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UNIDO

REPAIR AND MAINTENANCE OF INDUSTRIAL EQUIPMENT IN DEVELOPING COUNTRIES

Prepared for

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

by

NORCONSULT A.S.
OSLO - NORWAY

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FINAL REPORT 51p.+app.

CEYLON

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S Y N O P S I S

The general conditions of repair and maintenance in Ceylon have been surveyed by two experts, visiting 30 different industries and workshops in April - May 1969.

The main conclusion of this survey is that industrial equipment and machinery is with some exceptions rather well maintained, taking into account that imported spare parts are not readily obtainable and that the available maintenance and repair facilities are often inadequate.

The maintenance organisation followed mostly a rather old-fashioned pattern and should be substituted with more effective systems. Only a few factories had yet introduced systematic plans for their repair and maintenance activities. The administration systems in use for repair and maintenance are not efficient, although with a few exceptions.

The repair and maintenance workshops in the older factories are too small and poorly equipped, while most - but not all - of the modern plants have adequate facilities. The existing foundries are old and lacked instrumentation and laboratory facilities, no steel foundry does yet exist, only two forging shops of any size exist, and specialised equipment like gear-cutting machinery did not exist.

The internal efficiency of the repair and maintenance departments is generally low, but with some exceptions. The management of the departments left much to improvement, and time estimation or any other measure to control the efficiency is not in use.

The repair and maintenance activities throughout the country are not co-ordinated for maximum utilisation of the available facilities, and there are no centralised manufacturing facilities for the production of more special spare parts. Such facilities could be valuable by improving the spare part situation, which in general is difficult due to long delivery time for imported parts.

The stored amount of spare parts of various types and sizes was in most cases found to be inadequate. Total lead time for purchase of parts from abroad is long. The Governmental procedures should be liberalised and pur-

chase planning of spare parts at the plants be made more efficient.

The stores for spare parts leave much to improvement on layout, size, orderliness, and spare parts protection.

Some of the maintenance personnel had attended courses abroad, a few factories have training programmes for the workers, and the technical schools are of a good standard. Training of personnel on all levels should, however, be increased greatly and subject not yet taught in Ceylon should be taken up, such as maintenance management and maintenance systems. Courses should be given on instrumentation, welding, trouble-shooting, diagram reading, etc.

A number of top management representatives from chairmen to chief engineers have a very positive and advanced attitude towards modern maintenance. With such an understanding we feel certain that supplementary and more advanced training and the introduction of more efficient systems will give benefits. There also seems to be good relations between management and labour.

By implementing training of personnel and some important projects outlined in this survey, we feel certain that the Ceylonese industry with the assistance of a number of foreign experts, preferably under the auspices of UNIDO, and with financial and expert assistance from a developed country, could make great strides towards an efficient industrial maintenance which can contribute to the general development of Ceylon.

TABLE OF CONTENTS

Note : Figures and other information given in this reports are to a great extent based on oral communication between factory representatives and the experts.

Consequently, some figures or information may be incorrect. We very much regret if such errors occur in this report but would like to emphasise that such errors would have no influence on the general conclusions.

LIST OF BASIC DATA ABOUT CEYLON

Ceylon is a pear-shaped island located in the Indian Ocean southeast of India.

The climate is generally uniform tropical, however, the south-central mountains offer some relief from the tropical heat.

Ceylon has an area os 25,332 square miles. Its population was approximately 11.5 million in 1966. The population density is greatest in the southwest quarter of the island, where the agricultural conditions are most favourble. The annual population growth is estimated at 2.4%.

From about 1800 Ceylon was under the British Crown. In 1947 the Ceylon Independence Act was passed and on 4 February 1948 Ceylon became a fully independent member of the Commonwealth of Nations.

The constitutional head of the state is the Queen. The Cabinet and the Government are headed by the Prime Minister.

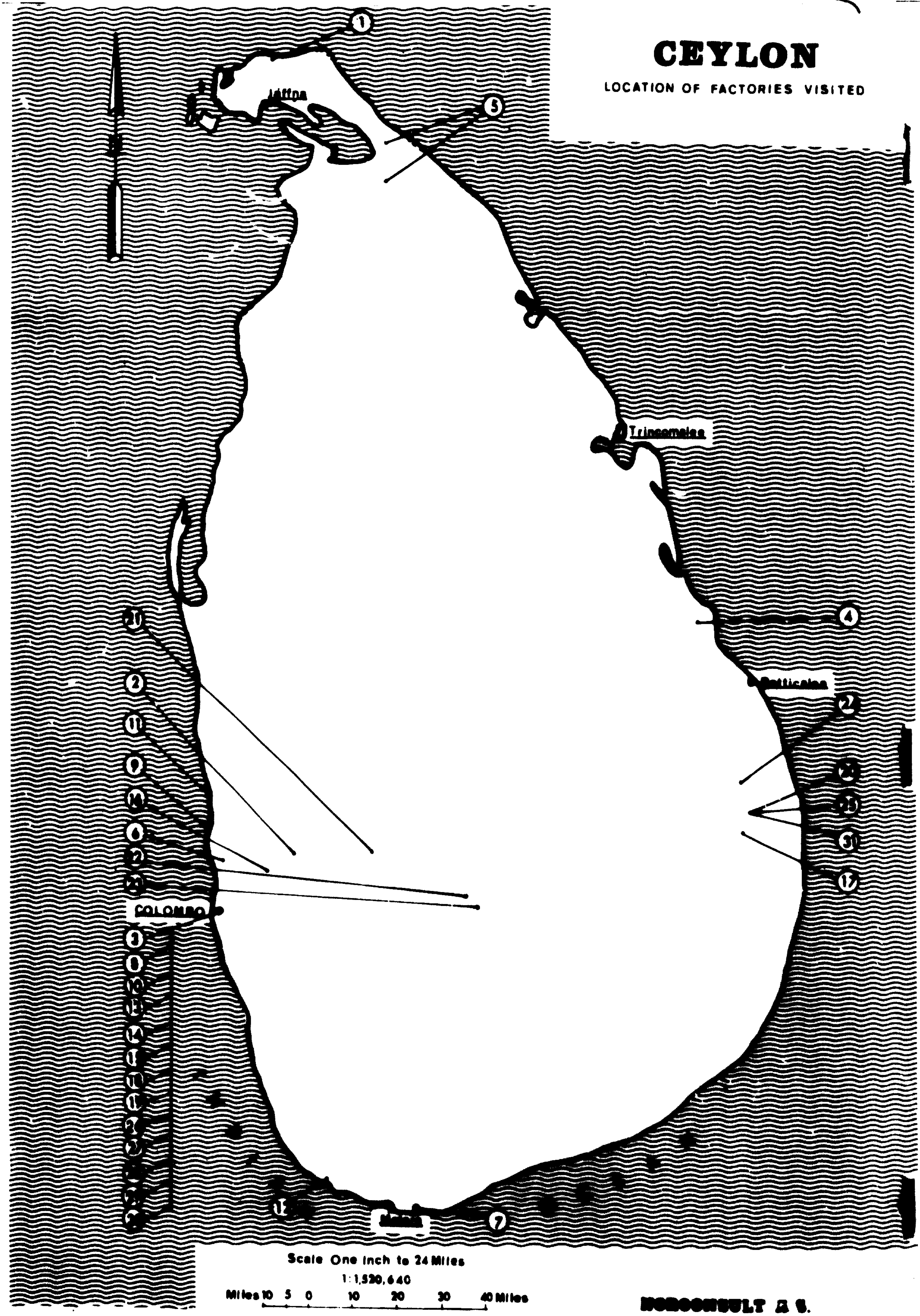
Ceylon's economy is predominantly agricultural with manufacturing accounting for only 8% of the gross national product which is U.S. $ 150 per capita. Tea, rubber, and coconut are Ceylon's most important products.

Currency : 1 Rs. = 1 rupee = 100 cents
U.S. $ 1 = Rs. 5.95 (May 1969)

Please note that "Poya-day" corresponds to Sundays.

CEYLON

LOCATION OF FACTORIES VISITED



NORCONSULT A S.

R E F E R E N C E S

1. Ceylon Investment Guide.

The general economic environment prepared for the Ministry of Industries and Fisheries, December 1968.

2. UNDP Report on Living Conditions in Ceylon, 6 March 1969.

3. Central Bank Report, Ceylon 1968.

4. Statistics of Industrial Production 1965 - 1967.

Ministry of Industries and Fisheries, July 1968.

5. Country Report on Ceylon.

Report by the UNIDO/ECAFE fact-finding team on industries manufacturing agricultural machinery, 1968.

Chapter 1 :

INTRODUCTION

1.1 SURVEY METHOD, DESCRIPTION OF FIELD WORK

The survey in Ceylon was carried out during the period 12 April to 7 May 1969. During this time the expert team visited factories, workshops, institutions, and Government departments, collecting details shown in the appendices, Nos. 1 through 31.

The team consisted of :

Mr. Egil Arneberg,	Team Leader, Senior Management Consultant
Mr. Knut Swärd,	Senior Maintenance Engineer.

Initial contact was made with :

Mr. Himalaya Rana,	Deputy Resident Representative of the United Nations Development Programme in Ceylon
Mr. M. Gomez,	Ministry of Industries and Fisheries
Mr. T. Mylvaganam,	Director, Ministry of Industries and Fisheries
Mr. R. Lannerolle,	Managing Director, Industrial Development Board
Mr. T. Ganesathasan,	Director, Technical Services Institute.

Two young engineers, Mr. T.P. Jesuratnam and Mr. H.C. Fonseka, from the Technical Services Institute, were immediately released from their ordinary work to act as assistants to the team. They worked very efficiently, making all kinds of contacts, arranging meetings and visits, travelling facilities, etc. During the factory visits they also collected some of the data while the team members interviewed persons in leading positions.

1.2 PLANNING OF FACTORY VISITS

The first few days were spent selecting factories and workshops to be visited. In addition to the Ceylonese persons mentioned above, the team received good assistance from :

Mr. L. Hartstein, UN Expert working in the Ministry of Industries and Fisheries

Mr. F.R.E. Armitage, UN Expert (ILO) working with the Management Development and Productivity Centre

in the selection of branches and industries which have greatest influence on the Ceylonese economy, preferably by increasing the export or decreasing the import by substituting products.

The first factory visit was made to the new steel rolling mill by the two team members and their two assistants. Most factory visits were made by one of the team members plus one assistant.

1.3 PLAN FOR A FACTORY VISIT

Usually a visit to a factory or workshop followed this pattern :

a. A short introduction visit to the factory manager, the general manager, or the chairman.

b. A visit to the factory area, production departments, maintenance workshop, storerooms, etc.

c. Interviews with production manager, maintenance manager, chief accountant, and other persons who could give details about the maintenance situation.

d. A final interview with the management.

e. Discussion between the team member and the assistant.

A questionnaire was prepared prior to the arrival in Ceylon and was duplicated there. It was used during the visits to make notes about facts and observations.

1.4 PREPARATION OF VISIT REPORTS

As soon as possible after the visit the report was set up. To a large extent drafts of these reports were typed at the Technical Services Institute before the team left Ceylon.

1.5 FACTORIES SELECTED

The team's choice of industries was based on the background material made available by the Ministry of Industries and Fisheries, especially the Ceylon Investment Guide, and on advice from Mr. Hartstein.

The criteria for the team's choice were :

a. Export industries such as tea, rubber, oils and fats.

b. Important factories serving these export industries.

c. Industries producing important material such as steel rolling mill, hardware factory, industrial engineering industries, rubber tyre plant.

d. Transport, railways, and buses.

The team made a total of 31 visits. The separate visits to chairmen and general managers at the main offices in Colombo are not included in this number.

1.6 GENERAL ATTITUDE

The experts were met with the greatest hospitality and willingness to answer all questions at all the factories and organisations.

Furthermore, the interest for the subject was found to be very great.

These two factors made it possible to implement the survey according to the set-up, for which the experts are very grateful.

1.7 DECLARATION OF THE TERM "REPAIR AND MAINTENANCE"

The expression "Repair and Maintenance" is used in the survey description and the experts have understood the meaning of the expression as the word "Maintenance" is defined in the modern management philosophy.

The objectives of the maintenance function are described generally by the following six points :

1. The maintenance function must be organised and act in close co-operation with all other functions within the enterprise,

and give the best possible contribution to the profitability of the total operation.

2. The maintenance function must organise and perform the maintenance work in such a way that the production capacity of the equipment corresponds to the current production plans.

3. The equipment quality must be controlled and actions taken to keep this quality on a level corresponding to the product quality level and so that unnecessary production difficulties are avoided.

4. The equipment wear and tear must be controlled in order to retain the capital invested in the production equipment during the time period stated by the enterprise's financial policy.

5. These objectives should be fulfilled with the lowest possible labour and material expenditures.

6. The safety requirements for the personnel must not be reduced.

The fulfilment of these objectives means that the maintenance function must co-operate with other enterprise functions and that these other functions must co-operate with the maintenance function. It means that a high level of control with feedback and analysing techniques has to be used.

It also means that the modern maintenance function takes an active part in :

- procurement of new equipment
- initiating replacement and improvement of existing equipment
- controlling the use of the capital invested in equipment to prevent too early detoriation and waste
- design and introduction of operator training plans.

1.8 PURPOSE OF THE STUDY

The object of the above study and through the subsequent report is to provide UNIDO with data concerning the repair and maintenance ser-

vices of industrial equipment in Ceylon.

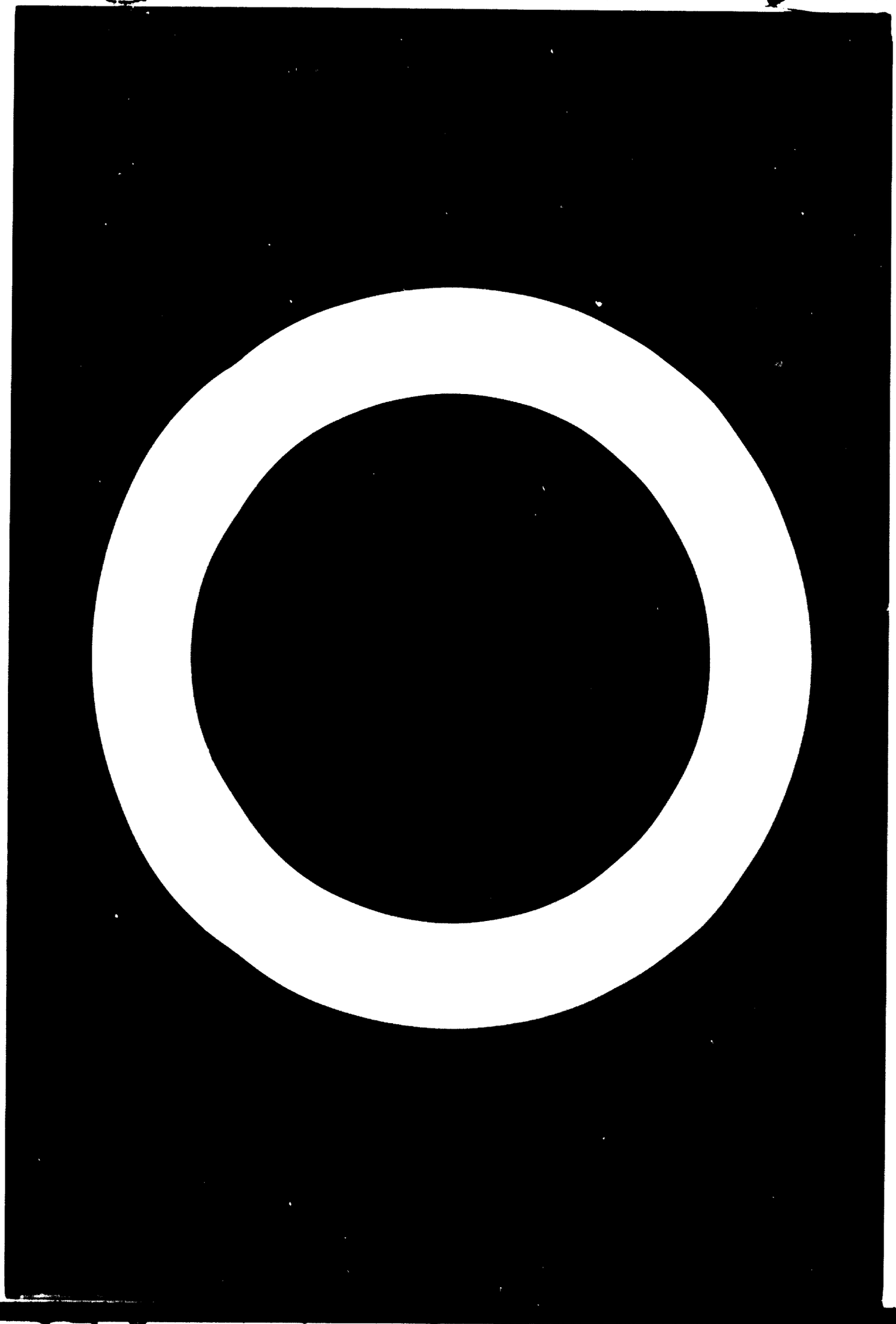
The study aims to identify the fields in which assistance is urgently needed.

Recommendations are given as to long-term policy and working programmes for technical assistance in the field of maintenance and repair.

1.9 OUTLINE OF REPORT

The report is mainly based on our findings in the factories visited. Details about these visits are presented in the appendices, Nos. 1 through 31, and cover the more important industries in Ceylon.

These industries have been visited and their factory location marked on a map of Ceylon. A general description is given of these factories and the existing maintenance facilities, the condition under which they work, and the personnel they employ. Further some recommendations are given for future maintenance policy and a programme for the implementation of this policy.



Chapter 2 :

REPAIR AND MAINTENANCE OF INDUSTRIAL EQUIPMENT IN CEYLON

2.1 IMPORTANT INDUSTRIES IN CEYLON

2.1.1 List of Important Industries

About 20,000 firms are performing some kind of industrial activity in Ceylon. Most of these are very small and about 1500 firms are using machines and power and have at least 10 employees.

In addition there are about 1000 tea factories and a great number of prime rubber factories.

The table on page 8 from the "Statistics of Industrial Production 1965 - 1967" prepared by the Ministry of Industries and Fisheries, July 1968, gives a picture of the number of firms in each section, the production value in millions of rupees, and the employment. In the preface it is said that this statistic only covers firms registered with the Ministry.

In the publication, Ceylon Investment Guide, prepared for the Ministry of Industries and Fisheries in December 1968, 20 State industrial corporations are listed, covering :

1. Cement
2. Textiles
3. Sugar
4. Paper
5. Chemicals
6. Oils and fats
7. Ceramics
8. Mineral sand
9. Leather
10. Plywood
11. Small industries
12. Salt
13. Fertiliser
14. Steel
15. Tyre
16. Hardware
17. Flour milling
18. Construction
19. Petroleum
20. Fertiliser manufacturing

Every corporation has one or more factories, and some under construction.

Table 1. Firms registered with the Ministry of Industries and Fisheries.

	Industry	Number of firms	Production value mill. Rs.	Number of employees
1.	Food	198	425	11,560
2.	Textile	391	141	18,500
3.	Chemical	208	134	6,800
4.	Leather, rubber, paper, wood	223	124	11,960
5.	Non-metallic products	53	75	5,450
6.	Metal industries	160	85	7,360
7.	Machinery	81	46	7,720
8.	Electric equipment	35	24	1,660
9.	Miscellaneous	131	28	3,380
	Total	1,480	1,082	74,390

The investment guide gives detailed information about these corporations. Since most of them have been visited during the survey, we refer to the reports on factory visits listed in the appendices.

The state industrial corporations all have factories of considerable size (compared to the size of Ceylonese factories in general). Together they represent about 17% of the total industrial production. (Tea and rubber processing is not included). Production of food, tea, and rubber in industry represents about 45% of the total industrial production. It should, however, be realised that the State industrial corporations will increase their share of industrial production considerably in the next five years. Some factories are still under construction and others have not yet reached full production.

The corporations represent, however, key products for the further development of the country (cement, steel, petroleum, etc.) They have a great impact on the national economy in the sense that the products otherwise had to be imported. At present, their importance as export industries is very little, however, there seems to be some development in this area. This year for instance, the first export

order of plywood was received.

The value of Ceylon's export in 1967 is estimated to be in the range of Rs. 1900 mill. or US $ 320 mill. The distribution of export is as follows :

- Tea 65%
- Rubber 16%
- Coconut products 9%
- All other products 10%

It is interesting to note that the three agricultural products, tea, rubber, and coconut, represent 90% of the export. These products are processed in tea factories, prime rubber factories, and coconut oil mills. The industrial processing is very simple and is done in a great number of very small factories.

2.1.2 Description of Important Industries

Tea :

The most important export item in Ceylon is tea products. The tea is sold mainly to England. The annual value of the tea export is Rs. 1250 mill., equal to 65% of Ceylon's export.

Tea is grown mainly in the high areas in the southwestern part of the island. The number of tea estates is about 1000.

The tea is processed in rather simple factories, using fermenters, rollers, sifters, and dryers. The main part of the tea is packed in plywood containers of about 130 lbs each.

Most of the tea estates are privately-owned. Even the largest have rather poor maintenance facilities.

The machinery is mostly of Ceylonese make and spare parts are available. Some difficulties have been encountered as the equipment age sometimes is as much as 20 to 30 years. The rate of wear is low.

Lorries, tractors, and cars are generally not maintained at the factories, though some have garages. Generally it is very difficult to get spare parts for these types of transport equipment and the age

is far too high to be feasibly maintained.

Some estate owners have started co-operative maintenance workshops. The private industrial engineering companies of Colombo, Walker Sons & Co.Ltd. (App. 18) and Colombo Commercial Co. Ltd. (App. 19) have subsidiary shops in the tea area, carrying out general repairs.

The maintenance level was found to be fairly high, but lacks systematic work. Savings are possible by applying simple general preventive maintenance systems, common workshops in specific areas, and a common spare parts procurement organisation. Such a systematic maintenance organisation would provide skilled engineers to advise the tea estate supervisors about maintenance and skilled craftsmen for more advanced maintenance work.

The experts have a feeling that the tea estate owners, probably most of the British owners, hesitate to invest more money in tea processing equipment because the profitability is gradually decreasing. To save on maintenance and to keep the old equipment in good operating condition may be one way to increase the profitability until the development work on new processes and new products as instant tea have come into a practical usable form.

Rubber :

Rubber is the second largest item on the export list with annual value at about Rs. 300 mill. The domestic consumption is still small.

At the moment, the world market is weak and the prices low.

Rubber is grown in the "wet" zone southwest of the mountains and usually the latex is processed in the smaller factories on the estates.

The process is fairly simple and consists of bleaching the latex, adding acid to coagulate it, settling, pressing, and washing the white rubber into crepe rubber, which is the product yielding the highest price.

The large number of small factories indicates that more profitable processing of the latex would be possible. The latex can easily be transported in tanks on lorries from one area to another.

The factory visited, the Paramba Group (App. 21), is rather old. The equipment is from 30 to 40 years of age. However, it is in good condition, which indicates that the wear is not very high. Spare parts are difficult to obtain, mainly due to the fact that the machines are old and imported. The medium-sized factory, the Paramba Group, is powered by an old 2-cylinder diesel engine made around 1930. The superintendent mentioned they have plans to install electric motors and save the diesel engine for emergency situations.

The rubber factories seldom have their own maintenance shops. They have up to now relied on annual overhauls usually made by a contractor, and Walker Sons & Co.Ltd. (App. 18) was mentioned as one of them. The day-to-day maintenance is done by a semi-skilled employee, usually the engine operator. No plans were available. As the equipment is simple, the plans were not really needed.

Rubber Industry :

The rubber-based industry is rather young in Ceylon. The largest plant, Ceylon Tyre Corporation (App. 14), a rubber tyre factory, has started operation a few years ago and is not yet running at its full capacity.

As transportation is a base for many other important industries, the manufacturing as well as the retreading and repairing of lorry and tractor tyres is essential. The annual production value of cars, lorries, and tractor tyres is about Rs. 25 mill.

The tyre manufacturing has to cover a wide variety of products, from small bicycle tyres to heavy tractor tyres. One disadvantage is the great number of large dimensions, each required in small quantities. It is impossible to have forms available for all and a great number of dimensions must therefore be imported.

One solution would be to standardise some dimensions, but as it is impossible to make the wheels in Ceylon, this solution becomes unpracticable. If only the purchaser would take the dimension of rubber tyres into account when buying new equipment, the situation might improve in the long run.

Oils and Fats Industries :

The coconut processing makes bases for several important industries which produce :

- coconut oils of various grades
- coconut fats
- cattle and poultry food.

Products of a value of Rs. 170 mill. are exported, the remaining for domestic consumption.

The first process is a simple pressing of the copra and about 35% of the oil is removed. This process takes place in several smaller and very simple factories all over Ceylon. These factories have little or no interest from the maintenance point of view.

The remaining substance, called poonac, is processed in some larger factories where several different extraction processés are used. The result is very promising and the profitability fairly good.

The maintenance situation is not very favourable. The production side is very dominating in one of the factories, Ceylon Oils & Fats Corporation, Seeduwa Factory (App. 6), and all the efforts from the aintenance engineers to introduce a preventive maintenance programme have yielded no practical result. In another factory, Harischandra Mills (App. 7), no maintenance engineer was engaged to be in charge of the maintenance procedures and only repairs were carried out.

In Lever Brothers (Ceylon) Ltd. (App. 8), a private company making soaps etc., a modern maintenance programme is working very well and the results are encouraging.

The production results are evidently very good. This could be one reason why some managers do not allow a preventive maintenance programme to be introduced. There is a great risk that within a few years the machinery will be exceedingly worn and that the production capacity will fall drastically. It would be advisable to initiate a maintenance programme before this situation arises.

As a consequence the maintenance workshops were mostly poorly equipped.

Industrial Engineering Industry :

Industries manufacturing machinery are very scarce in Ceylon. There are only a few, mostly privately-owned industries like Walker Sons & Co.Ltd. (App. 18) and Colombo Commercial Co.Ltd. (App. 19).

These are mostly well run and fairly well equipped, however, the machinery is old and some types, such as gear-cutting machinery, are totally lacking. The foundries are of low capacities and old-fashioned. Forge shops are found in the railway workshop, hardware factory, and two of the mechanical factories.

On the other hand, many other factories are well equipped. The steel rolling mill, Ceylon Steel Corporation (App. 13), has a very good workshop. The River Valley Development Board Base Workshop in Amparai (App. 20) has some very good (and poorly utilised) machine tools such as arboring mill and big grinding machines for crankshafts. The Ceylon State Hardware Corporation (App. 16) also has a large arboring machine and some other milling machines of modern design.

The Railways Workshop (App. 28) also has a great number of machine tools, mostly very old. These will now be left idle, as the steam locomotives are scrapped and the machines can not be used to make spare parts for diesel engines.

A new foundry is being built at the Ceylon State Hardware Corporation. There are plans to build a steel furnace at the steel rolling mill and quotations are now invited. It might be possible to utilise such a furnace for a steel foundry as well, but there ought to be some smaller furnace for special steel, i.e. stainless steel. A steel foundry is included in the oil refinery plant.

Some industries have a need for manufacturing or reconditioning of parts such as rollers (sugar factory), crankshafts (several, including the private market for cars and lorries), cylinders and liners (State Engineering Corporation, Irrigation Department, buses, etc.). Machines are available but spread out in various industries. Only larger special boring machines for cylinders and liners were not observed anywhere.

As spare parts and pieces of equipment like pumps and valves are not

readily obtainable, some factories are run at a too low capacity or the processing is even shut down temporarily.

There are several ways to improve the situation :

One way is to form a larger workshop for manufacturing of machinery and spare parts, set up with available surplus machinery from other factories.

The Ceylon State Hardware Corporation (App. 16) would form a good base workshop for making spare parts and smaller machinery like pumps, valves, gears, shafts, hubs, etc.

Another way is to utilise the "Volvo method", employing subcontracting for operations such as casting, milling, arboring, grinding, and gear-cutting. Some central organisation ought to issue periodically a list on available machinery and capacity. This is done in the Scandinavian countries through the common subcontractors' market.

The amount of foreign exchange spent on spare parts could be reduced considerably for any of these two alternatives and available money used to buy raw material like steel, iron, metal, sheet steel, tool steel, cutting tools, etc.

2.2 EXISTING REPAIR AND MAINTENANCE PHYSICAL FACILITIES

2.2.1 Survey of Existing Repair and Maintenance Facilities

The factory reports presented in the appendices give details of the existing facilities.

Most factories have a separate maintenance department headed by a responsible maintenance engineer or chief engineer. At a few factories the organisation is decentralised and the responsibility divided, resulting in poor maintenance.

Systematic repair and maintenance programmes such as preventive maintenance, overhaul systems, etc. are generally lacking, and where introduced are mostly not carried out efficiently. Lubrication programmes were in most cases good and the execution acceptable.

Generally most factories - although with a number of exceptions - have inadequate maintenance facilities. The workshops are often small and poorly laid out.

Some of the modern Government-owned factories as :

Ceylon Steel Corporation (App. 13)
Ceylon State Hardware Corporation (App. 16)
Ceylon Tyre Corporation (App. 14)

have good and well equipped workshops which also are utilised as production tool workshops.

At a few factories (also Government-owned) as :

National Textile Corporation's Mill (App. 2)
Eastern Paper Mills Corporation (App. 4)

new workshops were in the planning stage or had just been started up. The proposed equipment for the Textile Mill's workshop seems adequate.

2.2.2 Centralised Repair Workshops

Of the about 30 factories visited, three privately- and four Government-owned can be termed as centralised repair and maintenance workshops, namely :

Privately-owned :

Walker Sons & Co.Ltd. (App. 18)
Colombo Commercial Corp. (C.C.C.) (App. 19)
Brown & Co.Ltd. (App. 26)

Government-owned :

Base Mechanical Workshop, Irrigation Department (App. 27)
Ceylon Government Railways Workshop (App. 28)
Ceylon Transport Board's Workshop (App. 29)
State Engineering Corporation's Main Workshop (App. 30)

Of the privately-owned repair and maintenance shops, the two mentioned first (Apps. 18 and 19) are specialised in the repair of tea and rubber production equipment, while the last (App. 26) maintains

and repairs tractors (Massey - Ferguson).

No specific data were made available as to volume of work and type and condition of equipment. All these three firms are, however, large for Ceylonese conditions, and from the visits it could be ascertained that the equipment used was partly old. Statements about the quality performed varied from bad to good for the first two firms, while Brown & Co.Ltd. was considered to be the best of the local dealers for transport equipment.

The two large Government-owned centralised workshops for the railway and the buses were ample in size, but lacked good equipment. The River Valley Development Board Base Workshop (App. 20) at Amparai had on the other hand some fine machine tools which were little utilised because the work load was diminishing. The State Engineering Corporation was too small for its work load, but extensions are being erected. The quality of the work performed was generally not considered to be up to standard.

2.2.3 Spare Parts

The spare part situation was in general not good, but with some exceptions.

Most machines are imported and it is necessary to import spare parts for them. The foreign currency situation is unfavourable for Ceylon and restrictions are applied. Yet the actual situation varies from factory to factory.

The Sugar Factory (App. 17) has asked for tractor rubber tyres and some other spare parts for tractors, lining and machining of rollers for sugar presses, spare parts for pumps, and other machinery. More than 18 months have passed, but still no permission to buy has been granted.

The Bus Workshop (App. 29) has no difficulties in obtaining permission to import spare parts for diesel engines and gearboxes. The Railways Workshop (App. 28) has a large supply of spare parts for the new diesel locomotives and was granted permissions quickly when needed.

The spare part situation in the Steel Rolling Mill (App. 13) is acute. However, the difficulties are not foreign currency but supply from the manufacturers.

The privately-owned companies, Walker Sons & Co.Ltd. (App. 18), Brown & Co.Ltd. (App. 26), and Colombo Commercial Co.Ltd. (App. 19), receive sufficient foreign currency for spare parts.

Spare parts for heavy earthmoving equipment are difficult to obtain, possibly due to the large amount of U.S. dollars needed, and that the machines are more than 10 years of age.

Practically all maintenance managers complained about port and customs delays, goods having been held up three to four months before delivered to the customer. In many cases they further complained about delays when the applications were processed in the various ministries.

2.2.4 Spare Parts Manufacturing Facilities

There are hardly any special spare parts manufacturing facilities in Ceylon.

Iron foundries are found in the two big private mechanical industries, the Railways Workshop and a very small one in the Technical Services Institute. They are old and have no real temperature control and no laboratory facilities for quality control. A new foundry is planned at the State Hardware Corporation.

Brass and metal foundries with small capacities are found in some industries.

A steel foundry is planned in conjunction with the oil refinery, and a steel furnace is foreseen for the steel rolling mill. No other foundry facilities are available.

Steel forge shops of reasonable size are part of the Railways Workshop and the State Hardware Corporation. Small blacksmiths' shops are found at some factories.

For locally made machinery, mostly for the tea and rubber industries, spare parts are made in Ceylon. Also for the steam locomo-

tives most parts are made locally.

Some bigger machine tools such as roller lathes, arboring machines, and special grinding machines exist, but are in most cases not utilised to any great extent. Gear-cutting machines were not found at any of the industries.

The facilities for machining spare parts for imported production equipment are inadequate. Such facilities are important because of the long lead time for these parts when imported.

Even very simple machines such as centrifugal pumps and small electric motors are not produced in Ceylon.

Many interviewed managers mentioned they were under the impression that the Government does not promote local manufacturing of parts for imported machinery.

The quality of the few special parts produced in Ceylon is generally not up to standard, partly because of the lack of adequate production equipment.

There are no statistics by which the ratio between imported and locally made special parts could be evaluated, but from the fact that few parts are made in Ceylon can of course be derived that most of such parts are imported.

2.2.5 Spare Parts Stores

The modern industries usually have adequate and well equipped stores for spare parts. The older industries sometimes have too small stores and the buildings are not good enough for proper protection of the spare parts.

Card systems for the control of the spare parts stores were found in many industries, but the marking of the parts was in many cases not sufficiently effective.

The central spare parts stores in the privately-owned mechanical industries supplying tractors and automotive parts are fairly good.

The Railways Workshop's (App. 28) stores were of good quality and

run by competent personnel. The Transport Board's (App. 29) stores (for buses) were fairly good.

In most cases improvements are possible, especially the protection of more vulnerable parts such as ball bearings, gaskets, injection-pumps, etc.

The number of spare parts in stock is often either too large, as in the Government Rice Mill (App. 24), or too low, as in the Sri Lanka Sugar Corporation (App. 17).

Some managers mentioned they have great difficulties in obtaining permission to import parts, others had no difficulties. There was no general pattern to be found.

2.3 PREVAILING CONDITIONS OF REPAIR AND MAINTENANCE ACTIVITIES, AND DIAGNOSIS

2.3.1 Adequacy of Present Repair and Maintenance Facilities

In some Ceylonese industries, the production capacity exceeds by far the production, and the repair and maintenance standard - or lack of it - does not represent a great problem, at least at present. In other industries where the demand exceeds the supply, the production capacity is more than often not fully utilised because of deficiencies in maintenance and repair.

These deficiencies are :

1. High absence rate amongst the workers
2. Inadequate supply of spare parts
3. The planned complete production programme not yet started
4. Too little or no preventive maintenance during production causes too long stops for overhauls and repairs.

1. The high absence rate is a general problem. At the visit to the Railways Workshop (App. 28) only 25% of the workers were at work. The average absence rate in this plant was 35%. In the spinning and weaving mills the experts estimate the production to be down

10 to 15% because the workers are absent.

2. The Sri Lanka Sugar Corporation (App. 17) is an example on the inadequate supply of spare parts. Because they cannot obtain tyres for the tractors and wagons, the input of sugar cane is reduced by up to 40%. If less than 1000 tons of cane per day is delivered from the fields, they have to use fuel oil instead of cane under the boilers to keep the process running. Less input per day means a longer harvesting period and less yield. The yield is now about 6.5% instead of 7.5% of sugar per ton cane. The lost production has a value of about Rs. 375,000 and the fuel oil consumption a value of Rs. 500,000. The mill chief engineer mentioned that the average maintenance expenditures per extra production day are Rs. 18,000. This figure will be increased for a shorter production period, but still a short production period implies less maintenance expenditures.

3. The Ceylon Steel Corporation (App. 13), Ceylon Hardware Corporation (App. 16), and the Ceylon Tyre Corporation (App. 14) are working with a reduced production programme because there has not yet been time to introduce all the dimensions they have planned to make. The Ceylon Cement Corporation's (App.1) factory has difficulties in achieving full capacity as they have not the right quality of bricks for the new kiln.

4. The Oils and Fats Factory in Seduwa (App. 6) may be quoted as an example of too long stops caused by the lack of preventive maintenance. When a good preventive maintenance programme is in effect the stops for repairs and overhauls usually are short, one or two days. In Seeduwa they had to stop the production for two weeks because of inadequate preventive maintenance.

2.3.2 Particularly Acute Maintenance Problems

The Sugar Factory (App. 17) has an acute problem of getting some 70 rubber tyres for their tractors and wagons and some electrical spare parts for the starters. If they had received the tyres prior to the harvest season, the entire increased production could have been turned into profit.

An estimated 15% increase in the output of overhauled diesel engines would be possible in the Bus Workshop (App. 29) by introducing a good planning and scheduling procedure, by reducing the number of parts lying around in the shop, purchasing a few power wrenches, and hiring three to four skilled crankshaft grinders.

The Steel Works (App. 13), the Hardware Factory (App. 16), and the Rubber Tyre Factory (App. 14) must revise their supply of spare parts. It takes a considerable time to get these parts and they will be needed within a year or two.

2.3.3 Factors Effecting the Adequacy of Maintenance and Repair Facilities

In most cases the repair and maintenance facilities could be improved by the following items, listed in order of importance :

1. Improved supervision, planning, and scheduling
2. Introducing preventive maintenance programmes, which will reduce the need for emergency repair and prolong the machine lifetime
3. Introducing modern tools such as power wrenches
4. Standardising tool kits for craftsmen
5. Improved workshops
6. Better upkeep both in the production departments and maintenance workshops
7. Systematic collection of drawings, spare parts catalogues, and similar information about machines
8. Estimating time elements for every job, at least for planning and scheduling, possibly also as a base for incentive wages.

2.3.4 Standardisation and Variety of Equipment

There is a Government Bureau of Standards, but very little has been issued regarding machinery standards.

The variety of equipment causes severe problems in many industries.

The buses of the Ceylon Transport Board (App. 29) are of 24 different makes and types and the Sugar Factory (App. 17) has about 100 tractors of 17 different makes and types.

The usual procedure for purchase of equipment is to ask for tenders and the lowest bid is nearly always accepted without due regard to the advantages by standardisation. An example is that a factory needed another fork-truck. They had a Clark and according to existing Government rules they had to ask for three quotations. It happened that another make was a little cheaper and they had to buy that one instead of another Clark.

2.3.5 Organisations or Institutions Dealing with Repair and Maintenance

The only institution dealing with repair and maintenance is to the experts' knowledge the Management Development and Productivity Centre in Colombo (supported by the International Labour Organization).

2.3.6 Government Policies Affecting Repair and Maintenance

No written Government policy concerning repair and maintenance was brought to the experts' knowledge. The great improvements in the allocation of foreign currency for spare parts purchase should, however, indicate that the Government tries to improve the spare part situation.

2.4 PERSONNEL

2.4.1 Skilled Craftsmen, Foremen, and Maintenance Managers

In general, the number of trained craftsmen is said to be sufficient. More advanced trained craftsmen in fields like instrumentation and welding are however scarce. Mainly in industries in the eastern parts of Ceylon there is a need for more trained craftsmen. The Railways Workshop (App. 28) needs also more skilled personnel. The conditions in the eastern parts, especially Valacheniya, Jaffna, and Amparai, are such that skilled personnel try to get jobs, preferably in the Colombo area, where the wages seem to be higher. In

the eastern parts the cultural activities and the possibilities for promotion are scarce.

The Railways Workshop loses many skilled craftsmen to other industries, both privately- and public-owned, mainly because the wages are lower and the training level higher. The Railways Workshop has a very good training programme for all kinds of personnel.

There is a lack of managerial trained personnel among supervisors, foremen, and engineering management staff. Some of the personnel have attended courses on this subject in the U.S.A. and Europe.

There are no statistics available as to the number of craftsmen, foremen, and managers who have been given training in repair and maintenance, but it is evident that they are too few.

2.4.2 Training Facilities

The existing junior and senior technical training schools seem to be well equipped and run, with competent teachers, good equipment for training, and well established course programmes.

For further training, especially in welding, machining, maintenance techniques such as trouble-shooting, diagram reading, etc. only few courses are available. As the basic training does not and should not cover these subjects there is a need for separate courses of shorter duration as a complement to the basic training.

The technical schools and university courses do not cover such special subjects as :

- work study
- management techniques
- industrial economy
- maintenance management
- maintenance techniques.

In-plant training exists in a programmed form only in the Railways Workshop. On-the-job training was generally quoted to be the only training method used in the factories, without any programme or guidance from supervisors and foremen.

Few engineers have been sent for maintenance management or technique courses abroad. Two engineers, one from the Cement Factory (App. 1) and one from a ceramics factory, have after returning to their jobs, introduced modern programmes and the results are encouraging.

The Management Development & Productivity Centre in Colombo is supported by an ILO project. They have started 4 weeks' courses for maintenance managers and will undoubtedly fill a large need for such training.

The supervisors and foremen training follows the generally accepted form, but there is a great demand for management training, personnel management and psychology. Maintenance techniques should have separate training courses.

2.4.3 Management Attitude Towards Maintenance

The majority of the chairmen, general managers, and factory managers interviewed showed an advanced attitude towards modern management methods and maintenance. About the same attitude was met even on lower levels, however, the experts fear that this knowledge is only superficial.

On the foreman, supervisor, and the worker levels, the knowledge of modern maintenance is narrowed down. This is probably one of the reasons that modern maintenance was introduced only in very few factories.

Even if the managers are advanced it is impossible for them to get something done on the factory floor, because the levels under them do not understand fully what they mean and the managers are probably unable to communicate their ideas in detail to them. In factories, where the maintenance engineer was trained in courses outside Ceylon, the introduction of modern preventive maintenance has been successful. In both cases the general managers and the factory managers have given their support to the introduction. These facts indicate that a carefully programmed training of the maintenance engineers and supervisors is one way to improve the maintenance situation.

Some chief engineers, factory managers, and general managers expressed their willingness to contribute to courses and seminars arranged in Ceylon. Practically all these people are fully aware of the need for training on all levels. They suggested a programme for :

- general managers and others on the same management level
- production engineers
- maintenance managers
- maintenance engineers and foremen
- production foremen and supervisors
- maintenance supervisors and craftsmen.

As the production situation calls for close control by the managers it would be impossible to have courses of long duration. Seminars of up to 5 days' duration were suggested, preferably 3 days and made as parts of larger courses. The trend in the Scandinavian countries is to have 4 to 5 seminars in sequence, each lasting from 3 to 5 days, starting with production economy and ending with advanced methods for condition checking.

There are several active managers who could lecture and guide the discussions on these seminars. Some of the engineers trained in international courses could teach the technical subjects. The material for these seminars and courses could be made up of one general part and another part, dealing with Ceylonese matters as the national economy, Ceylonese training facilities, Ceylonese trade union problems, etc.

2.5 FUTURE POLICY

The recommendations on repair and maintenance in Ceylon have been prepared according to the Terms of Reference issued by UNIDO. Based on the findings during the visit to Ceylon and the experts' experience from similar work in other countries, some additional recommendations are presented.

2.5.1 Maintenance and Repair Needs

In some industries such as tea and rubber, inadequate maintenance

is not the reason for an output which is far lower than the production capacity. The bottleneck seems to be a lack of international marketing ability, by which the demand for such goods could be increased. The need for improved repair and maintenance is therefore low.

On the other hand, in industries as cement and sugar the production in Ceylon is not sufficient to cover the domestic consumption. The need for better repair and maintenance is great and any action taken for improving the repair and maintenance situation will increase the production.

If no action is taken the situation might turn in an undesired direction within a few years. This would imply :

- lost production capacity
- a still greater part of the foreign currency has to be reserved for the purchase of spare parts and new machines to replace the worn machines
- lost raw material
- lower development rate in other fields such as agriculture
- higher cost of living or lower living standard.

If an action should have any success it must be supported fully by the Ceylonese Government and industry. It must be understood by all civil servants and politicians that the maintenance programme is a small but important part of the national economy's development programme. The maintenance problems must also be fully considered when a new machine or plant is bought or planned.

2.5.2 Recommendations on the Upgrading of Existing Facilities

In modern factories like the Ceylon Steel Corporation (App. 13) and the Ceylon Tyre Corporation (App. 14), the workshops and the equipment are of fairly good standard. In the older factories like the National Textile Corporation, Weyangoda Mill (App. 2), Ceylon Ceramics Corporation, Negombo Factory (App. 9), and the National Small Industries Corporation Tile Factory (App. 11) the workshops are small and badly equipped.

The Railways Workshop (App. 28) is undergoing a change, as steam locomotives are replaced by diesel locomotives. A number of old machine tools will thus be of no use for the Railways Workshop, but although somewhat outdated, some of them could at least be of use to other industries.

The experts' recommendation is that the surplus machinery should be disposed of by some central organisation and sold or leased to other industries as for instance the textile industry.

The various factories are recommended to make a survey of their needs for workshops premises as well as equipment, machine tools, power tools, hand tools, measuring instruments, etc. These surveys should be performed in co-operation with the Technical Services Institute as this Institute is experienced in this field.

Upgrading of existing repair and maintenance facilities can only be done inside each factory. However, a number of programmes are suggested to assist the maintenance managers in the upgrading of the present facilities.

2.5.3 Maintenance Facilities, Central Repair Workshops

Generally, the experts do not recommend the establishment of central repair workshops. Exceptions are, however, the tea and rubber industries, and the repair and maintenance of heavy earthmoving equipment.

The Tea Industry :

Even the largest tea factory is too small to have its own well equipped repair workshop. But considered as a group, the tea factories together could use a central workshop employing qualified maintenance engineers.

The British Tea Company (App. 22) has 10 tea factories. The need for maintenance facilities for all 10 together would be sufficiently large to grant a good economy for a central maintenance and repair workshop employing a well trained maintenance engineer as the technical leader.

Tne maintenance engineer should be employed as :

- preventive maintenance programmer
- maintenance consultant within the group
- technical leader of the central workshop
- adviser on purchase and design of new machinery.

The workshop should be equipped with machine tools and other facilities for manufacturing of spare parts, a spare parts store, a section for purchase of material and spare parts, and a mobile unit for repair work in the factories. Small workshops in the various factories should remain in good working condition as support to the mobile unit.

This central workshop should act as a contractor for all factories within the area, competing with other repair and maintenance facilities.

The Rubber Industry :

A set-up similar to that of the tea industry is recommended.

The Repair and Maintenance of Heavy Earthmoving Equipment :

There are at least five large workshops maintaining heavy earthmoving equipment :

- River Valley Development Board, Base Workshop (App. 20)
- River Valley Project Second Workshop in the southern part of Ceylon
- Base Mechanical Workshop, Irrigation Department (App. 27)
- State Engineering Corporation (App. 30)
- Public Works Department Workshop.

These Government-owned workshops should establish a common planning and scheduling section for co-ordination of the activities. Savings can particularly be achieved on the purchase of special equipment.

It is recommended that a survey be conducted to ascertain the need for such a co-ordinating section, demand and cost figures, capacity, need of machine tools, equipment, etc. The survey should also include industries in adjacent areas including their workshop facilities as well as other competing maintenance facilities.

The experts suggest that these Government-owned workshops should be organised to provide maintenance services specialised on types of equipment (tractors, bulldozers, loaders, engines, etc.) and not for particular factories or industries. Such a specialisation by types would increase the efficiency considerably.

2.5.4 Recommendations on Improving Existing Stores and the Establishment of New Ones

The industrial equipment in the various branches is generally spread out on a large number of machine types and makes and a centralised store would not be feasible. Spare parts must be stored at the factory to a rather large extent anyway, and too heavy centralisation represents a danger for the maintenance efficiency and services.

It would be an improvement if the agent or local dealers could increase their store of spare parts and the consumers should try to persuade the agents to do so to a greater extent than is now the case.

The tea and rubber industries are, however, in most cases equipped with machines of similar design. The spare parts are manufactured in Ceylon to a large extent. Spare parts or old machines are made on order, which implies long delivery time.

A survey of tea and rubber industries inclusive transportation equipment should be carried out as to the number of spare parts stores needed, their capacities, types and quantities of spare parts, the size and organisation of the centralised stores, and other relevant information.

The establishment of a central spare parts store for the tea and rubber industries might very well prove valuable. Time and money will be saved by co-operative organisation of spare parts procuring and storing.

2.5.5 Training

Training of personnel in the field of repair and maintenance is inadequate and in certain instances neglected. Based on the experts'

judgement, accelerated training will have the largest impact on improving the maintenance situation in Ceylon.

A maintenance training programme should be stablished consisting of the following parts listed in priority :

1. Maintenance seminars for top-level managers
2. Establishment of groups of maintenance managers
3. Maintenance managers seminars
4. "Planning and scheduling maintenance jobs" course
5. Maintenance techniques courses for skilled craftsmen
6. In-plant training programmes for skilled workers.

It will be easy to introduce new maintenance programmes, plans, administrative systems, etc. if the personnel is well trained and the introduction has the managers' full support. The following is a list of the activities according to time schedule and priority :

First Year Training Schedule :

1. Maintenance seminars for top-level managers
2. Establishment of groups of maintenance managers
3. Maintenance managers seminars

Second Year Training Schedule :

3. Maintenance managers seminars
4. "Planning and scheduling maintenance jobs" course
5. Maintenance techniques courses for skilled craftsmen
6. In-plant training programmes for skilled workers

Consecutive Years :

- Continued courses.

1 : Maintenance Seminars for Top-Level Managers :

These seminars are aiming to inform general managers, factory or production managers, managers for economy and finance, and similar specialists in the higher management about modern maintenance philosophy as a part of the management concept, and provide a forum for discussing ways and means to introduce modern systematic maintenance in corporations, Government institutions, and private enterprises.

These seminars must be short, preferably not more than one or two days. Included in the seminar should be a visit to a well maintained factory.

The experts met many managers with modern and advanced views on management methods and philosophy, willing to take active part in such seminars. They should be invited as guest lecturers and if possible prepare a paper to be handed out to the participants.

The maintenance philosophy must, at least in the first seminars, be presented by a foreigner. There are a few engineers with knowledge of modern maintenance philosophy in Ceylon's industries, but unfortunately too young to lecture in this type of seminars. The Management Development & Productivity Centre can contribute to the seminars.

These seminars should start as quickly as possible in order to promote the introduction of practical maintenance projects in factories.

Suitable material in English can be provided from similar seminars in Sweden, Norway, and Denmark. This material is also used at the International Centre for Advanced Technical and Vocational Training in Turin, Italy.

These seminars should have a high quality as the average level of knowledge concerning modern management philosophy amongst Ceylonese managers is high. The detailed information about the maintenance function and its role in modern industry is, however, not so well known by all managers.

The programme for such a seminar could be as follows :

1.	Modern management philosophy	1 lecture
2.	The economic role of modern maintenance	1 lecture
3.	General views on the organisation of a maintenance function	1 lecture
4.	Trends in modern maintenance techniques	2 lectures
5.	Maintenance control systems	1 lecture
6.	Personnel, in-plant training	1 lecture
7.	Wage system incentives	1 lecture

8.	Discussions, groups, and in plenum	4 lectures
9.	Factory visit	2 lectures
		14 lectures

The delegates should be invited to a formal dinner on the first day and the seminar should preferably be of the residential type to give the delegates time and suitable surroundings for informal discussions.

2 : Establishment of Groups of Maintenance Managers (Chief Engineers) :

The experts have found some highly qualified maintenance managers in Ceylon. Their experience and qualifications can be drawn upon by others and through an exchange of ideas, mutual benefit will be gained.

One (or more) informal groups of 12 to 15 maintenance managers or maintenance engineers, with one representative from the various factories should be established. The group will have from two to four meetings a year at the various factories. A meeting will last one day and might for instance have the following programme :

1. A trip through the host factory.
2. A special presentation of the host factory maintenance set-up, workshop, etc. Questions and discussion.
3. A lecture on a particular maintenance subject, or a discussion on a problem of great common interest.
4. Dinner and informal get-together.

The host is responsible for the programme and all the practical details.

Through these activities the following advantages might be gained :

a. The maintenance manager has an opportunity to discuss subjects of common interest with colleagues from other factories.

b. He might get ideas to improve his own maintenance system.

c. In the long run his progress will make him a better maintenance manager.

d. The maintenance manager will become acquainted with colleagues from other factories, which might prove helpful in a critical situation.

After 3 - 4 years the group should be dissolved.

It might be mentioned that 5 maintenance groups of this kind have been active in the Norwegian industries since 1961, and with success.

3 : Maintenance Managers Seminars :

The experts have access to the programme for the maintenance managers seminars run by the Management Development & Productivity Centre. Based on the experts' experience from about 60 similar seminars in Scandinavia, they would like to propose a modification of these seminars.

The seminar is a 16-day training period, divided into 4 weekly parts, each consisting of 4 days with part-time lecturing from 08.30 a.m. to 12.30 p.m. The intention is that the delegates should be given time to partly deal with their ordinary tasks in the factory. This means that delegates from other parts than Colombo have the afternoon free and that the delegates from Colombo have their interests split during the seminar period. In Ceylon full-time seminars will be preferred.

Two courses are suggested :

Course 1 : A residential 5-day full-time seminar.

Course 2 : A special planning and scheduling course, a 5-day full-time course, dealing also with time estimation and time standards.

Course 1 is basically the same as used in the Maintenance Managers Courses and the Techniques in Maintenance Courses arranged by the International Centre for Advanced Technical and Vocational Training in Turin, Italy.

The programme for a maintenance managers seminar could have the following headings :

1. The maintenance function in modern industry : 2 lectures
   - Maintenance today and tomorrow
   - Factors which have economic influence on total business results
   - The aims and scope of the maintenance function
   - The importance of long-range planning
   - Efficiency in maintenance performance

2. Organisation of the maintenance function : 2 lectures
   - Incorporation of the maintenance function in the plant organisation
   - Centralised and decentralised maintenance
   - Line and staff responsibility. Protective and creative maintenance
   - Example of the organisation of the maintenance department in an iron- and steel works - or another industry

3. Procurement of new machines 1 lecture

4. General planning and scheduling 2 lectures

5. Maintenance planning : 2 lectures
   - Receiving a job request
   - Defining the work
   - Stating tools, aids, and spare parts

6. Time estimation and time standards 3 lectures

7. Existing standards for administrative systems 2 lectures
   Specially prepared material

8. Preventive maintenance, general principles 2 lectures

9. Inspections and condition checking methods 5 lectures

10. Test programmes and exercises 3 lectures

11. Preventive maintenance administration 2 lectures
    Special material

12.	Instructions for preventive maintenance Exercise (factory visit)	3 lectures
13.	Maintenance control systems :	3 lectures
	- Recording of maintenance data	
	- Record of machine data	
	- General outline of a computer programme for a process industry	
14.	Spare parts and material	2 lectures
15.	Repair service :	2 lectures
	- Fault finding technique	
	- Electromechanics	
	- Tools and aids	
	- Workers	
	- Foremen and engineers	
	- Ordering, planning, and scheduling	
16.	Personnel management :	4 lectures
	- Payment systems for maintenance staff	
	- Examples of incentive payment systems in maintenance	
	- Recruitment policy	
	- Training and development	
		40 lectures

Course 2, "Planning and Scheduling Maintenance Jobs", is a 5-day full-time residential course for foremen, supervisors, office clerks, and planners, all in the maintenance function.

1.	Introduction	1 lecture
2.	General planning principles	4 lectures
3.	Maintenance planning	3 lectures
4.	Orders and forms	2 lectures
5.	Time estimation	8 lectures
6.	Scheduling principles	5 lectures
7.	Maintenance scheduling	3 lectures
8.	Planning control	2 lectures

9.	Existing systems	4 lectures
10.	Network (PERT, CPM)	8 lectures
		40 lectures

For both courses 1 and 2 is included time for discussions. As the courses are intended to be residential courses also two evening sessions are included.

Each lecture is calculated to 45 minutes and the break between lectures to 10 minutes. Lunch is 1½ hour.

5 : Maintenance Techniques Courses for Skilled Craftsmen :

These courses should be arranged as :

- Residential courses if the number of participants from one industry is insufficient to make in-plant training courses feasible
- In-plant training courses if more than 10 craftsmen particicipate from one industry.

The following is a list of the subjects covered by these courses :

1.	Lubrication	3 days
2.	Ball and roller bearing maintenance in combination with chain drive maintenance	2 days
3.	Maintenance of electric motors and breakers	2 days
4.	Diagram reading for electricians and mechanics	2 days
5.	Basic electricity course for mechanics, including diagram reading	5 days
6.	Logical fault finding, trouble shooting for mechanics and electricians with courses Nos. 4 and 5	5 days
7.	Gas welding	5 days
8.	Electrical welding	5 days
9.	Instrumentation, electrical	5 days
10.	Instrumentation, mechanical	5 days

Programmes for these courses can be obtained from other countries and should not be worked out in Ceylon. Material and documentation can also be provided from outside Ceylon.

6 : In-Plant Training Programmes for Skilled Workers :

Each maintenance manager should make In-Plant Training Programmes for his own industry.

The intentions with such programmes are :

- General information about the factory.
- Detailed information about the existing maintenance system, the organisation, the administrative system, how to handle job and time cards, how to make a job report, internal training programmes, etc.
- Detailed information concerning machines in the factory.

These courses have to be repeated at certain intervals depending on the turnover of personnel.

Usually these courses are given during working time and the participants are paid. The time spent depends on the amount of information but is likely to be something between 10 and 25 hours.

2.5.6 Recommendations on the Establishment of Spare Parts Storage Systems; In-Plant Stores or Control Stores

The files for spare parts and maintenance material in the stores are in most factories adequate.

Stores layout and spare parts protection under tropical climatic conditions are not up to standard and should be improved in some factories. These two subjects should be included in the various maintenance training seminars, thus giving the maintenance managers and storekeepers the knowledge to carry out the necessary improvements.

2.5.7 Recommendations on the Establishment of Spare Parts Manufacturing Facilities With a Programme

Four activities listed in order of priority are recommended to provide adequate supply of spare parts :

1. Reduction in the total lead time for the imported spare parts.
2. Preparation of a booklet with information about possible subcontractors for machining spare parts.
3. A survey to establish a base for possible central manufacturing facilities for spare parts.
4. Implementation of future central manufacturing facilities for spare parts.

1 : Reduction in the Total Lead Time for the Imported Spare Parts :

The long lead time for supply of imported spare parts is a major problem in practically all the factories visited. The total lead time can be broken down as follows :

Outside Ceylon :

Delivery time at the vendor
Transport around Africa.

Inside Ceylon :

Acceptance in head office	1 week (or more)
Government licence	3 to 4 weeks
Obtaining price quotations	4 weeks (or more)
Port delays	Up to 4 weeks

Information from the various factories varied, however, considerably and the total lead time was quoted as from 5 months to 2 years.

One source suggested that each factory should get an annual licence for a certain amount of foreign exchange for necessary spare parts. This would make it possible to cable Europe and have a critical part sent by air in a couple of days, - if so desired.

The supply of spare parts has improved very much during the past

two years, but the possibilities for further improvements should be investigated.

2 : The Preparation of a Booklet With Information About Possible Subcontractors for Machining Spare Parts :

A quick survey should be carried out of the available machining facilities which might be utilised for manufacturing of spare parts in Ceylon. Included in the survey should be whether complete manufacturing is performed, or only certain operations as milling, arboring, larger lathe operations, surface grinding, cylindrical grinding, casting, forging, and welding are done.

The result of this survey should be presented in the form of a booklet which should contain necessary information for the initial contact between consumer and holder of available machining capacity.

Such lists of subcontractors have been used many years in the Scandinavian countries with great benefit to the entire industrial production. The Volvo Group, manufacturers of cars, tractors, and lorries, has for instance based their production on deliveries from subcontractors. In some of their products as much as 60% of the total value comes from subcontractors.

3 : A Survey to Establish a Base for Possible Central Manufacturing Facilities for Spare Parts :

A detailed survey should be carried out of the possibilities to establish a high quality mechanical industry with ample equipment to make spare parts as the main product. If possible,this production should be combined with manufacturing of medium and small machinery such as pumps, valves, small electric motors, and simple switches in order to secure a high capacity utilisation.

The industry must be based on high quality manufacturing methods and be run by service-minded people.

It might also be possible that this industry should be provided with a certain freedom to act as purchaser of spare parts from foreign countries. An annual foreign currency allowance which can be

used without special licences should be granted.

The survey should be carried out in the most important industries, such as food products, rubber, steel mill, hardware, contracting, and transportation. The necessary capacity for manufacturing spare parts like shafts, bushings, wheels, liners, pistons, valves, etc. and the needed output capacity of the various types of cutting tools like lathe tools, drills, and milling cutters should be estimated.

The survey may be done by local engineers under a skilled supervisor, preferably with previous experience from similar surveys. The duration would be about 4 weeks for the field work and 4 weeks to make the conclusive report.

4 : Implementation of Central Manufacturing Facilities for Spare Parts :

The experts noted great interest in Ceylon for central spare parts manufacturing facilities.

The final decision concerning establishment of such an industry should be taken only after careful evaluation of the findings from the above survey. Particular attention should be given to the profitability and the feasibility of this project.

2.5.8 Role that can be Played by Developed Countries

It seems to be a very good solution that one, or a group of industrially advanced countries could contribute to the establishment of advanced mechanical manufacturing facilities by participating in financing, planning, and training of Ceylonese personnel attached to this central establishment for production of spare parts and possibly minor equipment.

We do not believe in establishing a central spare parts store. It would be an improvement if the agent or local dealers could increase their store of spare parts and the consumers should try to persuade the agents into doing so to a greater extent than is now the case. Spare parts must be stored at the factory to a rather great extent

anyway, and too heavy centralisation represents a danger for the maintenance efficiency and service. Central spare parts store might, however, be feasible for separate branches such as tea, rubber, and heavy construction equipment.

Training in maintenance management has already started at the Management Development & Productivity Centre. We find it advisable to arrange further training under this organisation, possibly by recruiting one or two more foreign experts.

There is a definite demand to supply personnel who can work as consultants and give advice to and guide the personnel of the various plants. Some consultants might be found in Ceylon, but should work together with foreign maintenance experts. We find it natural that such a task should be organised by UNIDO as a part of their long-term engagement for improving maintenance and repair in developing countries.

2.6 SUGGESTED PROGRAMME OF IMPLEMENTATION

In the last Section 2.5, Future Policy, the experts have recommended a number of programmes and activities to improve the repair and maintenance situation in Ceylon. It should be stressed that a programme may consist of several activities, short term as well as long term, and that the activities can even be started independently of each other.

To obtain a considerable improvement in the repair and maintenance field, however, it must be realised that the combination of the various projects and the implementation of all or most of the listed projects is essential. The suggested projects together should therefore be considered as a total improvement plan where the priorities of the various projects are to a certain extent not so important.

The priority of the various projects is furthermore a matter for discussion, inasmuch as the estimated effect of the various projects and therefore their relative importance is not expressible in figures, but based on assessments.

2.6.1 Short-Term Activities

Below is a priority listing of the short-term activities :

1. Maintenance seminars for top-level managers.
2. Reduction in the total lead time for the imported spare parts.
3. Preparation of a booklet with information about possible subcontractors for machining of spare parts.
4. A survey to establish a base for possible central manufacturing facilities for spare parts.
5. Recommendations on the upgrading of existing facilities.
6. Maintenance facilities, central repair workshops; tea and rubber industries, heavy earthmoving equipment.
7. Recommendations on improving existing stores and the establishment of new ones.

Recommendations on the establishment of spare parts storage systems; in-plant stores or control stores, (Section 2.5.6), are covered under the training programme (Section 2.5.5).

2.6.2 Long-Term Activities

Below is a priority listing of the long-term activities :

1. Establishment of groups of maintenance managers.
2. Maintenance managers seminars.
3. "Planning and scheduling of maintenance jobs" courses.
4. Maintenance techniques courses for skilled craftsmen.
5. In-plant training programmes for skilled workers.
6. Establishment of possible central manufacturing facilities for spare parts.
7. Role that can be played by developed countries; training and spare parts manufacturing facilities.

2.6.3 Suggested Programmes of Implementation

This section aims to supplement the Bar Diagram, Priorities and Timing of Activities, presented at the end of this chapter.

Training Programme (Section 2.5.5) :

With the exception of maintenance seminars for top-level managers, which should be terminated after one year, the remaining activities are long term. The activities will have a duration ranging from one day to a couple of weeks. They will be repeated frequently depending upon needs and demand.

Recommendations on the Establishment of Spare Parts Manufacturing Facilities with a Programme (Section 2.5.7) :

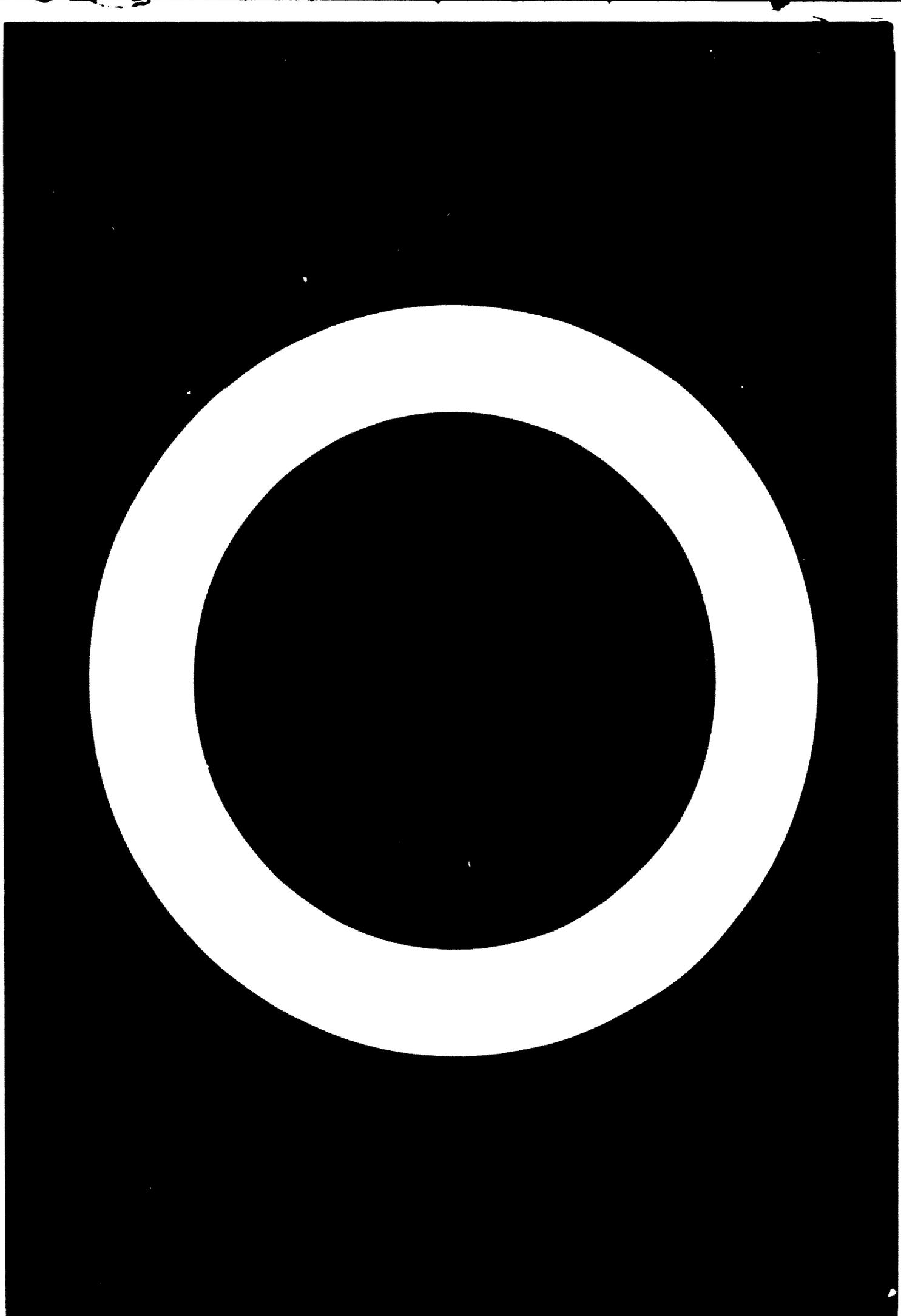
The first two activities, Reduction in the Total Lead Time for the Imported Spare Parts and Preparation of a Booklet with Information About Possible Subcontractors for Machining Spare Parts, can be started simultaneously. The third activity, A Survey to Establish a Base for Possible Central Manufacturing Facilities for Spare Parts, should be started when sufficient information is gathered in the two preceding activities. The fourth activity, Implementation of Central Manufacturing Facilities for Spare Parts, will be evaluated after the findings in the third activity have been presented.

Role that can be Played by Developed Countries (Section 2.5.8) :

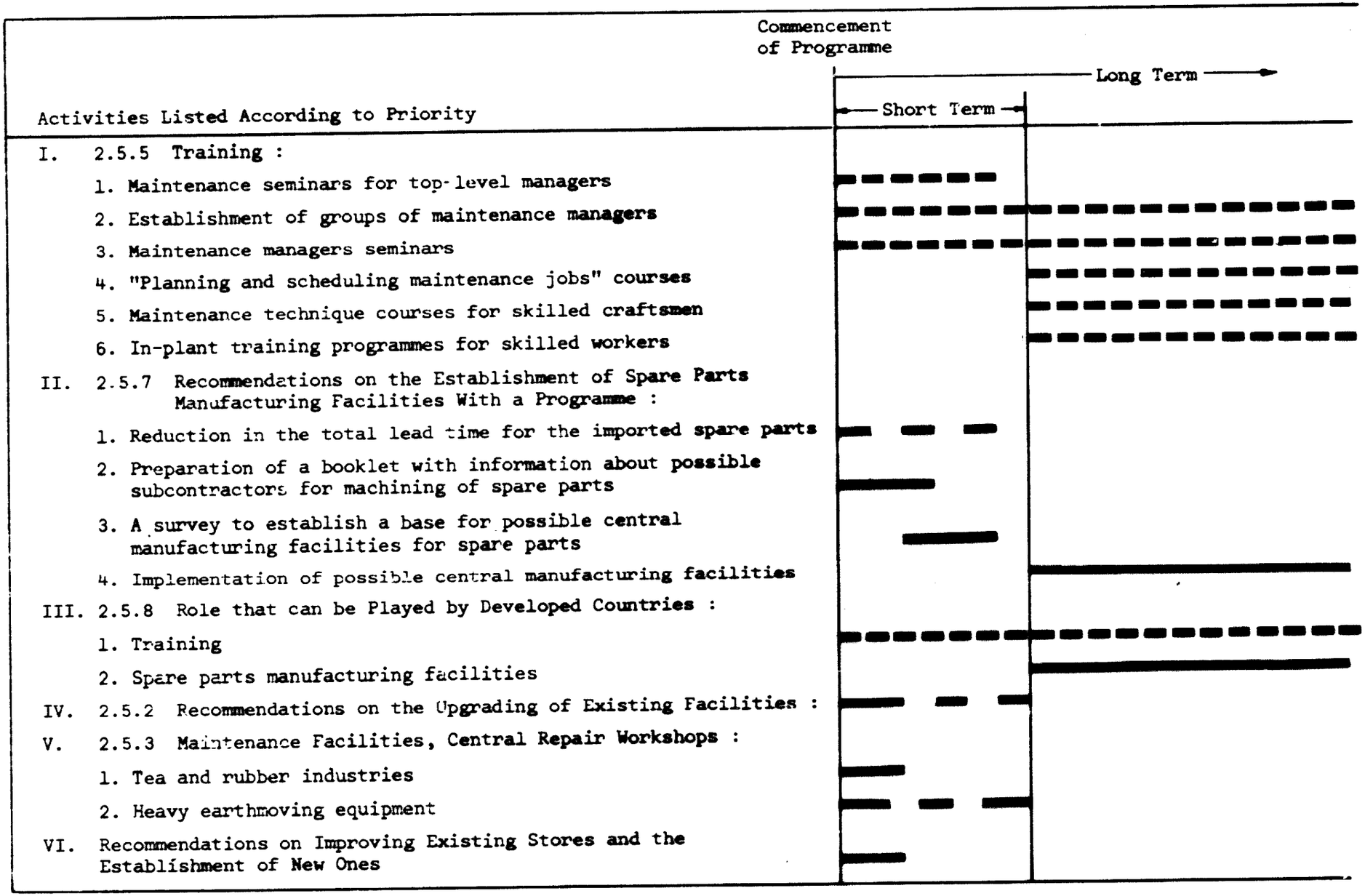
Developed countries can assist in the development of repair and maintenance of industrial equipment in Ceylon by providing assistance in the training programme (Section 2.5.5) and the establishment of possible central manufacturing facilities for spare parts (Section 2.5.7).

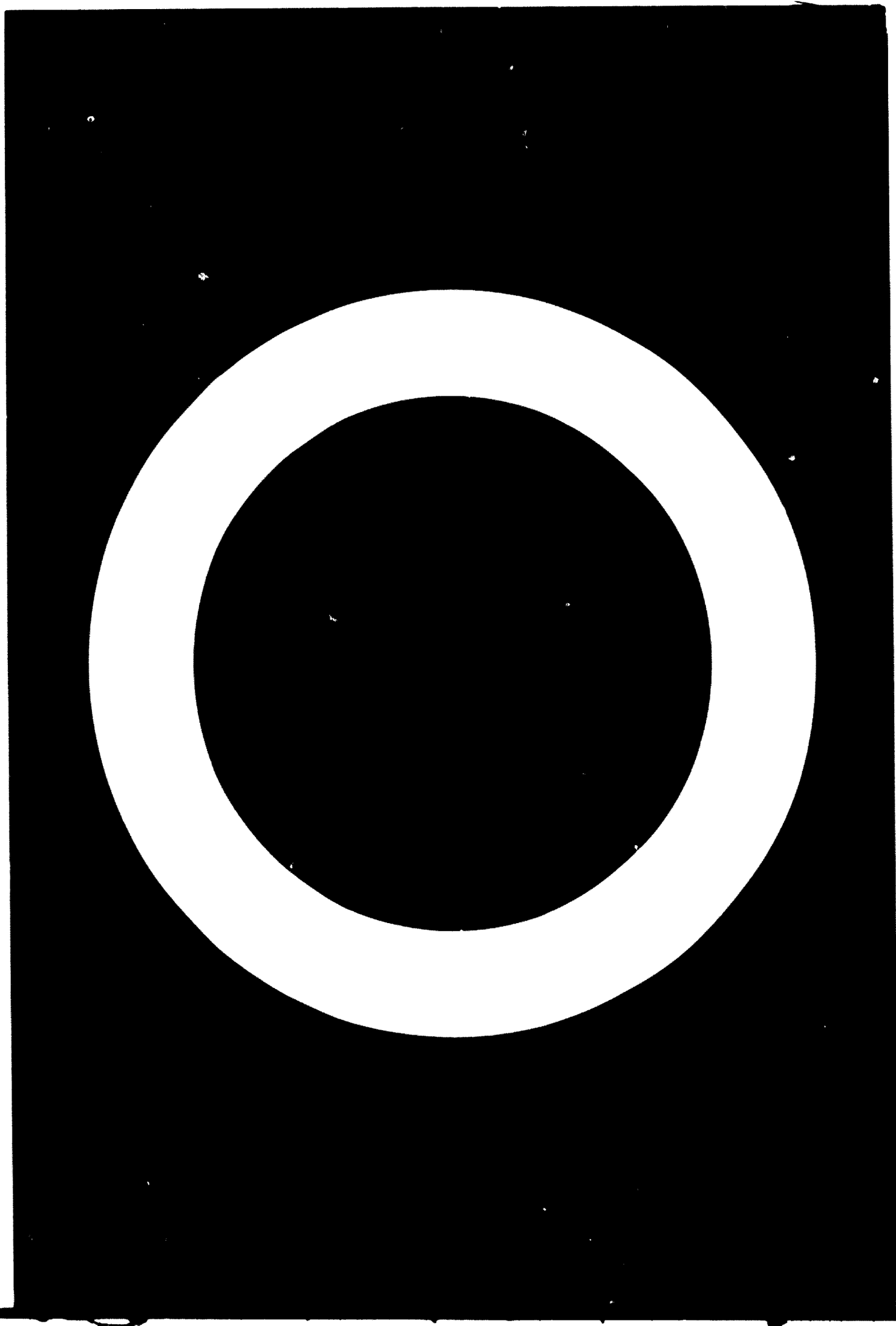
Recommendations on the Upgrading of Existing Facilities (Section 2.5.2) :

The short-term programme recommended consists of an initial survey period (establish needs), a second period for establishing what actions to be taken, and thirdly a period for implementation.



BAR DIAGRAM, PRIORITIES AND TIMING OF ACTIVITIES





Chapter 3 :

SUMMARY

3.1 GENERAL CONDITION OF INDUSTRIAL MAINTENANCE

Based on the findings of visits to about 30 factories and workshops in Ceylon, we can give the following brief description of the general conditions of repair and maintenance of industrial equipment in Ceylon. We have furthermore included our assessment of how the condition can be improved upon.

In general, the production equipment and machinery was taken well care of and very old equipment could still be seen running well and still perform an important task.

The maintenance workshops are however, in general with some definite exceptions badly laid out and equipped. It will be an important task to improve upon these conditions.

The spare parts stores are in some cases inadequate and disorderly and the layout is not good. This is particularly true for the public-owned enterprises. The wrapping and protection of the spare parts is not adequate.

Little has evidently been done for some co-ordination between the various factories regarding maintenance work. Such co-ordinated work could possibly start with having some spare parts machined in the workshop of another factory which possesses the necessary tools.

Some necessary and special machine tools seem not to be available in Ceylon, such as : special grinding and gear-cutting machines. It should be investigated whether central maintenance manufacturing facilities with such machines could be established to serve the entire industry in Ceylon. A supplement can be to use subcontractors, a system employed for instance by the Volvo Group.

The efficiency of the industrial maintenance in Ceylon varies from shop to shop, but is in general fairly low. In a few factories, the

maintenance crews were large and could probably be reduced in size. The absent rate is rather high in most cases. All necessary maintenance tools are not available and a large part of the maintenance personnel lacks skill and the necessary drive to get things done. At some factories the maintenance workers were also less paid than production workers and had no incentive bonus which could make their work more financially rewarding.

It was, however, a pleasure to note that the relation between the workers and their trade unions on the one side, and the management on the other side, was generally good, resulting evidently in few stoppages and strikes, a fact that contributes to heighten the efficiency.

The efficiency was in most cases hampered by bad or just lack of planning on the amount of normal wear and tear on the machinery to establish the list of spare parts to be needed at a certain time. This situation was further aggrevated by the long time needed to get the parts imported (see also Section 3.3). As a part of the machinery was very old, spare parts were not at all obtainable and had to be made or similar parts adjusted.

3.2 MAINTENANCE MANAGEMENT

Most managers interviewed by the experts were of the opinion that they possessed advanced ideas and good knowledge of management methods and philosophy, and this was verified by the experts. However, the top-level management should care more about their maintenance organisation in order to be able to support and promote sound ideas and proposals from their maintenance managers and engineers. In some cases such suggestions were turned down, postponed, or delayed on reasons based on unrealistic intentions to save cost. To cut down on maintenance expenditures meant in these cases also to reduce the income, to lower the production, or loss of invested capital.

To improve the understanding of the maintenance's role in the total economy, maintenance seminars should be given for chairmen, general managers, and factory managers; as well as the responsible civil

servants in Government departments dealing with spare parts import licences, production co-ordination plans, purchase of products, transportation, irrigation, road construction, and erection of factories, etc.

3.3 PROCUREMENT OF EQUIPMENT

When a new factory is planned, it is usually laid out without considering sufficiently the future need for maintenance. Spare parts are often included in the initial plan for a too short period.

The purchase regulations prescribe that at least three bidders shall be invited and that the lowest price shall be accepted. A new make of machinery may therefore be introduced and the spare parts stores will have to be correspondingly increased.

In such situations an experienced maintenance engineer should be consulted and the total expenditure for the factory be considered. Thus short-sighted reductions by purchasing the cheapest machine which will lead to higher outlays in the long run, can be avoided.

3.4 MAINTENANCE MANAGERS AND ENGINEERS

The level of technical skills is in most cases rather high or at least adequate. But in general they have little or no management training, and the knowledge of maintenance techniques and maintenance control methods is not sufficient.

The maintenance managers seminars described in Training, Section 2.5.5, are now laid out by the Management Development & Productivity Centre in Ceylon (sponsored by the International Labour Organization) ought to be expanded and given a broader frame. Then the number of participants would be about 500. The courses should be made compulsory for at least maintenance managers.

3.5 MAINTENANCE FOREMEN AND SUPERVISORS

The level of technical skill seems to be adequate although in some cases too low. Management skills are, however, in most cases poor.

In the maintenance management field improvements must come because the needed introduction of modern maintenance methods will otherwise be seriously hampered, or even impossible to introduce. This can be remedied by starting up management courses such as a "Planning and scheduling maintenance jobs" course (see Training, Section 2.5.5). There are several well established and documentated similar courses available from other countries. The existing courses should be introduced instead of making new courses particularly for Ceylon.

3.6 CRAFTMEN'S TECHNICAL TRAINING

The basic training is fairly good but not complete. A mechanic or an electrician should have his special maintenance training after a few years of practical work training in a plant. It was previously discussed to introduce basic maintenance training in the basic schools. It was, however, considered better to give maintenance courses such as maintenance techniques courses for skilled workers (see Training, Section 2.5.5) later on when the craftsman had obtained some practical experience by working in a plant.

Such courses can be readily be obtained from abroad.

Supplementary training in special skills as for instance instrumentation and welding seems not to exist and should be implemented quickly.

3.7 PREVENTIVE MAINTENANCE SYSTEM

Some of the industries in Ceylon had developed their own particular preventive maintenance system which gave some benefit to the plant.

It would, however, be advisable to employ an international accepted system which should be adapted to the conditions in Ceylon and the experience of the Ceylonese maintenance managers.

The advantages would be that factories within the same branch may exchange instructions, utilise the same training facilities, and save time and expenses. The generally used machine components or

simpler machines such as pumps, lifts, cranes, tractors, etc. can be handled in a similar way in all kinds of industry.

This subject is covered in Training, Section 2.5.5. A factory can in the beginning employ the simplest form and expand in steps to a complete preventive maintenance system which includes the use of computers without changing the previous procedures. It can be used in small and large factories without difficulty.

APPENDICES

A P P E N D I C E S

The following appendices contain the reports from the factory visits. Besides giving some general data about each factory such as production, sales volume, organisation, personnel, etc., the state of repair and maintenance in each factory is covered more fully.

The reports thus also contain "Experts' Comments" and "Experts' Recommendations on Maintenance" with the following sub-headings :

Organisation
Repair Facilities
Spare Parts Store
Spare Parts
Personnel.

Recommendations on all of these five items will not be found in some of the appendices, the reason being that there are no comments or recommendations to be made on that specific item.

LIST OF FACTORIES VISITED

Appendix No.	Name of factory	Location	Date visited 1969
1	Ceylon Cement Corporation, Kankesanthurat Factory	Jaffna	28 April
2	National Textile Corporation	Weyangoda	29 April
3	Wellawatte Spinning & Weaving Mills	Colombo	6 May
4	Eastern Paper Mills Corporation	Colombo and Valacheniya	25 and 26 April
5	Paranthan Chemicals Corporation	Paranthan	27 April
6	Ceylon Oils & Fats Corporation	Seeduwa	21 April
7	Harischandra Mills Ltd.	Matara	25 April
8	Lever Brothers (Ceylon) Ltd.	Colombo	4 May
9	Ceylon Ceramics Corporation, Negombo Factory	Negombo	21 April
10	Ceylon Ceramics Corporation, Piliyandala Factory	Colombo	19 April
11	National Small Industries Corporation	Bangadeniya	20 April
12	Ceylon Plywood Corporation	Galle	25 April
13	Ceylon Steel Corporation	Colombo	17 April
14	Ceylon Tyre Corporation	Colombo	18 April
15	Ceylon Leather Products Corporation, I.D. Shoe Factory	Colombo	22 April
16	Ceylon State Hardware Corporation	Yakkala	23 April
17	Sri Lanka Sugar Corporation, Sugar Factory	Amparai	27 April
18	Walker Sons & Co.Ltd.	Colombo	30 April
19	Colombo Commercial Corp. (C.C.C.)	Colombo	20 April
20	River Valley Development Board, Base Workshop	Amparai	27 April
21	Rubber Co.Ltd., Paramba Group	Undegoda	29 April
22	Diyagama West Tea Factory	Agrapatna	1 May
23	Coombewood Tea Estate	Colombo	2 May
24	Government Rice Mill, Charalakada	Kalmunai	28 April
25	Gal Oya Wood Working Industry	Amparai	28 April
26	Brown & Co.Ltd., Agricultural Division	Colombo	22 April

Appendix No.	Name of factory	Location	Date visited 1969
27	Base Mechanical Workshop, Irrigation Department, Ministry of Land, Irrigation and Power	Colombo	19 April
28	Ceylon Government Railways Workshop	Ratmalana	3 May
29	Ceylon Transport Board	Colombo	18 April
30	State Engineering Corporation, Main Workshop	Colombo	26 April
31	Hardy Senior Technical Institute	Amparai	27 April

Factory No. 1 : CEYLON CEMENT CORPORATION,
Kankesanthurai Factory,
Jaffna.

Report on Visit, 28 April 1969

Branch : Cement.

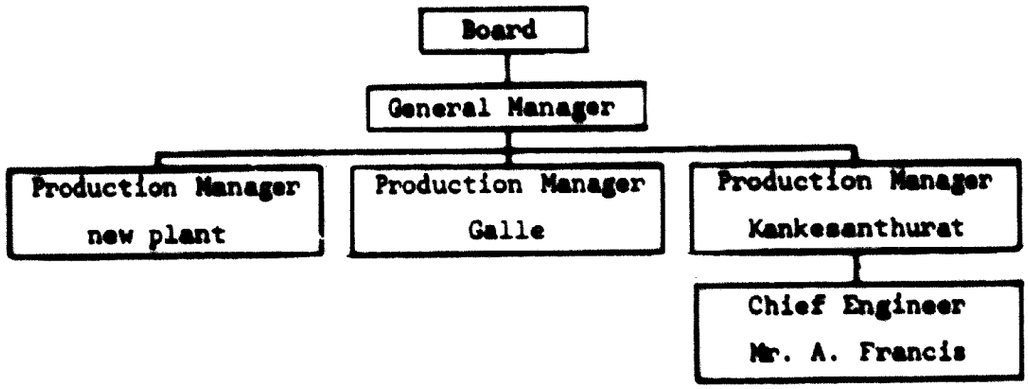
Products : Cement and some cement klinker.

Persons met : Mr. A. Francis, Chief Engineer (acting factory manager)
Mr. K. Sanmuganathan, Electrical Engineer
Earlier on we had met Mr. V. Perampalam, General Manager of the Head Office in Colombo.

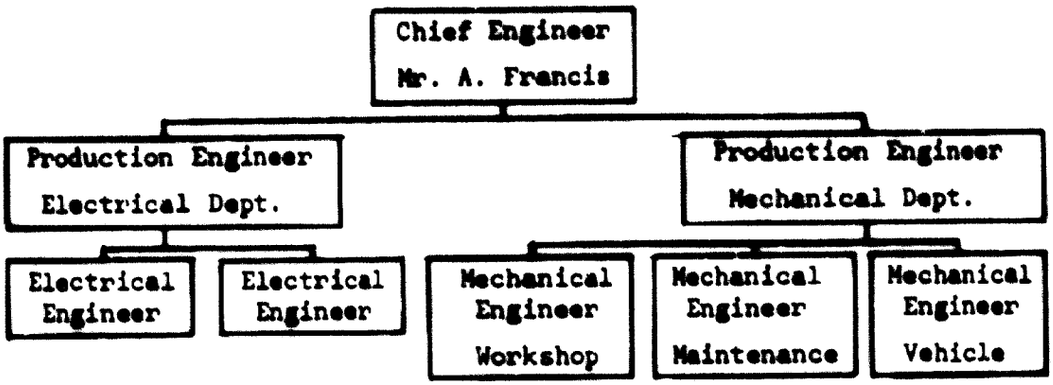
Basic Data :

Annual production, 1968/69	: 160,000 tons
Annual sales volume, 1968/69	: Rs. 33.6 mill.
Present factory capacity	: 275,000 tons
Production estimated 1969/70	: 250,000 tons
Number of workers, 1969/70	: 823
Total employed, 1969/70	: 1,018 (1968/69 : 661 + 350 casuals)
Ground area	: 25 acres + limestone area
Maintenance, labour expenditures, 1968/69	: Rs. 590,000
Spare parts + materials 1968/69	: Rs. 550,000
Maintenance supervision	: Rs. 150,000
Total maintenance expenditures, 1968/69	: Rs. 1,290,000
Expenditures on repairs, 1968/69	: Rs. 235,000
Preventive maintenance, overhaul and new, 1968/69	: Rs. 905,000
Inventory value of spare parts	: Rs. 4.4 mill.
Inventory value of bricks and steel balls	: Rs. 1.7 mill.

Corporation Organisation :



Maintenance Organisation :



Staff :

	Electrical Maintenance	Mechanical Maintenance	Mechanical Workshop	Vehicle Repair
Charge Hand I	2	2	2	2
Charge Hand II	1	-	2	-
Specially skilled	-	-	2	-
Skilled I	12	10	18	7
Skilled II	17	15	4	11
Skilled III	5	-	13	3
Skilled IV	5	-	-	-
Total skilled	42	27	5	23
Semi-skilled and unskilled	12	20	13	25
Total	54	47	54	48
	54		149 total mechanical	

Comments to Company Organisation :

Simultaneously with an expansion of the factory with a new kiln put into operation not long ago, the company rearranged the entire factory organisation including the maintenance set-up.

Basically the new organisation with the mechanical section divided into maintenance, workshop, and vehicle repair is very good. The maintenance management should, however, be given more staff functions and a planning office be established. These points were discussed during the visit.

The supervisors at the factory had two years at technical college before being employed. They received afterwards three years' training in the plant.

The skilled personnel of the repair crew received two years' basic training and three years' on-the-job training.

It was difficult to recruit instrumentation engineers with basic training.

Preventive Maintenance :

The chief of maintenance had introduced a good preventive maintenance programme for all equipment for limestone, mining, and transportation. The programme included lubrication, cleaning, and testing of condition at certain intervals. Planning forms for short- and long-term preventive maintenance had been made out. Next step would be to introduce preventive maintenance of the cement production equipment and machinery where it would be possible.

Various Information :

Workers' efficiency is estimated by us as average. Workers receive fixed monthly salaries plus one month's salary as incentive bonus every year. Absence rate is about 14%, which is an acceptable figure compared to the factories in Ceylon. No work study or rationalisation had been carried out in the factory.

Main Problems :

One of the main problems had been to obtain good enough high temperature refractory bricks for the burner part of the rotary kiln. This had caused frequent repairs on the rotary kilns. These stops had been recorded graphically in an excellent way, and showed that the production stops because of kiln

repair was about 20% of the production time, while around 6.5% would be a reasonable figure.

Another main problem was to find qualified personnel at the higher levels in the maintenance organisation.

The delivery time for spare parts was given to be one year, including one month for quotation from the vendors.

Experts' Comments :

The production equipment was well taken care of and maintained. The chief engineer, Mr. Francis, has a very good understanding of the modern maintenance organisation and the maintenance routines. He will, however, not be able to implement his ideas fully without assistance to train his personnel at all levels.

Experts' Recommendations on Maintenance :

Organisation	:	A planning section should be established. Planning and scheduling routines should be introduced; preferably a follow-up system. The preventive maintenance programme should be expanded as soon as possible.
Personnel	:	A training programme for all levels should be worked out and implemented.

Factory No. 2 : NATIONAL TEXTILE CORPORATION,
Weyangoda.

Report on Visit, 29 April 1969

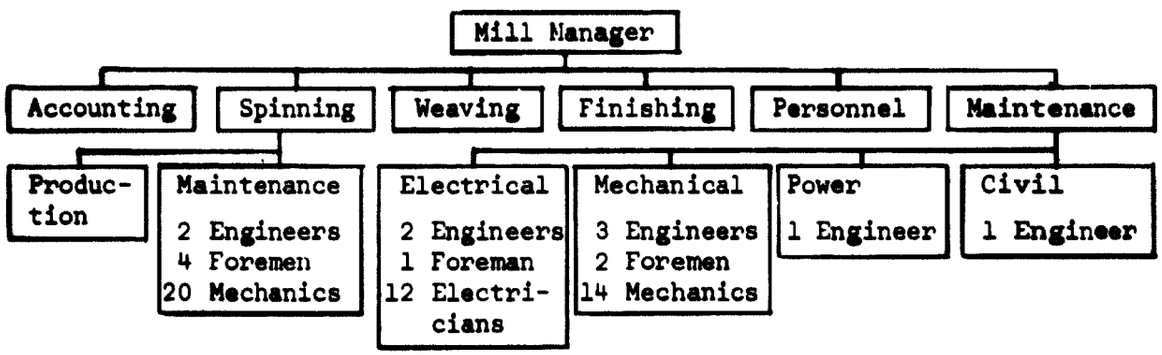
Branch : Cotton spinning, weaving, and finishing.

Products : Cotton yarn and cloth.

Basic Data :

Annual capacity	:	Spinning 3.4 mill. lbs. Weaving 14 mill. yards Finishing 20 mill. yards
Actual production	:	Yarn 3.1 mill. lbs. Weaving 8.5 mill. yards Finishing 14.4 mill. yards
Capital invested	:	Rs. 42 mill.
Number of workers	:	1400
Staff	:	200
Year built	:	Spinning mill, 1961 Weaving plant, 1964 Finishing plant, 1966

Organisation :



General about Production :

In the spinning mill many spindles were running idle due to the high absence rate and the capacity utilisation was consequently fairly poor.

The weaving department has the same problem.

The capacity in the finishing department is not fully utilised.

The power house is well maintained and has ample capacity.

Maintenance :

The spinning mill has its own preventive maintenance programme. Each unit is taken out of production at a predetermined time, inspected, adjusted, and worn parts replaced and then the machine is tested.

The programme is based on recommendations from the machine manufacturer and controlled by a simple scheduling board.

The main maintenance department should take care of the remaining three departments, weaving, finishing, and the power house. The workshop is very poorly equipped, but there are plans to increase its capacity by adding new machines and tools.

There is no planning or scheduling system, and only job cards are used.

The main stock of spare parts has just been moved to new premises and is well taken care of. The parts are protected against dirt and moisture. The card system and marking of parts and shelves are very effective.

The maintenance standard is very good in the spinning mill and in the power house, but slightly lower in the weaving and finishing plants.

Experts' Comments :

At the time of our visit the mill manager acted as maintenance engineer as well. He has a good background but has obviously a too heavy work load.

The power house engineer showed us the plant. He seems to be capable of managing his own department.

The maintenance assistant in the spinning mill knows very well how to run his department.

The lack of a good planning and scheduling routine in the weaving and finishing plants is obvious, and there is also no preventive maintenance system in effect.

In general, the engineers need training in management and maintenance techniques.

The skilled maintenance worker has a considerable lower absence rate than the unskilled.

Experts' Recommendations on Maintenance :

Organisation	:	The maintenance engineer should be in charge of the spinning mill maintenance group, not the spinning mill engineer. A planning and scheduling department should be organised. Preventive maintenance programmes similar to that of the spinning mill should be made for all departments, starting with the weaving department.
Repair Facilities	:	The new workshop will fill the needs when established.
Personnel	:	Management training should be started as soon as possible, and the vacancies filled. With the introduction of the maintenance programme, training should be started.

Factory No. 3 : WELLAWATTE SPINNING & WEAVING MILLS, Colombo.

Report on Visit, 6 May 1969

Branch : Textile. Spinning, weaving,and finishing.

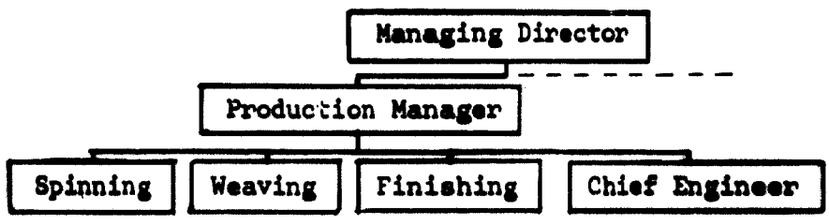
Products : Various cotton products.

Persons met : Mr. A.S. Russel, Managing Director
Mr. L.S. Wanigatunga, Production Manager
Mr. Joe Perera, Chief Engineer.

Basic Data :

Annual production, 1968/69	:	14 mill. yards
Annual sales volume, 1968/69	:	Rs. 45 mill.
Number of workers	:	3200
Total employed	:	3500
Ground area	:	12.5 acres
Year established	:	1882
Spare parts purchased	:	Ranging from Rs. 0.3 mill. to Rs. 1.5 mill.
		52 automatic looms and 30 manual looms.

Organisation :



Maintenance Crew :

1.	Central Maintenance Department	:	75 workers of which 40 skilled
2.	Weaving Department	:	8 workers, 40 assistant line workers, 15 others
3.	Spinning Department	:	5 workers, 3 fitters.

Maintenance Organisation :

The factory has a decentralised organisation with a maintenance group in the weaving and spinning departments to take care of lubrication, daily maintenance, and light repairs. The central maintenance department carries out all maintenance in finishing and heavy repairs of all factory equipment including overhauls. According to information obtained, the co-ordination between the different maintenance groups is good.

Various Information :

Absence rate is between 20 and 30%, which is a main reason for poor capacity utilisation. From the managing director's point of view, the main problem is the excessive amount of maintenance work. This must be linked together with the fact that a very large part of the spinning and looms machinery is very old indeed.

Available space and personnel in the maintenance workshop limit the capacity to overhaul only one loom at the time. Such an overhaul takes at least three weeks, which means that only 10 to 12 looms are overhauled every year.

Furthermore, the managing director would like to improve preventive maintenance during daytime. At present, there is no difficulty in obtaining spare parts. Previously, however, this was a problem.

Experts' Comments :

The organisation of maintenance is good, and the equipment is fairly well taken care of. In general, machines are very old and a rather extensive store for spare parts is required.

Experts' Recommendations on Maintenance :

Organisation	:	The central maintenance organisation should be expanded. A more specific preventive maintenance programme should be introduced.
Repair Facilities	:	The workshop should be expanded and given a much larger overhaul capacity.
Personnel	:	Training should be introduced.

Factory No. 4 : EASTERN PAPER MILLS CORPORATION,
Colombo and Valacheniya.

Report on Visit, 25 and 26 April 1969

Branch : Paper

Persons met : Mr. K.C. Tangarajah, Chairman
Mr. Abeeyanandam, Mills Manager
Mr. Hector Teyesighe, Production Manager
Mr. Hapugoda, Mechanical Engineer.

Basic Data :

Annual production	:	7,968 tons
Annual sales volume	:	Rs. 16.0 mill.
Capital invested	:	Rs. 30 mill.
Number of workers	:	625
Staff	:	155
Casual workers	:	300

Production :

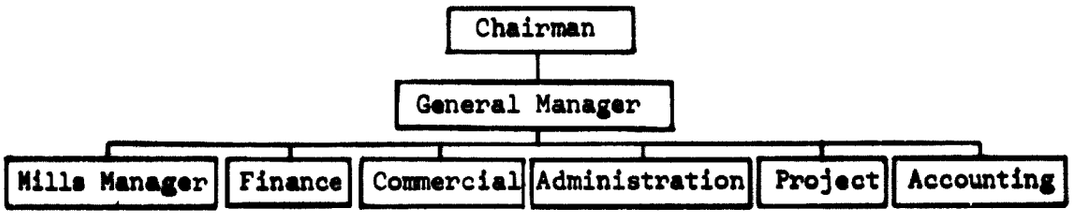
The factory is built to use straw as raw material. Straw is brought in, cut and digested. Imported pulp is added and different types of paper products are made on a Voigt paper machine, and are then finished and cut. Paper sacks and textbooks are manufactured in a separate department of the factory.

Workshop :

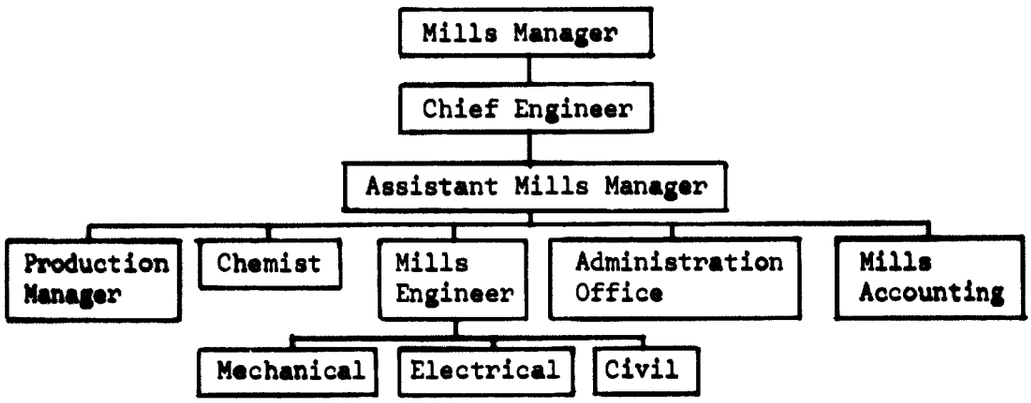
The maintenance workshop is rather small, but the construction of a new building has already been started. The layout for the new workshop seems to be quite good.

Organisation :

At the Head Office in Colombo :



At the factory :



Maintenance :

Labour	:	Rs. 410,000
Material	:	Rs. 170,000
Total annual costs	:	Rs. 580,000.

These figures are based on data per March 1969. In 1968 the total maintenance costs were Rs. 518,240.

Personnel :

Many positions are vacant as it is difficult to recruit qualified engineers in Valacheniya. Many engineers and foremen had received their training in India. They had few skilled craftsmen.

The planning procedure is simple. Weekly meetings are held with the production manager and the production engineers. The mechanical, electrical, and sometimes even the civil engineers attend these meetings. Before a production stop a list of tasks to be performed during the stop is made. The acting maintenance foremen have each a list of tasks to be performed during the day.

The efficiency of the skilled craftsmen is quite good, but there is waste of time.

The wage system is based on fixed rates. However, incentive bonus is given for attendance and production.

Trade union activities are encouraged by the mills manager and the relations are good.

Experts' Comments :

The number of workers seems to be rather high for a mill of this size. The engineers seem to be quite efficient. There is an obvious lack of managerial training.

No regular training programmes for skilled or unskilled workers are in effect. However, there seemed to be some training activities going on.

The mills manager and the chairman of the board have introduced a detailed monthly report on all production activities. The report contains a lot of useful material, but it might be easier to utilise this information if presented more appropriately.

Without any doubt, the managers at all levels have access to realistic information.

The modern attitude of the managers should guarantee success for a modern management training system as well as for an efficient preventive maintenance system.

Experts' Recommendations on Maintenance :

Organisation : A survey of the organisation should be conducted to arrive at the establishing of a common maintenance planning and scheduling department which could correlate the activities in the electrical and mechanical departments. A simpler and more rapid written orders system should be introduced. A preventive maintenance programme should be started up.

Repair Facilities : The mechanical workshop will be extended with a new workshop and the facilities will then be acceptable.

Personnel	:	Management training of engineers and foremen should be implemented, and training programmes for all levels made out and implemented.

Factory No. 5 : PARANTHAN CHEMICALS CORPORATION,
Paranthan.

Report on Visit, 27 April 1969

Branch : Chemical.

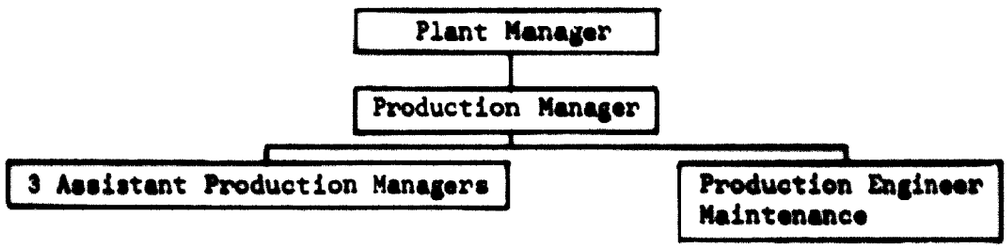
Products : Caustic soda, chlorine (liquid), table salt, potassium chlorate.

Persons met : Mr. P.A. Clatchithanandam,
Mr. K. Saravanamuffy, Production Engineer.

Basic Data :

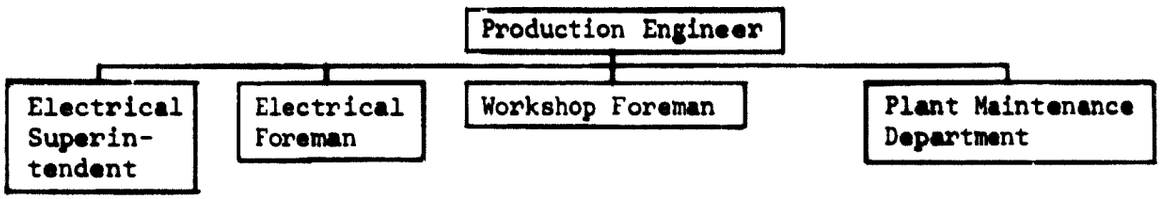
Annual sales volume	:	Rs. 2.4 mill.
Capital invested	:	Rs. 12 mill.
Number of workers	:	140 + 90 casuals
Total employed	:	280
Inventory, including spare parts and material	:	Rs. 2.5 mill.

Company Organisation :



Previously the plant had decentralised maintenance.

Maintenance Organisation :



5 skilled	20 Workers :	2 Foremen
3 unskilled	5 skilled, grade 1	8 Workers :
	6 skilled, grade 2	4 skilled, grade 1
	4 semi-skilled, grade 3	1 skilled, grade 2
	5 semi-skilled, grade 4	3 skilled, grade 4

Various Information :

Skilled workers are lacking and they are difficult to find and employ. The recording of repairs on job cards was started recently. Salaries are based on a job evaluation system. The actual production was calculated to be 72% of the maximum production capacity. This is explained by some of the following factors:

- The workers' efficiency is low.
- The high absence rate.
- 5% production down-time due to maintenance.
- It takes about twelve months to get the spare parts.

Experts' Comments :

Chlorine, gas and partly other products are very corrosive and for this reason the factory has an important and difficult maintenance problem. However, the management is very alert and makes sure that the parts are painted over and over again, which seems to be the only possible protection. Spare parts in store are to some extent kept in plastic covers to prevent corrosion. Even if this protection is quite good, it can be more systematically applied. The different production departments, workshop, and storeroom are exceptionally clean and not filled up with rubbish, etc.

Experts' Recommendations on Maintenance :

Repair Facilities : The workshop should be improved and better equipped.

Spare Parts Store : To be expanded and improved, even if the protection of the parts is quite good today.

Spare Parts	:	Action should be taken to reduce the spare parts lead time, if possible.
Personnel	:	An appropriate recruitment programme and a training programme should be started.

Factory No. 6 : CEYLON OILS & FATS CORPORATION, Seeduwa.

Report on Visit, 21 April 1969

Branch : Factory at Seeduwa (North of Colombo).

Products : Provender foods, fatty acids, oil from copra, oil from poonac, and glycerine.

Poonac is the solid matter content expelled after mechanical extraction of oil from dried coconut meat. As there exists a large number of privately-owned plants engaged in the mechanical extraction of oil, the Government has prohibited the state venture (Oils and Fats Corporation) to be engaged in mechanical extraction of coconut oil. Poonac contains about 12% oil which could only be extracted by solvent extraction.

The private industrialists are not equipped for this process. Hence poonac is collected from all parts of the country and processed in this factory.

Glycerine is produced of coconut refuse obtained after the juice (coconut milk) has been extracted. Centres have been set up to collect this material. Glycerine is exported to Europe.

Persons met : Mr. Navendran, Acting Factory Engineer
Mr. Silva, Assistant Factory Engineer (Maintenance).

Basic Data :

This factory is one of the largest provender plants in the country.

Annual sales volume	:	Rs. 24 mill.
Initial capital invested	:	Rs. 19 mill.
Subsequent improvement	:	Rs. 4 mill.
Actual production of fatty acids	:	80% of full capacity
Actual production in the provender plant	:	180% of specified capacity. (Improvement in material handling has resulted in this increase).

Actual production in the solvent extraction plant	:	9% of full capacity. (Started recently and is under a major development programme).
Number of workers	:	600
Total employed	:	800

Annual Maintenance Expenditures :

Labour	:	Rs. 2.5 mill.
Spare parts and material	:	Rs. 1.0 mill.
Total maintenance expenditures	:	Rs. 3.5 mill.

The maintenance expenditures have not been broken down to preventive, overhaul, repair, new, etc.

Inventory value of spare parts and material	:	Rs. 0.7 mill.

Maintenance Personnel :

The existing functions are the maintenance, modifications, and improvements of plants and machinery.

The functions of the engineers responsible for maintenance include work on new project development work.

The engineers are graduates of universities and engineering institutions, or diploma holders from technical institutes.

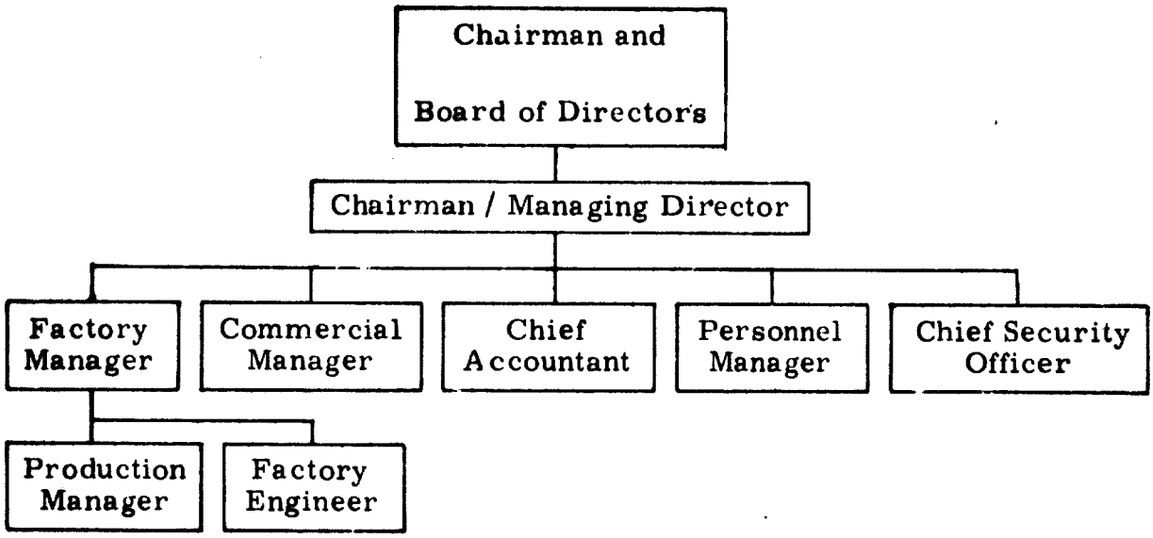
The foremen are diploma holders of technical institutions or they have 15 to 20 years of experience in engineering.

Though the engineers feel that the maintenance crew of 167 persons is too low, we think this figure is on the high side.

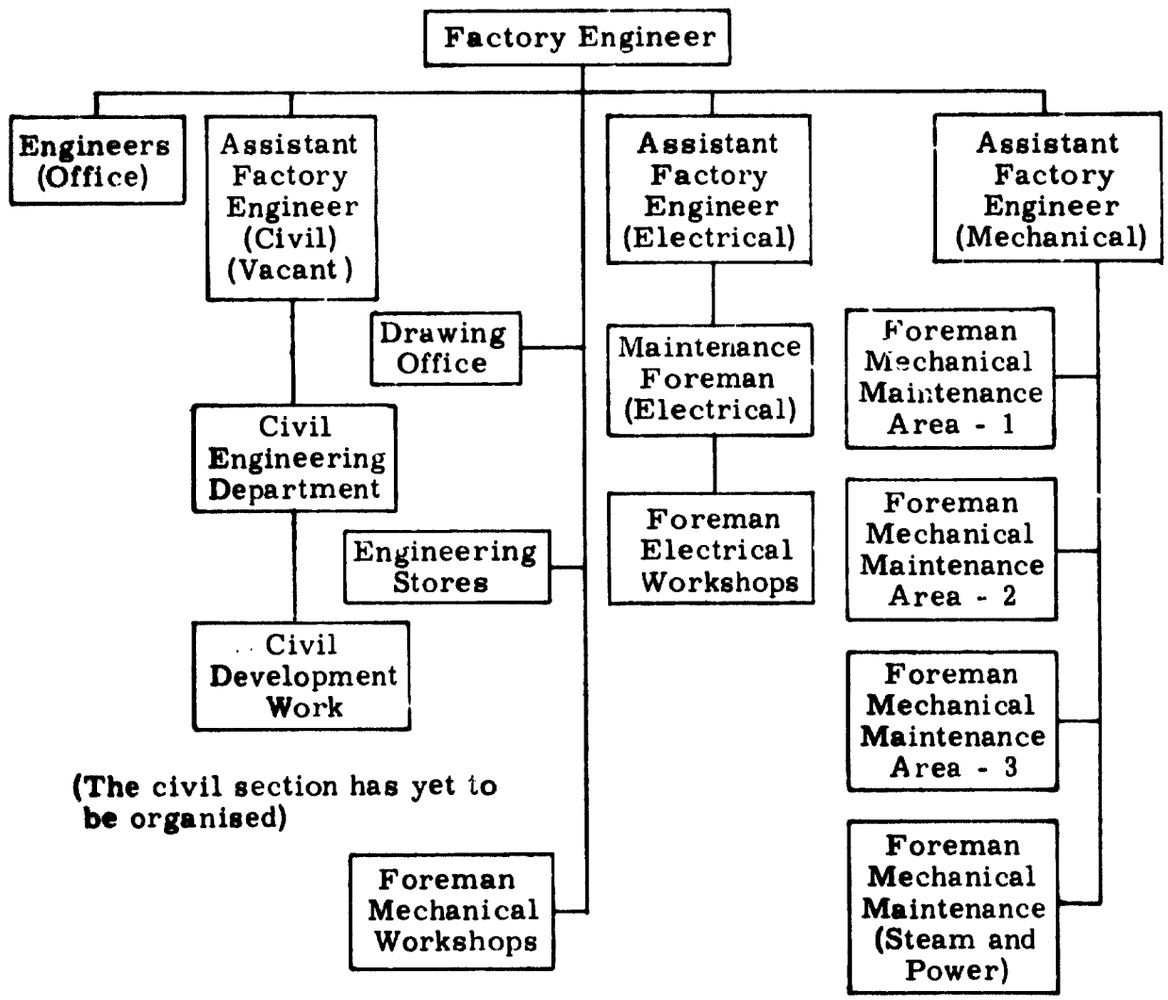
The efficiency of the crew is too low and the existing routines for maintenance have not been effective.

The morale of the workers, as complained by the engineers, is not conducive for development or progress. They operate in watertight compartments. The work discipline cannot be satisfactory as the maintenance appears to have been grossly neglected.

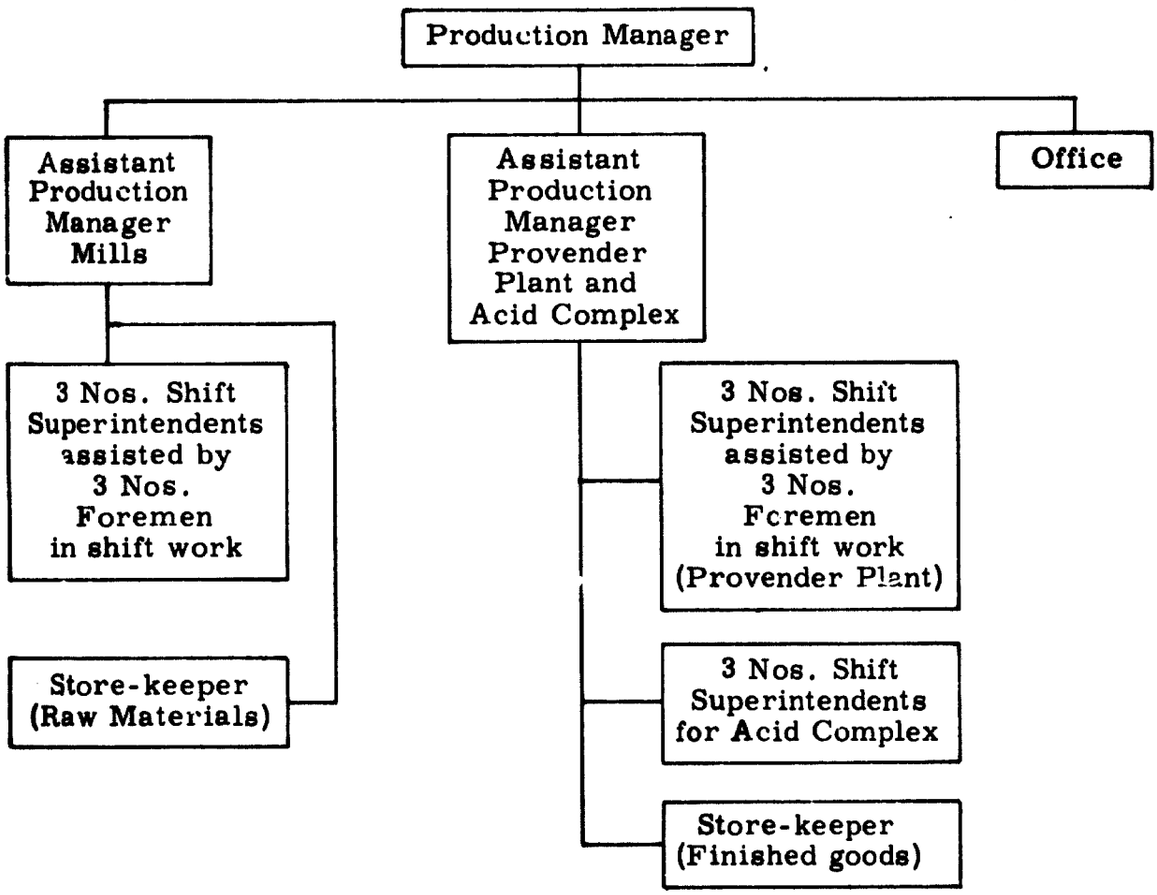
Organisation :



Maintenance Organisation :



Production Organisation :



Training in Plant :

Organised training procedures are not prevalent in this corporation. On-the-job training is practised.

Work Study and Rationalisation :

The new work study techniques in management have not been applied in this corporation.

One maintenance engineer has received training in modern maintenance practices in Germany. The other engineers have received introductions to the above fields of study.

Maintenance :

Down time due to maintenance has not been recorded.

The planning of maintenance during planned and unplanned stops is not properly organised.

The planning, scheduling, and recording procedure for maintenance work is at present being organised by using the maintenance procedure adopted in the Cement Industry of Ceylon as a guide.

Following-up procedure of failures has received but little attention.

Wage Systems :

The workers receive fixed salaries.

As an effort to overcome certain bottlenecks in the production processes, an incentive wage scheme is being prepared.

The maintenance workers are paid on the engineering wage system and receive a fixed salary on an incremental basis.

Trade unions are not adequately co-operative to the management.

Experts' Comments :

It would be most beneficial for the corporation if the top management has more discussions with the engineers who are young, energetic, and full of ideas about maintenance. Though it may be that some of these ideas are too ambitious or even outdated, it is always a good practice to listen to them.

A senior maintenance engineer may be hired for a short period to work with the engineers of the corporation to evolve a "Working System" for maintenance. This need seems to be of utmost importance as the engineers are yet indecisive about the system to be implemented for organised maintenance.

The corporation is planning a large-scale development programme. At this moment it would be very necessary to obtain the proper type of equipment for the new installations as some of the plant and the equipment, especially the motors of the old installations, have not been selected very carefully.

The layout in the factory has to be improved to reduce labour and operational costs.

Good upkeep has been very much neglected. It should be well remembered that the foundation for an effective maintenance is good upkeep.

The maintenance workshops are poorly equipped and not carefully maintained. This aspect should receive serious thought and planning as no proper maintenance is possible unless supported by an efficient workshop.

One of the major problems in the collapse of maintenance is the overlapping between the various sections of maintenance which provides adequate cover for workmen refusing to undertake certain jobs. This overlapping has to be minimised by introducing a system of "Describing Job Responsibilities".

There is a great need for training of the maintenance crew. An organised maintenance course could be designed and effectively executed by taking out only a few workers at a time for a repetition course in modern maintenance practices.

The biggest drawback in the maintenance organisation is to find enough support to implement a maintenance programme. The trade unions should also be consulted and the attitude of the workers should be enhanced to fulfill this task.

Experts' Recommendations on Maintenance :

Organisation	:	A planning and scheduling section should be established. Better co-operation from the production department is needed. A good system for written orders should be introduced to simplify the ordering and performing of maintenance, especially preventive maintenance. A maintenance programme should be outlined and introduced as soon as possible. The expanding industry needs extensive co-operation between maintenance and project engineers.
Repair Facilities	:	The workshop should be overhauled and better equipped.
Spare Parts Store	:	Should be overhauled and better equipped. Upkeep to be improved.
Personnel	:	Training programmes should be worked out and implemented, and management training started as soon as possible.

Factory No. 7 : HARISCHANDRA MILLS LTD.,
Matara.

Report on Visit, 25 April 1969

Branch : Chemical industry, soap, miscellaneous.

Products : Coconut oil in barrels and bottles, soap, rubber, noodles, fertiliser, food, etc.

Persons met : Mr. G.E. Clogsloun, Secretary to the Board and Manager of Supplies.

Basic Data :

Total annual sales (1968)	:	Rs. 18.5 mill.
Number of workers	:	450
Total employed, about	:	500
Extra labour on weekly basis		
Stock capital	:	Rs. 1 mill.

Information on maintenance expenditures was not available.

Company Organisation :

Very informal. A Board of Directors of five men, of which three, including the general manager, are working full time in the company.

Each production department carries out maintenance on its own equipment. One member of the board seems to co-ordinate maintenance work, without any maintenance engineer, and not even a foreman as far as we could gather. The maintenance crew consisted of 30 skilled fitters and 3 electricians. The maintenance crew is paid monthly.

Records of repairs done and their cost were not maintained.

Various Information :

Harischandra Mills Ltd. has recently purchased Italian equipment for a new soap factory. An Italian adviser will train operators and fitters and run in the plant. The company would hire a maintenance engineer when the plant would come into operation.

Blue-prints of the equipment were already available. Spare parts could be obtained within 5 to 12 months, including about 3 weeks' time for the licence, which was obtainable without difficulty.

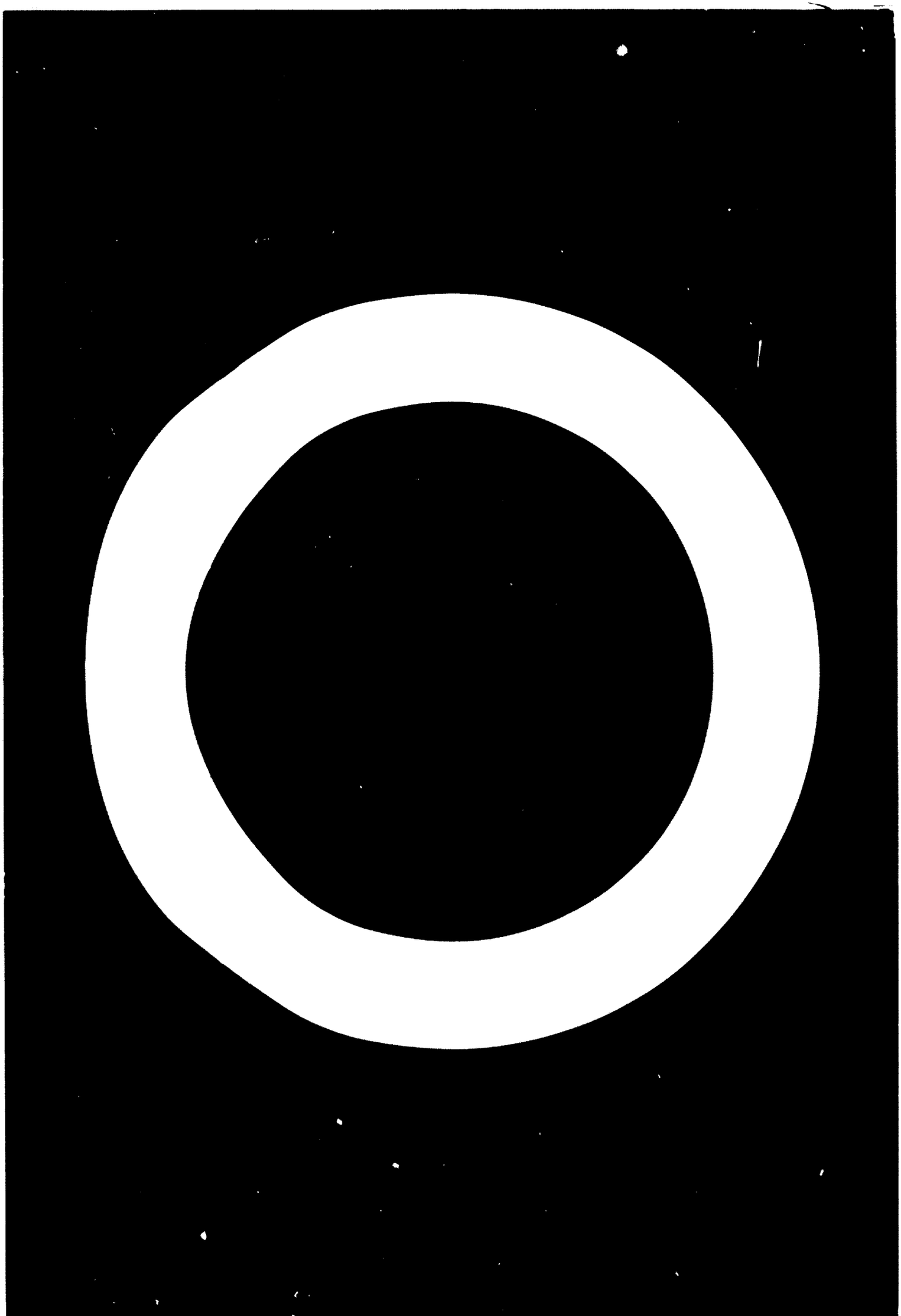
Experts' Comments :

The machinery in the factory is in general very simple and to a large extent also very old. But it seems to work and produce.

The factory's maintenance workshop looks very untidy and not much like a working place. The spare parts storeroom was inadequate.

Experts' Recommendations on Maintenance :

Organisation	:	In connection with the new soap factory, a maintenance department should be established, not only for the new factory but for the entire company.
		A preventive maintenance programme should be implemented.
Repair Facilities	:	A new and better workshop is needed.
Spare Parts Store	:	A new and better storeroom is necessary.
Personnel	:	Training is needed.



Factory No. 8 : LEVER BROTHERS (CEYLON) LTD.,
Colombo.

Report on Visit, 4 May 1969

Branch : Chemical Industry.

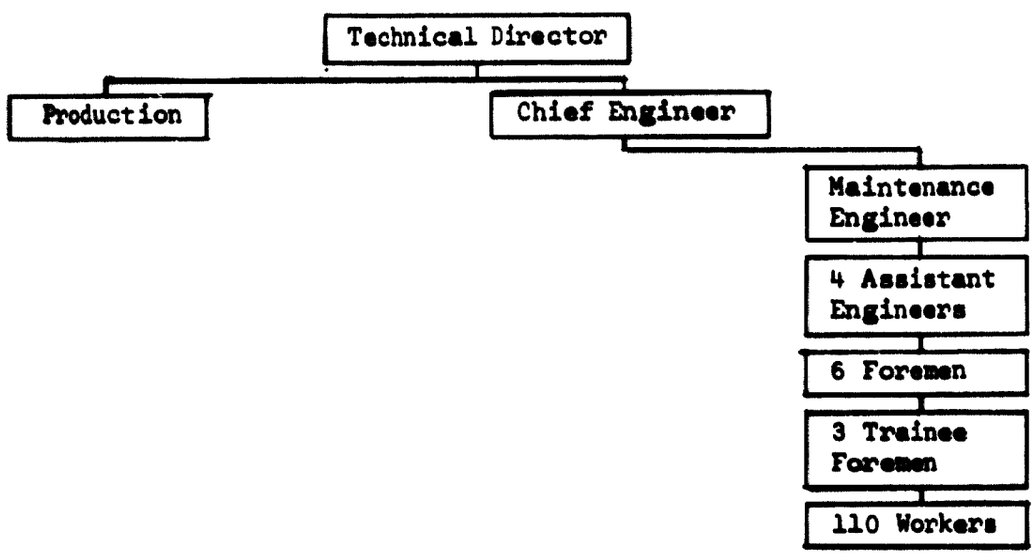
Products : Soap, detergent, toothpaste, margarine, various powders, and similar products.

Persons met : Mr. Mackenzie, Chairman of the Board of Directors
Mr. P.F.A. Wilson, Technical Director
Mr. Jayasooriya, Personnel Director
Mr. N.B. Jayawardane, Chief Engineer.

Basic Data :

Total sales volume (1968)	:	Rs. 50 mill.
Number of workers	:	650
Total employed	:	1000
Ground area	:	8.2 acres
Maintenance labour expenditures	:	Rs. 0.9 mill.
Spare parts and material	:	Rs. 1.0 mill.
Total maintenance expenditures	:	Rs. 1.9 mill.
Inventory value of spare parts and material	:	Rs. 1.2 mill.

Maintenance Organisation :



Specification of workers :

Multi-skilled fitters	2
Fitters	31
Lathemen	2
Welders	3
Electricians	7
Tinkers	2
Painters	4
Carpenters	4
Masons	3
Blacksmiths	0
Boiler house operators	7
Pumpers	3
Fridge plant operators	4
Garage personnel	9
Greasers	2
Apprentices	12
Storeman	1
Labourers	9
Charge hands	4
Lagger	1
	110

Of these 110 workers about 80 are in the various production groups and about 30 in the main workshop and central group.

The groups in the production department can receive repair orders direct and thus avoid delay and red tape. It must, however, be emphasised that the maintenance manager is in charge of all maintenance workers. Thus he can direct the manning in the production departments and get a flexible utilisation of available manpower.

The engineering department includes the operation of the boilers and the pump house.

Preventive Maintenance :

A preventive maintenance programme has been in operation in the plant for about 2 years. It is divided into **major** and **minor** inspections. In the begin-

ning there was a major inspection after one year and a minor inspection every six months. At present, the interval between the major inspections has been increased to three years for some equipment, whereas the six months' interval for the minor inspections is kept.

The inspections are carried out according to a plan worked out by the maintenance department. One month's notice is given to the production department and the schedule is followed 100%. This was confirmed by the general production manager.

The maintenance department has an index file of this planned preventive maintenance. However, breakdowns and repairing are recorded separately or works orders are filed for each department.

Equipment Breakdown Reports :

A weekly report on production includes specification of machine breakdowns, their nature, length of time, and to some extent their reasons.

Various Information :

Training is given to all workers so that they are multi-skilled (fitting, welding, turning, etc.). Fitters are rotated in order to become familiar with most of the machines at the factory.

Maintenance crew is paid monthly. The discipline and efficiency are good.

A methods department of 5 employees is included in the organisation of the factory.

The main problem of the chief engineer is further instrument maintenance and care-taking in general. The factory will increasingly apply instrumentation in the factory and probably have to send people abroad for training. The skill, in general, of employees at all levels should be improved. A big problem is the lead time of 5 months and up for order of spare parts.

The technical director mentioned especially the licence regulations and long lead time for order of spare parts and the replacement machinery. (Has been in Ceylon for about six months). A request for licence has often been rejected. Prior to ordering by cable small critical parts to be sent by air, the factory has to have a licence.

He suggested an annual lump sum licenced, as a kind of "budget" for spar. parts.

The technical director mentioned that the standardisation for instruments, motors, pumps, etc. was difficult due to import licence for replacement of machinery.

The information obtained here, as in other factories, concerning the supply of spare parts, does not tally with the information received from the Ministry of Industries. Either there is a misunderstanding or a lack of information.

Experts' Comments :

Production equipment is taken good care of.

The workshop is fairly well equipped with 2 lathes, one small milling machine, some small drilling machines, etc.

The storeroom for spare parts is very well organised and laid out, undoubtedly, the best we have seen in Ceylon. Spare ball bearings are kept in cabins and thus well protected, while other bearings are left unprotected.

The organisation and set-up of maintenance in general is good, and in particular, the preventive maintenance.

Influence probably comes from Unilever Ltd.

Experts' Recommendations on Maintenance :

Spare Parts	:	Take contact with The Ministry of Industry and other Government institutions to obtain improvements in the delivery time of spare parts and replacement machinery.
Personnel	:	Training is needed on most levels, particularly on instrumentation.

Factory No. 9 : CEYLON CERAMICS CORPORATION,
Negombo Factory,
Negombo.

Report on Visit, 21 April 1969

Branch : Ceramics factory.

Persons met : General Manager
Assistant Production Manager
Maintenance Superintendent
Chemist.

Basic Data :

This factory, manufacturer of glazed and decorated crockery and chinaware, is the second largest in Ceylon. About 80% of the products are glazed only, the remaining 20% are decorated and glazed.

Gross sales volume	:	Rs. 4.2 mill.
Capital invested	:	Rs. 9.0 mill.
Number of permanent workers	:	170
Number of casual workers	:	50
Total employed	:	250
Ground area	:	18 acres (including 6 acres for the factory).

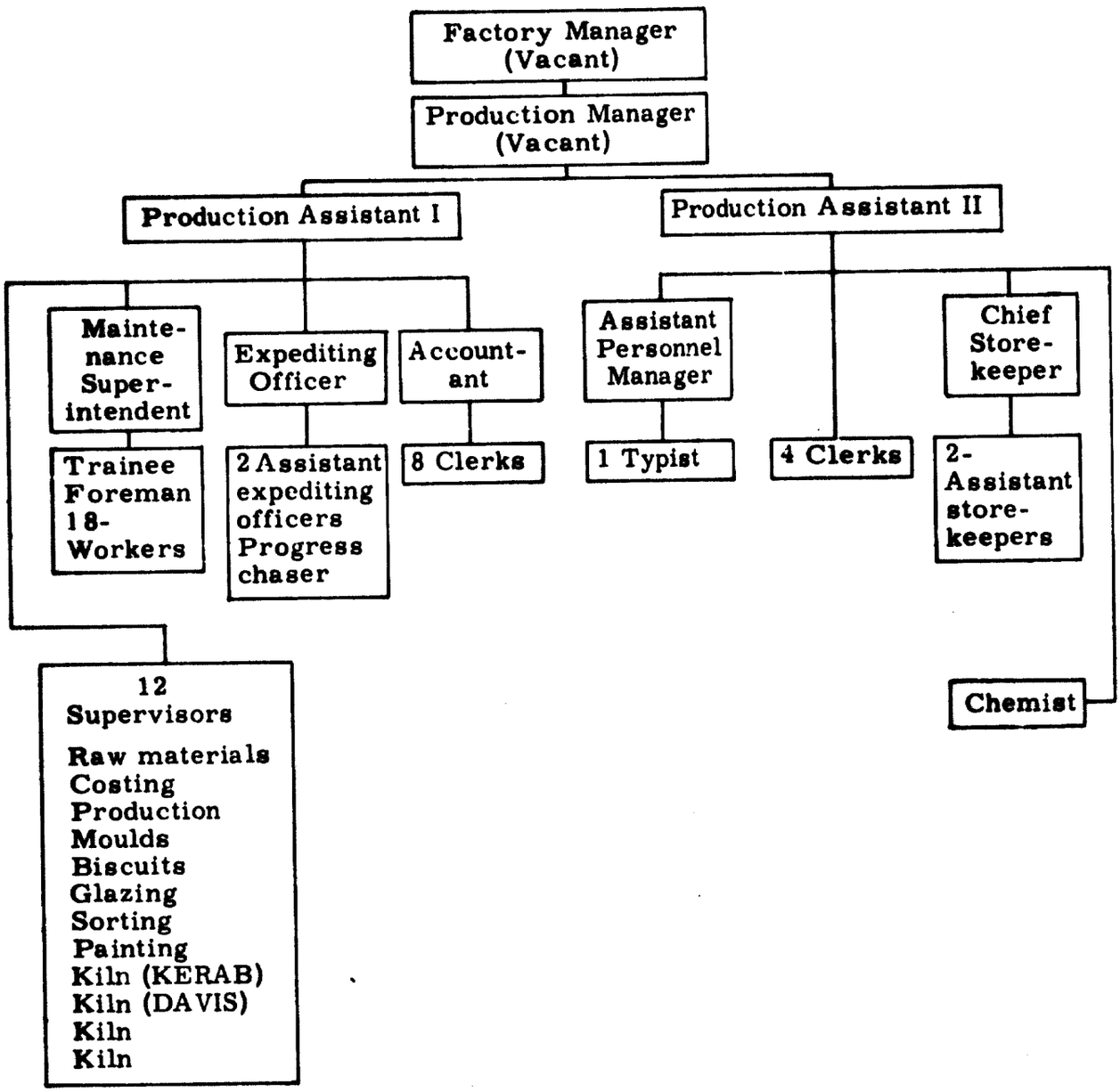
Wage System :

For the production section workers, an incentive bonus system exists based on the volume of articles produced. Average standards have been set.

Although the maintenance crew has skilled men on it, it was surprising to note that the maintenance personnel who receive no incentive bonus are not even paid by the Engineering Trade wage scales, the latter being appreciably above the wage rates for production. Owing to this situation, the maintenance workers who are paid by the same wage scales as that for the production workers receive smaller pay packets.

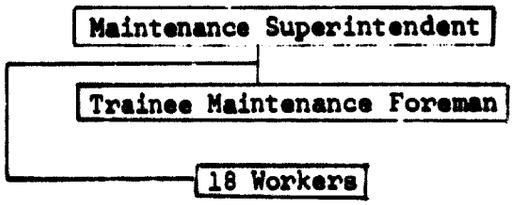
The two labour unions in this organisation are appreciably cordial with the management. But there have been occasions where a small fraction of the workers has caused some trouble owing to lack of understanding. Films are shown to enhance the morale and to increase the efficiency of the workers.

Production Organisation :



Note : The four kiln supervisors work on the shift operation system.

Maintenance Organisation :



The breakdown of the workmen's skills is listed below.

Electricians	Skilled	1
Fitters	Skilled	4
Tinkers	Skilled	1
Carpenters	Skilled	2
Welders	Casual	1
Helpers	Semi-skilled	3
Masons	Semi-skilled	3
Scavengers	Unclassified	1
Gardners	Unclassifed	2
Total number of workers		18

The maintenance foreman recruits more casual workers in the event of new installations, buildings, etc. After completion of the job they are let go.

Maintenance Expenditures :

The breakdown of maintenance expenditures for the financial year ending March 1968 was as follows :

Preventive maintenance	:	Rs. 5,000 + labour	
Repair	:	Rs. 5,000 + labour	
Overhaul	:	Rs. 140,000 + labour	
Spare parts and materials	:	Rs. 150,000	
Maintenance labour expenditures	:		Rs. 35,700
Total maintenance expenditures	:		Rs. 185,700

Maintenance Personnel :

Number of non-craftsmen	:	3
Number of engineers (superintendents)	:	1
Number of foremen (trainees)	:	1
Number of technicians	:	15

The existing functions of the personnel include the maintenance in civil, electrical, and mechanical departments at the factory. New installations and buildings are also handled by the maintenance organisation.

Schedules are maintained for regular checks on machinery and equipment, and a monthly report is forwarded to the general manager.

The maintenance crew is trained through an on-the-job training programme.

For a factory of this size the total of 18 workers is sufficient to carry out good maintenance.

The maintenance superintendent feels that he cannot check on all the lubricating and servicing points of the schedule. He is using a system of random checking which is not very efficient.

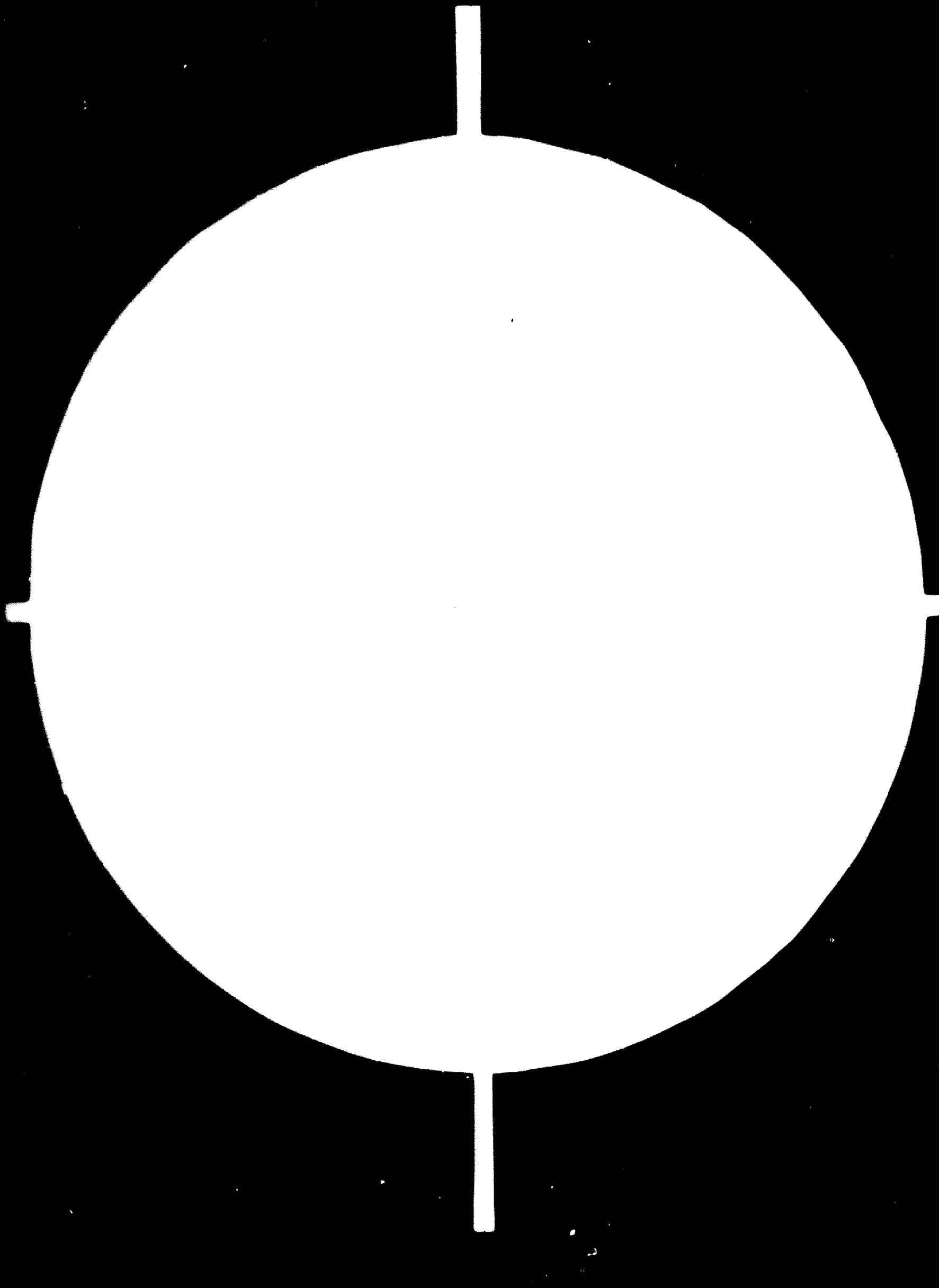
No regular routine training programmes are established. In the production and in the maintenance departments, the new recruits are given on-the-job training.

The superintendent and the assistant production manager have been introduced to the subjects of work study and rationalisation through some of the management courses. However, they do not possess adequate understanding of the techniques learned to practise them in the factory.

The down time caused by maintenance is low.

During planned stops burners are replaced and motors overhauled.

During unplanned stops planning of maintenance is done, but not on a systematic predetermined system. In the case of sudden power failures, the workers have been given instructions to rush to the standby power plant. Major overhauls are mostly done after working hours as an effort to save production time and losses. Only two big breakdowns have happened in the last five years.



Experts' Comments :

The general manager realises the importance of maintenance. He is very enthusiastic about the introduction of new products of higher quality to the market.

The assistant production manager is of the opinion that many of the spare parts should be manufactured locally to decrease the import. He wishes to organise special training programmes for the production personnel.

The main problem facing the maintenance superintendent is to organise a suitable checking procedure for preventive maintenance. Too many workers (18) are reporting to him, and he is responsible for three major divisions of maintenance in the civil, electrical, and mechanical fields. He should divide his responsibilities by training three of his best workers as leaders for the three engineering sections.

The superintendent should have his order list of spare parts as related to normal wear and tear of the machinery.

As most of the production operations are semi-automatic in this factory, the production volume depends largely on the efficiency of the workers. All these hand operations should go through an intensive work study (Time and Motion Study) programme to increase the production volume in the factory.

As wages are paid on an incentive bonus system depending on production volume, more rigid control methods have to be used to obtain high quality products.

Experts' Recommendations on Maintenance :

Organisation	:	A better planned maintenance programme with checking should be implemented.
		Reduce the number of workers reporting to the maintenance foreman.
		A good and simple system for written orders should be used, and planning and scheduling should be introduced.
Repair Facilities	:	A slightly larger workshop with more equipment is needed as the factory is quite far from Colombo and the other factory located in Piliyandala.
Spare Parts Store	:	The store is adequate, but needs cleaning up.

Personnel	:	A training programme should be implemented. Management training for the engineers and the foreman is needed. The superintendent and the 18 workers should be trained for maintenance work.

Factory No. 10 : CEYLON CERAMICS CORPORATION,
PILIYANDALA FACTORY,
Colombo.

Report on Visit, 19 April 1969

The questionnaire was left with the factory to be forwarded to the experts. It has, however, not yet been received and the following remarks and conclusions are therefore based on memory only.

Maintenance Organisation :

The maintenance organisation is quite good. An assistant mechanical maintenance engineer, Mr. U. Amaresekere, has returned from a training course, Technics in Maintenance, at the International Centre for Advanced Technical and Vocational Training in Turin, Italy. He has succeeded to introduce some preventive maintenance activities for the kilns and achieved results.

The system for written orders used in the maintenance department is to be changed and the proposed new system will be modern and simple.

The plan for the preventive maintenance is lined up and has the unlimited support of the factory manager.

Repair Facilities :

The workshop is new, of adequate size and is fairly well equipped. The same remarks apply to the maintenance stores, both the spare part store and the tool room.

Personnel :

The personnel on all levels needs training as well as more advanced management training. These training activities were mentioned as the most important parts of a Ceylonese maintenance development programme.

This factory is probably one of the most advanced when it comes to maintenance activities.

Experts' Recommendations on Maintenance :

Organisation	:	Expand the present activities and follow up the established plans.
Personnel	:	The personnel on all levels should be retrained and receive management training.

Factory No. 11 : NATIONAL SMALL INDUSTRIES CORPORATION,
Bangadenyiya.

Report on Visit, 20 April 1969

Branch : Tile factory.

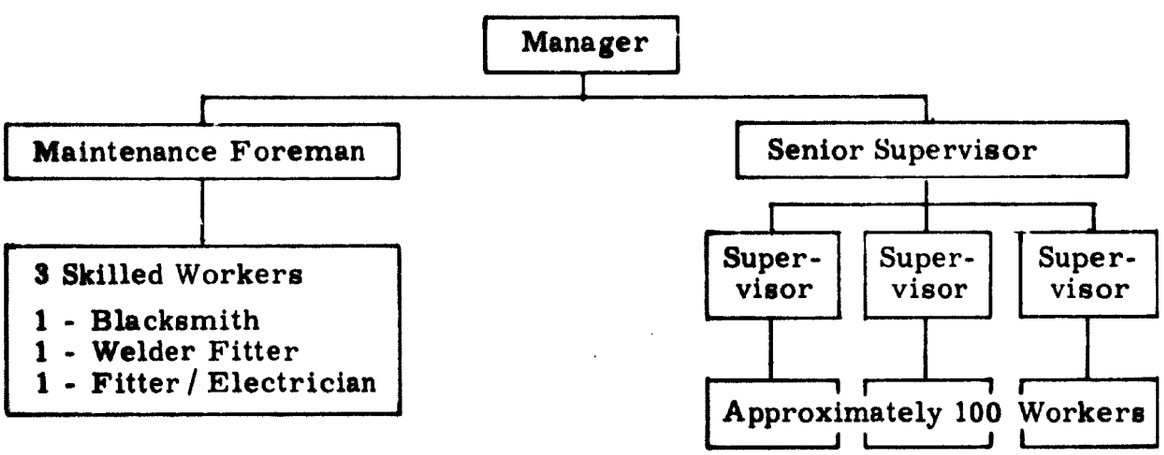
Products : Flat tiles, bricks, floor tiles (unglazed), and hollow bricks.

Persons met : Mr. David, Factory Manager.

Basic Data :

Annual sales volume	:	Rs. 0.75 mill.
Capital invested	:	Rs. 2.0 mill.
Number of permanent workers	:	89
Total employed	:	120
Ground area	:	4 acres

Organisation :



Annual Maintenance Expenditures :

Labour	:	Rs. 10,000
Spare parts	:	Rs. 20,000
Total maintenance expenditures	:	Rs. 30,000
Inventory value of spare parts	:	Rs. 100,000

There is a central spare part store in Colombo for five tile factories in Ceylon.

Maintenance Personnel :

The three skilled maintenance workers have been trained "on-the-job" by the manager to be all-rounders. The routines involved weekly checking of maintenance points on machines and equipment.

The number of maintenance workers (3) seems to be adequate for this organisation.

A booklet is maintained by the manager giving the history of the machine, major and minor repairs, etc. This serves as a guide to order spare parts.

Additional training seems to be necessary for the maintenance personnel as they seem to lack the real understanding of problems involved in maintenance and also what benefits that can be obtained. The efficiency of the work force is average.

Wage System :

As the maintenance workers belong to a skilled group, they are paid more than the production workers. The fixed wage system is used without any incentives or bonuses.

The management - labour relations are cordial. Night work, work on holidays, etc. are arranged quite easily.

Training in Plant :

There does not exist an organised training programme for the workers or the maintenance men. The recruits get on-the-job training.

Work study and rationalisation have never been practised in the factory. The managers have been introduced to these subjects.

Production :

There are no major records of down time due to maintenance. The only work stoppages were caused by power and water failures. Minor interruptions in the production have been caused by small failures in the boilers.

A weekly lubrication for the machines serves as the only preventive maintenance routine.

Major repairs are scheduled for weekends and long holidays.

Occasionally, the boiler tubes are found leaking and are replaced immediately. These failures have been investigated and it was found that the failures were caused by the corrosive ingredient in the water.

Experts' Comments :

Most of the work force consists of farmers. They usually return to the farms for cultivation and harvest. This causes a high absence rate.

The small workshop is very badly equipped. It has no machine tools. The only equipment in the workshop is a welding set, a radial drill, a bench-drill, and a small vice.

A simple exercise of work study could increase production appreciably, as most of the bottleneck machines are semi-automatic.

To avoid excessive inventory an organised procedure has to be adopted to estimate the volume of spares and materials.

Better lubricators, grease guns, etc. have to be utilised to increase the efficiency of the maintenance system.

Experts' Recommendations on Maintenance :

Organisation	:	Some of the production machines need a preventive maintenance checking system. To improve the cost control a simple standard system of written orders should be implemented.
Repair Facilities	:	A better equipped workshop, more tools, and a better spare parts store are needed.
Personnel	:	Establish and apply an organised training programme. Management training is needed.

Factory No. 12 : CEYLON PLYWOOD CORPORATION,
Galle.

Report on Visit, 25 April 1969

The Head Office in Colombo was visited on 20 April 1969.

Branch : Woodworking industry.

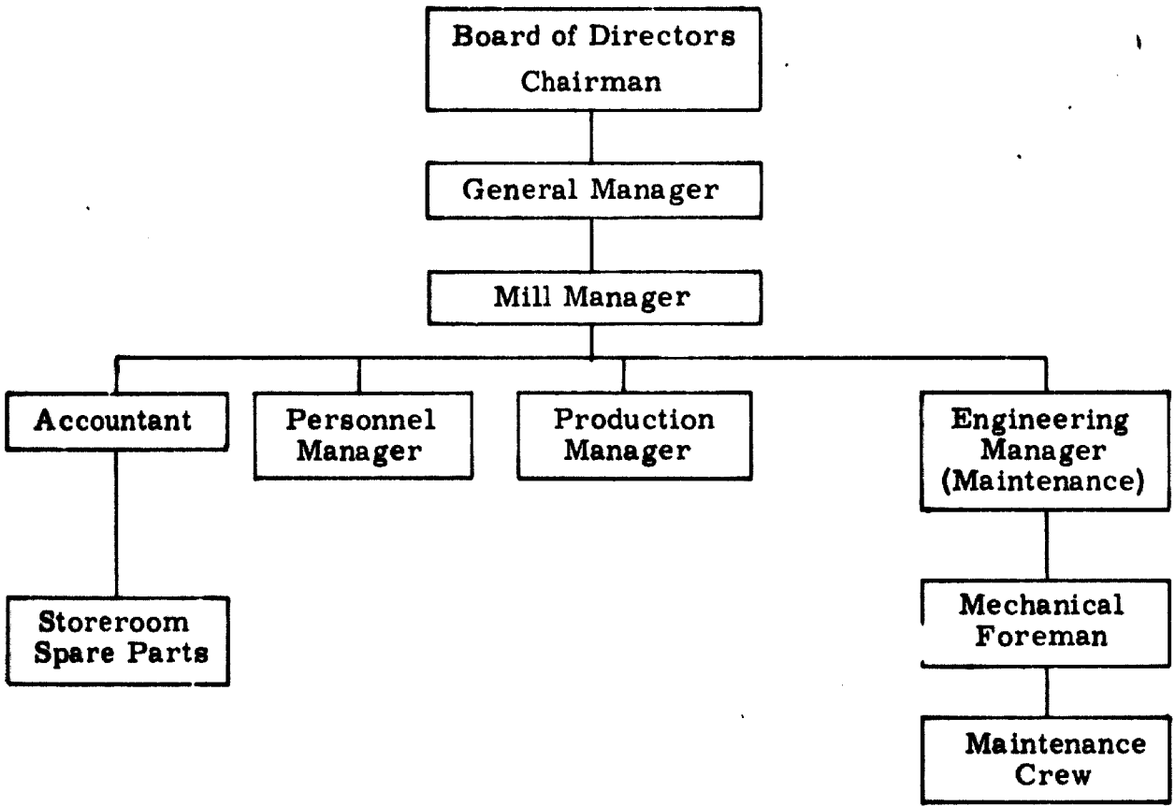
Products : Plywood (mainly for tea-chests, doors, furniture, etc.)

People met : Mr. E.M.P. Gunetilleke, General Manager, Colombo
Mr. Matacheck, Czech Expert, Colombo
Mr. Weerakoon, Acting Chairman of the Board
Mr. Ranasinghe, Mill Manager
Mr. K.B. Perera, Production Manager
Mr. K.S.O. Perera, Engineering Manager.

Basic Data :

Production (April 68 - March 69)	:	23.2 mill. square feet of plywood
Sales volume (same period)	:	Rs. 11.7 mill.
Number of workers	:	680
Total employed	:	1000
Factory built	:	1942
Maintenance labour expenditures (April 68 - March 69)	:	Rs. 29,000
Spare parts (same period)	:	Rs. 116,000
Total maintenance expenditures (same period)	:	Rs. 145,000
Inventory value of spare parts (March 1969)	:	Rs. 1 mill.

Organisation :



Maintenance Crew :

1 Mechanical foreman
8 Skilled fitters
1 Welder
1 Unskilled (help is obtained from production)
2 Machine tool operators
1 Boiler mechanic
2 Knife grinders
3 Skilled electricians
2 Unskilled electricians
3 Vehicle mechanics (for 11 cars, 2 light-trucks, and 2 forklift-trucks)

Various Information :

The maintenance crew receive no training or education. However, on-the-job training is given.

Preventive maintenance is carried out on Poya-days, but is not satisfactorily set up.

The working speed and the efficiency of fitters are satisfactory. All workers, supervisors, and foremen receive fixed monthly salaries and a monthly bonus. An annual bonus is given all employees.

Production down-time due to maintenance is not systematically recorded.

The factory's main problem is the low attendance of workers. (40% absence rate so far in April). This problem exceeds any maintenance problem.

The main problem for the production manager is the lack of a systematic maintenance programme.

The chairman would like to recruit more technically qualified personnel at all levels.

The engineering manager's (maintenance) main problem is the lack of really skilled fitters (only 2 or 3 of his 8 fitters were really skilled) and the procurement of spare parts.

The delivery time for spare parts is a year or more. Delays are caused by the closed Suez Canal. Delays in mail and clearing occur.

The State Engineering Corporation (Colombo) workshop is to some extent used for making spare parts.

At present, no machine cards and recording of repairs have been introduced. Almost no machine drawings exist. Job cards for maintenance is at the planning stage.

Experts' Comments :

The production equipment (coming mainly from the United States, Germany, and England) seems to be in rather good shape and is well taken care of. The repair workshop is very badly equipped. The equipment includes a good lathe,

an old shaper, a small drill, an electrical welding saw, and a grinder. Furthermore, the workshop has an inadequate layout.

The storeroom for spare parts is rather small and in bad shape. Parts in general are satisfactorily stored, but layout as well as protection of some parts can be improved.

Experts' Recommendations on Maintenance :

Organisation	:	Establish and apply a systematic maintenance programme and improve preventive maintenance. Machine cards, recording of repairs, and job cards should be introduced, standardised, and employed.
Repair Facilities	:	The workshop should be better equipped and laid out.
Spare Parts Store	:	Larger and better storing should be facilitated.
Spare Parts	:	Reduce the delivery time for spare parts if possible and more spare parts are needed.
Personnel	:	Recruit more skilled fitters and training is needed on all levels.

Factory No. 13 : CEYLON STEEL CORPORATION,
Colombo.

Report on Visit, 17 April 1969

Branch : Rolling mill, wire mill, and workshops.

Products : Steel profiles, channels, T-s, barbed wire, drawn wire, wire-mesh, netting, galvanised wire.

Persons met : Mr. Manikkam, General Manager
Mr. Wijesiri, Acting Production Manager
Mr. de Silva, Engineer.

Basic Data :

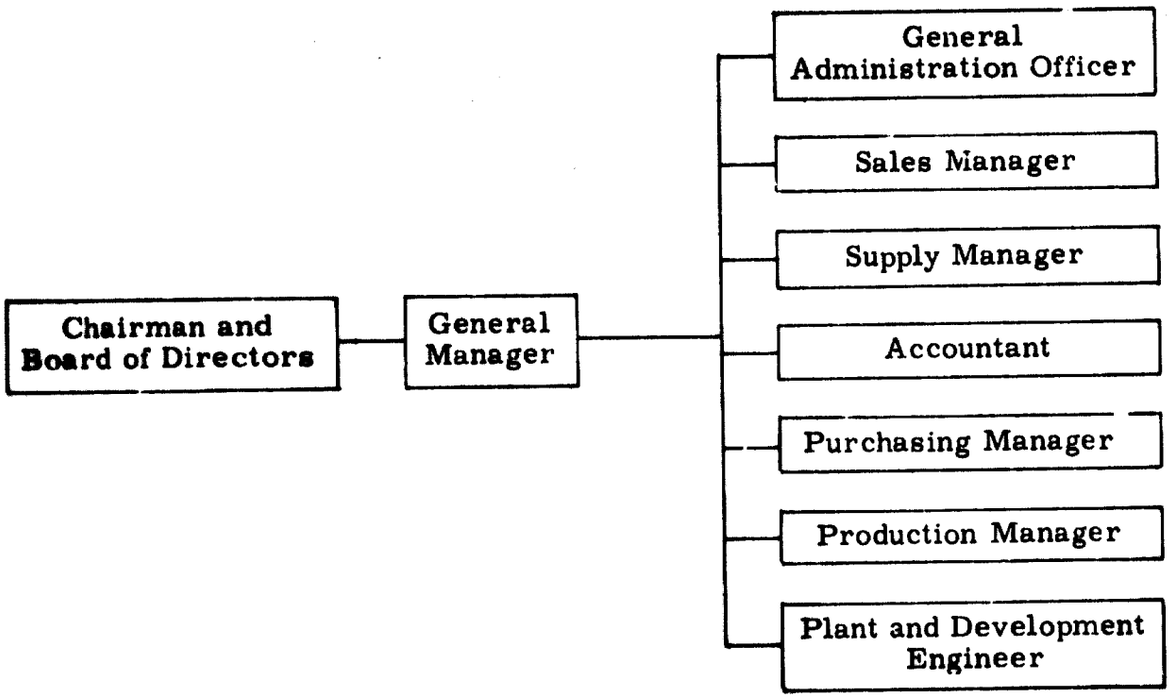
Annual sales volume	:	Rs. 30 mill.
Capital invested	:	Rs. 80 mill.
Number of workers	:	900
Staff	:	50

Wage System :

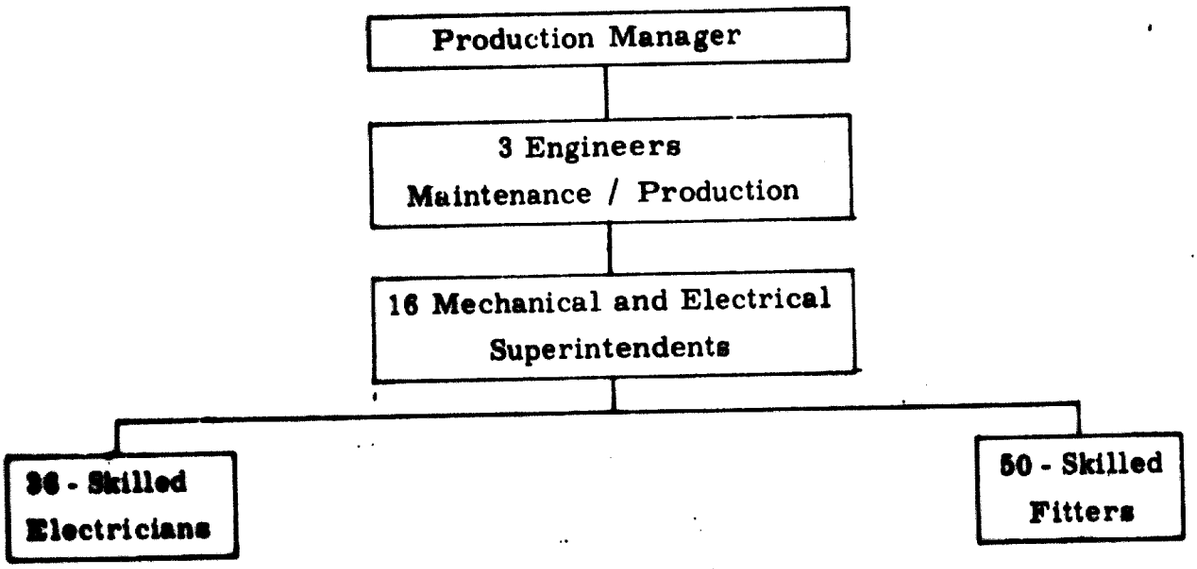
The workers receive fixed salaries based on merit rating.

The attitude of the workers was said to be favourably cordial and no serious difficulties with the union have been encountered.

Organisation :



Maintenance Organisation :



Annual Maintenance Expenditures :

Labour	:	Rs. 1,505,257
Spare parts and material	:	Rs. 716,621
Total maintenance expenditures	:	Rs. 2,221,878
Inventory value of spare parts and material	:	Rs. 1,696,278
Average turnover time	:	2.3 years

The maintenance expenditures broken down into preventive maintenance, repair, overhaul, and new parts are not available.

Maintenance Personnel :

Number of well trained engineers (trained in U.S.S.R.)	:	8
Number of trained mechanical and electrical superintendents (trained in U.S.S.R.)	:	16
Maintenance Crew :		
Number of skilled electricians	:	36
Number of skilled fitters	:	50

The total number of 86 on the maintenance crew seems to be adequate for a mill of this size.

In addition to these workers, the maintenance department employs :

Number of machine tool operators	:	15
Number of blacksmiths	:	3
Number of carpenters	:	5
Number of telecommunication electricians	:	8

This total of 117 workers in maintenance seems to be on the high side and possibly the number can be reduced if needed.

Maintenance Routines :

Preventive maintenance has started in the electrical and the rolling mill section and will be started in the wire mill and the workshop section in the near future.

Due to the holiday season and hence the high absence rate, the mill was not in operation and thus any estimation of the efficiency could not be done. The production manager confided that satisfactory maintenance work was executed in the wire and rolling mills. However, the maintenance work has to be improved in the central workshop.

Training in Plant :

Extensive training was given the workers during the construction and installation of the plant. The period of training is now ended. The planning of retraining of skills and attitudes is in progress for the work force and other personnel.

There are no specific functions for a work study and rationalisation group. The production manager and 4 or 5 of the engineers have had from 4 to 12 months' training in work study, and these skills have been used from the production start.

Production :

As the capacity of the plant has not yet been fully utilised, the down-time due to maintenance is of little interest for the planning of maintenance work. A certain degree of planning is done by listing the various jobs to be undertaken during planned stops. Planning of maintenance work during unplanned stops has not been enforced.

The number of breakdowns has been very low. However, they were not recorded and the facts are not available. Two or three big failures have been examined and followed up. A special task to follow up future failures has been given to a selected engineer.

Trade Unions - Management Relations :

The general manager mentioned that the open door policy which has been the practice from the inception has to a large extent prevented conflicts with the trade unions.

Experts' Comments :

The experts' opinion is that the general manager and the production manager possess an advanced attitude towards modern maintenance management in a

broader sense. The fact that no maintenance system was prevalent might depend on lack of time for the general manager and the production manager, and the lack of understanding and ability to absorb new methods by the middle management group.

The general manager rated the current maintenance problems in the following order of priority.

(1) Spare part problems
(2) Lack of adequate system for written orders
(3) Cost and equipment condition control.

A considerable amount of money has to be blocked in obtaining the spare parts due to long delivery time. A contract was said to be discussed between the Governments of Ceylon and U.S.S.R. about further delivery of spare parts.

Experts' Recommendations on Maintenance :

Organisation : The system for written orders should be simple and facilitate a close follow-up of the maintenance expenditures and performance. A modern system for maintenance should be introduced together with planning and scheduling procedures.

The co-operation within the various production departments still has to be improved.

The established maintenance programme should be checked and employed as soon as possible. The checking should involve more advanced methods for condition checking and planned inspections.

The cost system should be made in such a way that it is possible to follow up the maintenance expenditures for various types and groups of machines and also provide records on faulty analyses for future planning purposes.

Spare Parts : Investigate the possibility of reducing the delivery time of spare parts as well as the local manufacturing of spare parts.

Personnel : Retraining and management courses are needed for the middle management group.

Factory No. 14 : CEYLON TYRE CORPORATION,
Colombo.

Report on Visit, 18 April 1969

Branch : Rubber products.

Products : Tyres and tubes.

Persons met : Mr. D.S. de Silva, General Manager
Mr. G. Mohideen, Production Manager
Mr. Wijeyanandana, Power Engineer.

Basic Data :

Production 1968	:	60,000 tyres
Estimated production 1969	:	160,000 tyres
Designed capacity	:	250,000 tyres
Capital invested	:	Rs. 65 mill.
Number of workers	:	800
Total employed	:	1000
Factory area	:	4 acres
Ground area	:	34 acres
Maintenance labour expenditures	:	Rs. 2 mill.
Spare parts	:	Rs. 1 mill.
Total maintenance expenditures	:	Rs. 3 mill.
Inventory value of spare parts	:	Rs. 600,000

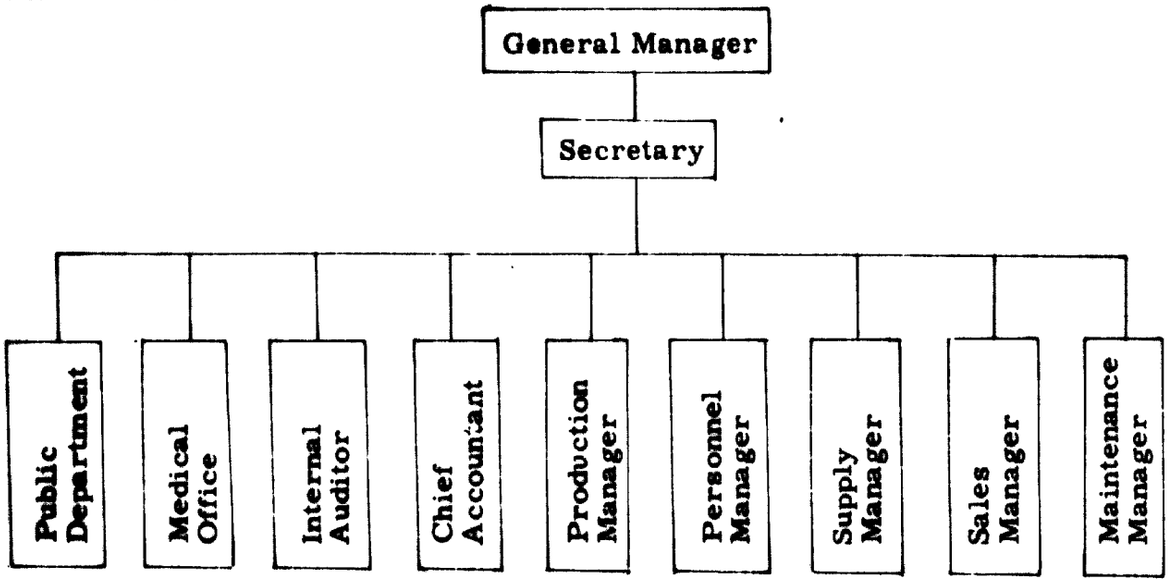
Various Information :

The company is looking for a maintenance manager to be in charge of the mechanical as well as the electrical maintenance.

Skilled workers with average efficiency are difficult to find. The factory has plenty of room for improvements.

At present bonus and incentive systems are lacking. There is no systematic training of the maintenance workers. The maintenance repair is done on planned stops and Poya-days.

Organisation :



Experts' Comments :

The plant was built recently by the U.S.S.R. and has a machine shop that is well equipped and has an efficient layout system. The storeroom for spare parts is good, but comparatively inadequate.

Experts' Recommendations on Maintenance :

Organisation : The central maintenance organisation should be built up according to plan.

Personnel : Systematic training is needed for workers and supervisors. An appropriate recruitment programme should be established.

Factory No. 15 : CEYLON LEATHER PRODUCTS CORPORATION,
I.D. SHOE FACTORY,
Colombo.

Report on Visit, 22 April 1969

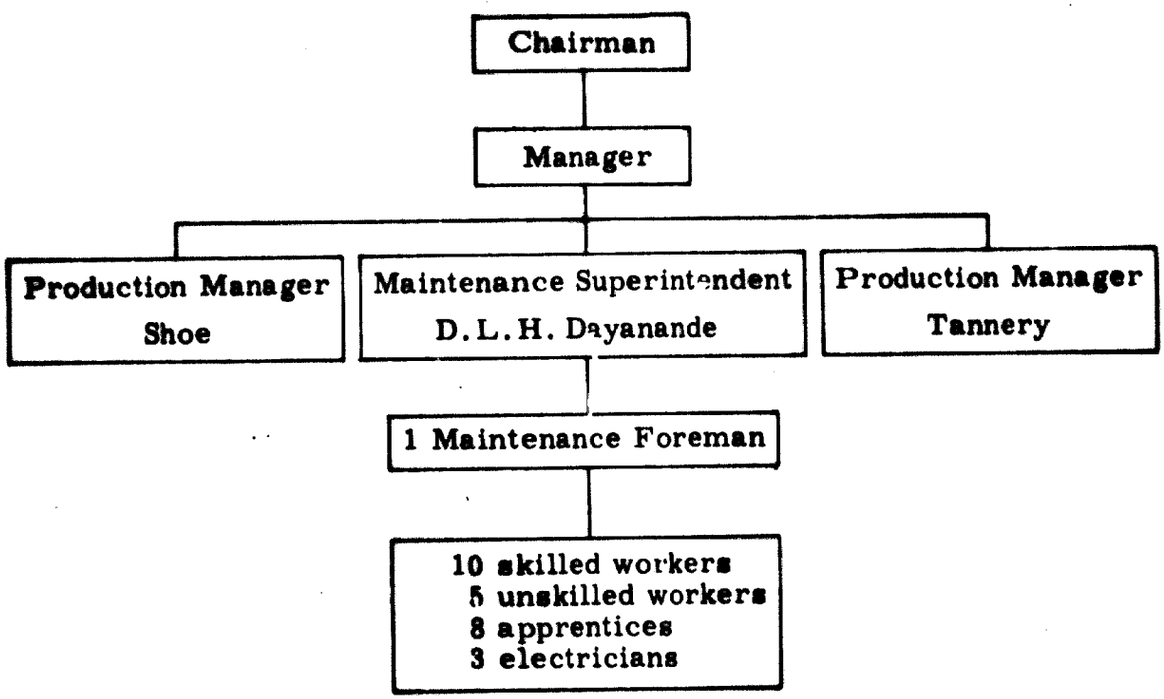
Branch : Tannery, leather products, mainly men's shoes, bags, suitcases, balls.

Persons met : Mr. Linus Silva, Chairman and General Manager
Mr. D.L.H. Dayanande, Maintenance Superintendent.

Basic Data :

Annual production	:	320,000 pairs
Annual sales volume	:	Rs. 8 mill.
Number of workers	:	520
Total employed	:	600

Maintenance Organisation :



Various Information :

The workers are paid monthly and the efficiency and discipline is good.

The operators call on the fitters when something is out of order. The key-machines are repaired on holidays.

Experts' Comments :

The main problems are the supplies of spare parts and the high absence rate of both the production and maintenance workers. The Czechoslovakian spare parts have a delivery time of 2 years, as compared to a delivery time of 6 months for German and British spare parts. The two Czech experts in the factory would not confirm these statements. The instruction book on Czechoslovakian machinery is very good with clear specifications and three dimensional drawings of how the machines are built up. However, there are no drawings showing the various dimensions on the parts. Import licence for spare parts is easy to obtain. The machinery is well kept. The tannery is very old, but a new one is under construction. The man in charge of maintenance does not seem to have the status in the management which his position deserves.

Experts' Recommendations on Maintenance :

Spare Parts : Investigation of the long delivery time for spare parts, particularly for the Czechoslovakian.

Factory No. 16 : CEYLON STATE HARDWARE CORPORATION,
Yakkala.

Report on Visit, 23 April 1969

Branch : Hardware.

Products : Mamoties, axes, brass bibcocks, etc.

Persons met : Managing Director
Electrical Engineer
Assistant Production Engineer.

Basic Data :

This corporation is the largest hardware manufacturer in Ceylon. The machinery is made and installed on a Polish Aid Programme.

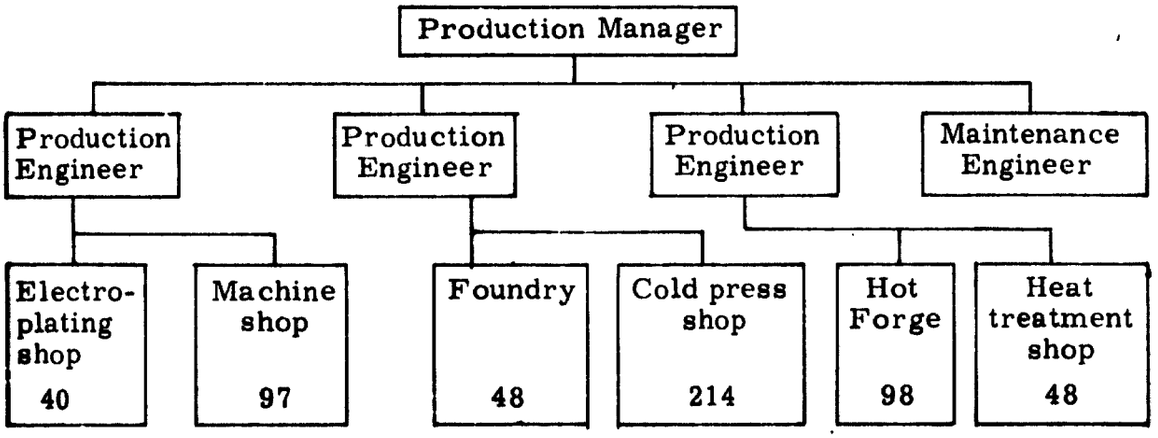
Annual production	:	Rs. 4 mill.
Estimated production, 1969	:	Rs. 12 mill.
Annual sales volume	:	Rs. 2 mill.
Number of workers	:	700
Total employed	:	875

A large inventory of surplus production is a result of the Government FEECS system for imports and thereby flooding the market with foreign hardware items resulting in a tough competition between local and imported goods.

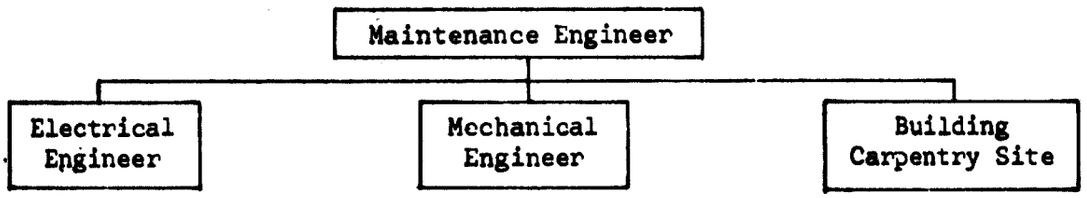
Wage System :

The workers are paid on a fixed wage system based on a merit rating system.

Production Organisation :



Maintenance Organisation :



Maintenance Expenditures :

Maintenance expenditures have not been systematically recorded or analysed.

Maintenance Personnel :

The maintenance engineer is a university graduate with 10 years of experience, but has only received an introduction to modern maintenance management. He was not available for an interview.

The managing director is also a qualified engineer who was too busy to grant us an interview at such short notice.

The work force allocated to the maintenance section seems to be adequate and possesses average skills.

The following is a breakdown of the work force :

Maintenance foreman	:	1
Skilled fitters	:	11
Welders	:	6

Machine tool operators	:	17
Electricians	:	12

The discipline and the morale of the workers was reported to be good.

Maintenance Routines :

There exists a system of security plans for presses. Otherwise there are no plans or systems for written orders.

The efficiency is not very high as there are no plans and estimates of skills, nor job evaluation procedures.

Training in Plant :

On-the-job training prevails in this corporation. Work study and rationalisation techniques are not practised as the management only has been introduced to these subjects. The production down-time due to maintenance is not known.

Experts' Comments :

The procedure to obtain spare parts has resulted in prolonged delays. Most of the operational faults are due to :

- No maintenance planning
- No training programmes for the workers to handle the new machines
- Overloading of plant and equipment beyond prescribed limits.

As the machines are new, the need for maintenance has not yet received much attention. This negligence might prove fatal later when machines become old or worn out. The "sudden" severe breakdowns in heavy machinery should prove the importance of good maintenance.

The major breakdowns and failures in the machinery and equipment should be investigated in order to establish the relationship between the causes for failures and operational defects. This may also provide enough knowledge to improve the design of the machinery and equipment.

Experts' Recommendations on Maintenance :

Organisation : A planning and scheduling section under the maintenance manager should be organised.

A programme for modern preventive maintenance and condition checking should be worked out and applied as soon as possible.

A properly organised system for written orders should be evolved to control the maintenance procedures of the vast complex of machinery and equipment. Definite functions have to be allocated to the various members of the maintenance crew and they should be particularly trained for the type of work specified.

Spare Parts : Investigate the procurement of spare parts in order to locate possible sources causing the long delays.

Personnel : The workers should be trained to be qualified to operate the new machines.

In-plant training programme should be worked out and applied, further, retraining and advanced courses are needed for the skilled workers. The foremen, supervisors, and engineers need management training.

Factory No. 17 : SRI LANKA SUGAR CORPORATION,
SUGAR FACTORY,
Amparai.

Report on Visit, 27 April 1969

Branch : Sugar from sugar cane, including cane production.

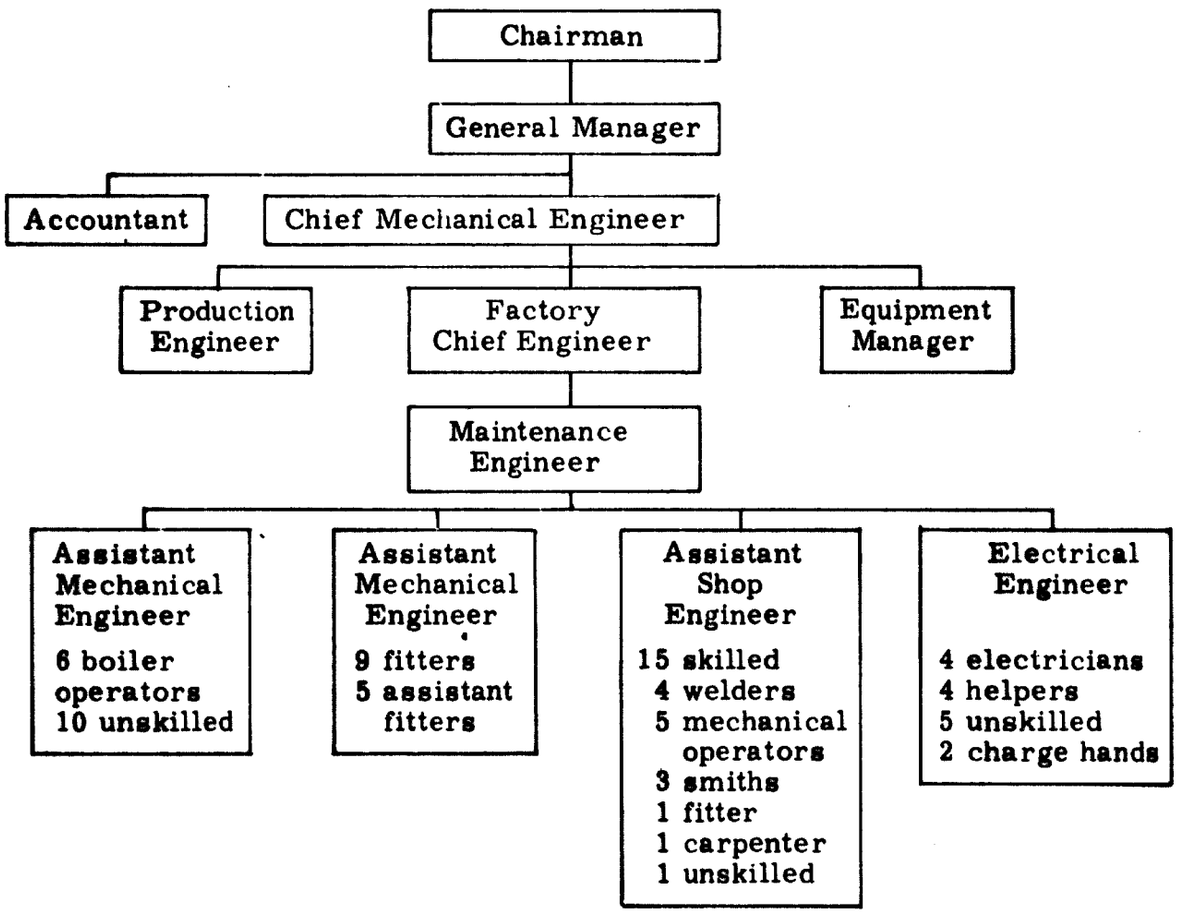
Products : White sugar, alcohol.

Persons met : Mr. Kasunasetne, General Manager
Mr. Toneja, Factory Chief Engineer.

Basic Data :

2000 tons of cane can be processed per day, yielding up to 200 tons of white sugar. Annual production figures were not available.

Organisation :



Production :

The factory was built with five rollers. The cane is cut, pressed, and finally burnt in the boilers. The juice is condensed and treated with acid and then further condensed before the sugar crystals are removed. The rest molasses are sent to the distillery and alcohol processed.

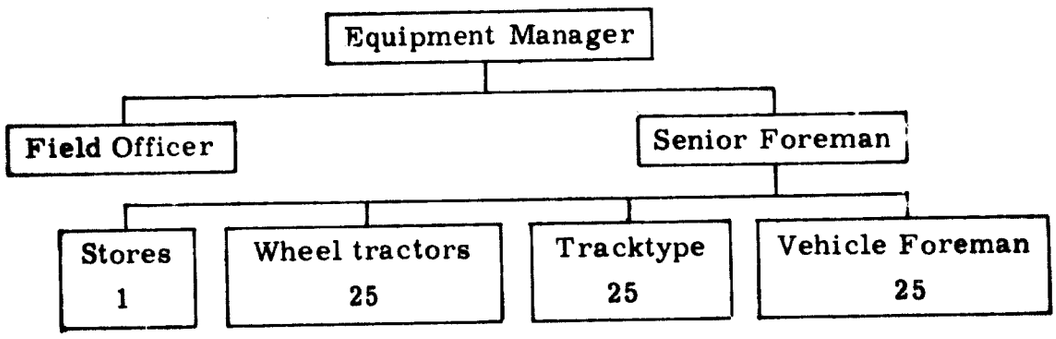
The factory is not very old, but the equipment is worn. Spare parts such as grey iron pipes, sheet steel, and copper tubing are not available.

The main problem is the rollers. They are worn and too little of the sugar juice is pressed out of the cane, thus giving a low yield.

The transport of cane from the fields must float with at least 1000 tons per day. If the input is less than 1000 tons oil has to be used in the boilers to produce enough steam for the process.

The harvest season should be as short as possible. If the cane is left out in the fields too long, the sugar yield becomes lower. If a field is burnt the cane must be brought to the factory within 24 hours.

Equipment :



The equipment manager has the responsibility for field equipment such as wheel tractors, track-type tractors, wagons, agricultural machines, and road graders. About 120 tractors of 17 different makes and types are used.

At the time of the visit 44 tractors in operating condition were stopped due to the lack of about 70 rubber tyres in four sizes. Another 30 were stopped due to lack of smaller spare parts such as armatures, relays, valves, starters, etc.

The absence rate was high during the harvest season, especially in the equipment department.

The number of skilled workers is too low. About 10 more tractor mechanics are needed.

The training facilities provided by the tractor manufacturers are utilised to a fairly large extent. The result was said to be quite satisfactory.

No internal training programme is used.

Maintenance :

In this kind of industry a fairly long period is available for annual maintenance. Due to lack of spare parts and material the time is not fully utilised. The harvest was to start within 2 weeks at the time of the visit, but still much work must be done before starting production.

Due to a very experienced factory chief engineer, the status of the maintenance is quite good, despite lack of material.

Experts' Comments :

The general manager has very modern views on management and a good understanding of the maintenance situation.

The sugar factory has a poor economy. The products are sold on the domestic market only and no foreign currency is invested as far as this can be avoided. The spare parts for the tractors, rubber tyres mostly, plus a grader to maintain the road, would save the situation and also save the foreign currency at present spent on oil. This amount was said to be something like Rs. 500,000.

It appears that the sugar factory has entered a vicious circle - too little cane per day - more oil used - low efficiency - little interest to spend foreign currency - no spare parts - no tractors and wagons - too little cane per day -

To break this vicious circle only a small amount of foreign currency is needed.

The intentions of the general manager include training of engineers and foremen in production and maintenance economy and introduction of a maintenance control system including work orders, planning and scheduling routines, long-

term planning, and spare part control. The efficiency of the factory would be greatly improved if these intentions were to be carried out.

Experts' Recommendations on Maintenance :

Organisation : A planning and scheduling section under the maintenance engineer should be established.

A preventive maintenance programme should be designed and introduced, also containing a checking programme and planned off-season repairs.

A modern planning and scheduling system inclusive work orders should be introduced.

Spare Parts : Rubber tyres for tractors, armatures, relays, valves, starters, etc. are urgently needed to fully utilise the production equipment and to achieve maximum production efficiency.

Action should be taken to improve the foreign currency situation for the purchase of these spare parts.

Personnel : In-plant training programmes should be worked out and used in training the maintenance workers and the operators of more important production machinery.

Management training needed on all levels.

Recruit skilled workers such as tractor mechanics.

Factory No. 18 : WALKER SONS & CO.LTD.,
Colombo.

Report on Visit, 30 April 1969

Branch : Mechanical industry.

Products : Tea and rubber machinery, workshop, ship repair, and equipment repair.

Persons met : Mr. L. Foster, Assistant Production Manager.

Basic Data :

Number of workers	:	1450
Number of skilled workers	:	1000
Total employed	:	1850
Number of branch workshops	:	8

Maintenance Organisation :

The company, more than 100 years old, takes in apprentices and trains them in the plants. Efficiency is said to be fairly good. The workers receive fixed salaries, some on weekly and some on daily basis.

The workshop has no maintenance organisation. The production engineers in the various departments are responsible for maintenance of their own equipment. The workshop has about 160 machine tools, most of them very old. There is no established programme for maintenance and overhaul of these machines. There is no routine for maintenance and repairs are not recorded.

The workshop is providing useful maintenance services, which industry, shipping, etc. can make use of.

The storeroom for spare parts and material is rather well equipped. The delivery time is long but licences for supply of material are easy to obtain. At present there is no set-up for improvement methods in the workshop.

Customers have complained about the costs, i.e. 450% overhead charge, low quality, and long delivery time. However, some customers are satisfied.

The workshop is not well equipped to do work requiring small tolerances.

No systematic attempt is made to improve methods and reduce costs. The company seems to have a market where very little competition is present. Any cost could automatically be charged to the customers.

Experts' Comments :

The skilled personnel from Walker has the reputation of being well trained. Certainly a mechanical workshop like this is in a better position to make necessary repairs to its own equipment than for example a factory in the process industry. Even so the complete lack of maintenance set-up is surprising.

Experts' Recommendations on Maintenance :

Organisation : The set-up of a maintenance group working with repair and maintenance of machine tools and other equipment in the workshop.

A programme for preventive maintenance, routines, and repairs should be established and practised.

Repair Facilities : The workshop should be equipped to do work with small tolerances as well.

Factory No. 19 : COLOMBO COMMERCIAL CORP. (C.C.C.), Colombo.

Report on Visit, 20 April 1969

Branch : Mechanical and electrical workshop.

Products : Tea and rubber factories, industrial refrigeration equipment.

Basic Data :

Annual sales volume	:	Rs. 25 mill.
Number of workers	:	1300 (70% skilled, 20% semi-skilled, and 10% unskilled)
Total employed	:	2000.

Organisation :

Rather informal organisation on the top level, with the four directors and the chairman of the board. The Colombo factory consists of a machine shop, an old cast-iron foundry, a repair shop, and an electrical shop. Basically, each department is responsible for its own maintenance. When more complicated repairs and maintenance arise, for instance in the foundry, help is requested and received from the repair shop. Recently a maintenance engineer was employed.

Training School :

The company runs its own 4-year training school in Colombo, including facilities, as well as theoretical and on-the-job training. This school has a capacity of 40 students a year.

Various Information :

Efficiency is good, and a bonus is included in the wage system. It is easy to get a licence for supply of spare parts.

The branch workshops are set up to serve the tea factories. During the last years some groups of tea factories have established their own local workshop which has become a problem for the company as the volume of business has been reduced.

Experts' Recommendations on Maintenance :

Organisation : The set-up of a central maintenance group for repair and maintenance of all the workshops and production equipment.

Necessary routines and preventive maintenance programme should be established.

Factory No. 20 : RIVER VALLEY DEVELOPMENT BOARD,
BASE WORKSHOP,
Amparai.

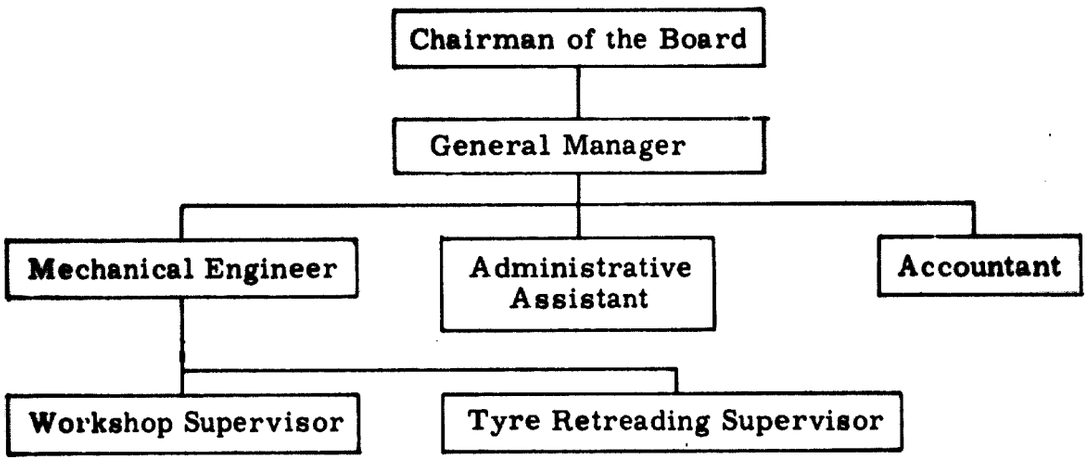
Report on Visit, 27 April 1969

Branch : Maintenance of heavy construction equipment, such as tractors, bulldozers, graders, shovels. Lorries and cars.

Basic Data :

Number of workers	:	582
Staff	:	450
Workers in the field area	:	Up to 200

Organisation :



Ten foremen, five technical assistants, and eight junior technical officers supervise the daily work.

Workshop :

The base workshop was built to take care of all equipment used in the Canadian aid project which started in 1949. More than 200 heavy track-type tractors, wheel tractors, and shovels were used and the overhaul and repair of these machines called for a big central workshop.

Today most of the big earthmoving jobs are completed and some of the tractors worn beyond repair. What remains is kept for finishing jobs and for new smaller jobs such as the construction of a new road from the cane fields to the sugar factory.

The future is uncertain. Without new projects, the base workshop is deemed to close down very soon, or at least to continue on a smaller scale.

Most machines are of US design and foreign currency is difficult to obtain for the purchase of spare parts. Port and customs delays of up to 18 months were mentioned.

In addition tools and other equipment are worn and need replacement badly.

No recommendations are given as the future of this plant has not been decided upon.

Factory No. 21 : RUBBER CO.LTD.,
PARAMBA GROUP,
Undegoda.

Report on Visit, 29 April 1969

Branch : Rubber.

Product : Crepe rubber.

Persons met : Mr. R. Wijayaratnam, Superintendent.

Basic Data :

Annual production	:	460,000 lbs. crepe
Annual sales volume	:	Rs. 420,000
Number of workers	:	250
Staff	:	7
Ground area	:	700 acres

Maintenance Expenditures :

Annual total costs	:	Rs. 25,000
Value of spare parts	:	Rs. 15,000

General Comments :

This factory represents a medium size rubber farm. Latex is collected, bleached, coagulated, washed, and dried. The finished product is high quality crepe rubber.

The factory is old and is driven by a 30-year-old 2-cylinder diesel engine. The machinery consists of 5 rubber rollers.

The maintenance creates no great problem. The plant is stopped for general maintenance 4 to 5 days a year and a contractor is hired for the job. The day-to-day maintenance is performed by the engine operator.

No internal maintenance organisation is needed.

Experts' Comments :

There is a large number of this type of factory. Many of them are old, however, they are well maintained and have high efficiency.

The major problems are that these plants have to rely on a contractor, that spare parts for the old machines are rare, and that no skilled labour is at hand in the factory.

Experts' Recommendations on Maintenance :

It appears that the maintenance services for a large number of small rubber factories must be organised on a co-operative basis or through a central mechanical workshop.

Factory No. 22 : DIYAGAMA WEST TEA FACTORY,
Agrapatna.

Report on Visit, 1 May 1969

Branch : Tea.

Persons met : Mr. G.M. Torrance, Manager (for both East and West factory)

Basic Data :

Annual production	:	2.5 mill. lbs. of tea
Number of factory workers	:	150
Number of fitters	:	3
Value of spare parts	:	Rs. 350,000
Tea estate area	:	3000 acres (East and West)

This is one of the largest tea factories in Ceylon. If tea leaves could come in regularly during the day and the year, the manager estimates the theoretical maximum capacity at 4 mill. lbs.

The workshop is old, with a lathe, a shaper, a drill, etc. Only one electric motor is used in the workshop.

Most of the equipment is produced by Walker and the Colombo Commercial Co. Ltd. The manager is, however, of the opinion that there is inadequate service on maintenance and repair from these vendors. Long delivery time for repairs was mentioned, i.e. a Land-rover had been to repair for more than three months.

The company has some Ferguson tractors. The service from this vendor (Brown & Co.Ltd.) is good.

One diesel engine with a broken head has been to repair for 1½ year and is still awaiting the new part.

A few electric motors are in store, however, the manager would have liked to have many more. The British Tea Company did not seem to be very interested in spending money on improving the equipment and increasing the stock of spare parts. The argument was lack of capital and profit.

This factory is one out of ten factories owned by the same British Tea Company. They are all of considerable size.

The Company did not have any common workshop for these factories, but the manager fully agreed that this would have been of great benefit.

Experts' Recommendations on Maintenance :

The British Tea Company should survey the possibilities of having a central workshop and maintenance services for all the tea factories.

Factory No. 23 : COOMBEWOOD TEA ESTATE,
Colombo.

Report on Visit, 2 May 1969

Branch : Tea.

Persons met : Mr. E.G. Peterson, Superintendent.

Basic Data :

Annual production	:	4000 lbs. of tea
Number of workers	:	30
Total employed	:	360 (including 330 tea pluckers)
Tea estate area	:	335 acres
Factory built	:	1952 (after a fire)

This is a tea factory of medium/small size. It was not operating on the day of visit (holiday).

In general, the machines are in good condition, however, some are rather old. One skilled fitter is employed at the factory. The repair and maintenance of the machines are carried out by Walker Sons & Co.Ltd., Walawakelle, a local repair shop. This workshop is also closed on holidays. About 75 persons are employed in the workshop.

Mr. Peterson is very satisfied with the services of this workshop, both as to the delivery time of work and the quality of performance. The price charged must also be classified as fair.

No recommendations.

Factory No. 24 : GOVERNMENT RICE MILL,
Charalakada, Kalmunai.

Report on Visit, 28 April 1969

Branch : Rice mill.

Basic Data :

Annual production capacity	:	950,000 bushels
Capital invested	:	Rs. 8.4 mill.
Number of workers	:	79
Number employed	:	88

Mill :

This mill was built in 1953 and is located near an irrigation channel and about 3 to 5 miles from paved roads. The intention was to transport the paddy on boats.

The mill is rather old and the upkeep is bad as dirt and cobweb have been allowed to accumulate. Still the mill is working very well.

Maintenance :

The maintenance is carried out by a small number of people :

- 3 charge hands
- 1 fitter
- 1 machine operator
- 1 electrician
- 1 welder
- 1 tinker
- 1 carpenter
- workers available at the moment.

Inventory value of spare parts : Rs. 32,000.

No additional data were available as the mill manager was absent.

After one month's operation the mill is stopped for a period of 4 days of maintenance.

No problems with spare parts existed as the stock will last for about 10 years.

No recommendations.

Factory No. 25 : GAL OYA WOOD WORKING INDUSTRY,
Amparai.

Report on Visit, 28 April 1969

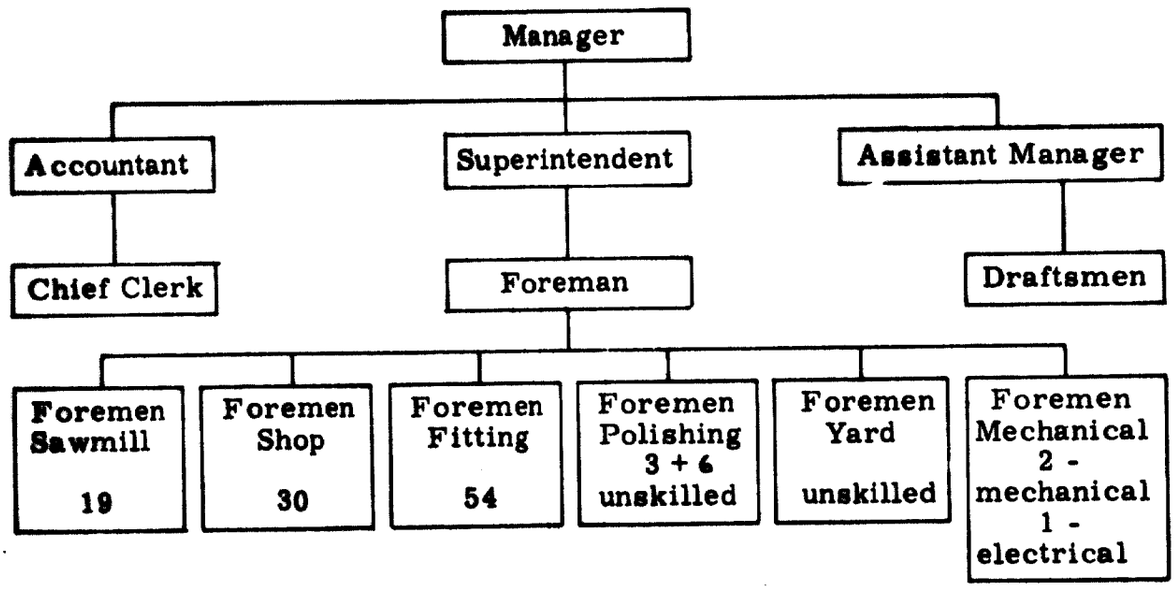
Branch : Timber, furniture for schools, window-frames, door-frames, etc.

Basic Data :

Annual sales volume	:	Rs. 3.0 mill.
Capital invested	:	Rs. 1.6 mill.
Number of workers	:	210
Staff	:	32

The industry was started in 1950 as a part of the big River Valley Development project.

Organisation :



Total unskilled workers : 60.

Various Information :

Incentives based on unit rates are used in the production departments.

The main :nance crew is paid monthly.

No job order was used in the routines.

Maintenance :

On every Poya-day a preventive maintenance programme is carried out. The machines are inspected and tested, lubricated and adjusted. If bigger repairs are necessary, these are done even during ordinary working hours.

Experts' Comments :

There is far too much material lying around in the factory. It was even difficult to walk around. Most of the machines are old and spare parts are scarcely available from the manufacturer. Modifications have to be done to fit new parts on these old machines.

Efficiency did not seem to be high, but even so the output is fairly large.

Experts' Recommendations on Maintenance :

Organisation	:	Centralised planning and scheduling to improve the personnel utilisation.
		A simple job order system should be employed.
		The existing preventive maintenance system should be better planned.
Repair Facilities	:	New equipment is needed.
Personnel	:	A training programme should be worked out and used. The foremen and supervisors should receive management training.

Factory No. 26 : BROWN & CO.LTD.,
AGRICULTURAL DIVISION,
Colombo.

Report on Visit, 22 April 1969

Brown & Co. is the agent for Massey Ferguson Ltd. and the visit was related only to maintenance and supply of spare parts to Massey-Ferguson tractors.

Persons met : Mr. S.A.G. Perera, Service Manager
The Sales Manager (previously Service Manager)
Mr. David Harris - Massey-Ferguson Sales Manager for the Far East (Singapore).

Basic Data :

The main workshop and the central store are in Colombo. Brown & Co. has four branches with workshops and stores. Fifteen dealers (agents) are spread out in the agricultural area.

Training School :

Since 1952-53 Brown & Co.Ltd. has operated a central training school in Colombo, with training facilities for dealers, salesmen, servicemen, and storekeepers. The company also arranges such courses outside Colombo.

Since 1953 at least 200 servicemen have been trained.

The training of tractor operators is included in the sales. Such training is now done in the field. An "installation certificate" and a guarantee of 600 hours of free service are given to the buyer.

All training and instructions are free of charge, and participation in the so-called "service weeks" is included in the price of the tractors. It is in other words up to the customer to utilise the training and the instruction facilities available.

Mr. Perera, the present service manager with 15 years of experience in the field, stated that his opinion was that much could be done to improve maintenance and repair. Sixty per cent of the tractors are being operated in the

muddy fields. This requires a completely different cleaning, oiling, and greasing, etc. than operation in dry fields. Furthermore, it is a common fault that the operators do not know how or like to use the proper gear. However, there have been great improvements in handling and care-taking of the tractors, especially by people who previously had tractors. Still, a lot can be done by proper training.

Stock of Spare Parts :

Today about 95% of the spare parts are available. A couple of years ago the figure was only 75%. The value of inventory is Rs. 60 mill. of which Rs. 3.5 mill. is at the branches and the dealers. The sales volume in 1968 was about Rs. 7.5 mill. Port and customs cause great delay for imported supplies.

Experts' Comments :

The storeroom and the workshops are well equipped and organised. We got the impression that the dealers concentrate much on training, information, and service, mainly to give their tractors a good reputation thus securing future sales.

The training and the instruction material for operation, maintenance, and overhaul should be improved.

No recommendations.

Supplement :

According to information obtained from various other sources, Brown Massey-Ferguson is the only supplier who has a good service system throughout the country.

Factory No. 27 : BASE MECHANICAL WORKSHOP,
Irrigation Department,
Ministry of Land, Irrigation and Power,
Colombo.

Report on Visit, 19 April 1969

Branch : Repair, overhauls, and maintenance of about 1000 units of mechanical equipment used for irrigation, jungle and forest clearing, road construction, road maintenance, power plant construction, etc.

Persons met : Mr. S. Mudalige, Chief Engineer
Mr. H.L. Piyasena, Accountant
Workshop Engineer
Stores Superintendent.

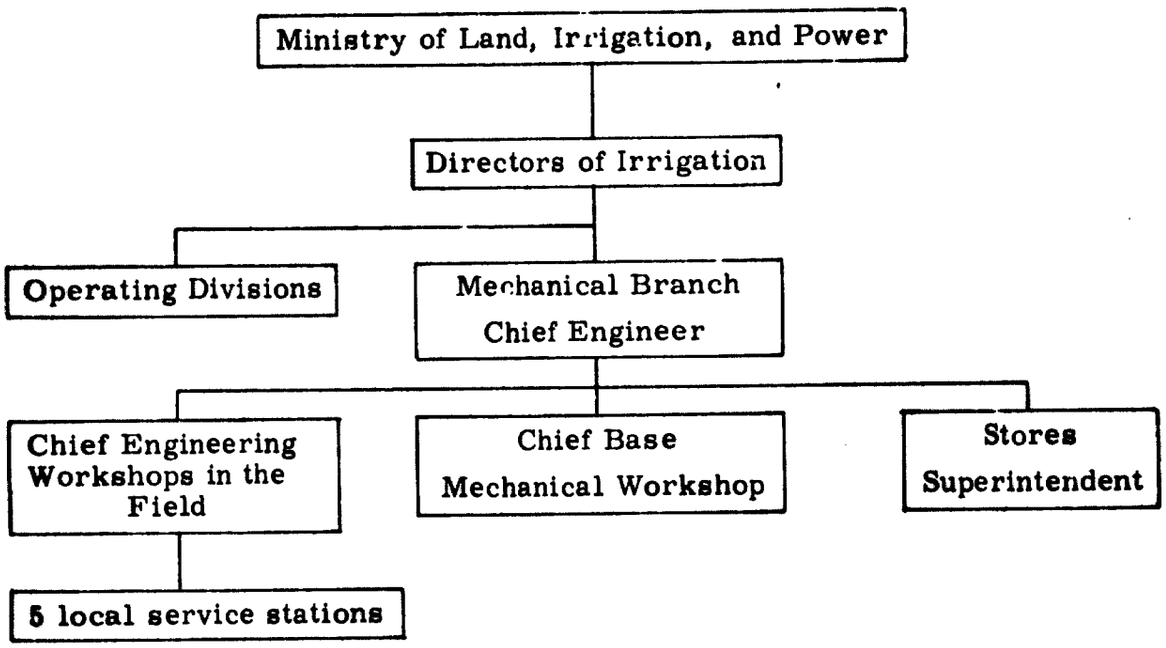
Workshops :

1. Base Mechanical Workshop, Ratmalana (9 miles from Colombo).

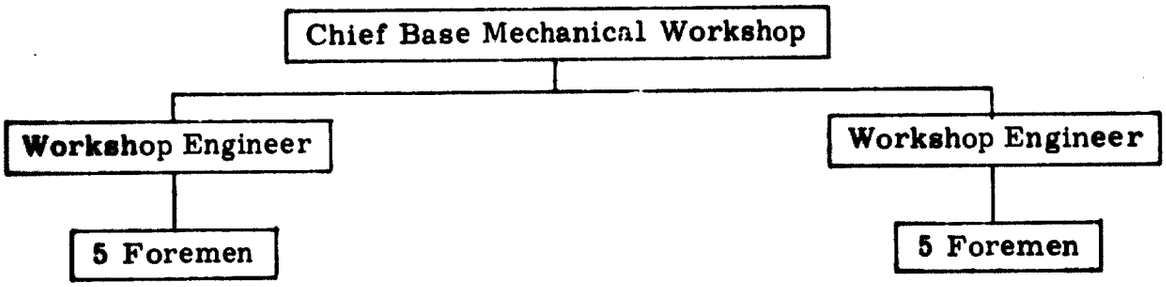
Number of skilled workers	:	220
Number of semi-skilled and unskilled workers	:	530
Total employed	:	1200

2. Five local service stations with some small workshop facilities located throughout the country. In total they employ about 1000 persons, of which close to 300 are skilled and the rest either semi-skilled or unskilled.

General Organisation :



Organisation of Base Mechanical Workshop :



Maintenance Expenditure Budget, 1969 :

Labour expenditures	:	Rs. 5 mill.
Spare parts and material	:	Rs. 3 mill.
Total maintenance	:	Rs. 8 mill.

About 75% of these expenditures are overhauls and 25% repair and preventive maintenance, very little on new products or parts.

The inventory value is about Rs. 8 mill. which gives a turnover time of 2 2/3 years.

Maintenance Routines :

General overhaul	:	2500 hours
Complete overhaul	:	5000 hours

The mechanical branch sends for the equipment to be overhauled.

Education and Training :

The workshop has its own training scheme for workers at the skilled and supervisory levels. Recruitment is made from those who have followed a course in the basic vocational training schools. Prior to training the trainees are requested to enter into a bond to serve the Department for a fixed period of time, and only a few people leave the Department to join private firms.

The efficiency rate is considered to be average. The workers are paid on a monthly basis.

No organised work study is being done.

Spare Parts :

The supply of spare parts seems to be the main problem for the Chief Engineer and all the workshops.

According to calculations, an average complete overhaul can be carried out within 22 days when the necessary spare parts are available. It is common that an overhaul exceeded one year due to lack of spare parts. Total delivery time is often more than one year.

All spare parts are imported except for some of the smaller ones.

Production of spare parts in Ceylon is very expensive. Furthermore, the quality is bad and there are difficulties in meeting the specifications, tolerances, etc.

The spare parts are not packed and sealed for storage in tropical climate.

Experts' Comments :

The store of spare parts is insufficient considering types and quantities, but what exists is well organised. Complete records are maintained of parts in stock and in and out of stock, and rather good physical storing of most spare parts is provided.

Example :

As a part of a U.S. development gift ten big Allis Chalmers tractors were supplied for which the total value is Rs. 2,500,000.

The value of the spare parts which came together with the tractors is Rs. 75,000, which is only 3% of the total value of the machines.

The chief engineer recommended the purchase of one tractor less and to get spare parts for another Rs. 250,000 instead, but this advice was not followed.

This example shows clearly that adequate supply of spare parts is not provided even if it is possible. The 3% is not sufficient as experience shows that maintenance expenditures run as high as 100 to 200% of the original value. The value of spare parts accounts for about 1/3 to 2/3 of the total maintenance expenditures.

Experts' Recommendations on Maintenance :

Spare Parts : The spare part policy in the Irrigation Department should be re-evaluated in order to arrive at a policy which would reduce workshop waiting time and decrease production time considerably for a number of key equipment.

The policy should consider possible reduction of delivery time, local manufacturing, increasing the inventory, and other factors bearing any relevance on the spare part situation.

Factory No. 28 : CEYLON GOVERNMENT RAILWAYS WORKSHOP, Ratmalana.

Report on Visit, 3 May 1969

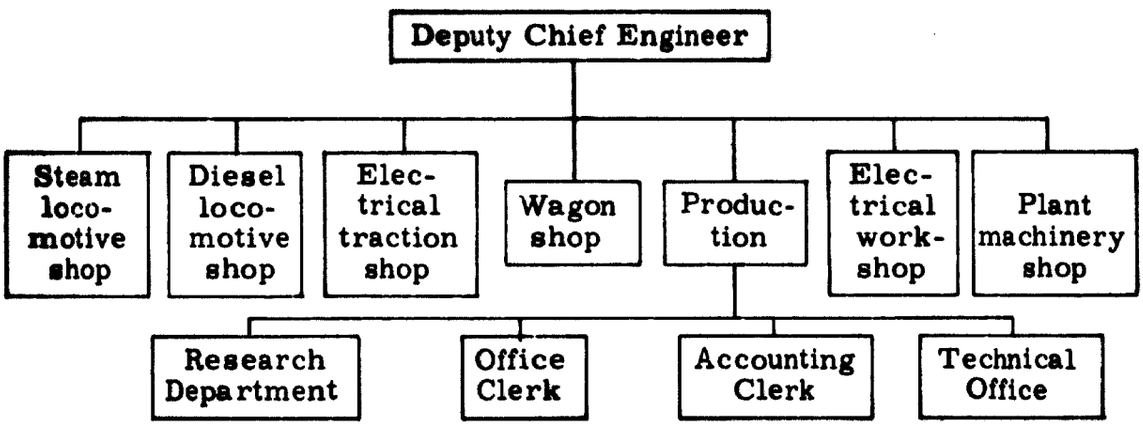
Branch : Railway material maintenance, steam and diesel locomotives, carriers, and wagons.

Persons met : Mr. Rajakulassariyar, Deputy Chief Engineer.

Basic Data :

Number of workers	:	4200
Staff	:	600

Organisation :



General :

The workshops were set up to take care of the steam locomotives and wagons and to provide spare parts for these. The machines in the workshops are partly very old.

The workshops consist of the following :

- Department for steam locomotives
- Department for diesel locomotives
- Department for wagons and carriers

- Carpentry
- Foundry
- Forge shop
- Machine tool shop
- Central store
- Electrical workshop.

As the diesel locomotives are increasing in number and the steam locomotives are laid up, the job situation is likely to change rather soon. The major part of the new diesel locomotives will be delivered this year.

The old machine tool shop, the foundry, and partly the forge shop will be drastically changed. The amount of spare parts made in these shops will decrease considerably and many of the machine tools will not be used at all.

A new kind of machine jobs will materialise for the diesel motor spare parts. Higher accuracy is demanded and many of the old machine tools will be unusable.

Comments from the Deputy Chief Engineer :

The main problem is the absence rate. On the day of the visit, only 25% of the workers were present. The average absence rate is 35%. Many of the workers are skilled, but poorly paid. Other workshops recruit from the personnel by offering a higher salary.

When a worker is present he works efficiently, however, the absence rate is too high.

Training :

A good training scheme is in effect. For a worker the training is 4 years, for a foreman 3 years, and for a graduate 3 years.

The production engineers are trained in work study. Time standards are used:

- in the machine tool department
- partly in the foundry
- partly in the blacksmiths' shop.

This year work study will be introduced in the carriage repair shop.

Experts' Comments :

The workshops are badly kept and the upkeep could be improved. Too much material lies around and the working-places are rather dirty.

The planning and scheduling could be greatly improved.

The deputy chief engineer is aware of these facts but is unable to correct them due to the shortage of trained engineers.

The engineers probably need management training and a better administration system.

For these shops a general plan should be made quickly, as the introduction of the diesel locomotives provides an excellent opportunity to change from old to modern methods.

Experts' Recommendations on Maintenance :

Organisation : A planning and scheduling section should be established for all the workshop departments.

Based on the job order system and the running time (or distance records), a follow-up system should be employed. This is partly done already, but this system should be modernised and changed to facilitate the future use of computers.

A simple and efficient job order system with standard repairs and time standards should be used.

Repair Facilities : Work studies should be introduced and employed. These would probably initiate changes in the workshop layout, and result in increased efficiency results.

Spare Parts Stores : Same recommendations as for the repair facilities.

Personnel : The training programme should be revised and modern training methods such as programmed training introduced and employed. The engineers need management training. Recruit trained engineers.

Factory No. 29 : CEYLON TRANSPORT BOARD,
Colombo.

Report on Visit, 18 April 1969

Branch : Workshops and Ceylon-German Training School at Werahera.

Persons met : Mr. Premaratne, Chief Mechanical Engineer
Mr. Unamboowa, Principal, Training School.

Workshop :

The workshop is responsible for the repair, overhaul, and body-making of about 5700 buses. This is the largest workshop of the Ceylon Transport Board. Minor overhauls, repairs, etc. are done in the district workshops graded Grade I and II according to the magnitude of the jobs undertaken. These functions include small-scale tinkering and welding operations; trouble detection; and minor repairs to engines in the ignition systems, brake lining, and brake systems, etc.

Major repair and overhaul work involving main repairs to engines including crankshaft grinding, cylinder reboring, axle repairs, gear-box and transmission repairs, etc. are always referred to the main workshops at Werahera. Chassis are imported and bodies are constructed in the Werahera workshops.

The workshops at Werahera employ about 2000 workers while the total employed in the organisation is about 36,000.

The workshops have an annual production capacity of 350 new bus bodies, 350 reconditioned bodies, and 1500 reconditioned engines.

Training School :

The Ceylon-German Training School admits about 60 students every term and trains them over a period of 4 years. The course is well organised with adequate practical training in the following fields :

- Motor mechanics
- Tool machinists

- Welders
- Auto electricians.

The students are employed at the workshops after the completion of four years.

The need for trained personnel is much greater and the management is planning expansion.

Tool racks are well laid out and the machines and equipment were well cleaned and maintained in an orderly manner.

Maintenance Expenditures :

The expenditures are not fully analysed. The inventory value of spare parts and material amounts to about Rs. 25 to 30 mill.

The large inventory is due to the following fact. When the bus services were nationalised by the Government the Ceylon Transport Board took over from the private sector a large number of buses of about 24 various makes, i.e. Leyland, Morris, Austin, Bedford, Benz, Fiat, Ikarus, Issuze, Dodge, Chevrolet, Commer, etc.

Recently the Board has decided to standardise the import of buses by reducing the number of makes.

Maintenance Personnel :

Most of the craftsmen in the organisation were recruited from the companies owning the buses prior to the take-over. Their efficiency is low by modern standards though their skills are appreciably high. The students at the German-Ceylon Training School are trained to perform tasks with maximum efficiency. The discipline is average but the attitude to work should definitely be improved.

Work Study and Rationalisation :

These concepts have never been employed as the management has received only introduction to these subjects.

Wage System :

The workers receive fixed salaries and are promoted according to merit rating scales depending mainly on experience and qualifications.

Experts' Comments :

The large inventory of spare parts, amounting to Rs. 25 to 30 mill., should receive attention. Proper up-to-date records and systematic analyses of repairs and overhauls of buses would definitely be beneficial in order to standardise the spare parts and reduce the inventory considerably. The chief mechanical engineer who has a very enlightened attitude towards methods of modern management has already launched a programme to this effect.

The bulk of the workshops operations is manual and semi-automatic. It was definitely felt that the introduction of work study could result in a great increase in the output which at present is far too low for this work force.

The layout needs improvement to obtain maximum space efficiency and to achieve a uniform flow of work.

Beneficial to the increase of output would be the introduction of power tools, pneumatic devices, etc. to tighten and loosen nuts, etc. At the present moment, these operations are done manually by using spanners, sockets, etc. Power-handling tools would also prove effective to increase the efficiency and output.

Better production planning and scheduling procedures have to be introduced as the production is far too low. The jobs should be broken down into standardised elements and then timed. These standard time elements are used to compose a major job and standards can be set. Incentives could be given for the production exceeding the standards.

Retraining of skills is quite necessary. Film shows, demonstrations, etc. of modern repair and overhaul procedures should prove beneficial to enhance the skills and the morale of the workers.

Major re-occurring failures in the engines, systems, etc. should be investigated and improvements suggested to the makers about design, construction, etc.

Experts' Recommendations on Maintenance :

Organisation : Under the chief engineer a work study department or section should be established. Also the planning and scheduling section should be revised.

Buses are usually run to a standardised maintenance programme. It should, however, be extended to include also the above-mentioned control programme, based on maintenance analyses.

A simple planning and scheduling system should be established and used, based on standardised repair and overhaul procedures and time standards. The system for written orders should be designed to give in-put information to the control system, facilitating maintenance analyses, both technical and economic.

Repair Facilities : One of the most important tasks for the work study section should be to study the flow of material and establish a material control system. At the same time modern equipment such as power wrenches, lifts, and turning fixtures should be investigated.

Personnel : The training programme is inadequate as the number of trainees is too small. The normal course might be shortened by applying modern programmed training methods, thus increasing the capacity of the training school.

Retraining courses should be introduced for further training of the skilled workers on new motors, equipment, etc.

All management personnel, engineers, foremen, and supervisors need management training. The number is large and own training courses might be an alternative.

Factory No. 30 : STATE ENGINEERING CORPORATION,
MAIN WORKSHOP,
Colombo.

Report on Visit, 26 April 1969

Branch : Mechanical and electrical workshop.

Products : Repair of vehicles such as cars, trucks, etc. Transportable cranes and other building machinery.

Persons met : Mr. W.S. Mendis, Production Engineer, central workshop.

Basic Data :

Number of workers	:	350
Total employed	:	380

At present the mechanical equipment is located at 51 construction sites, all with some repair facilities and 2 - 3 fitters at each place.

Craftsmen :

- 30 machine operators in 5 different skill grades
- 15 skilled fitters, same grades
- 20 builders
- 21 electricians
- 90 vehicle craftsmen.

New Workshop :

The main workshop is at present overloaded as the work has increased very much during the last couple of years.

A new workshop, 500 x 50 feet, will be completed in 1970 at the same site. Fifteen different machine tools exist, most of them are very good. Some new machine tools have been ordered for the new workshop.

Various Information :

The lack of skilled personnel is a problem. The persons employed are trained on the job. The workshop has no formal training school. At present, it is a great problem to get enough space for necessary repairs in the existing workshop. The workshop has difficulties with obtaining spare parts and the delivery time is at least 6 months. Beside space the machine shop is the main bottleneck today.

Experts' Comments :

The present workshop and its maintenance conditions are not commented as a new and larger workshop is under construction.

No recommendations.

Factory No. 31 : HARDY SENIOR TECHNICAL INSTITUTE, Amparai.

Report on Visit, 27 April 1969

Branch : Training in agricultural and technical fields.

Size : Residential capacity : 250.

The institute was founded 13 years ago to cover the need of senior training within the River Valley Project.

The buildings are very well kept and in good condition. The training equipment is fairly modern.

The purpose of the visit was to look into the possibilities for short-term management training for foremen, supervisors, and other trained personnel.

From July to October it would be possible to run short courses of the residential type for up to 100 students at the time without exceeding the capacity.

The instructors and the material must, of course, be provided from outside, as the school is manned for another type of courses.

No recommendations.

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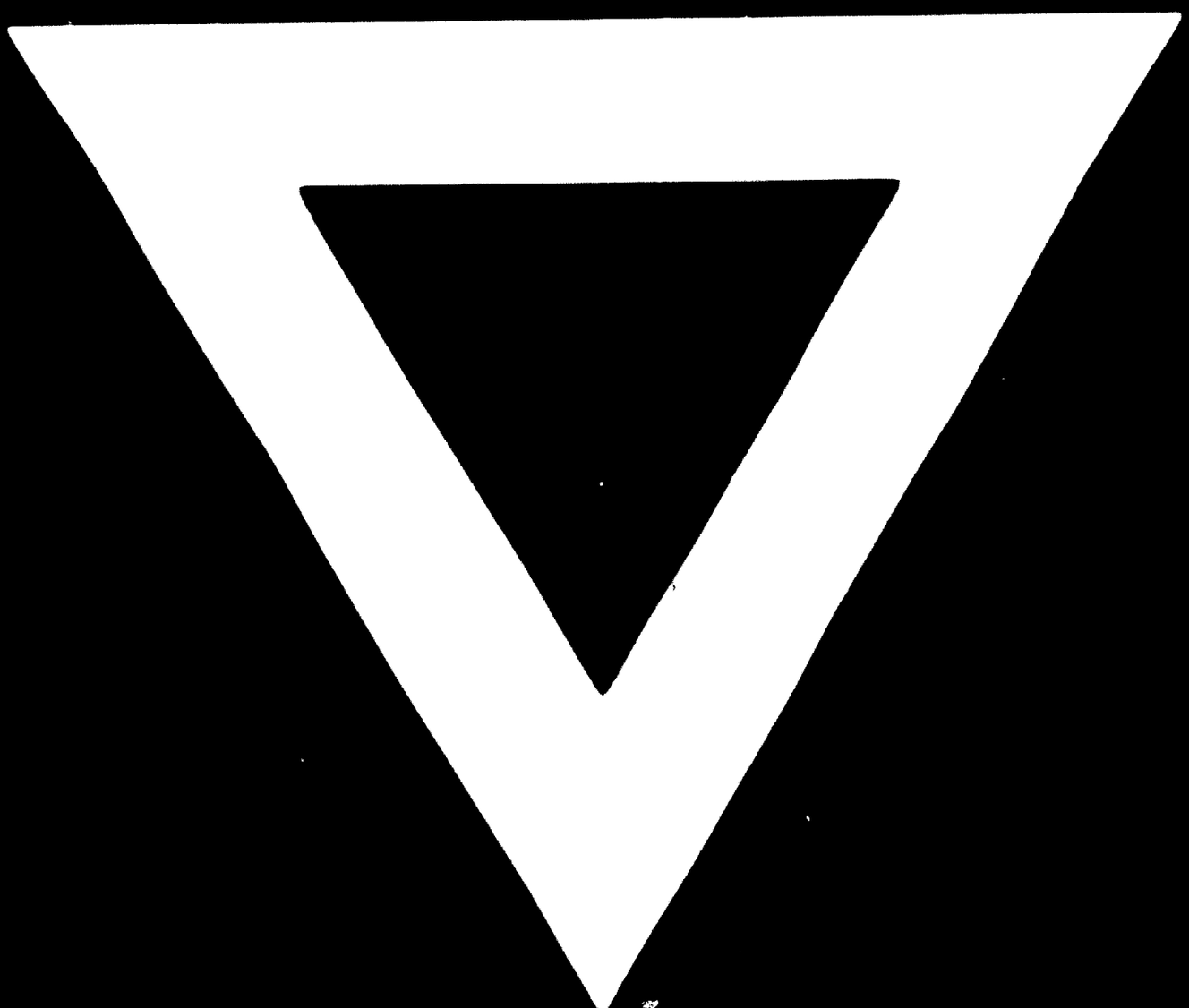

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