for defense and other industries if required, or steel castings could be supplied by the Spare Parts project. It is common in some developing countries such as India and Pakistan to combine the production of ferrous castings with the production of small uphill-teemed steel ingots for rerolling with reinforcing bar. This wculd be a future possibility if a rerolling mill were established.

11.2 Market Demand Capacity and Output

The demand for iron castings for trucks, buses and tractors is shown in Table 11.1. It is assumed that the foundry would satisfy the whole of this requirement, and a further 10 percent has been included for replacement parts. For the after market many of the blocks and main castings would be reclaimed by the Engine Rebuild Facility (Profile 4) so the after market will not be very large at first. As the fleet of vehicles using Ethiopian engines grows, however, the after market will also grow, and the foundry is designed with space for expansion to cope with this if required.

TABLE 11.1 - MARKET DEMAND, PLANNED OUTPUT AND CAPACITY

	1990		1995		2000	
	Low	High	Low	High	Low	High
Vehicle output:						
- Trucks and buses	2.0	2.0	3.4	4.1	3.6	5.0
- Tractors	2.9	2.9	4.2	4.2	5.7	5.7
Demand for castings:						
- Trucks and buses (tonnes)	1,393	1,393	2,368	2,855	2,507	3,483
- Tractors (tonnes)	4,029	4,029	5,835	5,835	7,917	7,917
Planned output (tonnes)*	5,964	5,964	9,023	9,550	11,466	12,540
Planned capacity	7,500	7,500	15,000	15,000	15,000	15,000

* including 10% of output for after market.

The design capacity on two shifts is 1 million parts totalling 15,000 tonnes of castings per year. In the early years when automotive manufacture is approximately 5,000 vehicles per year, the foundry would run on one shift with 7,500 tonnes capacity. There would be around 150 to 200 different patterns, excluding after market spares for other vehicles in the national fleet.

All component weights and dimensions are estimated by the consultant since design specifications for the vehicles to be produced in future are not known. The composition of 1990 planned output is detailed in Table 11.2.

TABLE 11.2 - DEMAND FOR AUTOMOTIVE IRON CASTINGS - 1990

Part	TRACTORS				TRUCKS AND BUSES			
	Number per tractor	Total number ('000)	Weight each (Kg)	Total weight (tonnes)	Number per vehicle	Total number ('000)	Weight each (Kg)	Total weight (tonnes)
Rear axle casing	2	5.8	200	1,160	-	-	-	-
Engine block	1	2.9	150	435	1	2.0	200	400
Cylinder head	1	2.9	60	174	1	2.0	60	120
Wheel hubs	4	11.6	10	11	6	12.0	30	36
Brake drums	2	5.8	30	174	4	8.0	40	320
Gearbox casing	1	2.9	50	145	1	2.0	50	100
Flywheel	1	2.9	30	87	1	2.0	40	80
Flywheel casing	1	2.9	20	58	1	2.0	20	40
Exhaust manifold (sections)	1	2.9	15	43	3	6.0	8	-
Steering box casing	1	2.9	10	29	1	2.0	10	20
Water pump housing	1	2.9	8	23	1	2.0	8	16
Univ. joint parts	12	34.8	5	174	12	24.0	5	120
Engine supports	-	-	-	-	4	8.0	5	40
Spring support bases	-	-	-	-	8	16.0	3	48
Starter/dynamo end caps	4	11.6	1	1	4	8.0	1	8
Rear attachment parts	20	58.0	5	290	-	-	-	-
Tool kit	5	14.5	0.5	7	5	10.0	0.5	5
Misc. small parts	20	58.0	1	58	20	40.0	1	40
Counter weights	10	29.0	40	1,160	-	-	-	-
TOTALS		252.3		4,029		146.0		1,393

Based on annual output of 2000 trucks and buses and 2900 tractors with full local assembly of engines and gearboxes.

11.3 Raw Materials

The main raw materials are:

* pig iron
* scrap iron and steel
* foundry sand
* ferroalloys, graphite and other additives
* binders
* wood for pattern making.

There is no ironmaking in Ethiopia and pig iron would need to be imported.

Apart from foundry sand, some iron scrap, and perhaps binders like bentonite, the main materials will need to be imported.

A robust electricity supply system is required to support the intermittent high load of the induction furnaces.

Raw material requirements are estimated as follows:

Metallics

a) Total finished castings (machined)	12 362	tonnes
b) Raw casting weight (10%)	13 598	
c) Gross castings (15%)	15 638	
d) Tapped metal (50%)	23 457	
e) Charged metal (5%)	24 630	
f) Foundry returns (d-b) x 95%	9 366	
g) Metallics requirement	15 264	

Sand

Heavy Line: mould box volume average	$0.35m^3$
moulds/year	103,000
sand @ $1.5t/m^3$	54,000t
Light Line: mould box volume	$0.2m^2$
moulds/year	133,000
sand	40,000t
Total sand	94,000t
Make up sand @ 3%	2,800t
Bentonite @ 0.5%	470t
Other binders @ 0.3%	280t

11.4 Location

The main determinant of location is the power requirement and the need for a stable industrial labour force. This means that an urban location is required, which should ideally be situated either close to the assembly plants or near the port. It is also desirable to have the main component manufacturers - the foundry, forge and machine shops - close together for easy interchange of knowhow and experience.

11.5 Project Technology

To obtain the quality necessary for automotive components a fair degree of mechanisation is required, with adequate finishing facilities and good laboratory/QC facilities. The throughput required is sufficient to justify two mechanised greensand moulding lines, without unnecessary automation.

No allowance has been made in the proposal for jobbing work, which would require a floor or pit moulding section. The Spare Parts Project is designed to cater for this type of work and it would complicate the planning, management and materials flow in an efficient automotive foundry.

The proposed lines are:

* heavy line: typical mould size 750 x 650 x 500/150mm (larger moulds for some components). The heavy line produces about 80% of castings in tonnage terms

* light line: typical mould size 800 x 500 x 200/200 132,750 moulds/year @ 3000 hours = 45 moulds/hour. The light line produces about 20% of catings in tonnage terms.

These lines would have roller tracks, and two moulding machines each for drags (bottom halves) and two for capes (top halves).

For melting, the options are:

* cupolas: these require good quality foundry coke which would have to be imported. It is a friable commodity and transport conditions would make this option uneconomic

* electric arc furnaces: require a stiff power grid to cope with the intermittent load

* electric induction furnaces: assumed for the present profile.

The average melting requirement to produce 15,000 t.p.a. on two shifts is 8 tonnes/hour over 3000 hours (two shifts with 75% availability). The maximum requirement would occur when the heavy casting line is making large engine blocks. In this case it would be working rather below the average line speed, and the light casting line would be programmed to be producing smaller castings. The total maximum requirement would be:

Heavy line: 200kg x 30/hour x 175% (melt/castings) = 10.5 t/hr
Light line: 20kg x 45/hr x 175% = 1.6 t/hr

Total : 12 tonnes/hour.

To meet this maximum requirement with adequate flexibility and stand-by capacity, two 3 tonne coreless induction furnaces and two 6 tonne coreless induction furnaces are proposed. Cycle time is about 1 hour.

After melting, the hot metal is held in a holding furnace. Two 20 tonne channel type induction furnaces are proposed.

The hot metal is transferred to the moulding lines in ladles. The two halves of the mould (drags and copes) are formed in jolt-squeeze moulding machines using wooden patterns. The cores are inserted, the two halves closed, and the hot metal teemed as the mould boxes move along a roller track. There is a cooling section, then the boxes are opened, used sand shaken out and returned to the sand plant for recycling. The castings are de-headed and go on to the finishing section for fettling, shotblasting and grinding.

Complex castings which are to be machined require heat treatment to relieve stresses. Some castings may need repair for which they are heated, welded, then heat treated if necessary. Finally the castings are tested, with ultrasonic and ultraviolet crack detection equipment, then hardness and dimensional tests.

Cores will mainly be made by the Ashland (cold-box) process. A small capacity for hot-box process may also be required. A range of large, medium and small machines, about 10 in all, is needed. Cores are made with new sand mixed with liquid resins, then coated. After knocking out of the mould, the sand from cores and moulds together returns to the sand plant.

At the sand plant, new sand is dried and stored in a silo. Return sand passes over a magnetic separator, then a rotary or vibratory cooler/breaker screen, and then held in two return sand silos. Sand and additives are then fed into a sand mill and then to the moulding lines.

11.6 Availability of Technology

Foundry work is a mature technology. There is world overcapacity because of the recent slow down in automotive demand and the automation and modernisation of many foundry operations. Equipment and technology is widely available, including second-hand equipment. Different items of equipment are supplied by different manufacturers and good specification and procurement is important. Some major engineering groups can provide a turnkey service, and could be interested in equity participation (although it may be difficult to obtain reasonable terms). There are independent consultants specialising in foundry design and project management.

11.7 Project Engineering

A suggested list of main equipment is given in Table 11.3. Specifications of individual equipment items would require a detailed feasibility study.

A suitable layout is shown in Figure 11.1. It consists of a site of 3.6 hectares, and covered area of $15,200m^2$. Allowance has been made for addition of a third line in future.

11.8 Project Schedule

The project is not viable until engine assembly has been established in Ethiopia. Since AMCE is still at an early stage of its deletion programme and there are as yet no firm projects for engine assembly, this will take quite some time.

Procurement and construction of the foundry project would take about 2 years, after several years for feasibility studies and negotiations with engine/vehicle manufacturers. With adequate training and technical assistance a learning curve of 2-3 years should be possible, to achieve full production, but the coordination of product design, development, product acceptance, and general

TABLE 11.3 - AUTOMOTIVE FOUNDRY - LIST OF MAIN EQUIPMENT

		US dollars ('000)
A: Stockyard: Cranes, bunkers, transfer cars, weighscale		730
B: Melting: 2 x 3t and 2 x 6t induction furnaces, 2 x 20t holding furnaces, weighscales, crane, bins, skips, bogies		4000
C: Mechanical moulding line for light castings: Roller track, 2 x moulding machines (drags), 2 x moulding machines (copes), crane, conveyors, hoppers, fume extraction		700
D: Mechanised moulding line for heavy castings: Roller tracks, 4 x moulding machines, hoists, cranes, chain conveyor, fume extraction, hoppers		1300
E: Moulding boxes, pattern equipment for two lines		1250
F: Laboratory		660
G: New sand drying: Sand drying equipment, hoppers, conveyors etc		550
H: Sand plant: 40t/h breaker cooler screen, sand mill, pneumatic conveyor systems, dust and fume control		2650
I: Core making and storage		2860
J: Cooling		330
K: Shot blasting:		600
L: Fettling		1900
M: Despatch		80
N: Pattern making		1000
O: Heat treatment		650
P: Services:		
Maintenance & stores		250
Transport		450
Weighbridge		80
General stores		60
General plant services (elec, water, air, oil)		620
HT elec. equipment		600
Gen. admin		350
TOTAL	US$	21 670 thousand
	Birr	44 234 thousand

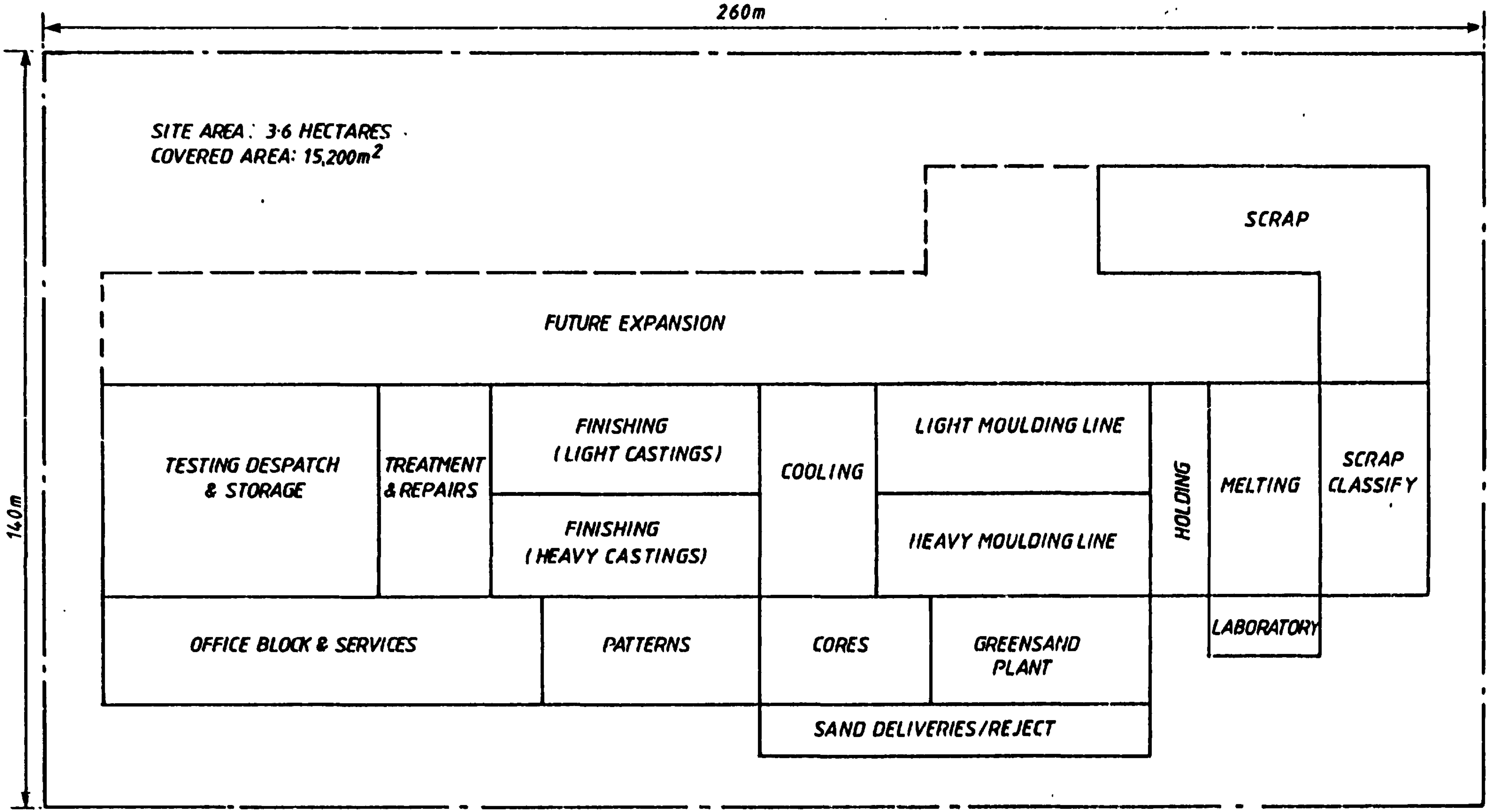

Figure 11.1 AUTOMOTIVE FOUNDRY LAYOUT, ETHIOPIA

quality assurance by engine and vehicle assemblers mean that in practice it would probably take very much longer to reach full production.

11.9 Manpower and Organisation

Manning requirements for single shift operation are shown in Table 11.4. A suitable organisation chart is shown in Figure 11.2.

TABLE 11.4 - FOUNDRY MANNING REQUIREMENT

	A Mgr	B Supt/ Eng.	C Foremen	D Sk	E S.Sk	F U.Sk	G Clerical	Total
General Manager	1							1
Prodn. Management	1	3	17	4	2	-	4	31
Maintenance	1		4	20			1	26
Technical/Lab	1		12				1	14
Quality	1		2				1	4
Methods		3	2	8			1	14
Sales	1	1					2	4
Accounts etc	1	1	3				15	20
Personnel		1	1				1	3
Medical				4	2			6
Stockyard					4			4
Melting					16			16
Moulding					34			34
Coreshop					20	2		22
Sandplant					3			3
Finishing					44	4		48
Transport					11			11
General					8	9		17
	7	9	41	36	144	15	26	278

11.10 Investment

The following estimated local and foreign currency investment is required for the project. This includes capitalisation as pre-operating expenses of one year's wage bill, plus an allowance for technical assistance and overseas training.

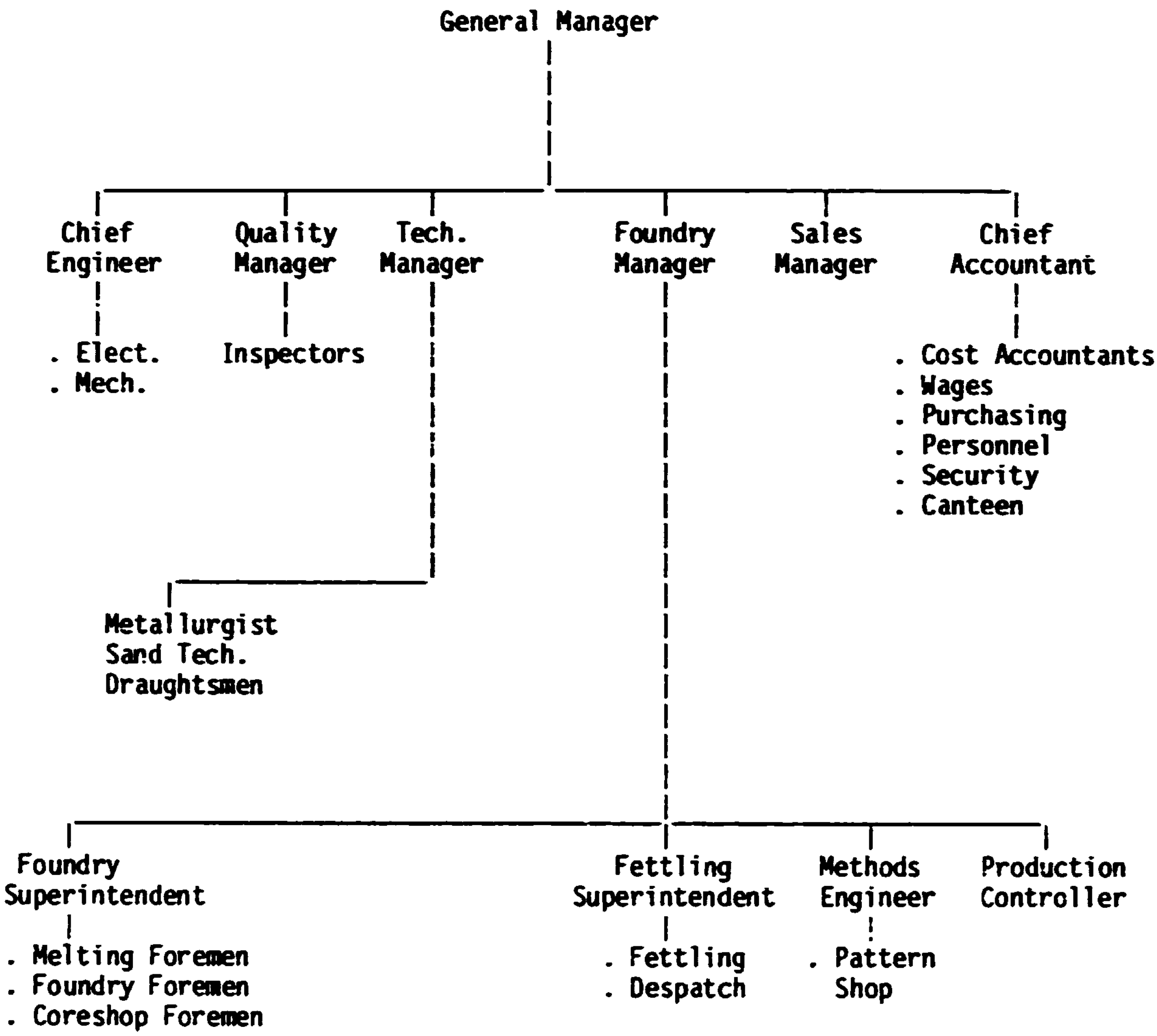

FIGURE 11.2 - FOUNDRY ORGANISATION CHART

	Foreign	Local (Birr '000)	Total
Buildings (15,200m² @ 1200B)	-	18,240	18,240
Services	730	182	912
Plant and equipment	50,846	15,250	66,096
Locally purchased equipment	-	2,600	2,600
Training and pre-op expenses	818	1,636	2,454
Total fixed assets	52,394	37,908	90,302
Working capital	-	8,498	8,498
Interest during construction	5,700	-	5,700
Total cost	58,094	46,406	104,500

A suitable financing package would be:

	Birr Million
Local equity	35
Foreign equity	5
Foreign loans	25
Suppliers' credits	35
	100

11.11 Production Costs

Estimated production costs for the planned 1990 output of 5,694 tonnes are as follows:

	Birr '000
Labour	1,050
Materials and electricity	11,601
Overhead expenses	3,514
Depreciation	10,800
Interest	5,956
Total production costs	32,921

11.12 Sales Revenue

The AMCE deletion price of castings ranges from about 3 to 10 Birr/kg fob, averaging about 5 Birr. This is equivalent to 8.15 Birr/kg delivered to Addis duty paid according to information from AMCE and from the Price Control Administration. Allowing an average 30% mark-up for machining, a typical sales price ex foundry is about 5.7 Birr per kg.

The forecast 1990 net sales revenue of the foundry is therefore:

5,964 tonnes x 5.7 Birr/kg	=	33.99 million Birr
- less 8% transaction tax	=	2.72
Net sales revenue	=	31.27 million Birr

11.13 Commercial Profitability

	Birr	Million
Net sales revenue		31.27
Operating Costs	16.16	
Depreciation	10.80	
Operating profit		4.31
Interest	5.96	
Gross loss before tax		(1.29)
Corporation tax	-	
Net loss		(1.29)

$$\text{Rate of return} = \frac{(\text{net profit} + \text{interest}) \times 100}{\text{total investment}}$$

$$= \frac{-1.29 + 5.96}{104.50} \times 100$$

$$= 4.5\%$$

$$\text{Repayment Period} = \frac{\text{total investment}}{\text{net profit + interest + depr.}}$$

$$= \frac{104.50}{-1.29 + 5.96 + 10.80}$$

$$= 6.7 \text{ years}$$

Note: there is likely to be a long period of learning before profitablity is reached which should be added to the repayment period.

11.14 National Economic Benefit

$$\text{Cost per job created} = \frac{\text{B 104.50 million}}{278}$$

$$= 375\ 900 \text{ Birr/job}$$

$$\text{FX Cost per job} = \frac{\text{B 58.09 million}}{278} = 208{,}956$$

	Million Birr	Million Birr
Import substitution (@ 3.5 B/kg)		20.81
Depreciation on plant	10.80	
Interest on plant	5.95	
Imports of materials and supplies	4.18	
Foreign exchange cost		(- 0.12)

12. AUTOMOTIVE FORGE

12.1 The Product

The forge project will make various forged steel components for the assembly of the engine, gearbox, transmission and steering systems of trucks and tractors. There is relatively little aftermarket for such components. When worn they are often reground (e.g. crankshaft) or the whole sub-assembly replaced (e.g. engine or gearbox).

There is a tendency for some of these components to be made out of S.G. iron castings (which are cheaper) on the latest car engines. This has not yet happened to any great extent on current truck engines. It is assumed that the engine designs to be introduced on trucks and tractors in Ethiopia will be used for at least a couple of decades, so the components will still need to be forged.

12.2 Market Demand, Capacity and Output

Table 12.1 shows the requirement for forged components and planned output. It is evident from the preceeding sub-section that this demand will only materialise if engine and gearbox assembly operations have previously been set up. In the AMCE truck deletion programme, the main forged components - crankshaft, camshaft, gears and transmission parts - are shown in the fifth (and final) local integration stage. A few parts - rockers, axles and axle stubs, con rods - appear in the fourth stage.

TABLE 12.1 - MARKET DEMAND, PLANNED OUTPUT AND CAPACITY

	1990		1995		2000	
	Low	High	Low	High	Low	High
Vehicle output:						
- Trucks and buses	2.0	2.0	3.4	4.1	3.6	5.0
- Tractors	2.9	2.9	4.2	4.2	5.7	5.7
Demand for forgings:						
- Trucks and buses (tonnes)	972	972	1,649	1,988	1,746	2,425
- Tractors (tonnes)	995	995	1,440	1,440	1,955	1,955
Planned capacity (tonnes)*	2,164	2,164	3,398	3,771	4,071	4,381
Planned capacity	4,000	4,000	4,000	4,000	8,000	8,000

Production would cover 150 distinct parts, requiring different tooling, assuming three models of AMCE truck engine and two tractor engines. This does not include any non-automotive parts, and no aftermarket spares for other models. It is likely that some other components will have a sufficiently important demand for tooling to be considered even for relatively small runs, for example for military vehicles, older but common trucks and tractors etc.

Non-automotive demand has not been considered because the Spare Parts Project for which a feasibility study has already been completed included forged parts for textile, sugar, metal works, and other industries, including gears and grinding balls. Grinding balls are a major capacity filler in many third world forges, and their exclusion from the present project reduces the potential economies of scale.

The capacity of the project depends on product mix but it is designed to meet demand to year 2000 (Table 12.1). It is the minimum capacity to cover this product range, and is approximately 4,000 t.p.a. on one shift or 8,000 t.p.a. on two shifts.

The composition of 1990 demand is detailed in Table 12.2. The component weights in Table 12.2 have been estimated by the consultant since detailed engine specifications for future vehicles are not known.

TABLE 12.2 - DEMAND FOR AUTOMOTIVE FORGINGS - 1990

Product Type	TRACTORS				TRUCKS AND BUSES			
	Number per tractor	Total number ('000)	Weight each (Kg)	Total weight (tonnes)	Number per vehicle	Total number ('000)	Weight each (Kg)	Total weight (tonnes)
Front axle	-	-	-	-	1	2,000	60	120
Crankshafts	1	2,900	45	130	1	2,000	45	90
Camshafts	1	2,900	15	43	1	2,000	15	30
Stub axles	-	-	-	-	2	4,000	18	72
Front wheel spindles	2	5,800	7	41	-	-	-	-
Gearbox parts	40	116,000	6	696	40	80,000	6	480
Steering parts	6	17,400	2	34	-	-	-	-
Universal joint parts	-	-	-	-	12	24,000	5	120
Steering linkages	-	-	-	-	6	12,000	2	24
Connecting rods	6	17,400	2	34	6	12,000	2	24
Rocker arms	12	34,800	0.5	17	12	24,000	0.5	12
TOTALS	-	197,200	-	995	-	162,000	-	972

Based on annual output of 2,000 trucks and buses and 2,900 tractors, with full local assembly of engines and gearboxes.

12.3 Raw Materials

Forging steel billets would need to be imported, along with die steel for tooling. Raw material requirements for the 1990 output would be as shown below:

	Tonnes
Finished steel forgings	2,164
Forged weight before machining	2,272
Cut piece weight	3,067
Forging billets (5% losses)	3,220
Die steel 1%	32

In addition a supply of oil (or gas) for furnaces, and power supply (approx. 3,500 kVA connected load) is required.

12.4 Location

There is no particular need for the forge to be close to the assembly plants. The weight of finished forgings to be transported is less than the weight of billets, although the bulk is greater. The forge could be close to the port where billets are imported - Assab - but it must have a pool of stable industrial labour, because skill acquisition is very important, and a high labour turnover would be disasterous for productivity and quality. This makes a city location desirable, and ideally the forge should be close to the foundry and to the machining facilities for good communications.

12.5 Project Technology

Billets of the correct steel specification are cut to length. This can be done by cold cropping or by cold sawing. Cropping is faster, but it is not suitable for some components because [illegible] sets up stresses in the cut piece which can cause cracking. S[illegible]e best for the proposed output levels.

The forging may be done with presses or hammers. Presses require less operator skill, but are only economic for large volume production. For high piece weight but low volume production, hammers are better. For the proposed product mix, a combination of small to medium presses, and some hammers is required.

Before forging, the cut pieces are heated to forging temperature. For the presses induction furnaces are required; for hammers which have longer cycle times batch oil fired furnaces are adequate.

Many components need preforming before forging. For this, a hammer, a preforming press or a billet roll machine may be used. Billet roll machines are most commonly used, and are more flexible.

After preforming and forging, the excess 'flashing' is removed in a trimming press.

Most components will require some form of heat treatment, which depends on the product specification.

Two types of furnaces are required:

* isothermal annealing, for products which need machining

* hardening and tempering.

These can be batch type or continuous. For the volume proposed a continuous isothermal annealing is justified, but batch type hardening/tempering furnaces are adequate.

After heat treatment there are a series of quality control tests and finishing operations. Finished components are packed in stillages and despatched to the machining facilities which are assumed to be at the vehicle assembly plant.

Quality control includes:

* raw material specification checks
* control of coding of raw material stocks
* 100% bridge sorting to check components against a known standard
* crack detection (by X-ray, ultrasonic or magnetic particle)
* hardness
* metallurgical tests
* visual and dimension checks.

A die shop is required since die making facilities are not available, although it is possible that die making facilities could be shared between the automotive forge and the Spare Parts Project. This is a heavy item of investment with a wide range of machine tools including spark erosion (Electro-discharge machines; EDM) and heat treatment.

12.6 Availability of Technology

Forging is a mature technology, with widely available equipment. Different items e.g. furnaces, hammer presses, test equipment, are supplied by different manufacturers. Some main suppliers provide a turnkey service, but it is more sensible to use an independent consultant to provide design, specification and procurement services. Technical assistance would then be required either from equipment manufacturers, consultants, or from an established producer. Forges are sometimes owned by vehicle manufacturers who would then provide both design, project management and training/technical assistance. Alternatively the forge may be set up by or in joint-venture with an established automotive component manufacturer.

If AMCE do not set up the forge, it is suggested that an independent consultant prepare a detailed feasibility study and tender documentation, and then discussions be held with an established component manufacturer with a view to direct investment or joint venture.

12.7 Project Engineering

A suggested list of main equipment is given in Table 12.3. This would need to be revised and equipment loading calculated in detail when engine and vehicle specifications are known.

Two press lines (1,000 Mp and 2,500 Mp) have been included, and two hammers (4,200 kgm drop and 18,000 kgm double-acting). These would produce:

* 1,000 Mp press; rocker arms, con rods, small steering parts and small gears (0.5 - 2 kg)

* 2,500 Mp press; steering parts and gear box parts (2 - 10 kg)

* 4,200 kgm hammer; wheel spindles, camshafts, larger gear box parts and simpler shapes (1 to 15 kg)

* 18,000 kgm hammer; larger camshafts, crankshafts, stub axles, front axles (up to 200 kg).

A suitable layout is shown in Figure 12.1. It consists of a site of 2 to 3 hectares, and approx. 12,500m^2 of covered area, consisting of three bays of 24m x 150m, and a 24 x 72 metre bay for steel cutting and cut piece storage.

TABLE 12.3 - FORGE SHOP MAIN EQUIPMENT

Item	No	Cost US$ fob
Storage and steelcutting		
Racks	40	100,000
Cold sawing machine, with feed	2	500,000
Sharpening, grinding, weighscale etc	-	110,000
1000 Mp press line		
1000 Mp forging press	1	900,000
150 Mp trimming press	1	150,000
1450 hg/hr induction billet heating furnace, with inverter, transformer and heat exchanger	1	200,000
Miscellaneous (fume extraction, cooling, die lubrication, conveyors)	-	60,000
2500 Mp press line		
2500 Mp forging press	1	1,500,000
350 Mp trimming press	1	180,000
3,300 kg/hr induction billet heating furnace	1	330,000
75mm billet roll machine (shared with 1000Mp press)	1	300,000
Miscellaneous	-	70,000
4200 kgm hammer line		
4200 kgm drop hammer	1	500,000
100mm billet roll machine	1	220,000
350 Mp trimming	1	220,000
2 t/hr oil fired furnace (batch)	1	100,000
Miscellaneous	-	5,000
18000 kgm hammer line		
18000 kgm double acting hammer	1	1,200,000
600 Mp trimming press	1	340,000
5 t/hr furnace	1	200,000
Mobile manipulator	1	50,000
Miscellaneous	-	20,000
Heat treatment		
Hardening and tempering furnace, 0.25 t/hr	2	350,000
180 thermal annealing furnace 1 t/h	1	750,000
Finishing equipment		
Shot blast, cold coining, strengthening, grinding, finishing, fettling, oil dip, weighscale	-	400,000
Inspection and quality control		
Hardness, weighing, crack detection etc	-	250,000
Craneage		250,000
Mobile handling equipment		100,000
Stillages		50,000
Services (air, water, stores, maintenance, lab, canteen)		500,000
Die Shop		
Machines		2,500,000
Vacuum hardening and tempering furnace		2,000,000
Miscellaneous		100,000
TOTAL US DOLLARS FOB		14,285,000

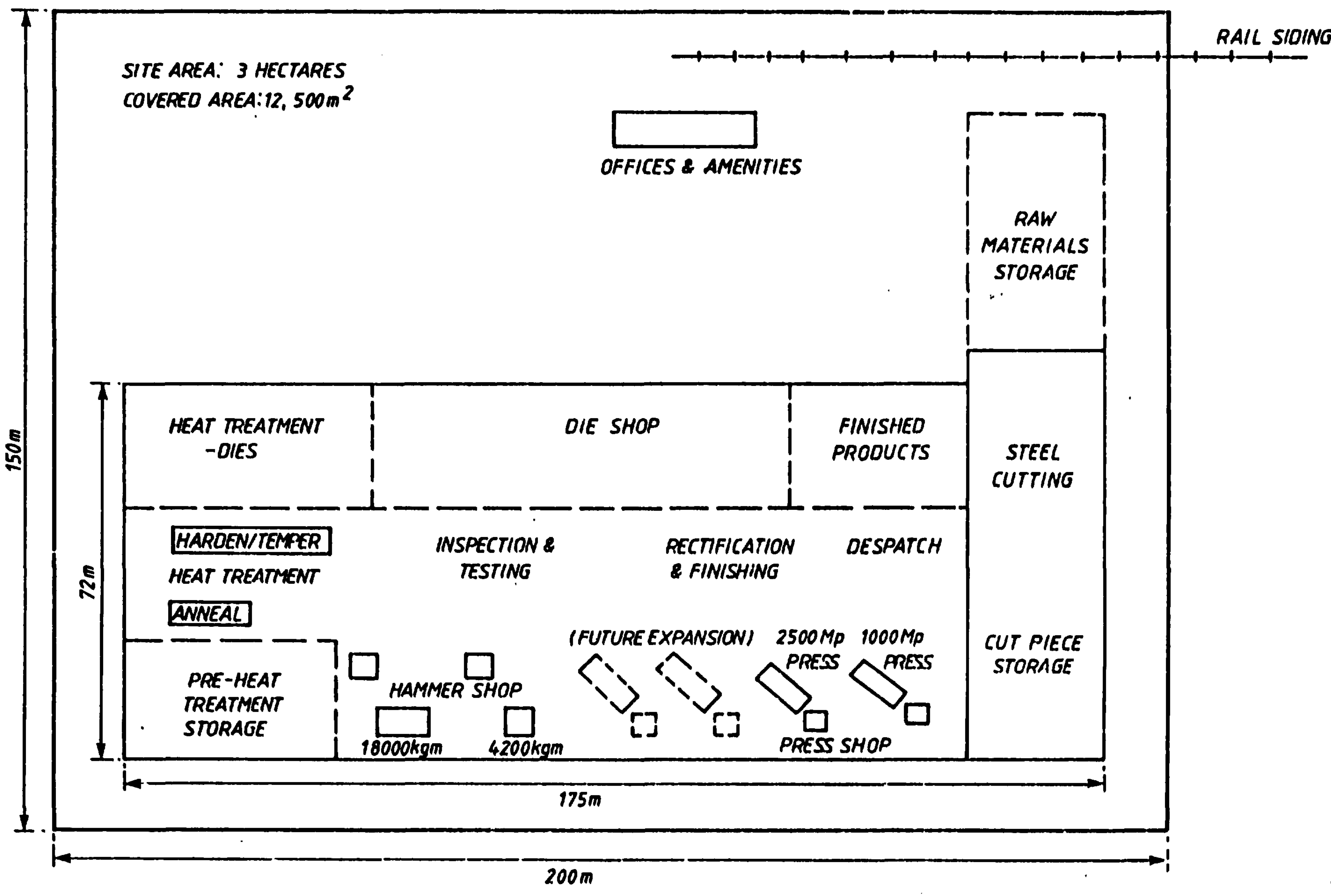

Figure 12.1 **AUTOMOTIVE FORGE LAYOUT - ETHIOPIA**

The layout has ample space for expansion and uncluttered material flow.

The capacity of the plant could be doubled by addition of further presses or hammers without any significant additional requirements for handling, heat treatment or finishing equipment, or buildings.

Forges, especially hammer forges, generate a lot of noise, heavy vibration and fumes. Very substantial foundations and well engineered buildings are therefore required.

A rail access is desirable for billet delivery.

12.8 Project Schedule

Go ahead for the project cannot be given until engine and gearbox manufacture are established in Ethiopia. Procurement and construction would then take around 2 years. After commissioning a substantial period is needed for product development and learning. This may take 5 years, and at least two years of technical assistance on a fairly extensive scale should be a minimum requirement.

12.9 Manpower and Organisation

For single shift operation the following manpower is required:

Managers	4
Administration	7
Inspectors and foremen	19
Skilled operators/fitters	50
Semiskilled	103
Unskilled	16
Clerical and security	34
	233

An organisation chart is shown in Figure 12.2.

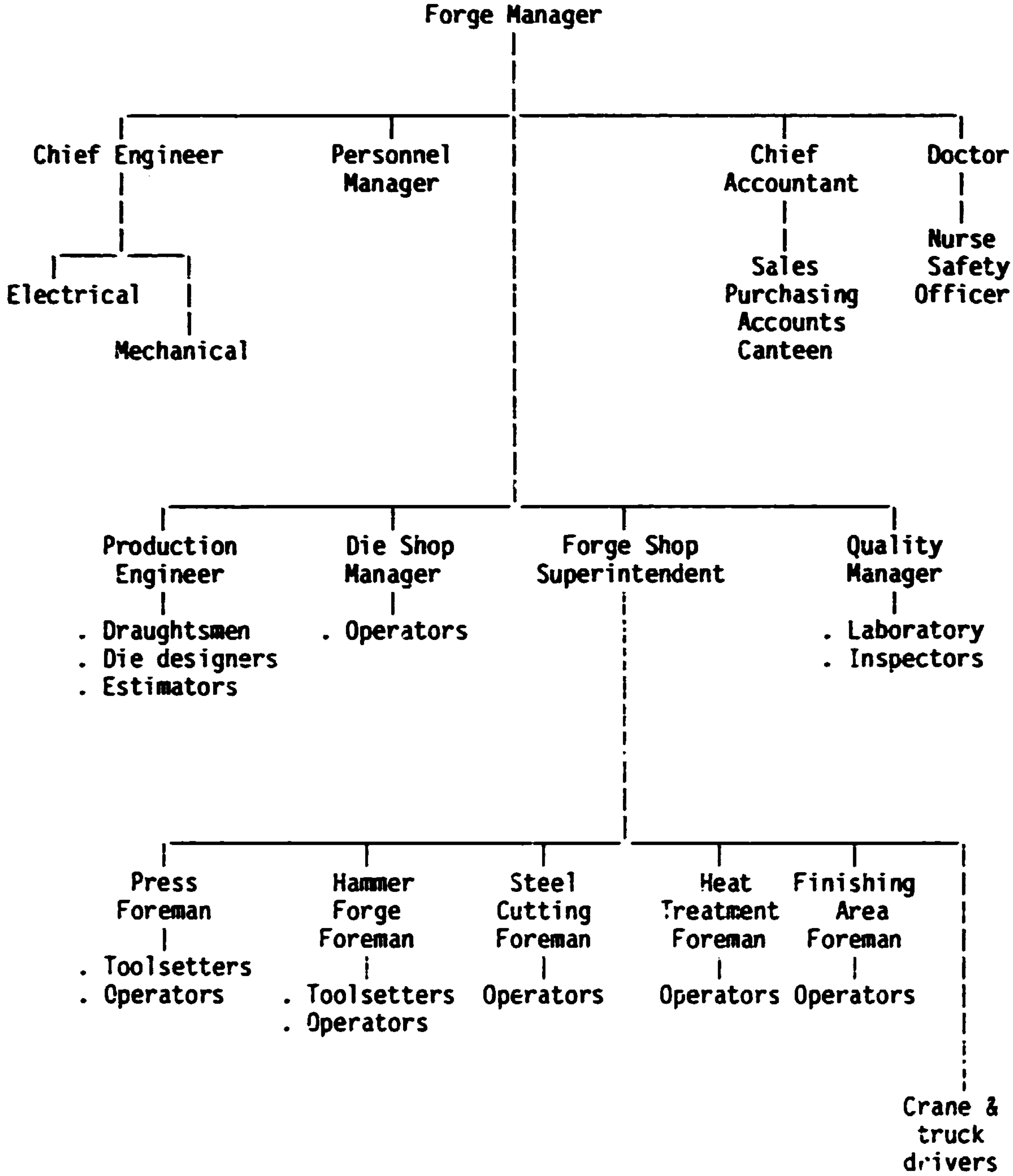

FIGURE 12.2 - FORGE ORGANISATION

12.10 Investment

The following estimated local and foreign currency investment is required for the project.

	Foreign	Local (Birr '000)	Total
Buildings (12600m² x 1200B)	-	15,120	15,120
Services	606	150	756
Plant requirement	34,364	10,309	44,673
Locally purchased equipment	-	1,770	1,770
Training and pre-op expenses	433	866	1,299
Total fixed assets	35,403	28,215	63,618
Working capital	-	4,055	4,055
Interest during construction	5,718	-	5,718
Total cost	41,121	32,270	73,391

A suitable financing package would be:

Local Equity	(29%)
Foreign Equity	(11%)
Foreign Loans	(31%)
Suppliers credits	9%)
	(100%)

12.11 Production Costs

Annual operating costs for the 1990 planned output are as follows:

	Birr '000
Labour	866
Materials and electricity	7,139
Overhead expenses	2,406
Depreciation	6,602
Interest	5,504
Total production costs	22,517

12.12 Sales Revenue

The AMCE fob deletion prices for finished forgings range from around 4 B/kg (simple heavy components with little machining like axles) to about 15-20 B/kg (complex parts with a lot of machining), averaging about 10 B/kg. This is equivalent to 16.3 B/kg duty and tax paid delivered to Addis Ababa according to information from AMCE and the Price Control Administration. Allowing 100% machining margin the typical ex-works price would be 8.15 B/kg.

The forecast 1990 net sales revenue of the forge is therefore:

2164 tonnes x 1000 x 8.15 Birr	=	17.63	
- less 8% transaction tax	=	1.41	
Net sales revenue		16.22	million Birr

12.13 Commercial Profitability

	Birr Million
Sales revenue	16.22
Operating costs	10.41
Depreciation	6.60
Operating loss	-0.79
Interest	5.50
Gross loss before tax	-6.29
Corporation tax @ 50%	-
Net loss	-6.29

$$\text{Rate of return} = \frac{(\text{net profit} + \text{interest}) \times 100}{\text{total cost of investment}}$$

$$= \frac{-6.29 + 5.50 \times 100}{73.39} = \text{Nil}$$

$$\text{Repayment period} = \frac{\text{total cost of investment}}{\text{net profit + interest + depr.}}$$

$$= \frac{73.39}{-6.29 + 5.50 + 6.60}$$

$$= 12.6 \text{ years}$$

Note however that there is likely to be a long learning period before profitability is achieved, which must be added to the repayment period.

12.14 National Economic Benefit

$$\text{Total cost per job created} = \frac{73{,}390{,}000}{233} = 314{,}978 \text{ Birr/job}$$

$$\text{FX cost per job} = \frac{41{,}121{,}000}{233} = 176{,}487 \text{ Birr/job}$$

Annual foreign exchange saving:

	Birr '000
Import substitution (@ 4.9 B/kg)	10.76
Depreciation on plant	6.60
Interest on plant	5.50
Imports of materials & supplies	5.96
FX cost	-7.30

APPENDIX A - ASSUMPTIONS

A.1 Market Demand

Demand for components has been calculated on the assumed fleet size, demand and local production of vehicles set out in Table A1 for 1990, 1995 and 2000. These estimates were presented and approved in the study Progress Report (February 1986).

TABLE A1 - FORECAST FLEET SIZE, ANNUAL DEMAND AND LOCAL PRODUCTION OF VEHICLES IN ETHIOPIA
('000 vehicles)

	1990		1995		2000	
	Low	High	Low	High	Low	High
Trucks (2 tonnes +)						
Fleet	19.2	19.2	23.6	23.6	24.0	24.0
Demand	1.9	4.8	3.0	5.9	3.1	6.0
Production	1.7	1.7	3.0	3.7	3.1	4.5
Buses (15 + seats)						
Fleet	2.2	2.2	2.8	2.8	3.4	3.4
Demand	0.5	0.5	0.4	0.4	0.6	0.6
Production	0.3	0.3	0.4	0.4	0.5	0.5
Tractors						
Fleet	10.5	10.5	21.0	21.0	28.0	28.0
Demand	3.6	3.6	5.2	5.2	7.1	7.1
Production	2.9	2.9	4.2	4.2	5.7	5.7
Trailers						
Fleet	2.9	2.9	3.5	3.5	3.6	3.6
Demand	0.7	0.7	0.8	0.8	0.9	0.9
Production	0.5	0.5	0.6	0.6	0.7	0.7
Cars						
Fleet	42.0	42.0	48.6	48.6	56.4	56.4
Demand	2.1	2.1	2.4	2.4	2.8	2.8
Production	-	-	-	-	-	-
Total						
Fleet	76.8	76.8	99.5	99.5	115.4	115.4
Demand	8.8	11.7	11.8	14.7	14.5	17.4
Production	5.4	5.4	8.2	8.9	10.0	11.4

The high and low estimates reflect the possible impact of military procurement on local production. The high estimate of local production assumes that military trucks will be made locally, while the low estimate assumes that military needs will be imported. In 1990 the high and low estimates for production are the same because in that year non-military demand is sufficient to take up planned local production. Thus if the military do not buy locally, sales from AMCE will be shifted to the civilian market, and production levels will be unchanged.

In 1995 and 2000, however, demand sets a ceiling on the higher planned level of local production, and if military requirements are not bought locally then production will be lower by that amount.

A.2 Prices

The prices used in calculating the import substitution value of output, and hence the national economic benefit, are fob prices ex-Europe, or Japan for spare parts bought by motor dealers for the after market. Supplies to the original equipment market have been priced at 40% of the after market price. (see Table A2).

For calculating the commercial profitability of projects the assumed prices are duty and tax paid prices of components delivered to Addis Ababa, against which the local manufacturer will be competing (see Table A3). The local manufacturers will in turn have to pay transaction tax, which has therefore been deducted to arrive at net sales revenue for each project.

A.3 Costs

Labour	- managers	800 B per month
	administration	400 B per month
	chargehands	300 B per month
	semi-skilled	250 B per month
	drivers, security	150 B per month
	unskilled	100 B per month
	- plus 25% social costs on all grades.	

TABLE A2 - ASSUMED PRICES OF COMPONENTS (f.o.b. Europe or Japan) FOR NATIONAL ECONOMIC ANALYSIS

(Birr per unit)

	1 Exhausts	2 Rubber extrusions	3 Rubber mouldings	4 Engine & power train remakes	5 Vehicle wiring harnesses	6 Radiators	7 Friction materials	8 Body pressings	9 Shock absorbers	10 Windows and windshields	11 Automotive castings (per kg)	12 Automotive forgings (per kg)
As original equipment for:												
Trucks and buses	115	11	2.5	-	151	213	3.7	67	20	w/s 50 s 24	)	)
Tractors	42	4	1.3	-	28	70	4.0	-			) 3.5	) 4.9
Cars and pick-ups	-	-	-	-	-	-	-	-	-	-	-	-
Trailers	-	-	2.5	-	20	-	3.7	-	20	-	-	-
As spare parts for:												
Trucks and buses	293	28	5.9	518	378	532	9.4	168	49	w/s 125 s 60	-	-
Tractors	105	10	2.5	518	70	176	9.9	-	-	-	-	-
Cars and pick-ups	105	5	0.9	-	126	294	7.7	112	25	w/s 84	-	-
Trailers	-		5.9	-	50	-	9.4	-	49	s 50	-	-

w/s = windscreens
s = side windows

TABLE A3 - ASSUMED PRICES OF COMPONENTS (duty and tax paid, delivered Addis Ababa)
FOR COMMERCIAL PROFITABILITY ANALYSIS

(Birr per unit)

	1 Exhausts	2 Rubber extrusions	3 Rubber mouldings	4 Engine & power train remakes	5 Vehicle wiring harnesses	6 Radiators	7 Friction materials	8 Body pressings	9 Shock absorbers	10 Windows and windshields	11 Automotive castings (per kg)	12 Automotive forgings (per kg)
As original equipment for:												
Trucks and buses	188	19	4	-	245	347	6	108	32	w/s 81 s 42	) 5.7	) 8.1
Tractors	63	7	2	-	43	106	6	-	-	-	)	)
Cars and pick-ups	-	-	-	-	-	-	-	-	-	-	-	-
Trailers	-	-	4	-	33	-	6	-	32	-	-	-
As spare parts for:												
Trucks and buses	650	63	13	1,250	842	1,182	21	372	109	w/s 279 s 143	-	-
Tractors	170	16	4	1,250	113	284	16	-	-	-	-	-
Cars and pick-ups	233	11	2	-	280	654	17	250	54	w/s 187 s 111	-	-
Trailers	-	-	13	-	111	-	21	-	109	-	-	-

w/s = windscreens
s = side windows

Raw materials	-	for commercial analysis, at duty and tax paid price, delivered Addis Ababa.
	-	for economic analysis, fob Europe.
Overheads	-	5% of plant cost, plus
	-	20% of labour costs.
Depreciation	-	4% on buildings and services 25% on vehicles 12½% on plant, tooling, racks etc
Interest	-	9.5% of bank loan and supplier credit element of total costs
Working capital	-	25% of net sales revenue
Financing	-	40% equity 60% loan, with suppliers credit element maximum of 80% of overseas plant cost.
Licence agreements	-	the cost of licence agreements, where required, are included in plant and material costs.