THE UNIVERSITY OF ZAMBIA

AN ANALYSIS OF THE PERFORMANCE OF THE MANUFACTURING INDUSTRY IN ZAMBIA:

THE ENGINEERING MANUFACTURING SUB-SECTOR

By

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Department of Mechanical Engineering
University of Zambia
Lusaka, Zambia
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A dissertation submitted to the University of Zambia in partial fulfilment of the requirements for the award of the degree of

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in

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Lusaka, Zambia

2000

Declaration

, GRAIN MUNANG'ANDU MUNAKAAMPE, do hereby declare that this dissertation represents my own work, and that it has not previously been submitted for a degree award at this or another university.

Signed : .....

Name : Grain M. Munakaampe

Date : November 7, 2000

Approval

This dissertation of Grain Munang'andu Munakaampe is approved as partial fulfilment of the requirements for the award of the degree of Master of Engineering in Production Engineering and Management by the University of Zambia.

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To my family:

For all those months you had to do without a husband and a father

"But they that wait upon the LORD shall renew their strength; they shall mount up with wings as eagles; they shall run, and not be weary; and they shall walk, and not faint."

- Isaiah 40:31 (KJV)

"But those who hope in the LORD will renew their strength. They will soar on wings as eagles; they will run and not grow weary, they will walk and not be faint."

- Isaiah 40:31 (NIV)

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A	-	Other factors including technological change
K	-	Capital input
L	-	Labour input
O	-	Total Output
sk	-	Share of Capital
sl	-	Share of Labour

List of Abbreviations and Acronyms

AT	- Appropriate Technology
BOP	- Balance of Payments
CNC	- Computer Numerical Control
COMESA	- Common Market for Eastern and Southern Africa
CSO	- Central Statistical Office
ECZ	- Environmental Council of Zambia
FNDP	- (Ministry of) Finance and National Commission for Development Planning
GDP	- Gross Domestic Product
GNP	- Gross National Product
GT	- Group Technology (or Cellular Layout)
IMF	- International Monetary Fund
INDECO	- Industrial Development Corporation Limited
JIT	- Just-In-Time (Type of production)
LENCO	- Lusaka Engineering Company Limited
LMA	- Livingstone Motor Assemblers Limited
MCTI	- Ministry of Commerce Trade and Industry
MSAM	- Management Systems Analysis Model(s)
NCDP	- National Commission for Development Planning
NCSR	- National Council for Scientific Research (forerunner to NISIR)
NISIR	- National Institute for Scientific and Industrial Research
PPCs	- Party Political Committees
R & D	- Research and Development
SAP	- Structural Adjustment Programme
SM	- Statistical Methods
SMEs	- Small and Micro Enterprises
SOEs	- State Owned Enterprises
TAZARA	- Tanzania Zambia Railway Authority
TDAU	- Technology Development and Advisory Unit
TFPG	- Total Factor Productivity Growth Function
TQM	- Total Quality Management

UDI	- Unilateral Declaration of Independence (by Rhodesia in 1965)
USD (US$)	- United States Dollar (or simply $ unless the context states otherwise)
VAT	- Value Added Tax
ZABS	- Zambia Bureau of Standards
ZACCI	- Zambia Association for Chambers of Commerce and Industry
ZAM	- Zambia Association of Manufacturers
ZAMEFA	- Metal Fabricators of Zambia Limited
ZCCM	- Zambia Consolidated Copper Mines Limited
ZCTU	- Zambia Congress of Trade Unions
ZESCO	- Zambia Electricity Supply Corporation Limited
ZIMCO	- Zambia Industrial and Mining Corporation Limited
ZMK	- Zambian Kwacha (ZMK1.00 = 100 Ngwee)

Abstract

The Zambian economy in 1964 was among the strongest in Sub-Saharan Africa. Through the years, however, it declined to among the weakest. The manufacturing sector's contribution to GDP declined from a peak of 30 per cent in 1992 to 24 per cent in 1996. The engineering manufacture sub-sector accounted for only 22 per cent of this contribution in 1971, peaking at 26 per cent (1975), but declining to 13 per cent (1996).

This study analysed the performance of manufacturing particularly the engineering sub-sector in Zambia from 1964 to 1997. It identified the effects on performance of technology choices, product range, technical and management skills, and operating environment. It also examined the effects of government's economic policies on industry. Trends were compared at macro (sectoral) and micro (firm) levels by in-depth studies of some firms.

Data collected was analysed using the Management Systems Analysis Model (MSAM), Statistical Methods (SM) and Total Factor Productivity Growth (TFPG) to determine sources of growth and/or decline in the performance of the manufacturing and engineering industries. Technologies employed by firms were analysed against the background of facility and job design, process variability, total quality management, level of labour skills, plant re-capitalisation and modernisation, environmental and energy considerations. The manufacturing technologies in use were further compared with more advanced ones.

It was found that TFPG contributed to the growth and decline of both manufacturing and engineering sectors. In both manufacturing sector and engineering sub-sector, there was rapid growth in output from 1964, but this growth declined after 1992 and 1982, respectively. Before 1991, government policies were commandist and did not encourage free enterprise and competition. Prior to 1991, it was also found that the energy crisis (1973), the Rhodesian border closure (1965), the freedom struggle in neighbouring countries and cost of spare parts affected the performance of the economy. However, after 1991, despite the liberalisation of the economy, there were no financial incentives for the struggling and emergent industries. Therefore, industry failed to re-invest in new and more efficient technologies, production

methods and total quality management to meet the challenges of an open market economic policy in Zambia. Research and development were neglected both before and after 1991.

From this study, it is recommended that both the government and industry need to play their respective parts, with government as a facilitator and formulator of policies conducive for growth of industry and industry itself taking initiatives that facilitate growth. Industrial initiatives must include research and development, investment into newer and more efficient technologies, improvement of existing facilities for better productivity and use of cheaper but sound raw materials. Organisational frameworks and information acquisition, generation, storage and dissemination must be improved.

The report, further, concludes that unless this partnership between government and industry is recognised and exploited, all efforts by either the government or industry to resuscitate the economy will be futile.

CHAPTER 1

INTRODUCTION

1.1 BRIEF ECONOMIC AND POLITICAL PROFILE OF ZAMBIA

For the post independence period, 1964 to 1974, Zambia enjoyed bright prospects for economic growth. The country's earnings from copper were high. In an effort to control the economy and ensure its growth through diversification and import substitution, the country adopted a socialist political system and nationalised most companies in the manufacturing sector. New companies were set up in various locations (particularly rural areas) of the country to improve rural standard of living and curb urban migration.

However, in the period 1975 to 1985, the situation of Zambia changed. The global energy crisis of 1973 and the dropping copper prices on the world market led to the country losing its high income. In the period 1985 to 1991, there were attempts made to restructure the economy through the implementation of IMF and World Bank measures. The 1985 IMF package of economic reforms and structural adjustment programmes had a negative effect on the overall performance of the economy. The introduction of foreign exchange auctioning in October 1985 led to the devaluation of the Kwacha by about 955 per cent between then and April 1986. Inflation rose from 20 per cent in 1984, to 60 per cent in 1986; formal employment declined from 365,190 in 1984 to 360,540 in 1986 and balance of payments deteriorated further. Withdrawal of subsidies on mealie-meal in 1986 led to widespread rioting prompting government announcement to part with the IMF. Thus, results and effects of the programmes were negative and the expected economic recovery did not take place.

With the change of government in 1991, emphasis was shifted towards a free market economy. The government adopted a major reform package, which emphasised, among other things, the opening of the domestic market to allow competitive trade and to encourage positive participation of the private sector in all aspects of economic life with Government merely as a facilitator to economic activities of the private sector.

1.2 BACKGROUND TO THE STUDY

The Zambian economy has over the years been a mono economy dependent on the mining industry. Although the mining sector's contribution to GDP was about 7 per cent (1993), it accounted for over 70 per cent of the nation's earnings. Agricultural performance has been poor, accounting for between 17 and 19 per cent of GDP from 1987 to 1993 while manufacturing contributed between 22 per cent (1987) and 27 per cent (1993). Other sectors outside mining, as indicated below, have not had any outstanding performance over the same period. In 1993, for example, their contribution to GDP was as follows: Electricity and Water - 2.3 per cent; Construction - 2.7 per cent; Wholesale and Retail Trade - 7.6 per cent; Hotels and Restaurants - 3.5 per cent; Transport, Communications and Storage - 4.8 per cent; and Finance Institutions and Insurance - 2.4 per cent. The rest performed as follows: Real Estate and Business - 7 per cent; Community, Social and Personal Services - 17.7 per cent; and Import Duties - 0.9 per cent [1].

The Manufacturing sector's contribution to GDP rose from 9.2 per cent in 1971 to a peak of 30 per cent (1992), but declined to 24 per cent (1996) [2]. The engineering manufacture (metal products) sub-sector, in 1971, accounted for only 22 per cent of the contribution by manufacturing, rising to a maximum of 26 per cent in 1975 [3], but declining to about 13 per cent in 1996 [4]. The Food, Beverages and Tobacco sub-sector accounted for over 50 per cent of this contribution. The low percentage contribution to GDP by the engineering sub-sector was an indication that the sub-sector was, compared to other sectors, not doing well.

This study, therefore, sought to analyse the poor performance of the engineering manufacture (metal products) sub-sector, particularly new products manufacture and re-conditioning. It examined the effect, on the performance of the sub-sector (by examining gross output, capital stock, and value added at constant prices, labour and capital productivity and employment trends), of product type and range, technology choices (types and appropriateness), and quality of management. "Appropriate technology (AT)" referred to technology that made the most economical use of a country's natural resources and its relative proportions of capital, labour and skills, and that furthered national and social goals. This implied low investment cost per workplace, low capital investment per unit of output, organisational simplicity, high adaptability to a peculiar social and cultural environment, sparing use of natural resources, low final product cost and high employment potential [5].

1.3 OBJECTIVES OF THE STUDY

The objectives of this study were:

(a) To analyse the performance of the engineering manufacture sub-sector since independence, identifying the effects of technology choices, product range, technical skills, management skills, and operating environment.

(b) To identify and inter-relate sub-sector and firm level trends and establish factors influencing such trends.

(c) To evaluate suitability of adopted technologies and compare with other manufacturing technology.

(d) To develop strategies for the future and sustainable development of the sub-sector.

1.4 RESEARCH METHODOLOGY

1.4.1 Sampling Procedure

A total of 35 companies (20 large-scale, 10 medium-scale and five small-scale) in the sub-sector were selected for use in the analysis of the performance of the Zambian engineering industry: Definitions of large, medium and small scale industries are given in Appendix D6.

1.4.2 Data Collection Methods

a) Data was collected using questionnaires to targeted firms and government departments; industrial visits; discussions/interviews with relevant management personnel; and extraction of performance statistics from available literature and reports.

b) Technologies in use were studied by physical visits to the shop floor.

1.4.3 Data Analysis and Interpretation for both Sector and Firm-Level Analysis

a) Mathematical models were used to analyse data in order to arrive at relevant conclusions and these included:
   i) Statistical methods for graphs;
   ii) Total Factor Productivity Growth (TFPG) to determine sources of growth or decline.

b) The technologies being employed were analysed in the light of the following factors:
   i) Facility and job design

ii) Planning, inventory and scheduling
iii) Production cost
iv) Process variability
v) Total quality management
vi) Level of labour skills
vii) Plant re-capitalisation and modernisation, and
viii) Environmental/energy considerations

c) These technologies were further compared with more advanced technologies, particularly CNC technology.

1.5 LITERATURE REVIEW

A number of studies relating to industry in Zambia have been undertaken. Notable ones were those conducted by Inter Africa Corporate Services (Zambia) Limited (1997), Dr. H. M. Mwenda (1996), Dr. E. G. A. J. de Bruin and Dr. M. J. Tambatamba (1995), Professor F. D. Yamba (1988) and Dr. P. K. Nkanza (1996). Others were those carried out by Elfatih Shaaeldin (1988), and Ravi Gulhati and Uday Sekhar (1981). Main conclusions of these studies are given below:

1.5.1 E. G. A. J. de Bruin and M. J. Tambatamba

The goal of this study was to evaluate the capabilities of the Zambian engineering companies in the agricultural machinery industry and to make suggestions for the technological development of the sub-sector [6]. The study, therefore, focused on the role of technology in the development of the agricultural machinery sub-sector in developing countries, particularly Zambia.

The study proposed a strategy for the sustainable improvement of the agricultural machinery sub-sector and established the need for the incorporation of technological considerations in development efforts, particularly those efforts targeted at the agricultural machinery industry. It pointed out that a sustainable agricultural machinery sub-sector would meet both the quantitative and qualitative demand of agricultural machinery in Zambia.

1.5.2 F. D. Yamba

The study by Yamba (1988) involved a market survey of the various sectors of the Zambian industry to ascertain the type and volume of imported spare parts and assembled components [7]. It further looked at determining the installed capacities with a view to determining the investment required for improving and rationalising their performance; and the creation of additional facilities to meet national requirements.

It revealed that although many of the existing foundries, fabrication and machining facilities were under utilised, they needed rehabilitation and modernisation to enhance their range of products and improve the quality of the products. It recommended that in the foundry and fabrication sectors, there was need to improve design and quality control while in the machining area, capabilities for gear making, precision work and fine finishing were required. The study also recommended that it was required to improve the number and quality of technical personnel.

1.5.3 H. M. Mwenda

In this study it was attempted to look at the general state of the manufacturing industry in the Zambian economy in the light of the mining and agricultural sectors and the changing national economic, political and fiscal policies [8]. It was concluded that there was reduced competitiveness in both the public and private sectors due to, among other reasons: poor financial management, lack of adequate capital and medium/long-term funding. It was further noted that there was too much competition from imports, lack of skilled and disciplined labour, outmoded production technologies, absence of enhanced management skills, high taxes and financing costs.

1.5.4 P. K. Nkanza

The study outlined the development of the Engineering/Manufacturing industry in Zambia. It sought to answer the question: "Can Zambia's industry compete in a world of rapid technological change, liberalised trade and global production?" [9]. It was viewed that the engineering and manufacturing industry in the liberalised Zambian economy needed to strive to compete. It was also recognised that there were major obstacles to be overcome.

According to the study, Zambia's manufacturing sector was built on the basis of "import substitution" which emphasised the desire for the country to lessen its dependence on imported manufactured goods. This strategy was inward looking and sought to satisfy the needs of the local market and discouraged imports. There was little evidence of serious parallel efforts to promote exports. In an environment of protection, state ownership and controls, subsidies and price control, there was little incentive for enterprises to invest resources for product innovation, reduction of production costs, improvement of product quality and the application of modern technology. The post 1991 liberalisation of the economy, coupled with the removal of protection and subsidies exposed the sector to intensive competition. As a result, many manufacturing enterprises experienced enormous difficulties because they were not ready for the new phenomenon.

It was further recognised that, given the "current" state of the sector, direct competition with external manufacturers was not a feasible solution. It was proposed that industry identify those areas where it could have competitive advantage and strive to be unique therein.

1.5.5 Inter Africa Corporate Services (Zambia) Limited

This study was aimed at identifying technical needs (technological and management) of manufacturing industries in Zambia, with emphasis on Micro and Small Enterprises (SMEs). It further sought to identify areas in which these industries could utilise the support services of the Zambia Bureau of Standards (ZABS), the National Council for Scientific Research (NCSR) and the Technology Development and Advisory Unit (TDAU) [4].

The study recognised that the establishment of sustainable linkages between TDAU, NCSR and ZABS and the small-, medium- and large-scale enterprises required government intervention and support - given the weaknesses on both sides. It was also recognised that TDAU, NCSR and ZABS needed to find ways of becoming financially self-sustaining in the face of reducing Government allocations to these institutions. It proposed that a grant system be established to assist micro, small and medium scale enterprises meet the cost of technical services provided by TDAU, NCSR and ZABS.

1.5.6 Elfatih Shaaeldin

In this study, it was attempted to provide an analysis of the sources of industrial growth in Kenya, Tanzania, Zambia and Zimbabwe [10]. It was observed that Zambia, unlike the other three countries, was sparsely populated and had a high dependence on copper mining. Capital accumulation was rapid in the aftermath of independence and initially output grew rapidly. However, a sharp drop in the price of copper on the international market and deterioration in the terms of trade in the 1970s led to considerable capacity under-utilisation and a slow-down in manufacturing output and value added. It was further pointed out that the level of capacity utilisation was determined by such factors as the shortage of foreign exchange and the size and growth of domestic market.

1.5.7 Ravi Gulhati & Uday Sekhar

This study attempted to assess the nature of industrialisation in Kenya, Tanzania and Zambia [11]. The study had a three-fold aim, viz.:

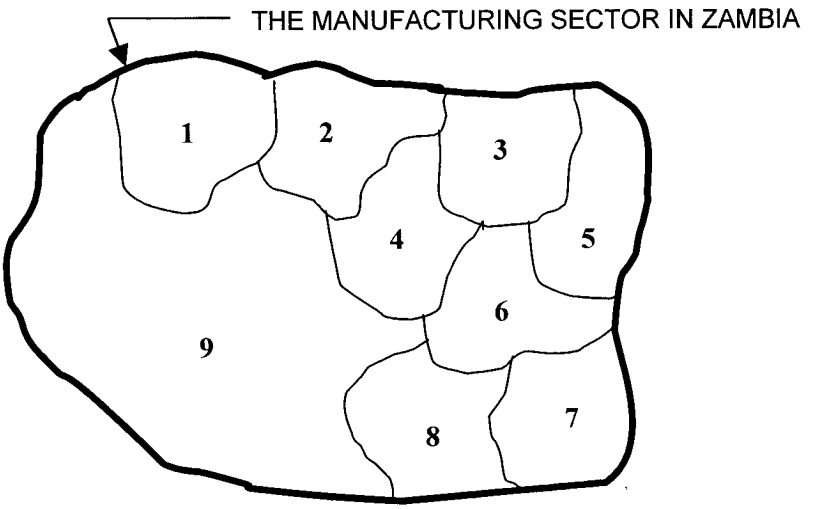
a) to summarise the record of industrial development of the three countries during the decade and a half up to 1981;
b) to explain this record in terms of:
   (i) historical factors,
   (ii) macro-economic conditions, and
   (iii) impact of industrial strategies; and
c) to examine some of the issues facing these countries as they designed future industrial policies.

It was observed that the performance of these countries was more influenced by the colonial legacy and the macro-economic situation of each country than by industrial policy. It was concluded that future industrial advance would depend heavily on the pace of rural development. Catering to world markets was not likely to provide a major stimulus for the industrial sector of many African economies in the near future.

1.6 OVERVIEW OF PREVIOUS STUDIES

The de Bruin and Tambatamba study concerned itself with the strategy formulation for technological development of the agricultural sub-sector in Zambia. Yamba made a market survey of the various sectors and their capacities with a view to determining the necessary

investment and improvement for them to meet national requirements. Mwenda looked at the manufacturing industry as a whole in the light of the mining and agricultural sectors; and the changing economic, political and fiscal policies in Zambia.



LEGEND (Sizes of the areas do not reflect the amount of work done)

1. **de Bruin and Tambatamba** - improvement of the agricultural sub-sector
2. **Yamba** - possibility of the manufacturing sectors to make the types and volume of imported spare parts and assembled components
3. **Mwenda** - general state of the manufacturing industry in the Zambian economy
4. **Nkanza** - Development of the engineering/manufacturing industry in Zambia
5. **Inter Africa Services (Z) Limited** - technical needs of the manufacturing industry in Zambia
6. **Shaaeldin** - Sources of industrial growth in Kenya, Tanzania, Zambia and Zimbabwe
7. **Gulhati and Sekhar** - Nature of industrialisation in Kenya, Tanzania and Zambia
8. **Current (Munakaampe) Study** - An analysis of the Manufacturing Industry in Zambia: the Engineering sub-sector
9. **Area for new studies**

FIGURE 1.1:The Scope of the Current Study in the Broader Manufacturing Industry in Zambia

The study by Nkanza tackled the survival of engineering and manufacturing in Zambia in view of international technological changes, liberalisation of trade, and global production. The Inter-Africa study sought to identify areas in which micro and small enterprises could get assistance from the Technology Development and Advisory Unit (TDAU) at the University of Zambia, the National Institute for Scientific and Industrial Research (NISIR)

and the Zambia Bureau of Standards (ZABS). The study be Shaaeldin and that by Gulhati and Sekhar made general reviews of industrial development and sources of growth and/or decline in the economies of some selected countries in East and Central Africa.

However, none of the above studies focused on the performance of the engineering sub-sector in Zambia (the area of interest in the current study), to investigate how engineering, management and economic factors affected the sub-sector and how it must be managed as a way forward for Zambia's development.

1.7 SCOPE OF THE CURRENT STUDY

Figure 1.1 shows the diagrammatic representation of the studies that had been carried out relating to the manufacturing industry in Zambia (areas 1 to 7). Area 8 represented the scope of the current study, while area 9 represented the area that was yet to be studied.

The current study concentrated on the performance of the manufacturing industry, especially the engineering sub-sector, targeting particularly the metal products area. The period of the study is from independence in 1964 to 1997. It covered three very significant phases in the political history of Zambia:

a) the multiparty democracy and private participation in the economy from 1964 to 1972,
b) the one-party state, a command economy and nationalisation from 1972 to 1991, and
c) the re-introduction of multipartism, a market economy and privatisation of SOEs in 1991.

The study looked at the performance of the manufacturing sector, particularly the engineering sub-sector against the background of these and other factors both within and outside the country.

CHAPTER 2

METHODS OF DATA ANALYSIS

2.1 INTRODUCTION

In analysing the data obtained and discussing the factors that led to the industrial trends of manufacturing sector and the engineering sub-sector, the Management Systems Analysis Model (MSAM), Statistical Methods (SM) and Total Factor Productivity Growth (TFPG) were adopted [12] [13]. The MSAM model was adopted because of the ease with which inputs into and outputs from the economic sectors under study and the intervening disturbances to the economic transformation processes could be related and discussed. Statistics was used for data presentation and plotting of relevant graphs while TFPG was used to determine the sources of decline and/or growth.

2.2 MANAGEMENT SYSTEMS ANALYSIS MODEL APPROACH

The management systems analysis approach was used in analysing the performance of the manufacturing and engineering sectors. A system was defined as simply "a set or assemblage of things connected or interdependent so as to form a complex unity; a whole composed of parts in orderly arrangement according to some scheme or plan" [14]. To see anything as a system, then, was to see it as an interrelated set of interacting components.

Once the engineering sub-sector or any other sector were viewed as a system, then the advantage of the systems approach was to see the critical variables and constraints and their interaction with each other. This approach made clear the fact that one single element, phenomenon or problem should not be treated without regard for its interacting consequences with the other elements.

2.2.1 Transformation of Resources

The manufacturing sector and the engineering sub-sector were considered as the 'black boxes' in which the conversion processes of inputs into outputs takes place, refer to Figure 2.1. The applicability of this approach is meant to be general for technology-based development policies and strategies. This approach recognises and gives importance to

technology as the most important factor in the transformation activities leading to economic growth. In line with conventional theories in a production system, this approach recognises that the conversion of natural resources to produce resources sustaining economic growth is achieved through the production system of a country.

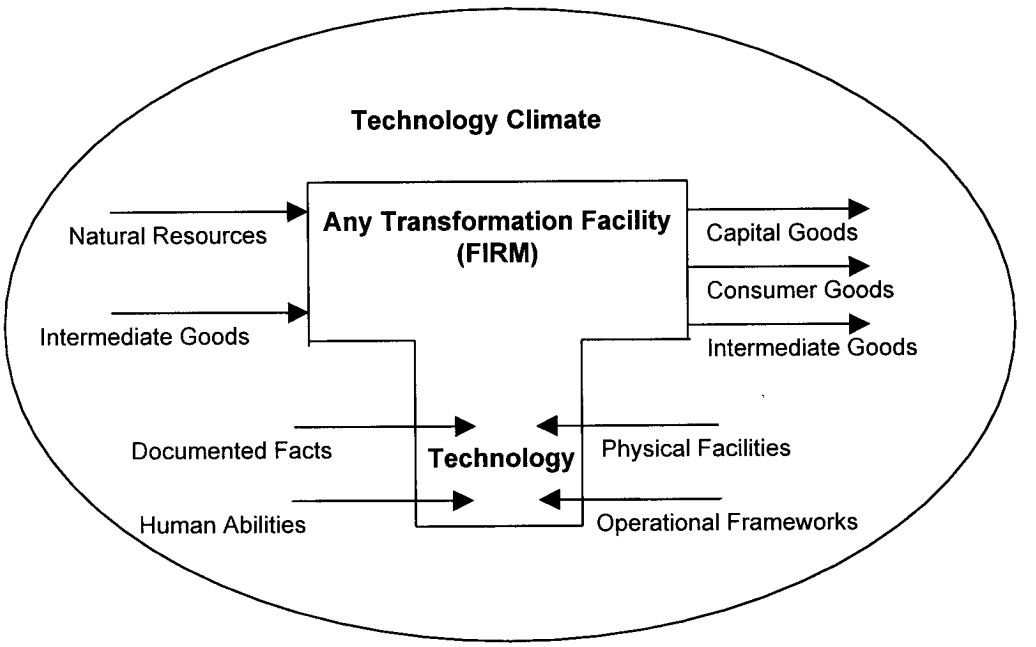


FIGURE 2.1:Technological Transformation of Resources (ATLAS, volume two, 1989 and de Bruin & Tambatamba, 1995)

The system consists of a series of transformation units, which are described in terms of four elements. Firstly, the inputs going into the transformation process - these include natural resources and intermediate goods and, secondly, the outputs going out of the transformation activity - which include capital, consumer and intermediate goods. Thirdly is technology, which essentially is the transformer core of the transformation activity. The fourth element, the technology climate, is the setting in which the transformation activity takes place.

The above model can be modified into open loop or closed loop systems. The open loop system is characterised by a one-way cause and effect relationship. In the open loop

system, the output has no influence on the input. In the closed loop system, the input is ultimately affected by the response of the recipients of the output - like clients in this case.

2.2.2 Closed Loop System Model

The model used in the current study is the closed loop or feedback system, shown in Figure 2.2. This model is adopted because whatever is produced in the industrial sectors and sub-sectors in passed onto consumers. These consumers in turn will give a response regarding how they find the product. Subsequent inputs are then modified in some way depending on the information from the system output [15].

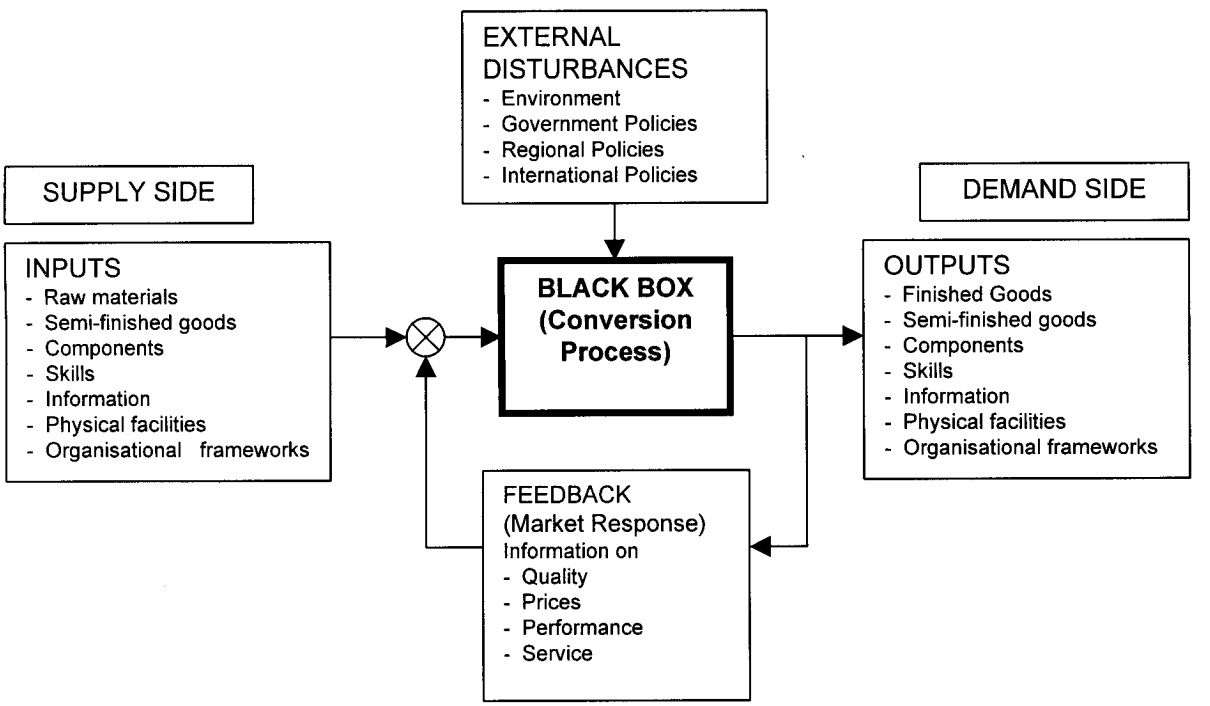


FIGURE 2.2: The Closed Loop System Analysis Model

2.2.2.1 Supply Side

In this model the inputs on the supply side included:

a) Raw materials, semi-finished goods and components;

b) Physical facilities (tools, equipment, machines, vehicles and physical infrastructure);

c) Human skills (abilities which including knowledge, skills, wisdom, creativity and experience of individual human beings or groups of people);

d) Information (on processes, procedures, techniques, methods, theories, specifications, observations and relationships described in publications, documents and blueprints – including designs and prototypes) used in the production process; and
e) Organisational frameworks (consisting of management practices, management policies and planning, linkages and other organisational arrangements required to facilitate the effective integration of facilities, abilities and facts).

2.2.2.2 Demand Side

On the demand side the outputs were finished goods for the market, semi-finished goods and components. Other forms of output were physical facilities, information, skills and organisational frameworks as defined in Paragraph 2.2.2.1 above.

2.2.2.3 Feedback

Feedback in this loop included information about the quality and quantity of the products to the market, the prices, performance of the goods when used by the clients and the general service of the sectors to its clients (whether or not the service generally satisfied the clientele). Feedback also included in-house information about the transformation process relating to the efficient utilisation of the various inputs to get the desired outputs.

2.2.2.4 External Disturbances

External disturbances or direct firm environment formed the link with the wider national and international context in which firms operated and had a bearing on the performance of the sectors. This national and international context determined the technology climate, which could either support or hinder the development of the sector. From a technological point of view, factors which determined the climate included status of the physical infrastructure and support services, stock of science and technology personnel, structure of imports and exports, inter-sectoral and intra-sectoral linkages, government strategies and policies, expenditures, the legal context, etc.

Other external disturbances included institutions such as government ministries (particularly the Ministry of Finance and the Ministry of Commerce, Trade and Industry), Zambia Bureau of Standards (ZABS), trade unions, Zambia Federation of Employers (ZFE), financial institutions, international organisations and the donor community.

2.3 STATISTICAL METHODS

2.3.1 The Method Used

Statistical computer software was used to generate the required graphs from survey data obtained through the questionnaire, interviews, physical visits and literature.

2.3.2 Interpretation of Results

The graphs and tables generated from the survey data were used to observe trends.

2.3.3 Limitations

Unless the data are correct and critically interpreted there is a likelihood of drawing wrong conclusions. The following are the important limitations of statistics [16]:

a) Statistics deals with mass and not individual measurements.
b) Statistics deals only with quantitative and not qualitative characteristics.
c) Statistical results are true only under certain and specified conditions.
d) Statistics is only one of the methods of studying a problem. Often, it is necessary to consider the problem in the light of other factors, such as the country's culture, religion and philosophy in which statistics can not be of much help.
e) The greatest limitation of statistics is that it is liable to misuse through:
    i) Basing it on incomplete data - leading to wrong conclusions,
    ii) Moulding it in any manner to establish the right or wrong conclusions,
    iii) Lack of experience to draw the correct conclusions; and, therefore,
    iv) Statistics cannot be used to full advantage in the absence of proper understanding of the subject to which it is applied.

2.4 TOTAL FACTOR PRODUCTIVITY GROWTH (TFPG)

Growth accounting models have been extensively used to explain sources of industrial growth in developed countries. Few such studies have been made for developing countries and hardly any for Africa. In this study the Cobb-Douglas production-function was used [17]. This function provides an analytical framework for segregating variations in manufacturing output due to changes in inputs from those due to technical change or total productivity.

Industrial growth results from increase in factor inputs and in the efficiency with which these are used, so that, conceptually, a rise in industrial output can be separated into that due greater resource use and that reflecting productivity gains. The impact of all inputs taken together is captured by Total Factor Productivity Growth (TFPG), defined as "the difference between the rates of growth of output and that of a weighted sum of factor inputs, including labour and capital stock" [13].

2.4.1 The Production Function

The concept of TFPG could be defined more sharply by manipulating the input-output relationships at the manufacturing sector level.

Let there be a differential production function (with respect to time) relating manufacturing output (O) to capital (K), labour (L) and a given parameter (A) representing other factors including technical change. Assuming the shifts in the production function were neutral in the sense that they affected the level of output but not the marginal rates of substitution between inputs, the production function could be written in a general as [18]:

$$\frac{1}{\mathbf{A}}\cdot\frac{\partial \mathbf{A}}{\partial t}=\frac{1}{\mathbf{O}}\cdot\frac{\partial \mathbf{O}}{\partial t}-\left(\frac{\mathbf{sk}}{\mathbf{K}}\cdot\frac{\partial \mathbf{K}}{\partial t}+\frac{\mathbf{sl}}{\mathbf{L}}\cdot\frac{\partial \mathbf{L}}{\partial t}\right) \qquad (2.1)$$

The right hand side of the equation is the difference between the percentage change in production output and the percentage change in inputs weighted by **sk** (the share of capital) and **sl** (the share of labour). The left-hand side is the total factor productivity growth (TFPG). To estimate the rates of growth of TFPG one needs growth of manufacturing output (**O**), capital (**K**), labour (**L**) and estimates of capital and labour shares.

2.4.2 Interpretation of Results

The growth accounting production function approach above makes it possible to separate the sources of growth into factor increases and TFPG. Quantifying the contribution of TFPG is a useful first step in explaining its role in output expansion.

TFPG can be suggestive to pointing to certain factors that need close examination. These include technical progress and efficiency gains (though not levels of efficiency). An increase

in output, which is more than proportionate to an increase in a weighted average of inputs, reflects disembodied technical progress, improvement in industrial organisation, economies of scale or external economies. Fluctuations in TFPG can result from changes in rates of capacity utilisation.

2.4.3 Limitations

The production-function approach used above has some drawbacks:

a) It deals with approximate rather than ultimate causality. Changes in factors of production and technical progress are treated as exogenous although in practice the supply of most resources is endogenous.

b) If the assumption of neutrality of technical progress is not maintained there is bound to be difficulties in separately identifying the effects of technical progress and changes in factor inputs. Neutral technical progress is reflected in shifts in the production function.

c) If physical investment becomes a major vehicle of technical progress, the estimates of TFPG can be biased because of the existence of embodied technical progress that is not captured when capital is measured at constant prices.

d) A related problem arises from qualitative improvements in the labour input. A lot of what might appear as shifts in the production function may have represented improvement in the quality of the labour input, and therefore a result of real capital formation of an important kind. To ignore these qualitative improvements would bias the results.

e) The general functional form used is assumed homogeneous of degree one. This implies an assumption of constant returns to scale. This assumption is considered practically unavoidable. Yet it is evident that increasing economies of scale contributes significantly to output growth.

f) An important empirical problem is that TFPG is a residual, thereby rendering estimates sensitive to errors of measurement in inputs and outputs and factor shares. Errors can result from data inadequacy or inconsistency, such as resulting from aggregation and appropriate measures of capital and labour.

Notwithstanding these limitations, the model provides an analytical framework that yields acceptable estimates of the contribution of labour, capital and TFPG.

CHAPTER 3

SURVEY FINDINGS

3.1 INTRODUCTION

This chapter presents the survey findings on the performance of the engineering sub-sector, the focal point of the study. Findings on the performance of the manufacturing sector and the economy as a whole were included in some cases to give a basis of comparison with the engineering sub-sector when discussing the results in Chapter 4.

3.2 THE SURVEY

Thirty-five companies in the engineering sub-sector were identified for study. The selection was a balance among large-, medium- and small-scale enterprises. Some effort was also made to mix private and parastatal (or former parastatal) enterprises. The response pattern was as shown in Table 3.1 and in Appendix D.

TABLE 3.1: Response Pattern of Companies Selected for the Study (Figures in brackets are percentages of the total number selected)

LOCATION	Responded and Included in Study	Not Willing to Take Part	Responded But Closed	Did Not Respond	**TOTAL**
Lusaka	12 (34)	01 (03)	0 (0)	01 (03)	**14 (40)**
Copperbelt	09 (26)	01 (03)	01 (03)	05 (14)	**16 (46)**
Other Areas	02 (06)	0 (0)	02 (06)	01 (03)	**05 (14)**
TOTALS	**23 (66)**	**02 (06)**	**03 (09)**	**07 (20)**	**35 (100)**

3.3 RELIABILITY OF RESULTS

The number of engineering-based companies registered with the Ministry of Commerce Trade and Industry was about 100. Thus the sample taken represented about 35% of the companies registered. To increase the reliability of the results, the companies selected were a cross section small- to large-scale enterprises and both private and parastatal (including those that had been privatised). However, the following points were noted:

a) The record at the Ministry of Commerce Trade and Industry might be inaccurate concerning the number of companies. It was possible that there were companies that were not registered while also due changing economic circumstances, many (especially small) companies might be set up, disappear or change ownership and type of core activities without the knowledge of the Ministry [6].
b) It was found out, during data collection, that some companies were not willing to give out information about their activities for fear of competition in case the information landed with competitors.
c) It was also observed that even for those companies that were willing to give information for the study, record keeping was not always very good. This also tended to reduce the reliability of the results.

3.4 THE ENGINEERING SUB-SECTOR

Below are presented the survey findings on the performance of the engineering sub-sector. In order to give an appreciation of the performance trends of the sub-sector, the performance of the manufacturing sector and industry as whole are presented

3.4.1 Structure of the Sub-Sector

Several engineering companies in Lusaka and the Copperbelt evolved over the past 35 years. Historically, engineering industries in Zambia evolved from the mining industry [6]. Most of those established on the Copperbelt predominantly supported the activities of the mining industry. Firms in the Lusaka area and the rest of the Midlands were set up to service the farming community while Lusaka was still growing as a major industrial centre. After independence, the Government stimulated the establishment of engineering manufacturing industries and various other industrial sub-sectors, based on the philosophy of import substitution and to curb the urban drift of the rural population.

3.4.2 Economic Performance

3.4.2.1 Gross Domestic Product (GDP)

The graph in Figure 3.1 shows the contribution to the total gross domestic product of the manufacturing sector and the engineering sub-sector for the period 1964 to 1997. More detailed data on Zambia's economic performance is shown in Appendices A1 to A5. It can, however, be seen from Figure 3.1 that both the manufacturing sector and the engineering sub-sector collapsed soon after 1992.

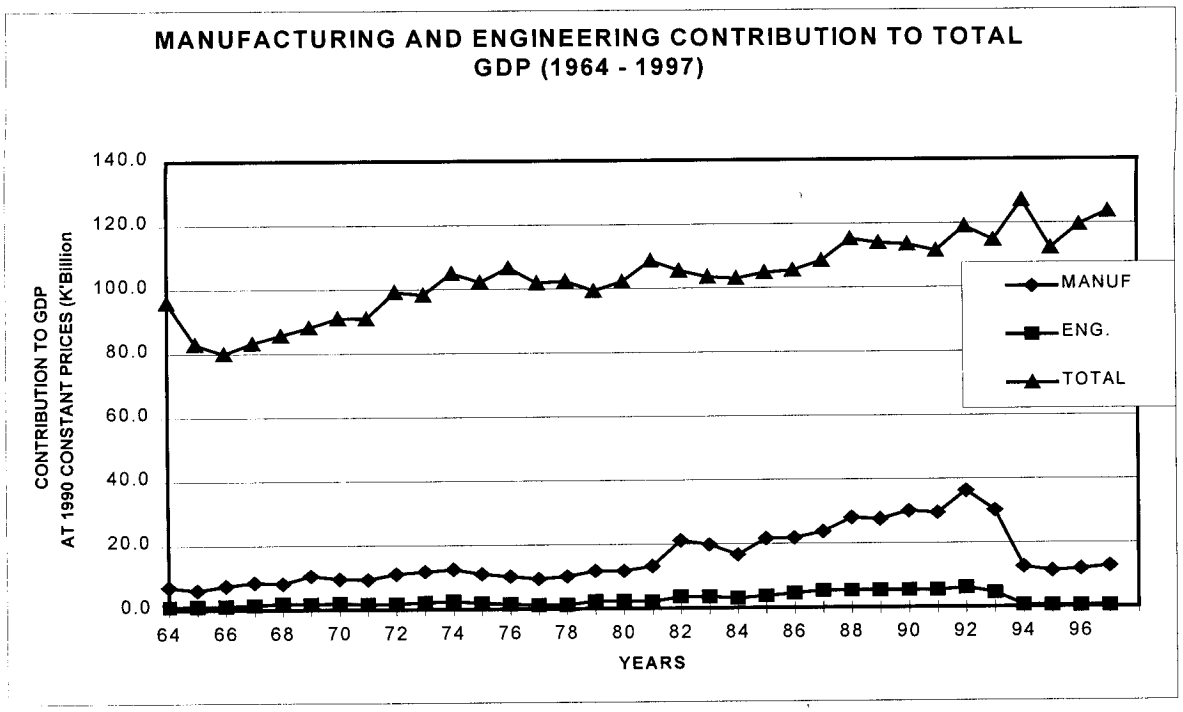


FIGURE 3.1: Manufacturing and Engineering Sectoral Contribution to Total GDP (1964 –1997)

3.4.2.2 Country Population

From Figure 3.2, it was observed that Zambia's population rose steadily at a fairly uniform rate of about 3.1 per cent per annum from 3.59 million in 1964 to about 9.70 million in 1997.

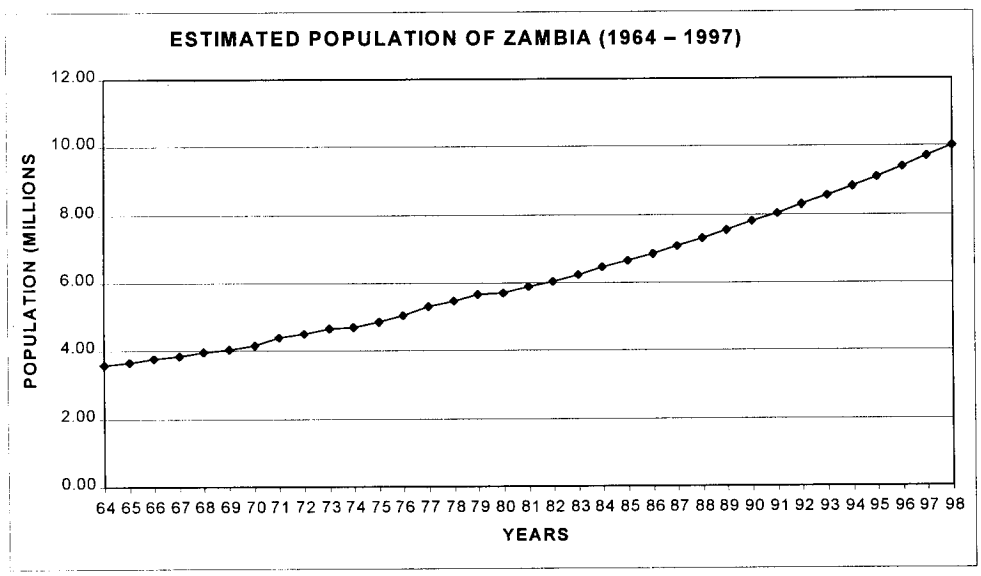


FIGURE 3.2: Estimated Population of Zambia from 1964 to 1997

3.4.2.3 Per Capita Profile

The per capita performance from 1964 to 1997 is given in Figure 3.3. Sample calculations are given in Appendix E1. It can be seen that although the total industrial output in per capita terms has been declining since 1964, both manufacturing and engineering showed some growth, though little, until the slump of 1982.

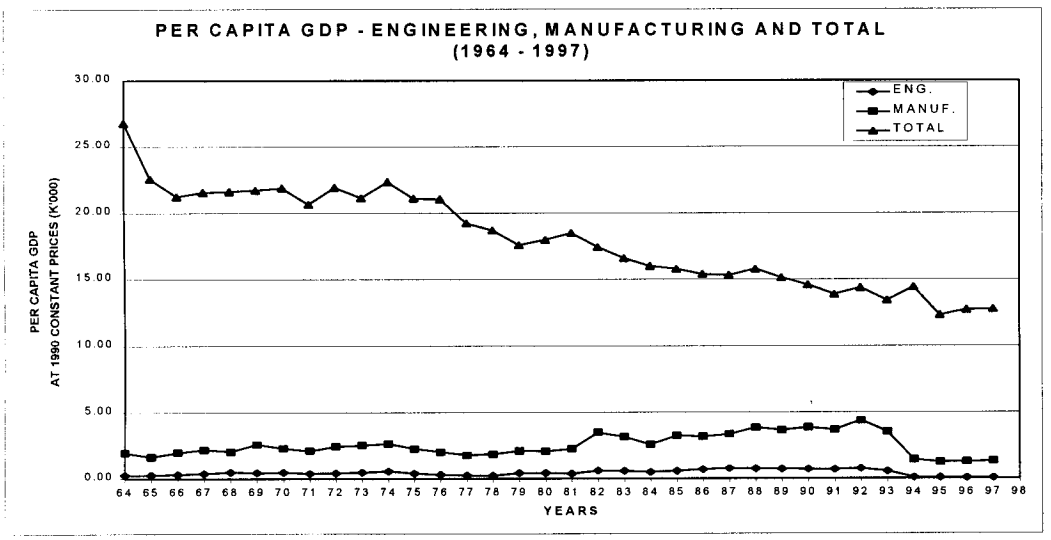


FIGURE 3.3: Per Capita GDP – Engineering, Manufacturing and Total (1964 – 1997)

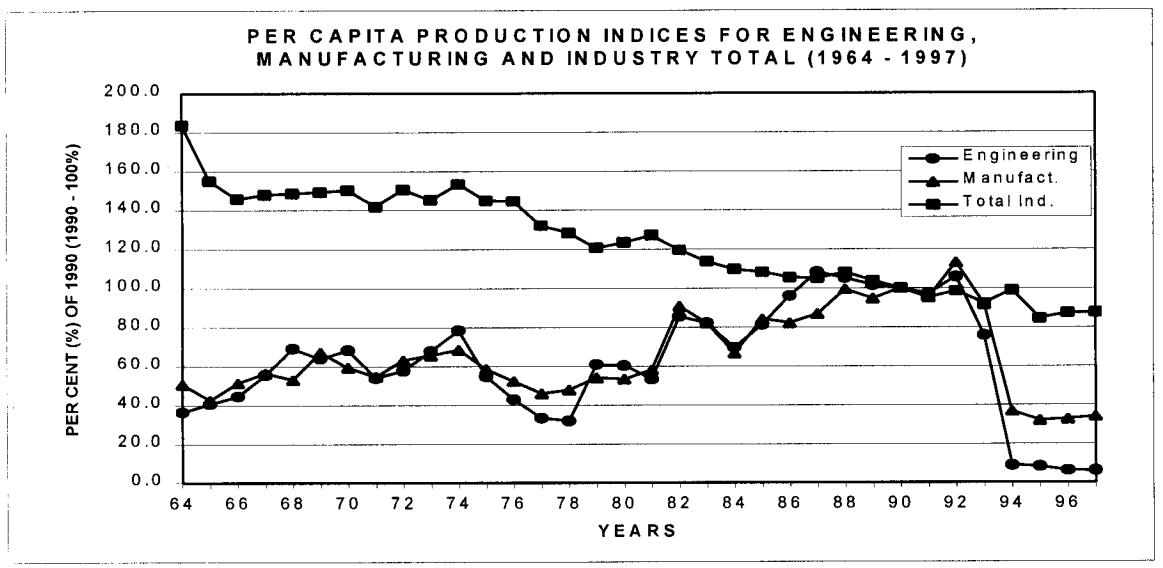


FIGURE 3.4: Per Capita Production Indices for Engineering, Manufacturing and Total (1964 – 1997) (with 1990 = 100%)

3.4.2.4 Indices of Production (Per Capita)

Figure 3.4 shows the per capita production indices of engineering, manufacturing and total industrial output from 1964 to 1997 based on 1990 production figures as 100%. Sample calculations are given in Appendix E2. This information is also tabulated in Table 3.2. It is seen that both manufacturing and engineering suffered from 1976 to 1978 as a result of the global energy crisis in 1973 and the falling copper prices on the world market. Total industrial output did not seem to be affected to the same extent, as its decline remained steady from 1964 to 1997.

TABLE 3.2: Per Capita Indices of Production for the Years 1964 to 1997

Year	INDICES OF PRODUCTION		
	Engineering	Manufacturing	Total Industry
1964	36.4	50.7	183.8
1965	40.7	47.6	154.8
1966	44.6	51.4	145.7
1967	55.6	56.5	147.9
1968	69.2	53.1	148.5
1969	64.0	67.2	149.1
1970	68.4	59.4	150.2
1971	54.0	54.6	141.8
1972	57.6	63.2	150.5
1973	67.9	65.7	145.1
1974	78.5	68.5	153.3
1975	54.7	58.6	144.9
1976	42.9	52.3	144.6
1977	33.3	46.0	132.0
1978	31.8	47.8	128.4
1979	60.9	54.2	120.7
1980	60.4	53.5	123.5
1981	53.4	58.1	127.1
1982	85.5	90.7	119.7
1983	82.1	82.1	113.9
1984	69.7	66.8	109.8
1985	81.4	84.2	108.3
1986	96.0	82.2	105.5
1987	108.3	86.8	105.1
1988	105.1	99.4	108.2
1989	101.6	94.7	103.8
1990	100.0	100.0	100.0
1991	97.3	95.2	95.2
1992	105.9	113.3	98.6
1993	75.7	91.6	92.1
1994	9.1	36.6	98.9
1995	8.3	31.9	54.5
1996	6.3	32.6	87.3
1997	6.1	34.0	87.5

(Source: Own Data.)

3.4.2.5 Total Factor Productivity Growth

(a) **Total Output**

Table 3.3 shows the average annual growth of total industrial output, factor inputs and total factor productivity growth over a number of periods between 1964 and 1997, whose sample calculations are given in Appendix E3. The years periods were decided on the following bases: 1964 - beginning of the period under review; 1969 - marked the first five years after independence; 1973 - year of the energy Crisis, 1982 - the year world oil prices doubled and the beginning of Zambia's struggle for economic recovery; 1992 - re-introduction of the market economy and 1997 was the end of the period under review.

TABLE 3.3:
Growth of Total Industrial Output, Factor Inputs and TFPG

PERIOD	AVERAGE ANNUAL GROWTH (%) OF				Share of		TFPG
	OUTPUT (*Q*)	LABOUR (*L*)	Cost of LABOUR	CAPITAL (*K*)	Labour *sl*	Capital *sk*	
1964 - 1969	-1.69	4.01	-1.06	9.06	0.61	0.39	-7.69
1964 - 1973	0.25	3.78	-0.21	8.81	0.53	0.47	-5.89
1964 - 1982	0.52	1.74	0.19	2.38	0.63	0.37	-1.45
1964 - 1992	0.76	2.53	0.33	0.24	0.72	0.28	-1.13
1964 - 1997	0.77	1.58	0.26	3.58	0.46	0.54	-1.90
1969 - 1973	2.68	3.50	0.86	8.49	0.53	0.47	-3.16
1969 - 1982	1.37	0.87	0.67	-0.19	0.63	0.37	0.89
1969 - 1992	1.30	2.21	0.63	-1.68	0.72	0.28	0.16
1969 - 1997	1.21	1.15	0.50	2.61	0.46	0.54	-0.73
1973 - 1982	0.79	-0.30	0.58	-4.06	0.63	0.37	2.47
1973 - 1992	1.01	1.94	0.59	-3.82	0.72	0.28	0.66
1973 - 1997	0.96	0.76	0.44	1.63	0.46	0.54	-0.27
1982 - 1992	1.21	3.96	0.59	-3.61	0.72	0.28	-0.66
1982 - 1997	1.06	1.40	0.35	5.03	0.46	0.54	-2.30
1992 - 1997	0.78	-3.72	-0.12	22.31	0.46	0.54	-9.56

N.B.: The growth rates are estimated on the basis of regression estimates of logarithmic time trends by using the following equation:

$$Ln\ X = A + at$$

Where X is the output or any input at time t, Ln is its natural logarithm. Using Ordinary Least Square, a could be estimated as the growth rate up to time t, while A is the natural logarithm of the initial value of output or any input at time $t = 0$.

Source: Own Data Based on Appendix B1

(b) **Manufacturing Sector**

Table 3.4 shows the growth of manufacturing output, whose sample calculations are given in Appendix E3.

TABLE 3.4:
Growth of Manufacturing Output, Factor Inputs and TFPG

PERIOD	AVERAGE ANNUAL GROWTH (%) OF				Share of		TFPG
	OUTPUT (*Q*)	LABOUR (*L*)	Cost of LABOUR	CAPITAL (*K*)	Labour *sl*	Capital *sk*	
1964 - 1969	8.11	10.01	5.14	0.67	0.38	0.62	3.93
1964 - 1973	5.80	8.15	7.03	6.91	0.33	0.67	-1.51
1964 - 1982	6.16	5.35	5.21	1.68	0.48	0.52	2.73
1964 - 1992	5.87	4.49	-0.44	0.59	0.26	0.74	4.24
1964 - 1997	1.81	2.80	-1.74	0.01	0.21	0.79	1.20
1969 - 1973	2.92	5.82	9.38	14.72	0.33	0.67	-8.89
1969 - 1982	5.40	3.55	5.24	2.07	0.48	0.52	2.63
1969 - 1992	5.38	3.29	-1.66	0.58	0.26	0.74	4.09
1969 - 1997	0.68	1.51	-2.96	-0.11	0.21	0.79	0.44
1973 - 1982	6.51	2.54	3.40	-3.56	0.48	0.52	7.16
1973 - 1992	5.90	2.76	-3.98	-2.40	0.26	0.74	6.93
1973 - 1997	0.31	0.79	-5.02	-2.58	0.21	0.79	2.17
1982 - 1992	5.35	2.95	-10.62	-1.36	0.26	0.74	5.57
1982 - 1997	-3.42	-0.26	-10.07	-1.99	0.21	0.79	-1.79
1992 - 1997	-20.95	-6.68	-8.98	-3.26	0.21	0.79	-16.96

N.B.: The growth rates are estimated on the basis of regression estimates of logarithmic time trends by using the following equation:

$$Ln\ X = A + at$$

Where X is the output or any input at time t, Ln is its natural logarithm. Using Ordinary Least Square, a could be estimated as the growth rate up to time t, while A is the natural logarithm of the initial value of output or any input at time $t = 0$.

Source: Own Data Based on Appendix B2

(c) **Engineering Sub-sector**

The performance of the engineering sub-sector is shown Table 3.5, whose sample calculations are given in Appendix E3. Compared with total output and manufacturing, engineering had the highest initial average annual growth rate at 13.86 per cent in the period 1964 to 1969.

TABLE 3.5:
Growth of Engineering Output, Factor Inputs and TFPG

PERIOD	AVERAGE ANNUAL GROWTH (%) OF				Share of		TFPG
	OUTPUT (*Q*)	LABOUR (*L*)	Cost of LABOUR	CAPITAL (*K*)	Labour *sl*	Capital *sk*	
1964 - 1969	13.86	4.35	-1.82	5.73	0.68	0.32	9.07
1964 - 1973	9.93	6.96	6.93	1.72	0.83	0.17	3.86
1964 - 1982	7.70	3.83	3.51	0.90	0.83	0.17	4.37
1964 - 1992	6.78	2.80	-2.40	1.11	0.54	0.46	4.76
1964 - 1997	-2.46	1.04	-4.51	0.04	0.41	0.59	-2.90
1969 - 1973	5.02	10.21	17.87	-3.29	0.83	0.17	-2.92
1969 - 1982	5.33	3.62	5.57	-0.95	0.83	0.17	2.48
1969 - 1992	5.23	2.46	-2.52	0.10	0.54	0.46	3.87
1969 - 1997	-5.37	0.45	-5.00	-0.98	0.41	0.59	-4.97
1973 - 1982	5.47	0.69	0.10	0.09	0.83	0.17	4.88
1973 - 1992	5.28	0.83	-6.81	0.82	0.54	0.46	4.46
1973 - 1997	-7.10	-1.18	-8.81	-0.59	0.41	0.59	-6.27
1982 - 1992	5.11	0.95	-13.04	1.47	0.54	0.46	3.92
1982 - 1997	-14.65	-2.30	-14.15	-1.00	0.41	0.59	-13.12
1992 - 1997	-54.16	-8.80	-16.38	-5.95	0.41	0.59	-47.05

N.B.: The growth rates are estimated on the basis of regression estimates of logarithmic time trends by using the following equation:

$$Ln\ X = A + at$$

Where X is the output or any input at time t, Ln is its natural logarithm. Using Ordinary Least Square, a could be estimated as the growth rate up to time t, while A is the natural logarithm of the initial value of output or any input at time zero.

Source: Own Data Based on Appendix B3

3.4.2.6 Accounting for Growth

Table 3.6 shows the contribution to manufacturing growth by capital, Labour and TFPG. It can be seen that most of the growth in industrial output in Zambia during the three periods shown was mainly due to the contribution of labour than capital. TFPG had a negative contribution, but improving for the period 1969 - 1982.

TABLE 3.6: Contribution to Manufacturing Growth by Capital, Labour and TFPG

PERIOD	CAPITAL	LABOUR	TFPG
1964 – 1973	6.91	8.15	-1.51
1969 - 1982	2.07	3.55	2.63
1964 - 1997	0.01	2.80	1.20

Source: Own Data

3.4.2.7 Comparison with Other Countries

Table 3.7 shows a comparison of TFPG rates for manufacturing between Hong Kong, Singapore, South Korea and Taiwan and Zambia, Kenya, Tanzania and Zimbabwe. For the periods considered, though not equal in length and are used here for comparison purposes only, the four Far Eastern countries seemed to have better TFPG rates than the four African countries. At 2.74, the TFPG of Zambia shows low but favourable growth pattern in the Manufacturing Sector compared to the higher TFPGs and, therefore, higher growth rates of Singapore, South Korea and Taiwan.

TABLE 3.7: Manufacturing TFPG Rates in Some Selected Countries

COUNTRY	PERIOD	TFPG
Hong Kong	1960 - 1970	2.29
Singapore	1957 - 1970	3.75
South Korea	1960 - 1970	3.47
Taiwan	1960 - 1970	3.59
Zambia	1964 - 1982	2.73
Kenya	1964 - 1983	-0.89
Tanzania	1966 - 1980	-0.51
Zimbabwe	1964 - 1981	0.03

Source: CSO, World Bank Statistics, 1987.

3.4.2.8 Capacity Under-utilisation

In the parastatal era, the capacity utilisation of the Zambian manufacturing sector in general was lower than 40 per cent, with some cases as low as 3 per cent [19]. The size and growth of the domestic market also affected the level of capacity utilisation. Table 3.8 illustrates the small size of the market in Zambia (and in Kenya, Tanzania and Zimbabwe) compared with Hong Kong and South Korea.

TABLE 3.8: GNP Per Capita and Per Capita Growth in Zambia, Kenya, Tanzania, Zimbabwe, Hong Kong and South Korea

COUNTRY	GNP (Millions of US Dollars)		GNP Per Capita	
	YEAR		1985 (Dollars)	Average Annual Growth Rate (%) 1965 - 1985
	1965	1985		
Zambia	1060	2330	390	-1.6
Kenya	920	5020	290	1.9
Tanzania	790	5600	290	-
Zimbabwe	960	4910	680	1.6
Hong Kong	2150	30,730	6,230	6.1
South Korea	3,000	86,180	2,150	6.6

Source: World Development Report, 1987.

3.4.3 Technological Performance

The analysis of the technological performance of the sub-sector was done in the light of the four technology components mentioned in Figure 2.1 and Figure 2.2 on pages 10 and 11, respectively. These were physical facilities, human skills, information and organisational frameworks. Technological characteristics and constraints were studied from the point of view on these four components.

3.4.3.1 Physical Facilities

The facilities studied in machine shops were found to be generally general purpose and simple machines. Only facilities at Boart Longyear were found to be quite specialised and sophisticated. Facilities in flow process production, like Drum and Can Plant and ZAMEFA, were specialised and had quite some degree of sophistication. Foundries mostly used semi-manual sand preparation and reclamation systems and cupola and electric furnaces for melting the charge. Engine reconditioning facilities and equipment were found to be rather

unsophisticated. All the equipment was found to be imported and very old – mostly far more than 15 years old. Some of the equipment was imported as used equipment, such that it was not possible to ascertain its actual age.

Most companies in the sub-sector did not have testing and laboratory facilities in heat treatment and metrology. The few that had heat treatment facilities, like Boart Longyear and Zambia Railways, used these facilities almost exclusively for either their service to the mining industry or for their own requirements.

3.4.3.2 Human Skills

In the engineering sub-sector, it was generally observed that, in relative terms, large-scale firms employed more skilled manpower than medium- and small-scale enterprises. Small-scale firms reported that there were not many qualified personnel on the market in Zambia. To this effect they usually trained their own operatives on the job.

3.4.3.3 Information

Of the companies studied, none gave much attention to in-house designing, prototype making and testing, evaluation, production drawing and material selection/specification and equipment selection. It was observed that firms used designs that were either foreign or inherited from many years of the firms' past. Another area that was not receiving much attention was market research.

3.4.3.4 Organisational Frameworks

It was observed that the majority of the companies studied did not have medium or long-term plans for their operations. The short-term plans that had been put in place usually related to profit maximisation, usually through high profit mark-ups (ranging between 15 to 25 per cent). However, large-scale organisations attempted to have long- and medium-term plans, but these were made difficult to implement and realise by the uncertainty of the economic climate of the country (especially the ever declining exchange rate of Kwacha to the hard currencies, particularly the US Dollar).

The other major finding was that apart from the larger firms (but even they only to a limited extent), there was a lack of or not much attention to the market and its requirements. Firms were more concerned with increasing production in their lines of business with no or limited

contact with the market. The only serious contact with the market was when customers went to the firms to either procure or have parts, components and machines made/repaired.

3.5 FIRM-LEVEL CONSIDERATION

Firm-level consideration was done in the light of the four elements of the production process, namely, supply side, demand side, feedback and external disturbances. On the supply side, inputs included the supply of raw materials, parts, components, information, physical facilities, human skills and organisational frameworks. Outputs, on the demand side, included finished and semi-finished products (including parts and components), information, physical facilities, human skills and organisational frameworks.

Feedback composed of such elements as market response in all its various forms transmitted back to the firm's management. Feedback also included the reaction of competitors. External disturbances were factors that were not directly in the firm's interest but were nonetheless important either in the production process or to the firm's environment. External disturbances included government policies (like statutory requirements and other policies at national level), regional and international policies that had a bearing on the firm's operations.

3.5.1 Supply Side (Inputs)

3.5.1.1 Raw Materials, Parts and Components

Machine shops obtained their steel (and other raw materials), parts and components and consumables from three main sources. They directly imported mainly from South Africa, bought from local suppliers who themselves imported the steel or bought from scrap steel dealers. Engine reconditioners got their raw materials mainly by direct importation from South Africa - because the material they needed was normally high-grade steels that were heat resistant. Some special grades of steel were imported from Europe and Japan. Foundries bought their raw materials from scrap metal dealers and machine shops.

In all cases where importation was involved, however, it was found that firms complained of high import duties and value added tax (VAT) to the extent that their profits were reduced drastically or the cost of the final product was too high. Availability of foreign exchange was not cited as a constraint provided firms had enough Kwacha cover to buy foreign currency.

3.5.1.2 Production Technology

Firms in the engineering sub-sector generally imported almost all the machinery, equipment and tools they used in their production processes. Major sources of this technology were South Africa, Europe (mainly the UK, Germany and Italy) and Asia (the former Soviet Bloc and Japan). This diversity in sources of supply tended to give serious repair and maintenance problems as spare parts were not easily available. In some cases, skilled labour to adequately keep these pieces of equipment in a good state of repair was not readily available.

3.5.1.3 Indirect Inputs (Energy)

Other inputs that were found to be costly to the firm included energy. While electricity was the more readily available source of energy and used by all firms, it was gradually getting very expensive. On the average, electricity accounted for between five to 10 per cent of the firms' production costs. It was also observed that electricity tariffs were consistently increased every six months by between 10 and 15 per cent.

Coal and oil were used mainly in the foundries. Oil was also used in heat treatment plants. It was observed that the cost of oil was also escalating at rates of nearly 10 per cent every six months. On the other hand, the cost of coal was more affected by the other fuels (diesel) used in mining it. However, because of relatively low quality (27,000 kJ/kg and an ash content of 16 per cent), many operators of coal fired facilities had changed or were changing to either oil or electricity.

3.5.1.4 Support Systems

Support systems included skills, information, organisational frameworks, research and development. The survey revealed that support systems in firms were weak. Information in its various forms (i.e. data, designs, production procedures and specifications) was lacking in most firms. Research and development was not encouraged in most firms. Even those that needed any R & D, it was done by their principals, usually outside Zambia. Most R & D in Zambia was being done by government institutions like NISIR, the University of Zambia and TDAU, but links between these institutions and industry were not strong. These institutions were, however, not sufficiently funded to transform their designs and ideas into practical and useful technologies.

At firm level, there did not appear to be enough organisational support for the development of indigenous designs, as a result of which there was lack of ingenuity and originality in Zambian firms.

3.5.2 Demand Side (Outputs)

On the demand side, output was in terms of products including (parts and components) and technology.

3.5.2.1 Products

The findings were that machine shops produced a wide range of products, parts and components. Engine reconditioning firms were also repairing a wide variety of engines. This trend was also observed in the foundries, where a variety of castings were produced, usually as per customer samples. Specialised firms (drum and can production and wire drawing) had a limited variety of products.

It was also found that quality controls were not strict in most of the companies studied. In one, total quality management was practised and the quality of the products was found to be very good. In about four companies, there was some fair amount of quality control through inspections at the end of the production line or after a product had already been finished. It was, however, found that almost all companies were talking about improving the quality of their products though only three had ISO 9002 accreditation and only one had a ZABS certification. For its part, ZABS was not enforcing the requirements that companies in the sub-sector should adhere to any standards.

3.5.2.2 Technological Output

Only one firm made serious efforts to improve their production technology from within the firm while others did not make any appreciable improvement to their technology. While most of the firms did not see the real need for technology improvement, it was also noted that there were no human skills to carry out improvements. Training of personnel was very limited. While from about 1969 to about 1990 companies sponsored students to technical colleges and university, they no longer did this due to lack of funds. It was noted that most of the training was on-the-job (or informal).

Improvement through inter-company technology transfer was not possible because firms did not favour information exchange for fear of competition. Moreover, small- and medium-scale companies did not seem to see any advantage to be gained from R & D (exchanging research information with research institutions).

Other major problems found were lack of investment in new machinery/technology and the general lack/poor maintenance of machinery and equipment in the firms. As a result, machinery was generally deteriorating faster than expected when the situation could have been helped. Difficulties in importing machinery and spare parts were cited as the major reasons for this while lack of experienced personnel to carry out periodic repairs was another. As already stated, high import duties and VAT were blamed for the high final import bill of spare parts and replacement machinery.

3.5.3 Feedback

The feedback part of the model was to provide the required information on the response of the demand side to facilitate necessary changes to the input on the supply side to improve the production process. This vital link was, however found to have been ineffective in the engineering sub-sector and the manufacturing sector as a whole for the following reasons:

a) Most industrial production, after the nationalisation of the 1970s, was aimed at import substitution and to satisfy the local market before going into export. Therefore, there was consumption of foreign exchange in the purchase of equipment and raw materials without corresponding generation of foreign exchange to sustain industry's operations. This depleted earnings from copper, leading to scarcity of foreign exchange.
b) Due to scarcity of foreign exchange to procure spare parts and inject re-investment in the production process, quality deteriorated and there was little that could be done to redress the situation.
c) With the country's national reserves declining due to poor copper prices and other factors, industrial production went down, leading to either scarcity or unavailability of products on the market. Therefore, consumers and users of the products started to accept substandard products for lack of any alternatives.
d) The main standards watchdog in the country, ZABS, could not force substandard products off the market because there were no alternatives.

e) ZACCI, ZAM and other such institutions that looked after the interests of the manufacturers seemed to be more worried about the general survival of their members, so that they did not pay much attention to maintenance of quality.
f) Since most production was from parastatal companies (private sector competition was very low), consumer complaints were of little effect because parastatals were protected and funded by the state.

Thus although feedback mechanisms were in place, they were rendered impotent because of the policies that obtained in the country. In the post liberalisation period, although the feedback mechanisms were stronger because people were able to make choices, firms were unable to meet consumer demand due to competition from the suppliers from abroad.

3.5.4 External Disturbances

It was pointed out in section 3.5.3.that national policies impinged upon the operations of the sub-sector and industry as a whole. This was not desirable. Therefore some of the national policies were disturbances to the smooth running and development of industry. Other disturbances were regional and international.

3.5.4.1 National External Disturbances

During the study no evidence was found of a national policy for the development of a sustainable engineering sub-sector. What was evident, though, was that since the establishment of the parastatal sector in the early 1970s, the private sector deteriorated to virtual collapse in the 1990/91. Thus when the parastatal sector collapsed in 1992, there was a virtual vacuum in the manufacturing sector. Remaining private engineering did not make any meaningful impact to the market.

The government policies immediately after 1991 had their own detrimental effect to the sub-sector. Some of the major economic policies in this respect were [6]:

a) Removal of all subsidies.
b) De-regulation of controls of prices, interest rates and foreign exchange.
c) Encouraging private investment through, among others, privatisation of most of the parastatal firms.
d) Strengthening of the financial market through, among others, the establishment of a stock exchange, investment and merchant banking.

Despite these policy changes, taxation, bank lending rates, and inflation were still high. With de-regulation, there was an influx of imports of foreign finished products. Local companies were not ready for this sudden competition, to the extent that in the immediate aftermath of the implementation of these policies, some parastatals collapsed altogether, while others tried to restructure before and after privatisation and retrenched some employees to shed off excess manpower. Private firms were also unable to take immediate advantage of the 'parastatal vacuum' because they also found it difficult to borrow money for re-capitalisation due to high interest rates and taxation.

3.5.4.2 Regional External Disturbances

For more than half of the period under consideration, the Southern African region had been in the struggle for independence. Zambia attained its independence in 1964, Malawi - 1964, Botswana - 1966, Mozambique and Angola - 1975, Zimbabwe - 1981, Namibia - 1988 and South Africa - 1994 (multi-party elections based on universal suffrage). The Democratic Republic of Congo and Tanzania got their independence earlier than Zambia in 1960 and 1963, respectively. Zambia had been providing support for the liberation movements of the neighbouring countries. This had a telling effect on the country's economy as a lot of the country's resources went to the support of these movements.

Relations between Zambia and the minority regimes of Rhodesia and South Africa (Northern Rhodesia's major trading partners before its independence to become Zambia) became sour until they attained independence and majority rule, respectively. Zambia had to find alternative trade partners and routes to the sea at heavy expense. This, coupled with the energy crisis of 1973, weakened Zambia's economy, among other causes.

At the resumption of trade with Zimbabwe and South Africa, the two countries were technologically more advanced than Zambia. This made Zambia a net importer from the two countries - further weakening the country's engineering manufacturing sub-sector and the manufacturing sector in general.

3.5.4.3 International External Disturbances

The economy of Zambia, and therefore the engineering sub-sector, was influenced by developments in the international community. In the years after independence, Zambia

received a lot of financial support from the international community for major projects - such as the setting up of infrastructure for the parastatal sector. At that time, the country used to have substantial earnings from copper. As world prices of copper fell, petroleum prices went up and the value of the Kwacha fell against hard currencies, Zambia's creditworthiness waned resulting in budget deficits since about 1975 [6].

The period 1985 to 1990 was characterised by attempts to restructure the economy and stop the continuous regression. In 1985, the IMF came up with a package of economic reforms and structural adjustment programmes. But the results and effects of the programmes were negative and the expected economic recovery did not materialise because the IMF had ignored the structural problems of Zambia and the need to focus on poverty issues.

In the "post-IMF" policy, the government severely restricted imports of non-essential goods. Resources were to be channelled into enterprises producing essential and basic goods or goods for export. The exchange and interest rates were both artificially stabilised. To realise what it termed the "New Economic Recovery Programme," government limited debt service to only 10 per cent of the net export earnings. In response, the World Bank - and many foreign governments - suspended loans to Zambia forcing the country to reintroduce the same measures that were part of the IMF package of 1985. Prices were being decontrolled and the Kwacha devalued again by 60 per cent. Food subsidies were reduced sharply.

The political changes of Eastern Europe in the late 1980s led to Zambia in 1990/91losing a lot of financial support from the developed economies. Aid was shifted to Eastern Europe, leaving Zambia and other third world countries with insufficient foreign aid for crucial and vital inputs to the running of their economies. In 1993, for example, Zambia's per capita debt was among the highest in the world and its government budget was for more than a third met through foreign aid [20].

The resulting effect was the collapse of manufacturing in Zambia after 1992 and, with it, the engineering sub-sector.

3.6 THE BLACK BOX (THE FIRMS) - FACILITY DESIGN, LAYOUT AND PROCESS VARIABILITY

It was observed, from the preceding paragraphs, that the performance of the firms (the black box) in the sub-sector depended on the inputs, outputs, feedback mechanisms and the external disturbances. Because of the factors raised in Section 3.5, above, the firms were generally unable to improve their production processes and technologies since they did not have the financial resources to do so. It was also observed that the processes themselves had not been updated to match the changing production environment the firms were operating in. An attempt was also made to look at facility design, layout and process variability.

Of all the machine shops studied, only one had been constantly improving its production process by investing in new technology and improving the productivity of existing facilities by modification and re-designing facility layouts (adopting the cellular layout or group technology). These changes had greatly improved productivity at the plant. The rest had maintained the functional layout system, Table 3.9. Large-scale firms, particularly those operating on flow layout, had maintained the same layout since their installation.

Table 3.9: Plant Layouts of Companies Studied

LAYOUT	NUMBER OF COMPANIES	%
Cellular (GT)	01	4
Flow	03	13
Process	19	83
TOTAL	**23**	**100.0**

Source: Own Data.

From the findings in Table 3.9, it was clear that most engineering companies in Zambia (about 83 per cent) used the process (functional) layout system in their production facilities against only 4 per cent and 13 per cent using cellular and flow layouts respectively.

3.6.1 Reasons For the Layouts Found

Proprietors and/or managers of these companies were then interviewed to find out why they were using the layouts found. The responses received are tabulated in Table 3.10.

It was observed from Table 3.10 that out of the 23 companies that responded. Of the 18 firms that were jobbing production type were all process layout systems. Of the 22 that were batch production type, only one was cellular layout, three flow layout and 18 were process layout of the 23 firms, 12 planned their in advance. It was observed that the 18 firms that had process layout could not easily vary their production sequences. On the other hand, both cellular and flow layout type firms had their production specialised and targeted for a particular market. Of the 23 companies, only seven had re-designed their layout to the current set up. The rest of the firms were using the same layout they had since their inception.

3.6.2 Products Being Made

Products being made in the companies studied were broadly grouped as shown in Table 3.11. The general observation made concerning the products from the companies studied was that there was a tendency among most of them to produce a very wide range of products. This approach did not augur well with any attempts to achieve high quality because workmen were seeing different jobs all the time.

Table 3.10: Reasons for the Layouts in Use

REASONS FOR LAYOUTS IN USE	LAYOUT			
	C	F	P	Total
Work is jobbing type	-	-	18	**18**
Work is batch type	01	03	18	**22**
Work can not be planned well in advance	-	-	12	**12**
Work is flow type	-	04	-	**04**
Work sequence can not be easily varied	-	-	18	**18**
Production is specialised and is for a target market	01	03	-	**04**
Layout deliberately re-designed to current set-up	01	-	06	**07**
Layout found that way	-	04	12	**16**
Legend: C- Cellular (GT) Layout, F- Flow Layout, and P - Process Layout				

Source: Own Data.

Table 3.11: Companies by Type of Production

TYPE OF PRODUCTION	LAYOUT			
	C	F	P	Total
General Machining only	-	-	12	**12**
General Fabrication only	-	-	02	**02**
Gen. Fab./Machining	-	-	06	**06**
Specialised Fabrication	-	02	-	**02**
Specialised Machining	01	-	-	**01**
Foundry	-	-	04	**04**
Extrusion Process	-	01	-	**01**
Metal Stitching	-	-	01	**01**
N.B.: Some companies carry out both machining and fabrication works, therefore the grand total would add up to more than 23.				

Source: Own Data.

3.6.3 Observations on the Process Layout

a) When there were many jobs of relatively diverse machining operations, as was usually the case, machine loading and process routing were not easy, resulting in too much work-in-progress. Certain semi-finished products tended to wait long before they were processed at certain machines due to earlier jobs already at those machines.

b) Depending on the complexity of the jobs being done, tooling and jigs/fixtures might have to be changed with successive jobs - resulting in too much set-up time and set-up and tooling costs. This also generally delayed the completion of the jobs and greatly compromised the quality of the finished products.

c) Because the jobs to be done were not always predictable (usually depending on the customer orders), the right tooling and jigs/fixtures were not always available. These had to be procured for the particular jobs even if the customer would have been advised to go to other workshops. This approach tended to inflate the final product cost because these costs had to be absorbed by the one batch (which sometimes could be a 'one-off' batch).

d) As a direct consequence of b) and c) above, there tended to be too much inventory of tooling in anticipation of various jobs.

3.6.4 Observations on the Flow Layout

Other than for ZAMEFA and Drum and Can Plant, the other company visited, Monarch Zambia, did not have a full flow type production. While it could easily convert to process type, it was termed flow type because of its line production arrangement where the product was moved from one machine to the next (in a line) until the finished product came out at the end of the line. The two that employed full flow type layout had very little flexibility in both product routing and product variability. This layout was best suited for such production as wire drawing.

3.6.5 Observations on the Cellular (GT) Layout

Boart Longyear had successfully implemented the cellular layout production system. They had grouped their products (pneumatic and mining accessories for the mining industry) into family groups. Each family group was produced in a cell. Machines were re-arranged to form cells without creating any additional workshop floor space.

The advantages that were observed were the following:

a) The company operated on a manufacturing cell principle. Each product was finished within the cell. The only processes carried out outside the manufacturing cells are specialised processes like insertion of bits and heat treatment.
b) In each cell, the company's approach had been multi-skilling (an operator was trained to operate more than one machine to improve versatility and efficiency) and multi-operation (many operations in one cell). As a result, the company was able to reduce its workforce from 350 in 1997 to 96 in 1999, with improved production. With labour costs accounting for about 15 to 17 per cent of the total production costs, this reduction (of about 73 per cent) in labour force was a considerable saving.
c) In each cell, members formed a team that met at the beginning of each shift to review the previous shift's work and plan the day's work. This way, all of them got involved in some decision making process.
d) While there was a quality inspector before products were taken to stores or dispatched to customers, quality control was effectively carried out by the workmen within the cells. This way, each worker took as their responsibility to ensure that there were no defects from their cell, bringing the company very close to zero defects manufacturing.
e) It was easy to achieve just-in-time (JIT) production; greatly reducing stocks of finished products yet becoming more competitive in their lines of production.

3.6.6 Process Variability

It was evident from Table 3.10 that process layout was used mainly because the firms were jobbing shops. Most of the shops could not predict with any accuracy what jobs they were going to do in the foreseeable future, as a result the process layout seemed to be the best for them. The flow of work-in-progress was not the same all the time. While the process was variable, the distances that work moved between production stages sometimes could be quite long. Those plants that were operating on flow layout were producing a particular range of products on a continuous or semi-continuous basis. This process was not easily variable both in terms of routing and product range.

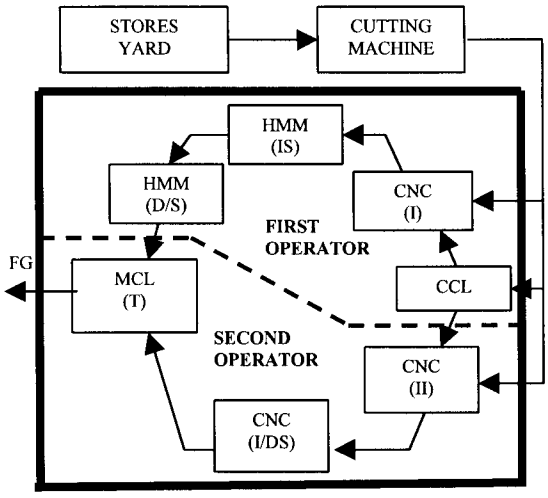
The shop that used cellular layout had specialised in a particular range of products. It was also able to plan its production because it was producing for a target market. Moreover, within each cell, it was possible to vary the production routing with appreciable ease. It was further observed that this plant had a very low operator-to-machine ratio. One operator could operate as many as three machines, which was a considerable saving in terms of labour costs. As a direct result the productivity of the operator was quite high.

A typical manufacturing cell is shown in Figure 3.5.

In the case shown in Figure 3.5, there were only two operators attending to all the machines in the manufacturing cell. Once the CNC machines were loaded, they were left running while the operator attended to (loaded/unloaded) the other machines in the cell.

It must, however, be pointed out that even ordinary machines could be loaded and left running without much risk. In this case, for example, horizontal milling machines (HMM) were loaded with five work pieces at a time just by suitably mounting the pieces on the arbour. On a modified centre lathe (MCL) used for threading, it took less than 15 seconds to make a through T38 or R32 thread 120 mm long with an internal diameter of 38 mm.

Moreover, once the cutting of the blanks was done properly at the cutting stage outside the cell, the use of the conventional centre lathe (CCL) at entry into the cell became optional. In that case, the work pieces were taken directly to the CNC machines, which were the machining centres.



LEGEND:

CCL - Conventional Centre Lathe

CNC (I) - First Computer Numerical Controlled Machine

CNC (II) - Second Computer Numerical Controlled Machine

CNC (AS) - Computer Numerical Controlled Machine for air slots

HMM (IS) - Horizontal Milling Machine for insert slots

HMM (AS) - Horizontal Milling Machine for air slots

MCL (T) - Modified Centre Lathe for threading

FG - Finished Goods

FIGURE 3.5: Engineering Manufacturing Cell Making Mining Drill Bits Seen at Boart Longyear

Another observation made was that for all companies, there was a decline in manpower levels from 1992. It was, however, observed that for most companies the decline was not so much because of improved efficiency, but rather because of declining production, and therefore, business. Only Boart Longyear, which had adopted group technology had reduced manpower but increased production.

3.6.7 Facility and Job Design

The following basic questions were vitally important in facility and job design: What is the forecasted product demand? Where is the plant to be located? How much capacity should it have? How should it be laid out? And how should its jobs be designed? [21]. The following were the findings of the study:

3.6.7.1 Forecast Demand

It was found that demand forecasting was not being done in almost all the companies, except crudely – by estimating the expected turnover in monetary terms without really determining what products might bring in that money. Other than Boart Longyear, the other few companies that could do some forecasting were those in the engine reconditioning business. This was because these tended to do the same jobs all the time and inputs could be determined with some certainty. Machine shops and foundries did little forecasting. Most were job shops that did not know in advance what jobs they were going to receive.

3.6.7.2 Plant Location

On the Copperbelt, most engineering companies were cited with a view to serving the mining industry more than any other companies. To this effect, it was observed that most of them were sited in close proximity to the mines. Even those in Ndola were sited there as a springboard to serving the mines while also serving the industry within the city.

Lusaka was the major commercial centre outside the Copperbelt. Many of the engineering firms outside the Copperbelt were, therefore, concentrated in Lusaka. Major companies that were located outside Lusaka and the Copperbelt were mainly parastatals, which had been sited during the development plans of the 1970s to develop the rural areas to curb urban migration. Most of the parastatals invariably crumbled because, among other reasons, the distances to the main markets were too long. Examples of these were Luangwa Industries in Chipata, which had to transport its bicycles more than 600 kilometres to Lusaka for onward distribution to the rest of the country. Livingstone Motor Assemblers in Livingstone had to transport its cars more than 500 kilometres to Lusaka and nearly 1,000 kilometres to the Copperbelt.

3.6.7.3 Capacity Planning

It was observed that those companies that were not able to make demand forecasts were also unable to reasonably plan the capacity utilisation of their plants. It was noted that capacity planning was merely based on the performance history of the companies. Other than Boart Longyear, none of the plants were operating anywhere near full capacity. Most plants were operating below 40 per cent. Business was particularly low on the Copperbelt, following the 'delayed' privatisation of the mines. In Lusaka, major industries had collapsed

and therefore there was limited business for the remaining engineering companies that were still operational. As a result of which none of them was presently planning any additional capacity to their plants.

It was, however, noted that Boart Longyear operated at a capacity utilisation exceeding 75 per cent. Engine reconditioners also operated above 70 per cent capacity utilisation. These plants were kept busy basically because of the general inability by the population to buy new cars due to high cost.

3.6.7.4 Job Design

It was observed that operators and other workers did not rest according to the recommendations in Table 3.12. Workers were at best, just given three breaks – mid-morning tea break of between 15 and 30 minutes, lunch break of 30 to 60 minutes and an afternoon tea break of about 15 to 30 minutes. This was observed in all companies and applied to all workers on the shop floor irrespective of the jobs they did.

TABLE 3.12: Energy Requirements for Various Activities

Type of Activity	Typical Energy Expended in Calories per Minute*	Rest Minutes Required for Each Minute Worked
Sitting at rest	1.7	-
Writing	2.0	-
Typing on a computer	2.0	-
Medium assembly work	2.9	-
Shoe repair	3.0	-
Machining	3.3	-
Ironing	4.4	-
Heavy assembly work	5.1	-
Chopping wood	7.5	1
Digging	8.9	2
Tending furnace	12.0	3
Walking	12.0	3

*Five calories per minute is generally considered the maximum sustainable energy level throughout the workday.
Source: CHASE & AQUILANO (1995).

For example, if a job took in excess of five calories per minute (the rough baseline for sustainable work) to do, the required rest period must equal or exceed the time of working. It, therefore, followed that the harder the work, the more frequent and longer the rest periods. Table 3.12 shows energy requirements for various activities.

In all cases job design questions raised in the decision making process were not taken into account for all jobs being done. Behavioural considerations were hardly ever considered at all in most companies. Companies were concerned with meeting targets such that the development of the worker was not always a priority. In almost all the cases, there was extreme specialisation such that one operator learnt to operate, and was therefore attached to, only one machine.

Boart Longyear was an exception to this general observation. At Boart Longyear, one operator operated at least two machines. This was horizontal enlargement because at his level, each worker had an enlarged sphere of operation [21]. There was also job enrichment because apart from horizontal enlargement, there was also vertical enlargement because he was exposed to decision making through daily meetings in the work groups.

3.7 SUMMARY OF FINDINGS

The engineering sub-sector was concentrated mainly in Lusaka and the Copperbelt. The sub-sector was still not making much contribution to GDP because it was still struggling through the effects of the post-1991 economic policies. Capacity was still low, due to lack of cheap raw materials. Taxation (both import duty and VAT) was high, while the sub-sector was not protected from the influx of imports.

The sub-sector was generally not involved in R & D, and was hardly in any constant communication with quasi-government research institutions. Quality was not seriously pursued in the majority of the firms. The Zambia Bureau of Standards did not seem to be effectively enforcing matters of quality on the firms, most likely due to a lack of quality know-how in the bureau itself relating to the products of the sub-sector. The government on the other hand did not seem to have any serious strategy to develop the sub-sector. While the economy was liberalised, there did not seem to be any serious incentives to develop a sustainable engineering sub-sector in Zambia.

Table 3.13 summarises the main survey findings.

TABLE 3.13: Summary of Main Findings

Area	Main Findings
National/Regional/International	- Nationalisation was not good - Political interference in running of firms was not good - High taxation (VAT & import duty) - No financial incentives - No strategy for a sustainable engineering sub-sector or even manufacturing sector - Privatisation and liberalisation hastily done - Regional freedom struggles had adverse effects - Adverse effects of global energy crisis - Adverse effects of low copper prices on world market - IMF & World Bank squeeze in the 1980s had adverse effects
Engineering Sub-Sector	- Firms concentrated in Lusaka & Copperbelt areas - Low contribution to GDP - Sub-Sector recorded some marginal growth in both gross and per capita terms until 1992 when it collapsed - Contribution to growth by capital, labour and TFPG was initially high, but declined in the 1970s - Capacity utilisation generally low - No sector-level R & D - Imported raw materials expensive
Firm-Level Consideration	- Most firms still used old/conventional technologies - Plant variability - good in functional & cellular layouts - - limited in flow layout - Functional layout - no product, process planning, no capacity planning, no demand forecast - Cellular layout - very good product, process, capacity planning, good demand forecast - Capacity utilisation mostly lower than 40% - Functional layout used in most machine shops - No firm-level R & D (no collaboration with NISIR, TDAU, UNZA-Engineering) - Source of raw materials not standard - Production equipment from too many places - Electricity and fuels getting too expensive - Product ranges too wide (no specialisation) - Product quality poor (no TQM, no quality certification or accreditation, no guidance from ZABS) - Market survey poor (no good linkages with clients)

CHAPTER 4

DISCUSSIONS

4.1 INTRODUCTION

In Chapter 3, the performance of the engineering sub-sector in particular and the manufacturing sector in general were highlighted. This chapter discusses the results highlighted and their implications to the engineering sub-sector in particular and the manufacturing sector in general.

4.2 ECONOMIC PERFORMANCE

4.2.1 Gross Domestic Product (GDP)

The first two years after independence registered a decline in total GDP. This was probably due to lack of trust by the Europeans in the newly independent state thereby either leaving the country or withholding their investment. While Rhodesia closed its border with Zambia in 1965, Zambia's economy managed to grow until about 1975 when the effects of the 1973 energy crisis were felt. Though there was a recovery from 1980, the tight exchange controls and foreign exchange auctioning introduced in 1982 led to further decline.

While the Manufacturing sector and the Engineering sub-sector were of the same growth pattern as total GDP, these virtually collapsed after 1992 following the withdrawal of subsidies in 1991. It was almost certain that the growth of both Manufacturing sector and Engineering sub-sector were supported by revenue from outside them, mainly from copper. It was also observed that while Manufacturing and Engineering's contribution to GDP went down drastically in 1992, Wholesale and Retail Trade steadily rose (Appendices A1, A3 and A5). This indicated that instead of manufacturing locally, the country resorted to trading (mainly in imported finished goods).

4.2.2 Country Population

From Figure 3.2 and Appendices A3 and A4, Zambia's population increased at about 3.1 per cent per annum from 3.59 million in 1964 to about 9.70 million in 1997. This rate was high compared to, say, Botswana (about 0.6 per cent) and The Netherlands (2.5 per cent) [22].

4.2.3 Per Capita Profile

The per capita performance given in Figure 3.3 and Appendices A3 and A5 revealed that the overall performance of the Zambian economy was bad. There was a decline right from 1964 to 1997. The initial decline, however, steadied up in 1966 and there was some growth until 1974 when the decline resumed. This decline was accelerated by the Energy Crisis of 1973. This trend had three implications on the country, especially since 1971. Zambia continued to suffer the effects of (i) the border closure with Rhodesia earlier in November 1965; (ii) The Energy Crisis of 1973 and the rise in petroleum price in 1974; and (iii) the decline in Copper prices on the world market. These led to the depreciation of the Kwacha from November 1976 and repeated budget deficits since 1975.

It was also noted that while the total GDP per capita was declining from 1964 the Manufacturing sector and the Engineering sub-sector were growing until 1974, when they started to decline. However, from 1981 there was some recovery until about 1992 when they both collapsed. Clearly, from Figure 3.3 and Appendices A3 and A5, the country's manufacturing base was weak. After 1992, the sector virtually collapsed with the parastatal companies. Private manufacturing firms did not make any significant impact to fill up the void. From 1994 to 1997, while manufacturing sector showed marginal growth, the Engineering sub-sector was still declining per capita though it seemed static in gross terms.

The implication of the above scenario for Zambia was that, to satisfy the basic needs of the population, either the economy of the country should grow at a very substantially high rate or the population should grow at a lower rate than 3.1 per cent.

4.2.4 Indices of Production

Table 3.2 Appendices A3 and A6 reveal that, taking 1990 as the base year (100 per cent), the index of production for total industrial output on a per capita basis declined from almost 184 per cent in 1964 to about 88 per cent in 1997, except for some marginal growth between 1966 and 1974.

The indices for engineering and manufacturing on the other hand showed that the sectors grew in the years 1964 to 1992. Although engineering attained its peak growth, at 108.3 per cent in 1987, and manufacturing at 113.3 per cent in 1992, their patterns and percentages of growth were almost the same throughout the period. However, the growth of engineering had

more variations than manufacturing in some years (1968, 1974, 1978, 1987, and 1994 onwards). This indicated that the sub-sector was more sensitive to disturbances than manufacturing. Further, while the decline in the production index of total industrial output remained steady after 1992, those of manufacturing and engineering dropped drastically to 9.1 per cent and 36.6 per cent respectively in 1994 and showed no recovery since.

4.2.5 Industrial Expansion, Factor Accumulation and Productivity Growth

Initial economic conditions in post-independent Zambia were characterised by limited levels of infrastructural and industrial development. Mining and agriculture (though farmers were mostly Europeans) predominated. Thus Government needed to urgently establish the social, physical and technological infrastructures necessary for industrialisation. Simultaneously, it embarked on programmes of industrialisation, essential for attaining rapid and sustained growth.

4.2.5.1 Factor Accumulation

Zambia, as a land-locked and sparsely populated country, had a high dependence on the mining of copper. Capital accumulation was very rapid in the aftermath of independence and initially output grew rapidly. However, the sharp drop in copper prices and deterioration in the terms of trade in the 1970s led to considerable capacity under-utilisation and a slow-down in manufacturing output and value added. Nonetheless, the rapid capital formation in the manufacturing sector in Zambia led to rising capital-labour ratios, particularly the period up to 1973 - implying capital deepening or increasing capital stock whether or not it was utilised efficiently.

4.2.5.2 Total Factor Productivity Growth

(a) **Total Output**

Table 3.3 shows the average annual growth of total industrial output, factor inputs and total factor productivity growth over a number of periods between 1964 and 1997. The average growth rate of total output, though mostly positive, was generally small over all the sub periods. From Table 3.3, it was also seen that the poor growth in output from 1964 to 1997 was mainly due to the adverse growth of TFPG over the same period. The growths of labour and capital were generally good and therefore should have had a positive contribution to the growth in output. TFPG, on the other hand, had negative or insignificant growth for all the periods. The decline in capital stock in certain periods contributed to the low growth in output.

(b) **Manufacturing Sector**

Table 3.4 shows that the growth of manufacturing output grew faster soon after independence than in later years. For the period 1964 to 1969 there was an average annual growth rate of 8.11 per cent. Although there was an adverse growth of -20.95 per cent for the period 1992 to 1997, the overall growth for the entire period 1964 to 1997 was still favourable though low at 1.81 per cent. The growth of labour showed a trend similar to total output. From 1964 to 1969, it had an average annual growth rate of 10.01 per cent but decreased to -6.68 per cent (1992 to 1997). The overall growth was, however, still favourable at 2.80 per cent for the period 1964 to 1997. The growth of capital stock for manufacturing was insignificant at an average annual growth rate of 0.01 per cent for the period 1964 to 1997. This had a negative impact on the growth of total manufacturing sector output.

Total factor productivity growth was favourable, with positive annual growth rates most of the period under review except for the sub-periods 1969 to 1973 (-8.89 per cent) and 1992 to 1997 (-16.96 per cent). Despite these adverse annual growth rates, in the later years of the period under review, the overall growth rate was 1.20 per cent. This, therefore, had a positive impact on the growth of manufacturing output.

(c) **Engineering Sub-sector**

Table 3.5 shows the performance of the engineering sub-sector. Compared with total output and manufacturing, engineering had the highest initial average annual growth rate at 13.86 per cent in the period 1964 to 1969. This, however, as was the case with the other sectors, declined with time. The decline in the engineering sub-sector was faster than that of manufacturing. In the period 1992 to 1997 there was a large adverse growth of -54.16 per cent. Because of this decline in growth from 1992 to 1997, the overall growth was adversely affected with an annual average value of -2.46 per cent for the period 1964 to 1997.

The average annual growth of labour was very high in the period 1969 to 1973 (at 10.21 per cent), though gradually declining over the years. The overall rate for 1964 to 1997 was, however, still favourable at 1.04 per cent, although there was an adverse growth of -8.80 per cent (1992 to 1997). Capital stock grew rapidly at 5.73 per cent (1964 to 1969), but was negative for the other periods, leading to an insignificant but favourable 0.04 per cent per annum for the period 1964 to 1997.

It was noted that the growth experienced in the output of the sub-sector in the early years was mainly due to TFPG, though it was also declining from an annual average rate of 9.07 per cent per annum (1964 to 1969) to -2.90 per cent (1964 to 1997). This poor overall rate could be attributed to the unfavourable rate for the later years (-6.27 per cent for 1973 to 1997, -13.12 per cent for 1982 to 1997 and -47.05 per cent for the period 1992 to 1997). The decline in the last six years was particularly so bad that the sub-sector went into a state of virtual collapse after 1992.

4.2.5.3 Comparison with Other Countries

Table 3.7 shows a comparison of manufacturing TFPG rates between Hong Kong, Singapore, South Korea and Taiwan and Zambia, Kenya, Tanzania and Zimbabwe. Though the intervals are not equal in length and are used here for comparison purposes only, the four African countries performed extremely poorly compared with the four Asian newly industrialised countries in their respective intervals. While for the three, Kenya, Tanzania and Zimbabwe, the TFPG was marginally below zero and Zambia's 2.73 per cent, the TFPG of the Asian countries, except Hong Kong (at 2.29 per cent), was over 3 per cent each.

4.2.6 Sources of Economic Growth and/or Decline

This section suggests some plausible sources of Zambia's economic growth/decline (particularly in manufacturing). These include capacity utilisation, market size, import substitution policies, external and economies of scale and technological development.

4.2.6.1 Capacity Under-utilisation

One important factor that led to slow or negative TFPG was capacity under-utilisation. Empirical evidence from other case studies showed that growth in capacity utilisation rates was a significant source of growth in TFPG [23]. Particularly in the parastatal era, Zambia had industrial capacity utilisation of lower than 40 per cent.

The size and growth of the domestic market also affected the level of capacity utilisation, Table 3.8. The combined GNP of the four countries Zambia, Kenya, Tanzania and Zimbabwe was less than two-thirds of that of Hong Kong and about one fifth of that of South Korea. South Korea and Hong Kong achieved very high rates of growth in GNP and in per capita income during 1965 - 1985. In comparison, there were negative growth rates in Zambia,

nothing reported for Tanzania and poor growth rates in Kenya and Zimbabwe. Poor growth in domestic demand limited expansion in industrial production.

The degree of capacity utilisation was also linked to the trade-orientation of the country. This determined the size of market and availability of foreign exchange. While both Hong Kong and South Korea followed an export-led growth, Zambia had an inward oriented strategy of industrial development. After the Mulungushi Declaration (1968), policies concentrated primarily on import substitution. The main impact was to create an anti-export bias. But by concentrating on the local market firms became vulnerable to the fluctuations and low growth of the limited domestic market - leading to capacity utilisation below the installed capacity.

4.2.6.2 Economies of Scale

In addition to their impact on the level of capacity utilisation, import substitution policies were expected to create external and scale economies. The exploitation of these economies was an important factor in growth and they depended on growth of output.

It should be realised that the estimates made in this study were based on a production function with constant returns to scale. This assumption of linear homogeneity of the production function made it possible to assume the distribution of factors' shares according to the marginal productivity theory (Euler Theorem). In case of increasing returns - which was to be expected - the estimates of the residual would be biased upward. Studies like those of Kwon (1986) and Brown and Popkin (1962) empirically verified the contribution of economies of scale to TFPG [24]. The negative TFPG rates for Zambia suggested that if these estimates were accurate, either the economies of scale realised were insignificant (might be due to small size of market) or were outweighed by other factors, especially capacity utilisation.

4.2.6.3 Import Substitution and Efficiency

Increased import substitution led to lower TFPG, perhaps due to low cost-saving incentives [25]. High import substitution lowered productivity and impacted adversely on domestic efficiency and innovation. High levels of protection that the local companies enjoyed sheltered them from foreign competition. In addition, the limited domestic market resulted in the existence of monopolistic industries. Monopolies led to a lesser competitive environment, as a result of which there was less or no inducement to reduce cost and improve technology.

4.2.6.4 Poor Development of Technological Capabilities

The low growth of TFPG implied poor technical progress. Zambia had a large parastatal sector for a period of nearly 20 years (more than half the time of the country's independence). The state's efforts in direct investment were designed for acquiring technology but not technological capabilities. Expenditure by the state on research and development was crucial for developing technological capabilities. But in Zambia, while there was virtually no expenditure on basic research, expenditure on applied research was largely devoted to the agricultural sector. Unfortunately for Zambia, in the absence of a significant capital sector vital in the process of technology generation and diffusion (since all technical changes required the development of modified or new machinery and equipment), it was mostly up to the firm to acquire/develop, master and adapt technology.

4.2.6.5 Research and Development

This study revealed that most engineering companies did not do any research to improve their products and/or production technologies. There were also no development programmes for new products. Only one company, Boart Longyear, did any research and development though this was done outside Zambia at its principals' research facilities.

Lack of research and development had the following effects on Zambian goods:

a) The country had not developed truly Zambian engineering products that were patented in Zambia making it remain a net importer of both technology and products (either as finished products, parts or part prints for eventual assembly/production locally).
b) There had been no serious advances in the quality of products and efficiency of production due to lack of competition.
c) The drive for innovation and invention among engineers was not being developed due to lack of funding.

4.2.6.6 Implications

Decreasing or low TFPG if allowed to continue had serious implications. Lag in productivity growth was a major obstacle to economic growth and development. Productivity growth led to the expansion of capacity for production. It was an indicator of the efficiency with which resources were used. It was a key to improving competitiveness and narrowing the gap with other countries.

4.3 MANAGEMENT OF PARASTATAL COMPANIES

At independence, the private sector managed most of the country's economy including major industries like the mines, the manufacturing sector, and utilities in the transport and energy sectors. Parastatal companies were all put under the holding of INDECO and ZIMCO. Most of the managers were appointed by the state, rarely on merit but to Zambianise. Moreover the management system assumed was classical scientific management, with the formal pyramidal organisation structure. This emphasised power, conformity to and loyalty for company objectives. These emphases were embodied in four principles of scientific management theory to increase administrative and organisational efficiency, quality and quantity of output [26]. These principles were: task (work) specialisation, chain of command, unity of direction and span of control.

Thus employees had limited control over their workday world, depending on directives from head offices. They became dependent on and subordinate to INDECO and/or ZIMCO and frequently used very little of their abilities. Thus they worked under conditions leading to psychological failure. All that was done in the parastatal was initiated more by the head offices at ZIMCO/INDECO rather than being initiated mainly by the workforce on the ground. Thus workers become more passive than pro-active and innovative.

The effects of the observations made above were that: (a) for its part, management increased the degree of directive leadership, increased management controls, dividing the workforce into the *leaders* and the *led*. (b) Workers did not really feel a part of the team but as instruments toward achieving set objectives of the organisation; and (c) There was mistrust between the workers and management, leading to the formation of unions for workers to protect themselves against perceived ill treatment by management. Ultimately, the parastatal sector had a workforce in which the average worker was demoralised, alienated from the objectives of the organisation, and, therefore, inefficient.

4.4 POLITICAL INTERFERENCE

Until 1972 when the One-Party Participatory Democracy was introduced, Zambia was a Multi-Party State. This marked the birth of the 'Second Republic' in which only the ruling political party was legal. In order to ensure the realisation of party and government objectives, Party Political Committees (PPCs) and Works Councils were formed at places of work [27].

Because of these political institutions management had to tow the Party line, to the detriment of firms. PPCs entangled themselves in labour/management disputes resulting in rivalry with trade unionists and works councillors. It also became difficult for management to punish errant workers, as long as they were party members, resulting in indiscipline and inefficiency.

Works Councils failed to achieve their intended goals of promoting and maintaining participation of workers in management decisions, improving industrial peace as well as increasing productivity and efficiency.

a) Works councillors had low education and, most times, limited knowledge of the enterprise and its operations.
b) Companies looked down on works councils and did not take them seriously. Management often used them merely to gauge workers' feelings on decisions to be or already made.
c) Where Works Councils, trade unions and political party committees existed in one organisation, there usually was rivalry and conflict among them because of overlap in the functions, lack of understanding of individual roles and poor intra communications.
d) Some elected councillors were cut off from fellow workers because of their association with management.

4.5 RESULTS OF PRIVATISATION

The results of Privatisation were analysed from four (government, workers', public's and donors') perspectives.

4.5.1 The Government View

Of more than 230 state owned enterprises (SOEs) privatised since July 1992, approximately three per cent had not performed well [19]. Some had completely wound up while others went under receivership and yet others were still struggling.

Government viewed the collapse of newly privatised companies as being mainly due to:

a) The heavy indebtedness of some parastatals such that new investors failed to realise meaningful returns on their capital, as was the case with Kapiri Glass Products.
b) Lack of capital, forcing many newly privatised firms to rely on the money market, which they eventually failed to service. This led to receiverships and liquidations, especially for

those companies sold to Zambians, like Drum and Can Company. Those sold to multinationals used foreign capital to survive.

c) Liberalisation in most cases led to the influx of heavily subsidised imports that choked local companies into extinction because of unfair competition. This was the case with Livingstone Motor Assemblers, LENCO and steel fabrication companies. However, some organisations such as Monarch (Zambia) Limited managed to withstand this competition using survival strategies like adding value to their products, reducing production costs and going into partnerships with foreign companies.

d) Operations of these companies before privatisation were so poor (they were loss makers) that, after they were privatised and despite efforts by the new owners to revitalise the business, they failed because competitors took advantage of their poor operations to control the market.

e) Those companies that depended on other parastatals for business found it difficult to operate because of the closure or sale of parastatals that gave them business. For example, Drum and Can Company, whose main market was BP Zambia and ZCCM, virtually collapsed when BP Zambia decided to import their own drums and cans while the mines faltered in their operations due to delayed privatisation.

It was, however, the Government's view that, with a failure rate of about three per cent in Zambia, privatisation had been successful compared with other countries pursuing similar transformation programmes such as Germany which whose failure rate was as high as 20 per cent [19].

4.5.2 Workers' Views

The general view of the unions and retrenched workers was that privatisation had brought suffering due to general loss of employment. According to the Zambia Congress of Trade Unions (ZCTU), formal sector employment had shrunk from nearly 550,000 in 1992 to about 300,000 in early 1999 [28]. However, workers in enterprises that performed well before and after privatisation, and had not been retrenched, were generally pleased with the programme.

4.5.3 The Public and Business Views

Varied views on the successes and failures of privatisation in Zambia had been expressed, among them the following:

a) The majority of privatised companies so far were performing well due to massive investments poured into them by various new owners [29]. It was viewed that privatisation and liberalisation in general had brought a culture of transparency in government and removal of corruption from tender boards [30].
b) Abandoning the privatisation programme would be more disastrous than divesting all the remaining SOEs [9]. Long term lending/financing was, therefore, necessary so that companies did not continue to register a declining growth.

4.5.4 Donor Perspective

While, in general, the programme had been praised, there were misgivings about the rate at which it was being implemented. It was the view of the donor community that the pace of privatisation could be quicker. The major criticism was the slow privatisation of the mines, as a result of which the Paris Club withheld balance of payments (BOP) support and other loans to Zambia. The European Union even threatened to withhold US$7 million balance of payment support to force the Zambian government to implement the COMESA Zero-Tariff Treaty [9]. This had a negative impact on the economy because investment coming into the country was reduced.

From the foregoing, it was clear that each of the groups considered had their own interests in taking the stances they took. It was however observed that immediately after the introduction of privatisation and liberalisation (with the subsequent withdrawal of subsidies), most parastatals collapsed after 1992 except for those like the Zambia Electricity Supply Corporation, Zambia Telecommunications Corporation and Zambia Railways which still had a high degree of government support.

4.6 QUALITY MANAGEMENT, PROBLEMS AND IMPLICATIONS

With only one company practising TQM, one with ZABS certification and three with ISO 9002 certification, the quality picture in the engineering sub-sector was bad. The lack of both quality control and recognised quality certification led to Zambian products, generally, being of low quality and unable to compete on the open market. Nationalisation, import substitution, lack of exports and short money supply also led to poor quality in production. Quality inspection and enforcement by statutory bodies like ZABS were virtually non-existent [31].

When the market was liberalised, it was clear that local industry would not stand international competition, especially from Zimbabwe and South Africa - the immediate traditional competitors of Zambian industries. Liberalisation led to the advent of importation of high quality goods from abroad. Consumers were, once again able to buy goods whose quality they were satisfied with. The ensuing industrial collapse was, therefore, inevitable because local industries were no longer monopolies under government protection.

4.7 TECHNOLOGY CHOICES - FACILITY DESIGN, LAYOUT AND PROCESS VARIABILITY

It was observed that most companies did not innovate to improve their production processes. They did not even procure new production technologies in order to enhance their productivity. It was found that Boart Longyear was in the lead in this area. The company had made deliberate efforts to modernise production by procuring new and more advanced production technologies (like CNC technology). It was also making efforts to improve older technologies already in use. The modification of an ordinary centre lathe into a threading machine for the mining drill bits increased throughput to about 100 pieces per hour from about 10 before the modification was carried out, an increase of 1,000 per cent. This machine became invaluable to production such that the difference between the cost of its modification and that of a new threading machine became the saving to the company.

The following advantages resulted because of the changes made within the firm. The company operated on a manufacturing cell principle. Each product was finished within the cell. The only processes carried out outside the manufacturing cells were specialised processes like insertion of bits and heat treatment. In each cell, the company's approach was multi-skilling (an operator was trained to operate more than one machine to improve versatility and efficiency) and multi-operation (many operations in one cell). As a result, the company was able to reduce its workforce from 350 in 1997 to 96 in 1999, with improved production. With labour costs accounting for about 15 to 17 per cent of the total production costs, this reduction (of about 73 per cent) in labour force was a considerable saving. In each cell, members formed a team that met at the beginning of each shift to review the previous shift's work and plan the day's work. This way, all of them got involved in some decision-making process. While there was a quality inspector before products were taken to stores or dispatched to customers, quality control was effectively carried out by the workmen within the cells. This way, each worker took as their responsibility to ensure that there were no defects

from their cell, bringing the company very close to zero defects manufacturing. Finally, it was easy to achieve just-in-time (JIT) production; greatly reducing stocks of finished products yet becoming more competitive in their lines of production.

4.8 ENVIRONMENTAL AND ENERGY CONSIDERATIONS

4.8.1 Waste Disposal and the Environment

While some efforts were being made to control pollution resulting from industrial emissions and wastes, a lot still needed to be done by the engineering sub-sector. Currently, fumes and smoke were hardly controlled at all. Although high stacks could be used to improve dispersion, this was not being done. Some attempts were being made to control ground pollution from used oil by collecting the same and keeping it in suitable containers before disposal to used oil recycling plants such as BP Lubrication Oil Recycling Plant in Kitwe and Lublend in Ndola. Nonetheless, a lot of oil still found its way into the ground - thus polluting ground water.

The best control was found in the disposal of metal off-cuts and chips. These were collected at the end of each shift and kept in suitable containers or designated areas and then sold to the foundries for re-melting. Ash from foundries was collected and thrown away at designated dumping sites. However, this meant that ash was easily blown and carried away by wind and running water - polluting the environment.

Appendices C1 to C3 show the air and water pollution limits allowable for industry. In the absence of any strict checks on industry by the Environmental Council of Zambia, it could be assumed that there was a lot of air and ground water pollution resulting from most industrial operations in Zambia.

4.8.2 Energy Cost and Its Effect on Industry

The cost of energy in Zambia has been steadily increasing over the years in Kwacha terms. The construction of the Kariba North Bank and Kafue Gorge (and other smaller) hydroelectric stations, the construction of TAZAMA Pipeline and Indeni Petroleum Refinery in Ndola and the development on the Maamba Collieries in Choma were expensive but necessary ventures. These were needed to cut the country's dependence on Rhodesia.

Therefore, although Zambia eventually attained self-sufficiency in energy, its cost did not fall or stagnate. Electricity tariffs, for example, were being revised upwards twice a year by as much as between 10 and 15 per cent per revision. Prices of petroleum products had equally been revised upwards from time to time (the diesel price rose from about K10.00 per litre in 1988 to about K1,100.00 per litre in 1998 - a rise of over 11,000 per cent in ten years). The price of coal also rose though to a lesser extent in comparison with electricity and petroleum.

In an average engineering company, electricity constituted between five and ten per cent of the total production cost, while that of solid/liquid fuel was about five per cent. Although this cost was small, compared with labour, for example, accounting for as much as 15 to 17 per cent of the total production cost, it was nonetheless quite substantial for industry.

4.9 MANAGEMENT SYSTEMS ANALYSIS MODEL

What came out clearly from the findings was that, if the firms or the sub-sector were treated as a black box with inputs and outputs, the feedback part of the loop was not effective. While firms had problems with the acquisition of inputs (raw materials, spare parts, machinery and services), maintenance of plant and equipment - leading ultimately to poor quality but expensive goods and services, the market response was either not effective or was ignored by the policy makers. This, clearly was a very costly oversight in the policy framework of the Zambian economy which led to the decline that was resulted.

CHAPTER 5

NEW APPROACH TO IMPROVE THE ENGINEERING SUB-SECTOR

5.1 INTRODUCTION

This chapter proposes a Model Solution in the formulation of strategies for the future and sustainable development of the engineering sub-sector in Zambia in particular and manufacturing in general. It proposes the way forward for the country, showing the inter-relationships among the players in the economy and how important each one is for the sub-sector to grow by providing remedial actions to the constraints identified in the study. These solutions ultimately will provide the strategy for the way forward for a sustainable manufacturing and engineering sectors.

In order to resuscitate the economy, and the manufacturing and engineering sectors in particular, both the government and industry need to play their respective parts. In the free market economy in Zambia, government is a facilitator – formulating policies that are conducive to the growth of industry. For its part, industry needs to take initiatives that will also facilitate growth. Unless this partnership between government and industry is recognised and exploited, all efforts by one or the other party will be futile. Zambia's developmental path is precarious because of the economic and political changes of 1991 and the regional and international economic and political developments taking place.

5.1.1 The Zambian Manufacturing Industry

Soon after Zambia got its political independence in 1964, the development of industry required radical changes in the structures inherited by the country [32]. Under the Federation of Rhodesia and Nyasaland, revenue from copper in Northern Rhodesia (now Zambia) was used in the creation of secondary industries in Southern Rhodesia (now Zimbabwe), whose market depended heavily on Zambia and Malawi (formerly Nyasaland). A second inherited structure was the dominance of the mining sector over all the other economic activities. While this presented the advantage of substantial foreign exchange earnings, it also had the disadvantage of unbalancing the country's economy as a whole.

The problem in Zambia was; firstly, to create industries that would substitute locally produced goods for many of the imported ones. Secondly, by physical diversification, to create centres of economic activity away from the line of rail - thus contributing to the transformation of the stagnant rural areas into areas of buoyant economic activity. Industrialisation was intended to make a lasting and growing contribution to the balance of payments position, both by import substitution and by developing an export capacity in the new industries. The policy of import substitution was intended for the country to achieve self-sufficiency in industrial and consumer goods. It was assumed that a number of the industries put up would develop exports to neighbouring countries provided such products were of international quality and their prices were competitive. It was further intended that local firms should not just industrialise yet producing inferior goods for the local market.

Though these policies were either ill-implemented or not implemented at all, the dominating considerations in the industrial programme were to obtain the highest productivity of capital equipment, to achieve a high quality of products and to reduce the country's dependence on Rhodesia and South Africa.

5.1.2 The Zambian Engineering Manufacture Sub-Sector

The engineering manufacture sub-sector formed an invaluable link in the country's chain of development. With other productive sectors of the economy, it formed the production base of the country. When a country had a solid production base, the economy was strong, goods became more readily available and affordable to the citizenry, and the national currency strengthened, resulting in the citizens' improvement of their standard of living. Beyond the borders of the country, a strong production base left some of its output for export after satisfying the internal market. This earned the country foreign exchange and ultimately improved the balance of payments situation.

However, through most of the period under study, the engineering sub-sector had not contributed meaningfully to Zambia's development. New metal products manufacturing firms had failed to perform well while re-conditioning firms, that ordinarily kept the existing industrial and other machinery running, had also been struggling.

Against this background, this study aimed at providing both an engineering and economic in-depth understanding of what went wrong in Zambia's engineering manufacture sub-

sector from 1964 1997 and to offer practical solutions and strategies to revitalise and sustain the development of the sub-sector as a way forward for Zambia. A strong industry would also create employment for the citizens.

5.2 THE MODEL SOLUTION

Figure 5.1 introduces the Model Solution in a management systems analysis modular form. Apart from the blocks shown in Figure 2.2, a block representing 'catalysts to development' is introduced. 'Catalysts to development' are circumstances that firms in the engineering sub-sector have no control over but whose effects are beneficial to the firms' performance. On the other hand 'disturbances to development' is left to mean those circumstances that the sub-sector has no control over, and whose effects are detrimental to its performance. In the black box (the firms or the sub-sector), are identified activities that take place.

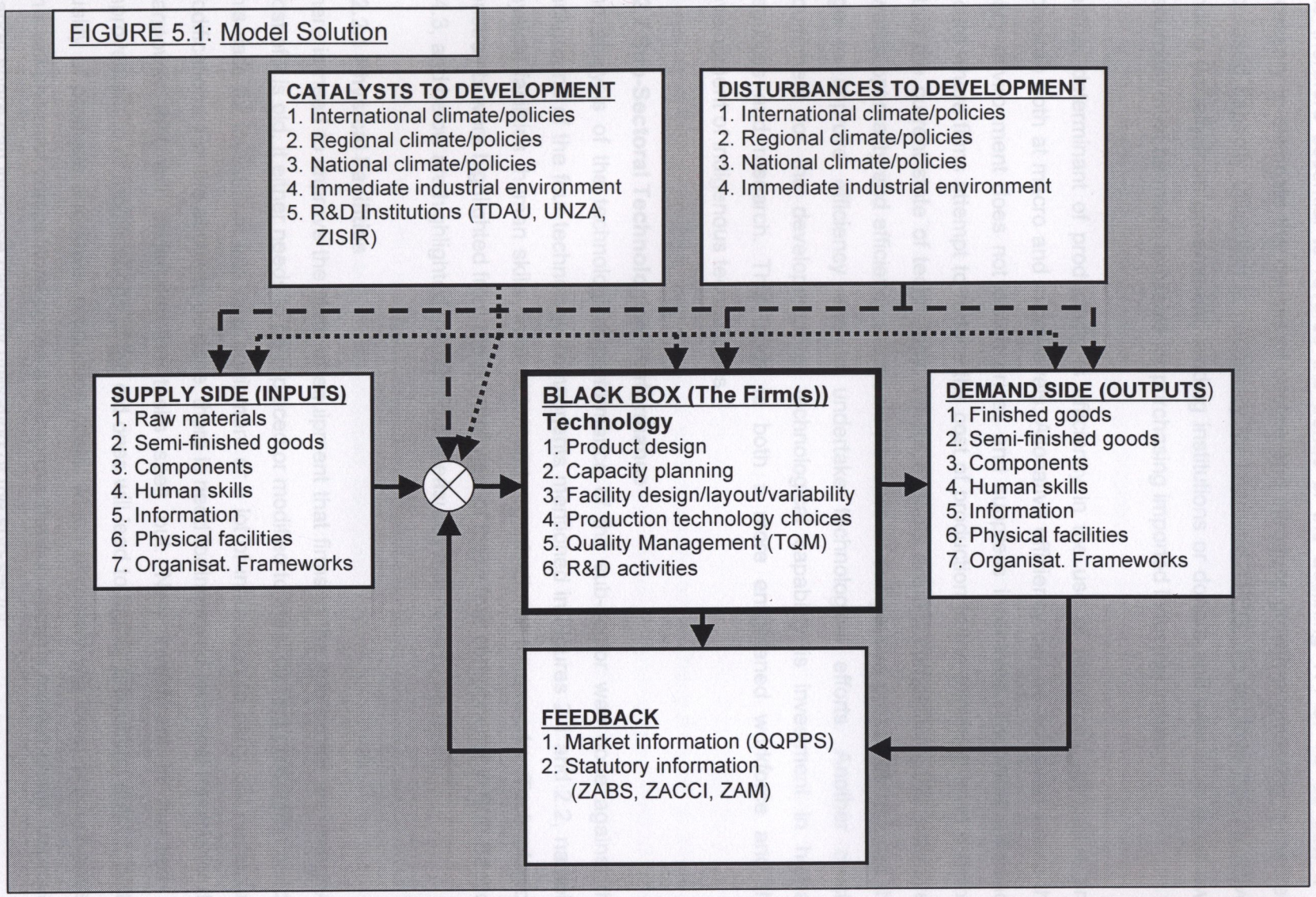
Interrelationships that involve catalysts and disturbances as they affect the production process are also shown by dotted lines. Ordinarily, it would be thought and taken that disturbances and catalysts only affected the black box directly as shown in Figure 2.2. From this study, it was clear, however, that they affect the production process at all levels from the input stage to the output. How effectively their effects are dealt with depends at what stage and how much they affect the production process and how quickly some actions (proactive or reactive) are taken.

Before the model solution is fully developed, the implications of TFPG are highlighted in Sub-section 5.2.1, below, with remedial actions that can be taken to improve it for the better performance of the sub-sector.

5.2.1 Implications of Total Factor Productivity Growth (TFPG)

Decreasing or low TFPG, as shown in Chapter 3 (Sub-Section 3.4.2), if allowed to continue has serious implications. Lag in productivity growth is a major obstacle to economic growth and development. Productivity growth leads to the expansion of the capacity for production. It is an indicator of the efficiency with which resources are used. It is a key to improving competitiveness and narrowing the production gap between Zambia and other countries, particularly those in the sub-region.

FIGURE 5.1: Model Solution



It is therefore essential to reverse the trends of the declining TFPG. To do this, it is necessary to eliminate the causes of decline and introduce growth-augmenting measures. Increased capacity utilisation is necessary for improved TFPG. To achieve this objective, funding (initially from government, lending institutions or donors and later from firms' own resources) must be made available for purchasing imported industrial inputs.

Another determinant of productivity is efficiency in the use of resources (allocative and technical) both at macro and micro levels. Allocative efficiency can be achieved where the policy environment does not distort prices and suppress incentives. Technical efficiency occurs where firms attempt to reduce the cost of production to the minimum level possible within the current state of technology. Where markets are not competitive, the incentives towards optimality and efficiency are weak. Absence of competitive pressures reduces the urge to improve efficiency and to undertake technological efforts. Another crucial requirement for the development of technological capability is investment in human resources and research. This leads to both a more enlightened workforce and the development of indigenous technologies.

5.2.2 Sub-Sectoral Technological Performance

The analysis of the technological performance of the sub-sector was done against the background of the four technology components mentioned in Figures 2.1 and 2.2, namely, physical facilities, human skills, information and organisational frameworks. Technological constraints were highlighted from the point of view of these four components in Sub-Section 3.4.3, and below are highlighted the remedial measures that need to be taken.

5.2.2.1 Physical Facilities

There is need to improve the state of equipment that firms in the sub-sector are using. As most of it is old, it either needs to be replaced or modified to meet current production needs. This calls for investment into new equipment or a lot of innovation to carry out necessary modifications. For the above to be done, there is need for improved technical training for the manpower that will undertake the tasks spelt out. New investment in facilities or improvement to or modifications of the old ones will lead to higher production output, better quality of products and lower production costs, which ultimately will lower product prices. This will undercut competitors' prices and improve the sub-sector's market share. Improved market share can increase capacity utilisation of the sub-sector.

Low capacity utilisation was cited as a major problem in the sub-sector. To lower production costs and improve capacity utilisation, it is also necessary, therefore to have access to cheaper sources of raw materials. Where production technology is 'imported' from outside the country, as is the case in most firms in the sub-sector, there is need to get technology that is appropriate and easy to adapt to local conditions.

5.2.2.2 Human Skills

The calibre and numbers of technically qualified personnel on the market raised a lot of concern among many firms in the sub-sector. There is need to improve technical training facilities in the country. There is need to produce engineers, technologists, technicians and artisans who have a good balance between theory and practice in their respective areas of specialisation at their respective levels. In addition, there is need to blend technical training with suitable business and management training so that these personnel are broad minded when they enter the working environment.

Research and development is a result of an inquisitive mind. There is need to improve laboratory and workshop facilities in technical training institutions so that graduates of those institutions have a quest for improvement in whatever they did. This will lead to an unceasing process of research and development and, therefore, to continuous improvement in production.

5.2.2.3 Information

The information culture of a company, normally, needs to be developed from within and by the company itself. For there to be in-house designing, prototype making and testing, evaluation, production drawing and proper material selection/specification and proper equipment selection, it is necessary to give new recruits into the company the correct induction immediately at joining. Staff need to be inducted into the culture of generating, proper keeping and sharing (with other relevant staff) of information that can improve production.

It is necessary that members of staff are trained on-the-job to not only use foreign designs, but also develop newer and more relevant ones, that are responsive to the changing environment and needs of the firms and users. Thus, there is need to know the needs of the

market and to respond to those needs in the form of making available all relevant information to improve production. It is also necessary to generate product information for the consumers and clients to make informed decisions when picking on particular products.

5.2.2.4 Organisational Frameworks

Companies need to lay down development plans in the short term, medium term and long term. Plans guide companies' operations at all points in time. This calls for good organisational skills among all staff at various levels. There is need to enhance the organisational capabilities of the firms and, hence, the sub-sector. All strata of employees need to know how they relate to everybody else in the firm. There is need to organise the information base relating to the market, products, production process, and the overall improvement of management and skills training.

5.2.3 Firm-Level Focus

Firm-level consideration was done in the light of the four elements of the production process, namely: supply side, demand side, feedback and external disturbances. On the supply side, inputs included the supply of raw materials, parts, components, information, physical facilities, human skills and organisational frameworks. Outputs, on the demand side, included finished and semi-finished products (including parts and components), information, physical facilities, human skills and organisational frameworks.

Feedback composed of responses of all forms transmitted back to the firm's management. Feedback also included reaction of competitors. External disturbances were factors that were not directly in the firm's interest or control and worked against the interests of the firm. External disturbances included government policies (like statutory requirements and other policies at national level), regional and international policies that had a negative bearing on the firm's operations. These were highlighted in Sections 3.5 and 3.6. In the Model Solution (Figure 5.1), catalysts to development were included and separated from 'disturbances to development.' Catalysts were essentially 'positive or favourable disturbances' on the firm but over which the firm had no control.

5.2.3.1 Supply Side (Inputs)

It was identified that on the supply or input side of the production process were raw materials, semi-finished products, components, human skills, information, physical facilities and organisational frameworks.

(a) Raw Materials, Semi-Finished Products and Components

In Chapter 3 it was pointed out that 'raw materials' (including semi-finished products and components) for the sub-sector are obtained from varied sources. These sources include Europe, Asia and South Africa. Some machine shops and foundries even get their raw materials from scrap metal dealers. There is immediate need for firms to standardise their supply of raw materials. As at present, it is impossible to assure the clients that similar products have the same properties because of the possibility that they might have been made of different materials. When deciding where to procure raw materials from, the underlying factors should always be quality and cost, in that order.

The other approach regarding raw materials is to embark on R & D in order to find alternative and cheaper local materials that can be used to replace what is currently (and traditionally) in use. This is a more sustainable way to proceed for a firm because a material currently or traditionally in use to make a particular product may not necessary be the most suitable for that product and in Zambia.

Indirect inputs like energy need particular attention because these become substantial cost components in the end. There is need for companies to consider using cheaper sources of energy. Firms, like foundries and heat treatment facilities, which use fossil fuels, should consider changing to electricity as it is presently the cheapest energy source in Zambia. Electricity is also the most environmentally friendly.

(b) Human Skills

There is need for firms to invest in the area of personnel training. As in the sub-sectoral consideration, there is need to improve the skills of personnel, particularly technical personnel, in key areas of production. This could be done through formal training before joining the firm, refresher training at formal training institutions while employees remain in employment or on-the-job training. This will improve the capabilities of staff in their work and research and development.

(c) Information

Important information in a firm setting pertains to the production process, product design, product quality, research and development (continuous improvement), costs (their implications and management), market positions and supply agreements, and the financial position of the firm. It is important that as much of the workforce as possible is availed this information so that they become a well-informed workforce. A knowledgeable workforce is a reliable and productive workforce.

There is need for firms to invest in R & D as to improve their product quality and production processes. Where firms might not have the ability and capacity to carry out their own individual research and development, they should collaborate with research institutions. These are such institutions as the Technology Development and Advisory Unit (TDAU), the National Institute for Scientific and Industrial Research (NISIR) (formally, the National Council for Scientific Research), and the University of Zambia - School of Engineering.

(d) Physical Facilities and Organisational Frameworks

What was said about physical facilities and organisational frameworks at sub-sectoral level (paragraphs 5.2.2.1 and 5.2.2.4) also applies at firm level. There is need to invest in better facilities, and carrying out necessary modifications of existing facilities to further improve production and lower costs while improving quality. Firm-level developmental plans in the short-, medium- and long-terms are an absolute necessity. These give direction to the firm, and provide the necessary mechanisms for checking whether or not a firm is on the right track in its operations. Plans must include information base on the market, products, production process, and the overall improvement of management and skills training for both managers and other employees.

5.2.3.2 The Black Box (The Firm in the Sub-Sector)

The black box represents the firm. This is where all inputs interact with the available production technology to produce the various outputs. For the correct outputs to be realised there must be an acceptable blend of all the essential elements. Apart from already mentioned inputs and the disturbances and catalysts, the major factors in the black box are job design, capacity planning, facility design, layout and variability, quality management and research and development.

(a) Job Design

There is need for operators to perform their jobs with minimum fatigue. In Chapter 3, Table 3.12 gave the energy requirements for various activities that are done in the workshop, in the office and in general life. It is suggested that firms follow this proposal because it is based on actual studies. Continuous work without sufficient rest reduces workers' output, and therefore increases production costs in the end.

(b) Capacity Planning

It was necessary that all firms plan the capacities of their plants. The benefits are immediate. Firms will know how many people to hire to avoid over employment, they will know what machines they were likely to use and therefore plan maintenance properly, they will know what raw materials, tools and fixtures to stock to avoid over stocking. Proper capacity planning also allows firms to know if they need extra capacity - which they could either, procure from neighbouring (similar) firms or which they need to invest in as additional assets to what they already have.

(c) Facility Design, Layout and Variability

Most facilities visited were general-purpose workshops and foundries. This did not allow any specialisation in particular products, as a result quality was compromised, delivery periods were long, and at times the right materials and tools were not even readily available when a job was accepted.

It is necessary that firms specialise and limit their range of products to improve product quality and productivity. With a limited range of similar products, most workshops (machine shops) need to adopt cellular layout or group technology production. It was observed that this system is more productive than the functional layout most firms were using. In cellular layout, there is minimum redundant machinery and personnel. Section 4.7 enumerated some practical advantages that can result when a workshop changes from functional to group technology layout.

(d) Quality Management

Quality has been a far cry in most products made in Zambia for many years. There is immediate need to embrace total quality management (TQM) if firms are to survive the new

competitive era in Zambia and abroad. Firms need to invest in quality management. Firms should not just be encouraged to take quality seriously, but it must be a statutory requirement that all firms serving the public must have current quality certifications by ZABS in addition to ISO certifications. Therefore, ZABS needs set standards for all products. It must be given statutory mandate to take punitive measures on firms that fail to meet minimum quality requirements in their products.

(e) Research and Development (R & D)

Firm-level research, for better product design and better production methods, is a necessary antidote to continuous improvement. However, as stated in paragraph 5.2.3.1(c), certain firms might be unable to undertake the research and development function on their own. There is need to encourage such firms to partner with sister firms or to use the facilities of institutions like TDAU, the National Institute for Scientific and Industrial Research (NISIR) (formally, the National Council for Scientific Research), and the University of Zambia - School of Engineering.

5.2.3.3 Demand Side (Outputs)

The output side of the production process consists of finished goods, semi-finished products, components, human skills, information, physical facilities and organisational frameworks.

(a) Finished Goods, Semi-Finished Goods and Components

There is need to improve market understanding by firms so that they become responsive to the specific needs of their clients (the market). This calls for interaction between the firms and their clientele. Firms need to induce clients to come to their facilities through regular visits to customer premises to discuss customers' specific problems and needs. It is suggested further that for the firms to break into the export market, they need to attain export quality standards. They need to have a good understanding and appreciation of what it takes to produce for the export market instead of just the local market alone.

(b) Other Outputs

These include resultant human skills, information, physical facilities and organisational frameworks. These must be evaluated in the light of the product outputs and adjusted accordingly to refine the output product into what is required to satisfy the market.

5.2.3.4 Feedback

Firms need to monitor all their activities at all levels and stages of the production process, particularly at the output stage. Output information provides the firm with hindsight regarding its performance - production efficiency, product quality, market response (to own and competitor products), the firm's financial status and the possibility of breaking into the export market. This information should be used to 'modify' the inputs and the performance of the black box for better outputs. The services of ZABS, ZACCI and the Zambia Association of Manufacturers (ZAM) should be used as a matter of course.

Institutions like ZACCI and ZAM give a feedback to policy makers in government on the requirements of industry in general, and the effects of the policies that are being formulated from time to time. However, from the response obtained from industry it is clear that there is some discontent in industry about government's lack of seriousness to develop the sub-sector. Taxation and import duty are high, and there are no steps being taken to redress this situation.

5.2.3.5 Catalysts to Development

Catalysts to development were earlier defined as essentially 'positive or favourable disturbances' on the firm but which the firm has no control. These include policies that are put in place to stimulate industrial growth. Catalysts are found at international, regional and national levels. Since the local firm, or even the sub-sector for that matter, does not have control over these catalysts, there is only need to recognise them in time. It is necessary to see how they affect production and take measures necessary to maximise the derived advantages.

(a) International

International catalysts need to be taken advantage of by the local firm. It is necessary for each firm to see its place in the global market place. If the world economy went into recession, there is need for the firm to try and take advantage of falling world prices to invest in new machinery and technology. Firms need to take advantage of offshore lending facilities, which are available but have not been explored by local firms. Firms need to go into partnerships with reputable foreign investors in order to inject new capital into their operations to avoid going into liquidation or keeping struggling with poor production.

(b) Regional

The sub-sector should take advantage of the large marketplace created by such groupings as SADC and COMESA. With the easing of tariffs in member countries, there will be easier accessibility of each other's market among members. To take advantage of this new economic scenario, there is need for well-defined export strategies at firm and sub-sectoral levels. There is further need to reduce production costs through shedding off of excess labour, improved production methods, cheaper raw materials and other inputs and using more efficient production facilities.

(c) National

At the national level, there is need to take advantage of positive policies such as: liberalisation, privatisation and financial incentives in place. Firms need to explore the use of electricity, which is lesser expensive than fossil fuels.

5.2.3.6 Disturbances to Development

Disturbances, just like catalysts, can be on a national, regional or international scale. Since the firm has no control over disturbances, one fundamental requirement is that the firm must recognise the disturbances as quickly as possible. It must be noted where disturbances affect the production process so that pre-emptive (preventive) actions can be taken. There is need to take preventive and corrective measures as soon as possible after the effects of the disturbances become apparent in the firm.

(a) International

There is need to understand the international economic climate in general and be able to interpret it in the context of the local firm. Internationally, there are donor policies that impose strict requirements on the country. It is necessary to recognise what the effects of these donor requirements are on a firm even though the firm itself might not have any direct benefits from such borrowing.

(b) Regional

At present, Zambian firms stand to lose their market to regional competitors once the country ratified the COMESA Zero-Tariff Treaty because of the poor quality of their products and the high production costs, among other reasons. There is need for firms in Zambia to

improve the quality of their products and reduce production costs. They need to survey the regional market to see the segment of the market they can target in order to have relative advantage over other regional competitors.

(c) National

At national level, there is need for firms to support associations that represent their interests - like ZACCI and ZAM. While firms have no direct control over government policy on development, there is need, through these associations, to insist on passing necessary information to policy makers so that this information is considered when policies are being made.

For its part, government needs to formulate policies that are implementable and stimulate industrial growth in the country. There is need to reduce VAT from the current 17.5 per cent to around 14 per cent. VAT payment period could be extended from the current 21 to 45 to 60 days to allow firms' credit customers to pay before the tax becomes due. The alternative approach would be to allow firms to pay VAT in 21 days after invoices have been paid. Presently, firms pay VAT from their reserves before credit customers pay, and by the time these customers pay, the firm is already in dire straits in its operations. The current tax system is working against the development of industry in Zambia.

Government also needs to ensure that there is close co-operation between its planners, policy makers and industry. This would make quasi-government research institutions (like NISIR, University of Zambia and TDAU) more useful and responsive to industry and its needs. Industry needs to initiate research projects for these institutions to broaden the local technology base.

There is need to improve technical training in the country. Graduates from training institutions must be prepared not only to perform their technical jobs, but to also manage firms (with basic financial appreciation, business and personnel management).

(d) Immediate Firm Environment

In its immediate environment, the firm needs to know its performance and market share in comparison with its competitors. There is need to take advantage of own strengths and competitor weaknesses. While competition is necessary in order for firms to improve the

quality of their products, it must be justified. There is need for firms to venture and invest in new areas of operation where they would have a market advantage with little or no competition at all.

5.3 COMMENT

The Model Solution proposed in the preceding pages is broad-based, but it attempts to point out the needs of the sub-sector, and industry and the country as a whole. It further suggests the steps both government and industry (including the engineering sub-sector) can take to redress the current situation – which is not yet beyond redemption. As earlier stated, unless this partnership between government and industry is recognised and exploited, all efforts by one or the other party will be futile. Zambia's developmental path is precarious because of the economic and political changes of 1991 and the regional and international economic and political developments taking place.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

From this study, a number of points on the performance of the manufacturing industry in Zambia in general, and the engineering sub-sector in particular, were brought to the fore. It was seen that the performance of manufacturing industry in general and the engineering sub-sector in particular in Zambia was not good for the period under review. It was also seen that the performance in the earlier years was better than it became in the latter years. The performance of these sectors was a serious departure from government's intentions, particularly when the parastatal sector was set up in the early to mid-1970s.

It was clear that problems that led to the failure of the engineering manufacture sub-sector were many, varied and quite complex. Some of the problems experienced were caused by government policies in place from time to time over the period under review. As a newly independent state in the early years after 1964, Zambia was in a hurry to develop industrial infrastructure in order to have a strong manufacturing base. As a result, while infrastructure was developed, there did not seem to be a matching development in the prudence with which the new companies would be managed. When revenue from copper (which was the fulcrum of all economic activities in Zambia) began to decline, all sectors suffered. The mines (and with then, the other industries in the engineering sub-sector) operated below capacity, borrowing became expensive, quality declined (because the economy was protectionist), the technical training base seemed to collapse and the economy weakened.

The adoption of free market policies in 1991/1992, became a 'shock poke' to industry because it was not ready for competition in order to survive. With the non-availability of financial support from the state, the parastatal sector crumbled. The small private sector that existed was far too small and weak to make any significant impact to fill the void left by the parastatal sector.

Other factors were due to industry's own problems. In such cases, intervention by industry itself could assist in improving the economy of the country. Firms neglected quality, R & D, personnel training, medium- and long-term planning and technological improvements.

6.1.1 Economic Performance

A number of factors were responsible for the poor performance of industry in Zambia. Some of these factors were easily identifiable while others were not. The effects of some of the factors on economic performance were not as direct as others were. GDP was used to capture the economic performance of the sectors and TFPG was used to identify some sources of growth and decline on the sectoral performances.

6.1.1.1 Gross Domestic Product and Indices of Production

It was evident from the gross domestic product of the country, both in gross terms and per capita, that the economy, particularly manufacturing and the engineering sub-sector, was not doing well (Figures 3.1 and 3.3). The per capita growth in gross terms for total industry output and the index of production were declining right from 1964. This meant that the population was outgrowing industrial output. This generally meant that the economy was not able to support the population of the country.

The per capita growths of the contributions of manufacturing and engineering to gross domestic product, though growing until about 1992, collapsed thereafter to very insignificant levels. These sectors, however, performed better than total output in that they recorded per capita growth while total did not.

6.1.1.2 Productivity Growth and Sources of Growth/Decline

It was clear that the total industrial output, manufacturing output and engineering sub-sector output in Zambia were, among other factors, dependent upon TFPG, labour and capital factor inputs. Other factors that affected the sectoral outputs were the Rhodesian border closure of 1965, the energy crisis (1973), the nationalisation if industry from 1972, the low copper prices on the world market and the subsequent weakening of the Kwacha against world currencies. The market reforms of 1991 also had a telling effect on the performance of the Zambian economy in general and the manufacturing industry in particular.

(a) Total Industrial Output

In total industrial output, it could be concluded that the TFPG generally contributed adversely to the growth of output throughout the period 1964 to 1997. The share of labour was generally higher than that of capital, indicating that labour contributed more to the growth of the total output than capital. This would suggest that there was inefficient use of capital in industry in Zambia. This was expected since most plants operated far below capacity. Negative TFPG also implied that other factors, like technology advances were poor, as suggested by the Cobb-Douglas production function introduced in Section 2.4, pp.13 - 15).

(b) Manufacturing Sector

Manufacturing TFPG was better than that of total industrial output. This showed better positive growth of the sector per capita than that of total industrial output. With the share of capital being generally higher than that of labour, it could be concluded that the sector was more capital intensive. With growth of labour being far higher than that of capital, it could be concluded that labour made more contribution to output than capital. TFPG made significant contribution to the growth of output in the manufacturing sector. In the last six to seven years, however, the TFPG was declining, leading to the decline in output for the period. Negative growths in capital and labour compounded this decline in output in later years.

(c) Engineering Sub-Sector

The engineering sub-sector was more labour intensive than manufacturing in comparative terms. It could, however, be concluded that output, which was growing at high rates in the early years, was a result of good growth rates in labour, capital and TFPG. Nevertheless, the faster decline in the growth rates of capital and TFPG contributed to the resultant decline in the output of the sub-sector.

(d) Indices of Production

It was noted that both manufacturing and engineering indices of production showed that there were drops in growth of output in the periods:

a) 1968 to 1972, due to the border closure with Rhodesia;
b) 1974 to 1978, following the Energy Crisis of 1973 and the subsequent faltering Kwacha on the international money market;

c) 1982 to 1985, because of limited import capacity of the country due to balance of payments deficits following the fall in copper prices on the world market; and
d) 1992 to 1994 and then to 1997, due to the adoption of the free market policies in 1991. These policies led to the subsequent collapse and ultimate close down of many parastatal firms in Zambia.

6.1.2 Sub-Sectoral Focus

This study revealed that infrastructure and systems in most of the sub-sector had deteriorated to very worrying levels and very urgent measures needed to be taken in order to reverse the situation. While government pursued the command economic policies (1972 - 1991), industry declined. The little private sector seemed to have given up the fight because when the parastatal sector suddenly crumbled, the private sector was not there to rise to the challenge and fill the void.

The major conclusion drawn when considering the sub-sector was twofold. While government needed to provide a more conducive environment for industrial growth, there was need for initiative and innovation within the industry itself so that government responded by supplementing these industrial initiatives in order to ensure that the sub-sector grew. Industrial development was primarily an industrial initiative, and then government responded to this initiative. In other words, development was a partnership between industry and government.

Improvement and maintenance of infrastructure already in place was a responsibility of the sector and its constituent firms. Identification of new and better technology was the responsibility of the sector. Innovation and creativity were lacking in the modernisation of the current technology in industry. It appeared as though many of the firms that were included in the study were resigned to fate in that there were no developmental activities that they were doing. At sectoral level, there was a lot that associations like the ZAM could do to raise the creativity of firms instead of waiting on the government all the time.

6.1.3 Firm-Level Consideration

6.1.3.1 Supply of Inputs

It was established that inputs (in terms of raw materials, semi-finished components and spare parts) were expensive for industry in Zambia. This was because most of these were

procured from outside the country. There was not much that was manufactured locally. Much of the steel and non-ferrous material that was being used by machine shops and foundries was scrap. This obviously put Zambian industry at a very serious disadvantage. It was concluded that unless the country developed its own primary industries to produce steel and other basic metals for secondary industries, raw materials for the engineering sub-sector would continue to be expensive.

Lack of trained manpower was as much a problem of the industry itself as it was for government. In the past, industry used to sponsor students to institutions of higher learning in order to boost its manpower reservoir. While now it might be argued that government had neglected technical training, it could also be argued that industry had neglected what it had done for years. As was the case now, industry was the one that suffered ultimately.

Information systems and organisational frameworks were a result of the quality of personnel running a firm. While it was important to have these in place, there was need to have personnel, in the first place, who appreciated information and good organisation. Good-calibre personnel would pursue R & D, good-calibre personnel would undertake necessary machinery and process modifications improve productivity and high-calibre personnel would recognise the need for new and better technology to augment or replace the current in order the keep the firm abreast with world technological trends.

6.1.3.2 The Black Box and Production Technology

(a) Technology Choices

i) If companies were innovative to improve production by procuring new production technologies in order to enhance their productivity or modifying existing technologies to enhance production, the sub-sector would have been more productive than it was at present. It was found that Boart Longyear was in the lead in this area. The company had made deliberate efforts to modernise production by procuring new and more advanced production technologies (CNC technology). It was also making efforts to improve the older technology already in use.

An example of improving old technology was the modification by Boart Longyear of an ordinary centre lathe into a threading machine for the mining drill bits. The modified centre lathe, which had its throughput increased to about 100 pieces per hour, became

a very invaluable addition to production machinery in the company. The company made tremendous savings by modifying a centre lathe (already in the company) instead of procuring a new threading machine.

ii) The use of electricity in many of the operations that currently used petroleum fuels such as firing boilers and furnaces could also be done. Electricity was still cheaper than petroleum fuels.

(b) Development of Technological Capabilities

With poor R & D, the sub-sector could never improve its technological capabilities. Moreover, once production declined, it was not possible for the sub-sector to fund its own research functions. Since there was no close liaison between the sub-sector and the quasi-government research institutions, there was little engineering research going on, to the extent that the sub-sector gained little or nothing from these institutions.

From visits to some of the firms in the sub-sector, it was apparent that there was much that could be done to improve their capabilities. Firstly, they could invest in new and more efficient technologies to enhance production. Secondly, they could have made modification to existing facilities to improve work flow, and therefore, production and efficiency. Thirdly, they could have made modifications to existing machinery to improve output and efficiency. Fourthly, they could have (each firm) specialised in a limited range of products and master those products to the extent that they gained competitive advantage.

With the way many firms were currently operating, it was not hoped that there would be improvement in the performance of the sub-sector any time soon. While the sub-sector was now unable to improve or create its own technological capabilities, it was also not really able even to import new but foreign technologies.

(c) Cellular Layout (Group Technology)

Use of Cellular layout system of production offered unique opportunities to engineering companies that were innovative and wanted to have competitive advantage over others in their field. Opportunities it offered included:

(i) improved production,

(ii) improved capital and labour productivity through multi-skilling and low operator-to-machine ratios,

(iii) improved quality and enhanced competitiveness through the development of total quality management (TQM) in the production cells, and

(iv) reduced inventories in tooling, jigs/fixtures, raw materials, and finished goods – thus untying funds for other uses.

The change, especially from process layout, to cellular layout was a challenge, to companies, that called for intense market survey, and production focussing. While it might appear a difficult task, there was no doubt that its benefits would ultimately be immense.

(d) Total Quality Management (TQM) and Quality Certification

The effect of poor quality standards in the manufacturing industry in general, and the engineering sub-sector in particular, was disastrous in Zambia. With liberalisation came high quality goods from abroad and consumers had a choice once again. Since local industries were no longer monopolies protected by government, the industrial collapse that followed, therefore, was inevitable under these circumstances.

One unquestionable factor that determined the success of any manufacturer was the quality of its products. There was need for manufacturers to ensure that they adopted TQM in their every day operations if they were going to be competitive both on the local and international markets. Consumers would continue to demand better quality products, and therefore, companies did not have the luxury to wait long periods before they adopted TQM fully.

The ISO 9000 series certification standards put forth by the International Organisation for Standardisation now played a major role in setting quality standards for global manufacturers in particular. Many European companies now required that their vendors met these standards as a condition for obtaining contracts. It was just a matter of time before this condition affected Zambian manufacturers more seriously than it did presently, with the evolution of the world as a global village.

6.1.3.3 Output Side and Feedback

One lesson to be learnt from the Zambian experience was that, with or without competition, quality must never be neglected in production. It was seen that when competition suddenly

came onto the scene, Zambian firms were at a very great disadvantage compared with firms from the sub-region where the market economy was already in place. While, initially, the consumer/clients did not complain much about the quality and quantity of output, they nevertheless longed for something better. Firms failed to see the needs of the clients and, instead, continued to produce what they were able to without serious attempts to improve.

Institution like ZABS, ZACCI and ZAM were not able to implement quality requirements, and therefore failed to meet the needs of the people they were supposed to be serving.

6.1.3.4 Disturbances

(a) VAT

Currently, ZRA were too hard on companies by demanding payment within 21 days from the end of the invoice month. Essentially in 21 days, customers on 30-day credit terms would not have paid the companies. The present tax system was harsh on industry. The 17.5 per cent VAT was too high to stimulate any meaningful industrial growth. Moreover the tax base was not wide enough, as there were businesses and firms that did not pay any tax because the present tax system did not cover them. ZRA were crippling industry with what companies termed heavy taxation and the 'unreasonable' attitude of ZRA when demanding payment.

(b) Import Duty

Import duty and VAT charged on imports appeared as double taxation to the importers. When a firm imported raw materials and machinery to set up a plant or to keep an existing one running, imposition of both VAT and import duty on the imports - especially those that could never be found or made locally - meant the final products would be expensive. Obviously, such products would be lesser competitive than those finished goods directly imported from countries that subsidised their exports.

(c) Zero-Tariff COMESA Treaty

With the ratifying of the Common Market for Eastern and Southern Africa (COMESA) no-tariff treaty, Zambian manufacturers stood to lose business to their counterparts, especially, from Zimbabwe and South Africa. This would be disadvantageous to the Zambian manufacturers because they heralded from a weak and command economy. Quality in the Zambian manufacturing industry and the spirit of competition still needed to be developed

and it would take some time before quality awareness and management took hold in the Zambian industry.

(d) Financial Aid

The cost of borrowing in Zambia was high and not many industries were able to get loans from financial institutions to enhance their production. This was because of high interest rates that lending institutions were charging on loans. While there was no clear policy from government to assist industry financially, it must be appreciated that other countries in the sub-region did this. In Botswana, for example, it was government policy to assist emerging industries through soft loans and other financial incentives.

(e) Management of Companies

Among the errors made in the management of parastatal companies and other manufacturing companies, in general, was that there was too much concentration of power in the top management. When power was concentrated in a few people at the top there developed two classes of employees. Either they felt they were 'the managers' - in which case they had to make all the decisions or 'the managed' - in which case they did not make or felt no need to make any decisions.

(f) Privatisation of ZCCM

Much of the lull in industry, especially on the Copperbelt, could be directly linked to the delayed privatisation of the Zambia Consolidated Copper Mines (ZCCM). Most engineering companies on the Copperbelt got the major part of their business from ZCCM. With the delay in the privatisation of the remaining assets of the mines, ZCCM operations were at their lowest ebb, and this had adversely affected the engineering companies as well.

(g) Energy Costs

Zambia was currently self-sufficient in electricity and coal. Zambia exported electricity to other countries like Zimbabwe, Namibia, Botswana and the Democratic Republic of Congo. Though locally available coal was of lower quality than what was obtained from the Wankie Coalfields in Zimbabwe, it was quite a saving on foreign exchange to get the fuel locally.

Petroleum was imported from the Arab world as crude oil that was refined at Indeni Petroleum Refinery in Ndola. This was at a very high expense and quite a drain on the

country's meagre resources. The use of electricity as an alternative to petroleum fuels had not been fully explored as a viable option. Presently electricity was cheaper than petroleum, and was lesser harmful to the environment than petroleum fuels.

(h) Import Substitution

This was a good policy if it had been pursued with due consideration of other salient factors as well. When Zambia embarked on this policy, there was too mush protection of the local industry by the state, to the extent that complacency crept in so much that the spirit of competition among firms was destroyed. Since all parastatal firms belonged to the same holding company, ZIMCO, either directly or through INDECO, they became a 'sisterhood' of companies such that there was no need to compete. Instead companies started bailing each other out of financial problems.

It could be concluded that because of this policy and due to the intra assistance that was taking place within the ZIMCO group, those companies that were doing well were being plundered while those that were not doing well, could not improve because there was ready help all the time.

(i) Management of Parastatal Firms in the Sub-Sector

From the way the parastatal sector was managed, it was concluded that at the time the sector was set up, it was necessary to use formal management that concentrated power at the top. At that time government had an interest in charting the developmental path of the country. Against that background, once the sector was able to stand on its own feet, it should have been left to use more flexible management styles by which all workers would be involved in the management process.

It also was clear that Zambianisation was the driving force in the appointment of certain Zambian managers though they were not really experienced enough to run the firms they were appointed into. In any case, there was the ZIMCO/INDECO dependency that they could fall back on in case of problems in their firms. Thus managers never really developed the required independence in managing the sub-sector.

(j) Political Interference

It could be concluded that, from the experience of Zambia, too much political involvement in commerce, trade and industry had a very serious and damaging effect on the economy. From Zambia's experience, it was clear that the interests of the country and those of the political parties were confused and, perhaps, considered the same. Nationalisation was not entirely necessary for Zambia. Zambianisation was done too quickly. The formation of political party committees and works councils at places of work (and the resulting wrangling with trade unions) was destructive because these institutions were obviously abused by those who belonged to them.

(k) Privatisation

In principle, privatisation was a good policy because it delinked government from the direct running of the economy. It was, however, done in a hurry. The government should have tried to resuscitate the enterprises just before privatising them so that it could earn more money from their sale. Although the official failure figure of was 3 per cent of all the firms privatised, in practice, many of the companies still considered operational were as good as closed because of low levels of output and their inability to pay their workers on time.

It was concluded that in the privatisation process, government lost out in the sale values of the companies. Workers who lost employment were not properly catered for, as many of them were not paid their terminal benefits on time. There should have been a more deliberate policy to ensure that multi-nationals that wanted to buy interests in the former parastatals should have done so in partnership with Zambians. This would have been a surer way to 'empower' Zambians economically than was the case at present.

(l) Environmental Considerations

The Environmental Council of Zambia and industry had not adequately tackled issues of the environment in general. Presently, there was too much smoke from industry, there were too many effluents being let into storm drains, without due regard to the harm these did to the environment. It did not immediately appear serious now that these effluents were being let into the environment so care freely since production was low. However, once industry stepped up production and there were more effluents being let out, the effect of these effluents would become a very serious environmental problem.

6.2 RECOMMENDATIONS

It is recommended that the Model Solution proposed in Chapter 5 be implemented without delay as a way forward for a sustainable engineering sub-sector in particular and the manufacturing sector in general. It is believed that the steps proposed can be implemented. The Model Solution points out the needs of the sub-sector, the industry and the country as a whole. It further suggests the steps both government and industry (including the engineering sub-sector) can take to redress the current situation.

6.2.1 Recommendations for A Sustainable Engineering Sub-Sector

6.2.1.1 Industry Initiatives

For its part industry must do the following:

a) Firms must upgrade production technologies either by procuring new equipment or modifying the existing ones in order to be more competitive
b) Firms (machine shops) must endeavour to change to cellular facility layout in order to make it easier for job design, job flow, capacity planning and utilisation, machinery arrangement and modernisation
c) Firms must limit range of products in order to avoid over stocking or under stocking of requisite materials, tools, equipment and fixtures and to improve quality of products
d) Firms must limit sources of supply of raw materials in order to standardise the product properties
e) Firms must also find alternative local raw materials to replace some imported ones
f) Firms must either invest in own R & D, go into joint research with other companies or use the facilities of quasi-government research institutions (NISIR, TDAU, University of Zambia School of Engineering)
g) Firms must develop a culture for design within the firm so that the engineers are living in constant challenge for the better of the firm
h) Total Quality Management must be implemented by all firms in order to produce high quality products that will compete on the world market (ZABS must be more aggressive in the implementation of quality standards in Zambia)
i) In addition to foreign quality certification, firms must also have local quality certification
j) Firms must carry out market surveys in order to be sure that their products have market or in order to know what market to produce for in the first place
k) Firms that use fossil fuels must consider using electricity for their operation because electricity is still cheaper than petroleum fuels.

6.2.1.2 Government Initiatives

For its part the government as a facilitator must do the following:

a) Come up with a strategy for a sustainable engineering sub-sector and manufacturing as a whole, like introducing financial incentives for emerging and struggling firms so that they could develop, especially that privatisation was carried out in a hurry and to the detriment of the manufacturing sector and the engineering sub-sector
b) Make a clear distinction between politics and commerce, trade and industry. While this might not appear a serious problem with the current government, it can only be insisted that there must be no political interference in the running of industry.
c) Regional treaties like the COMESA Zero-Tariff Treaty must be entered into with the utmost of caution, as they are likely to put local industry at a disadvantage in favour of other regional competitors. Local industry will need initial limited government protection upon implementing the Zero-Tariff Zone.
d) Reduce taxation for the manufacturing industry, in order to reduce the financial burden on and boost the sub-sector.
e) Reduce import duty on imported raw materials and capital machinery, especially those that are not made in Zambia to encourage investment in manufacturing.
f) Broaden the tax base in order to ensure that all entrepreneurs pay tax.
g) As a matter of policy, foreign investment must be permitted in partnership with Zambians. This will economically empower Zambians.

As earlier stated, unless this partnership between government and industry is recognised and exploited, all efforts by the one without the other party will be futile. Zambia's developmental path is precarious but it can be put right.

6.2.2 Recommendations for Future Work

This study brought to the fore the broader problems in the Zambian manufacturing industry, particularly the engineering sub-sector. There is need to carry out more research concerning this vital sector in the Zambian economy. Future research work must be smaller in scope, more targeted and more oriented towards solving more of actual industrial problems.

The following recommendations are being made for future work:

a) This study could be re-done in its present form, taking into account the recommendations made in Section 6.1.4.2 (re-focusing and narrowing the scope down) but involving more companies within and outside Lusaka, Ndola, Kitwe and Luanshya. It is believed that the results found would be more representative of what is really obtaining in the country.

b) One major setback in the engineering industry in Zambia is the poor quality of its products. There is very urgent need to carry out a study on problems associated with companies that have already implemented, those that are still trying and those that are not yet trying to implement total quality management (TQM). With the world fast turning into a global village, companies that do not implement TQM will lose both on the local and international markets.

c) Privatisation was introduced to enhance a private sector driven economy in Zambia. Whether or not this programme has been successful in Zambia should be the subject of a study. The study should look at the local industry prior, during the process of and after privatisation. Could the results of privatisation have been better if it was implemented another way?

d) A study should be carried out to analyse the trend of capacity utilisation with current the current changes in policy in Zambia, i.e. the current focus on both internal and external markets.

The following considerations would be of particular importance as regarding approach to future research:

e) Funding was the most serious limiting factor in this work. It was felt that had there been reasonably good funding for this research (at least 50 per cent of the budgeted US$3,700), more work, in terms of quality and quantity, would have been done and better results achieved.

During data collection it was found that some company officials who were custodians of the required information were not eager to complete questionnaires for the researcher or

to look through the archives for the required information. They felt that this was another job in addition to their normal work. It would, however, appear that they would do this 'extra job' for some additional pay. At the same time, the research student was not able to stay at any company for more than a part of a day on each visit because of funding constraints.

If funding had been ample, it was necessary to stay at companies much longer than was actually done. It would have been necessary to, also, pay some of the people who assisted in order to ensure they did their best to give the researcher correct information.

f) This study was found to be very broad. It was felt that it attempted to tackle too many things. Focus could have been on two things: technology choice in the engineering sector and productivity growth. Questions with regard to technology choice such as - What kinds of choices have actually been made in the sector? What kinds of machinery have been acquired? What are their technological characteristics? Why and how have they been acquired? What use has been made of them? What capital labour ratios does one find? How well is capital utilised? What are important technological bottlenecks? These would have received more attention and would have reduced the scope but increased the focus of the study.

g) Some companies were so uncomfortable giving information to third parties that they refused to release data to the research student for this study. Others accepted the questionnaires but were unwilling to complete them. It was feared that information released for this study might reach their competitors and put them to competitive disadvantage. Companies needed to be given more formal assurance that their company data and information released to an academic institution was safe and would not inadvertently fall into the hands of their competitors.

h) Companies that were used in this study were all based in Lusaka and the Copperbelt (Ndola and Kitwe) only. Due to funding constraints, it was easier to deal with companies within Lusaka and those within a small area on the Copperbelt - because they could be reached with minimal expense. This limited the number of companies that could have been used in the study. Companies in other parts of the Copperbelt and the country would have been suitable for the study, too, had they been included.

SEMINAR PRESENTATIONS

1. "An Overview of the Performance of the Manufacturing Industry in Zambia (1964 - 1997)." Paper presented to The Engineers' Registration Board of Zambia National Symposium on the theme: "Engineering: A Sub-Regional Perspective" at the Taj Pamodzi Hotel Lusaka, Zambia on 27 and 28 August 1999.

2. "Cellular Layout Production: Is It Feasible in Zambia?" Paper presented to The First National Conference on Recent Advances in Engineering Research and Development, organised by The University of Zambia in conjunction with The Engineers' Registration Board on the theme: "Engineering Research and Development Beyond 2000" at the Hotel Intercontinental, Lusaka, Zambia on 12 and 13 November 1999.

REFERENCES

[1] GRZ (CSO) (1994), **Census of Production**, Lusaka: Government Printer.

[2] GRZ (ZIC) (1997), **Comparative Statistics**, Lusaka: Zambia Investment Centre.

[3] GRZ (NCDP) (1979), "Manufacturing," in **The Third National Development Plan, 1978 - 1982**, Lusaka: Government Printer.

[4] Inter-Africa Corporate Services (Zambia) Limited (1997), Promotion of Sustainable Linkages between the Technology Development and Advisory Unit, National Council for Scientific Research and Zambia Bureau of Standards and Industry. (A study) Commissioned by the Government of the Republic of Zambia (Ministry of Commerce Trade and Industry), Lusaka: Ministry of Commerce Trade and Industry.

[5] Willoughby, K. W. (1990), **Technology Choice: A Critique of the Appropriate Technology Movement**, London: Intermediate Technology Publications.

[6] De Bruin, E. G. A. J. & Tambatamba, M. J. (1995), **Technology Based Development Strategy for the Agricultural Machinery Sub-Sector: Zambia as a Case Study**, Eindhoven: Eindhoven University of technology.

[7] Yamba, F. D. (1988), Pre-Feasibility Study on Upgrading and Rehabilitation of Foundries, Forges, Fabrication and Machining Facilities for the Manufacture of Components and Spare Parts in Zambia, Lusaka: University of Zambia.

[8 Mwenda, H. M. (1996), The Current State of the Manufacturing Industry in the Zambian Economy, Lusaka: University of Zambia.

[9] Nkanza, P. K. (1996), "Future of Engineering and Manufacturing in a Liberalised Economy," in The Proceedings of the Engineering Institution of Zambia (EIZ) Conference on the, 24 August 1996, Lusaka: The Engineering Institution of Zambia.

[10] Shaaeldin, E. (1988), Sources of Industrial Growth in Kenya, Tanzania, Zambia and Zimbabwe, Abidjan: The Africa Development Bank.

[11] Gulhati, R. & Sekhar, U. (1981), Industrial Strategy for Late Starters: The Experience of Kenya, Tanzania and Zambia, World Bank Staff Working Paper No. 457, Washington, D.C.: World Bank.

[12] Koontz, Harold & O'Donnel, Cyril (1972), **Principles of Management: An Analysis of Managerial Functions**, 5th Ed., New York: McGraw-Hill Book Company.

[13] Shaaeldin, E. (1988), Sources of Industrial Growth in Kenya, Tanzania, Zambia and Zimbabwe, Abidjan: The Africa Development Bank.

[14] ATLAS (1989), A Framework for Technology Based Development, Technology Needs Assessment, Vol. 2, Bangalore: UN/ESCAP.

[15] Brogan, William L. (1974), **Modern Control Theory**, New York: Quantum Publishers, Incorporated.

[16] Guppy, S. P. (1981), **Statistical Methods**, 26th Ed., New Delhi: Sultan Chand & Sons Publishers.

[17] Surrey, M. J. C. (1976), **Macro Economic Themes**, Oxford: At the University Press.

[18] Sumanth, David J. (1984), **Productivity Engineering and Management, Productivity Planning and Improvement in Manufacturing and Service Organisations**, New York: McGraw-Hill Book Company.

[19] G.R.Z. (ZPA) (1999), "The collapse of some privatised entities," in Privatisation News: A publication of the Zambia Privatisation Agency, Issue No. 4, January 1999, Lusaka: Zambia Privatisation Agency Public Relations Department.

[20] GRZ, MOF (1994), Budget Address to the National Assembly by the Minister of Finance, Lusaka: Ministry of Finance.

[21] CHASE, Richard B. & AQUILANO, Nicholas J. (1995), **Production and Operations Management: Manufacturing and Services**, 7th Ed., Chicago: The McGraw-Hill Companies, Inc., pp. 235-479.

[22] Van ENGELEN, Donne, et al. (1999), **Engineering and Society (I): Economic Aspects of Development**, Lusaka: University of Zambia.

[23] KWON, J. K. (1986), "Capacity Utilisation, Economies of Scale and Technical Change in the Growth of Total Factor Productivity: An Explanation of the South Korean Manufacturing Growth," **Journal of Development Economics,** Vol. 24, No. 1, New York: World Bank.

[24] BROWN, M. & POPKIN, J. (1962), "A measure of Technological Change and Returns to Scale," **Review of Economics and Statistics**, New York: World Bank.

[25] NISHIMIZU, Micko & ROBINSON, Sherman (1984), "Trade Policies and Productivity in Semi-Industrialised Countries," **Journal of Development Economics**, New York: World Bank.

[26] ARGYRIS C. (1960), **Understanding Organisational Behaviour**, Tavistock.

[27] Machungwa, Peter D. & Mwaba, Tresford K. (1988), **Works Councils and Other Committees, Aspects of Zambian Industrial Relations**, Lusaka: M & M Management and Labour Consultants Ltd, pp. 25 - 27.

[28] Shamenda, Fackson (August 1999), Address to the ZCTU National Conference in Kitwe on 27th August 1999.

[29] Krebbs, Dr. Jochem, (1999), Addressing Government Officials at the head of an EU Delegation to Zambia, August 1999.

[30] Murray Sanderson (1996), "The Business Perspective," in The Bank of Zambia International Conference on Economic Liberalisation: Experiences and The Way Forward, Lusaka: BOZ.

[31] Siaminwe, Levy (August, 1999), "Quality Transformation in Zambia – What Strategy?" Paper presented to the Engineering Institution of Zambia National Symposium on the Theme: "Engineering: A Sub-regional Perspective," at Taj Pamodzi Hotel, Lusaka on 27th August 1999.

[32] GRZ (FNDP) (1966), **First National Development Plan, 1966 to 1970**, Lusaka: Government Printer.

APPENDICES

APPENDIX A - ECONOMIC PERFORMANCE

APPENDIX A1: 1/6

GROSS DOMESTIC PRODUCT - 1964 TO 1998 (BY ECONOMIC ACTIVITY)

(AT 1990 CONSTANT PRICES)

TYPE OF ECONOMIC ACTIVITY / YEAR	1964		1965		1966		1967		1968		1969	
	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*
Agriculture, Forestry and Fishing	10.86	11.3	8.28	10.0	7.51	9.4	7.64	9.2	6.99	8.2	6.82	7.7
Mining and Quarrying	44.97	46.8	31.57	38.1	29.81	37.3	29.34	35.2	26.88	31.4	31.12	35.3
Manufacturing	7.02	7.3	6.04	7.3	7.47	9.3	8.43	10.1	8.11	9.5	10.54	12.0
Food, Beverages and Tobacco	2.29	2.4	1.87	2.3	2.51	3.1	2.40	2.9	2.58	3.0	4.69	5.3
Textile and Leather Industries	0.51	0.5	0.57	0.7	0.56	0.7	0.93	1.1	0.75	0.9	0.98	1.1
Wood and Wood Products	0.39	0.4	0.35	0.4	0.43	0.5	0.31	0.4	0.21	0.2	0.57	0.6
Paper and Paper Products	0.43	0.4	0.30	0.4	0.31	0.4	0.41	0.5	0.56	0.7	0.43	0.5
Chemical, Rubber and Plastics	0.71	0.7	0.53	0.6	0.53	0.7	0.85	1.0	0.84	1.0	1.34	1.5
Non-Metallic Mineral Products	1.22	1.3	0.92	1.1	0.77	1.0	0.81	1.0	0.82	1.0	0.70	0.8
Fabricated Metal Products	0.90	**0.9**	1.03	**1.2**	1.15	**1.4**	1.47	**1.8**	1.88	**2.2**	1.78	**2.0**
Other Manufacturing	0.57	0.6	0.45	0.5	1.20	1.5	1.22	1.5	0.47	0.5	0.04	0.0
Electricity, Gas and Water	1.02	1.1	0.80	1.0	0.92	1.1	0.93	1.1	1.31	1.5	1.80	2.0
Construction	4.07	4.2	5.95	7.2	6.70	8.4	6.44	7.7	6.72	7.8	6.77	7.7
Wholesale and Retail Trade	9.33	9.7	10.77	13.0	9.72	12.2	11.06	13.3	12.19	14.2	8.99	10.2
Restaurants and Hotels	0.00	0.0	0.54	0.7	0.58	0.7	0.56	0.7	0.57	0.7	1.13	1.3
Transport, Storage & Communications	4.20	4.4	4.90	5.9	4.02	5.0	5.69	6.8	5.12	6.0	4.37	5.0
Financial Institutions and Insurance	0.12	0.1	1.62	2.0	1.43	1.8	1.82	2.2	2.03	2.4	2.94	3.3
Real Estate and Business Services	2.16	2.2	2.83	3.4	2.95	3.7	3.72	4.5	3.83	4.5	4.44	5.0
Community, Social & Personal Services	12.30	12.8	9.60	11.6	8.88	11.1	8.60	10.3	10.97	12.8	10.51	11.9
Import Duties	0.00	0.0	0.00	0.0	0.00	0.0	1.31	1.6	1.70	2.0	2.71	3.1
Less: Imputed Bank Service Charges	0.00	0.0	0.00	0.0	0.00	0.0	-2.33	-2.8	-0.80	-0.9	-3.99	-4.5
Total GDP at Market Prices	**96.0**	**100**	**82.9**	**100**	**80.0**	**100**	**83.2**	**100**	**85.6**	**100**	**88.2**	**100**
Real GDP Growth Rates**	**0.0**		**-13.7**		**-3.5**		**4.0**		**2.9**		**2.9**	

Notes: * Percentages for each activity are of the Total GDP for that year.

** Each Real GDP Growth Rate is compared against the previous year, except 1964, which is the starting point.

Source: Central Statistical Office & International Financial Statistics, 1995, 1997 and March 1990.

APPENDIX A1- Continued: 2/6

GROSS DOMESTIC PRODUCT - 1964 TO 1998 (BY ECONOMIC ACTIVITY)

(AT 1990 CONSTANT PRICES)

TYPE OF ECONOMIC ACTIVITY / YEAR	1971		1972		1973		1974		1973		1976	
	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*
Agriculture, Forestry and Fishing	12.74	14.0	14.12	14.2	13.07	13.3	13.52	12.9	13.94	13.6	14.39	13.5
Mining and Quarrying	21.85	24.1	23.78	24.0	22.26	22.7	24.16	23.0	21.17	20.7	24.84	23.3
Manufacturing	9.27	10.2	11.04	11.1	11.78	12.0	12.43	11.9	10.94	10.7	10.22	9.6
Food, Beverages and Tobacco	5.06	5.6	6.14	6.2	4.72	4.8	4.56	4.3	4.22	4.1	4.19	3.9
Textile and Leather Industries	0.57	0.6	0.85	0.9	1.17	1.2	1.29	1.2	1.28	1.3	1.28	1.2
Wood and Wood Products	0.20	0.2	0.22	0.2	0.45	0.5	0.66	0.6	0.45	0.4	0.30	0.3
Paper and Paper Products	0.35	0.4	0.44	0.4	0.47	0.5	0.44	0.4	0.48	0.5	0.37	0.4
Chemical, Rubber and Plastics	0.79	0.9	0.87	0.9	2.12	2.2	2.28	2.2	2.15	2.1	2.13	2.0
Non-Metallic Mineral Products	0.63	0.7	0.71	0.7	0.65	0.7	0.61	0.6	0.48	0.5	0.40	0.4
Fabricated Metal Products	1.63	**1.8**	1.79	**1.8**	2.17	**2.2**	2.53	**2.4**	1.82	**1.8**	1.49	**1.4**
Other Manufacturing	0.03	0.0	0.02	0.0	0.03	0.0	0.02	0.0	0.05	0.1	0.04	0.0
Electricity, Gas and Water	2.13	2.3	2.97	3.0	4.42	4.5	5.20	5.0	5.44	5.3	5.66	5.3
Construction	5.51	6.1	6.19	6.2	6.28	6.4	7.11	6.8	8.58	8.4	9.32	8.8
Wholesale and Retail Trade	9.43	10.4	9.80	9.9	10.15	10.3	42.45	40.5	42.09	41.2	10.83	10.2
Restaurants and Hotels	1.33	1.5	1.49	1.5	1.63	1.7	0.00	0.0	0.00	0.0	1.35	1.3
Transport, Storage & Communications	5.12	5.6	4.80	4.8	4.96	5.0	0.00	0.0	0.00	0.0	4.30	4.0
Financial Institutions and Insurance	2.04	2.2	1.93	2.0	2.47	2.5	0.00	0.0	0.00	0.0	1.81	1.7
Real Estate and Business Services	4.86	5.4	4.88	4.9	5.32	5.4	0.00	0.0	0.00	0.0	6.37	6.0
Community, Social & Personal Services	14.79	16.3	16.26	16.4	14.56	14.8	0.00	0.0	0.00	0.0	16.33	15.3
Import Duties	2.48	2.7	2.55	2.6	2.13	2.2	0.00	0.0	0.00	0.0	1.76	1.7
Less: Imputed Bank Service Charges	-0.72	-0.8	-0.69	-0.7	-0.81	-0.8	0.00	0.0	0.00	0.0	-0.67	-0.6
Total GDP at Market Prices	**90.8**	**100**	**99.1**	**100**	**98.2**	**100**	**104.9**	**100**	**102.2**	**100**	**106.5**	**100**
Real GDP Growth Rates**	**-0.2**		**9.1**		**-0.9**		**6.8**		**-2.6**		**4.3**	

Notes: * Percentages for each activity are of the Total GDP for that year.

** Each Real GDP Growth Rate is compared against the previous year, except 1964, which is the starting point.

Source: Central Statistical Office & International Financial Statistics, 1995, 1997 and March 1990.

APPENDIX A1 - Continued: 3/6

GROSS DOMESTIC PRODUCT - 1964 TO 1998 (BY ECONOMIC ACTIVITY)

(AT 1990 CONSTANT PRICES)

TYPE OF ECONOMIC ACTIVITY / YEAR	1977		1978		1979		1980		1981		1982	
	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*
Agriculture, Forestry and Fishing	14.22	14.0	14.51	14.2	11.59	11.7	11.98	11.7	13.17	12.1	14.82	14.1
Mining and Quarrying	23.37	22.9	25.10	24.5	28.32	28.5	28.72	28.1	31.70	29.2	10.99	10.4
Manufacturing	9.42	9.2	10.11	9.9	11.81	11.9	11.73	11.5	13.17	12.1	21.20	20.1
Food, Beverages and Tobacco	3.79	3.7	3.90	3.8	4.09	4.1	4.26	4.2	4.76	4.4	7.86	7.5
Textile and Leather Industries	1.09	1.1	1.59	1.6	1.63	1.6	1.84	1.8	2.17	2.0	3.89	3.7
Wood and Wood Products	0.34	0.3	0.31	0.3	0.31	0.3	0.35	0.3	0.50	0.5	0.68	0.6
Paper and Paper Products	0.41	0.4	0.53	0.5	0.43	0.4	0.39	0.4	0.39	0.4	0.67	0.6
Chemical, Rubber and Plastics	2.17	2.1	2.04	2.0	2.22	2.2	2.01	2.0	2.55	2.4	3.48	3.3
Non-Metallic Mineral Products	0.38	0.4	0.49	0.5	0.74	0.7	0.52	0.5	0.63	0.6	1.02	1.0
Fabricated Metal Products	1.21	**1.2**	1.20	**1.2**	2.36	**2.4**	2.36	**2.3**	2.15	**2.0**	3.55	**3.4**
Other Manufacturing	0.04	0.0	0.04	0.0	0.02	0.0	0.02	0.0	0.02	0.0	0.04	0.0
Electricity, Gas and Water	6.11	6.0	6.23	6.1	5.87	5.9	6.11	6.0	6.69	6.2	3.87	3.7
Construction	8.99	8.8	6.54	6.4	5.02	5.1	5.70	5.6	4.44	4.1	4.29	4.1
Wholesale and Retail Trade	39.77	39.0	39.81	38.9	6.50	6.5	7.14	7.0	7.22	6.7	9.11	8.6
Restaurants and Hotels	0.00	0.0	0.00	0.0	1.21	1.2	1.40	1.4	1.78	1.6	3.03	2.9
Transport, Storage & Communications	0.00	0.0	0.00	0.0	4.57	4.6	4.07	4.0	4.37	4.0	6.07	5.8
Financial Institutions and Insurance	0.00	0.0	0.00	0.0	3.25	3.3	2.96	2.9	2.92	2.7	3.62	3.4
Real Estate and Business Services	0.00	0.0	0.00	0.0	6.12	6.2	6.56	6.4	7.18	6.6	7.95	7.5
Community, Social & Personal Services	0.00	0.0	0.00	0.0	14.64	14.8	15.18	14.9	15.17	14.0	20.11	19.1
Import Duties	0.00	0.0	0.00	0.0	1.09	1.1	1.23	1.2	1.43	1.3	1.39	1.3
Less: Imputed Bank Service Charges	0.00	0.0	0.00	0.0	-0.72	-0.7	-0.66	-0.6	-0.65	-0.6	-1.01	-1.0
Total GDP at Market Prices	**101.9**	**100**	**102.3**	**100**	**99.3**	**100**	**102.1**	**100**	**108.6**	**100**	**105.4**	**100**
Real GDP Growth Rates**	**-4.4**		**0.4**		**-3.0**		**2.9**		**6.3**		**-2.9**	

Notes: * Percentages for each activity are of the Total GDP for that year.

** Each Real GDP Growth Rate is compared against the previous year, except 1964, which is the starting point.

Source: Central Statistical Office & International Financial Statistics, 1995, 1997 and March 1990.

APPENDIX A1 - Continued: 4/6

GROSS DOMESTIC PRODUCT - 1964 TO 1998 (BY ECONOMIC ACTIVITY)

(AT 1990 CONSTANT PRICES)

TYPE OF ECONOMIC ACTIVITY / YEAR	1983		1984		1985		1986		1987		1988	
	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*
Agriculture, Forestry and Fishing	16.19	15.6	17.83	17.3	17.62	16.8	19.13	18.2	18.73	17.3	22.35	19.4
Mining and Quarrying	11.41	11.0	10.74	10.4	9.52	9.1	9.03	8.6	9.44	8.7	8.22	7.1
Manufacturing	19.79	19.1	16.61	16.1	21.61	20.6	21.77	20.7	23.71	21.9	28.02	24.3
Food, Beverages and Tobacco	7.34	7.1	6.26	6.1	9.07	8.7	9.20	8.7	9.69	8.9	12.79	11.1
Textile and Leather Industries	3.14	3.0	2.74	2.7	3.81	3.6	3.25	3.1	3.49	3.2	3.91	3.4
Wood and Wood Products	0.36	0.3	0.30	0.3	0.48	0.5	0.47	0.4	0.41	0.4	0.41	0.4
Paper and Paper Products	0.74	0.7	0.54	0.5	0.78	0.7	0.99	0.9	1.53	1.4	1.78	1.5
Chemical, Rubber and Plastics	3.31	3.2	2.89	2.8	2.20	2.1	2.13	2.0	2.00	1.8	2.02	1.8
Non-Metallic Mineral Products	1.34	1.3	0.76	0.7	1.34	1.3	0.98	0.9	1.09	1.0	1.29	1.1
Fabricated Metal Products	3.52	**3.4**	3.08	**3.0**	3.72	**3.5**	4.52	**4.3**	5.27	**4.9**	5.28	**4.6**
Other Manufacturing	0.04	0.0	0.04	0.0	0.22	0.2	0.23	0.2	0.24	0.2	0.54	0.5
Electricity, Gas and Water	3.72	3.6	3.81	3.7	3.73	3.6	3.64	3.5	3.19	2.9	3.14	2.7
Construction	4.56	4.4	4.76	4.6	3.95	3.8	4.15	3.9	3.96	3.7	3.60	3.1
Wholesale and Retail Trade	8.84	8.5	9.01	8.8	8.95	8.5	8.93	8.5	9.30	8.6	9.49	8.2
Restaurants and Hotels	2.87	2.8	2.63	2.6	2.63	2.5	2.40	2.3	2.38	2.2	2.49	2.2
Transport, Storage & Communications	6.15	5.9	6.24	6.1	5.60	5.3	5.64	5.3	5.87	5.4	5.80	5.0
Financial Institutions and Insurance	3.41	3.3	3.36	3.3	3.11	3.0	2.91	2.8	2.60	2.4	3.07	2.7
Real Estate and Business Services	8.25	8.0	9.64	9.4	9.17	8.8	9.14	8.7	9.69	8.9	9.79	8.5
Community, Social & Personal Services	18.31	17.7	18.30	17.8	18.74	17.9	18.32	17.4	18.99	17.5	19.13	16.6
Import Duties	0.95	0.9	0.97	0.9	1.02	1.0	1.15	1.1	1.18	1.1	0.86	0.7
Less: Imputed Bank Service Charges	-0.95	-0.9	-0.94	-0.9	-0.87	-0.8	-0.81	-0.8	-0.72	-0.7	-0.85	-0.7
Total GDP at Market Prices	**103.5**	**100**	**102.9**	**100**	**104.8**	**100**	**105.4**	**100**	**108.3**	**100**	**115.1**	**100**
Real GDP Growth Rates**	**-1.8**		**-0.5**		**1.8**		**0.6**		**2.8**		**6.3**	

Notes: * Percentages for each activity are of the Total GDP for that year.

** Each Real GDP Growth Rate is compared against the previous year, except 1964, which is the starting point.

Source: Central Statistical Office & International Financial Statistics, 1995, 1997 and March 1990.

APPENDIX A1 - Continued: 5/6

GROSS DOMESTIC PRODUCT - 1964 TO 1998 (BY ECONOMIC ACTIVITY)

(AT 1990 CONSTANT PRICES)

TYPE OF ECONOMIC ACTIVITY / YEAR	1989		1990		1991		1992		1993		1994	
	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*	K'Billion	%*
Agriculture, Forestry and Fishing	21.49	18.9	19.78	17.5	20.45	18.4	15.00	12.6	22.85	19.9	17.14	13.5
Mining and Quarrying	8.89	7.8	8.32	7.3	7.44	6.7	9.20	7.7	7.61	6.6	21.20	16.7
Manufacturing	27.55	24.2	30.02	26.5	29.50	26.5	36.23	30.5	30.22	26.3	12.48	9.8
Food, Beverages and Tobacco	12.21	10.7	13.75	12.1	14.30	12.8	19.68	16.6	17.34	15.1	7.64	6.0
Textile and Leather Industries	3.80	3.3	4.27	3.8	3.67	3.3	3.87	3.3	2.51	2.2	1.41	1.1
Wood and Wood Products	0.41	0.4	0.53	0.5	0.60	0.5	0.63	0.5	0.60	0.5	1.16	0.9
Paper and Paper Products	1.89	1.7	1.73	1.5	1.68	1.5	1.79	1.5	1.59	1.4	0.32	0.3
Chemical, Rubber and Plastics	2.56	2.2	1.95	1.7	1.94	1.7	1.96	1.7	1.87	1.6	1.03	0.8
Non-Metallic Mineral Products	1.33	1.2	1.68	1.5	1.15	1.0	1.60	1.3	1.00	0.9	0.23	0.2
Fabricated Metal Products	5.26	**4.6**	5.35	**4.7**	5.37	**4.8**	6.03	**5.1**	4.45	**3.9**	0.55	**0.4**
Other Manufacturing	0.56	0.5	0.69	0.6	0.80	0.7	1.04	0.9	0.86	0.7	0.14	0.1
Electricity, Gas and Water	2.63	2.3	3.06	2.7	3.21	2.9	3.34	2.8	3.13	2.7	4.10	3.2
Construction	3.20	2.8	3.20	2.8	3.11	2.8	3.22	2.7	2.23	1.9	6.33	5.0
Wholesale and Retail Trade	9.56	8.4	9.25	8.2	8.93	8.0	9.13	7.7	9.16	8.0	18.84	14.8
Restaurants and Hotels	2.77	2.4	2.77	2.4	2.46	2.2	4.33	3.6	3.78	3.3	2.05	1.6
Transport, Storage & Communications	5.58	4.9	5.22	4.6	4.88	4.4	4.66	3.9	4.06	3.5	7.59	6.0
Financial Institutions and Insurance	3.11	2.7	2.75	2.4	2.75	2.5	2.88	2.4	2.70	2.4	10.37	8.2
Real Estate and Business Services	10.17	8.9	9.35	8.3	8.96	8.0	10.23	8.6	9.56	8.3	6.41	5.0
Community, Social & Personal Services	19.01	16.7	19.52	17.2	19.51	17.5	21.24	17.9	19.53	17.0	10.14	8.0
Import Duties	0.81	0.7	0.81	0.7	0.85	0.8	1.20	1.0	1.00	0.9	16.43	12.9
Less: Imputed Bank Service Charges	-0.87	-0.8	-0.76	-0.7	-0.76	-0.7	-1.76	-1.5	-1.14	-1.0	-5.96	-4.7
Total GDP at Market Prices	**113.9**	**100**	**113.3**	**100**	**111.3**	**100**	**118.9**	**100**	**114.7**	**100**	**127.1**	**100**
Real GDP Growth Rates**	**-1.1**		**-0.5**		**-1.8**		**6.8**		**-3.5**		**10.8**	

Notes: * Percentages for each activity are of the Total GDP for that year.

** Each Real GDP Growth Rate is compared against the previous year, except 1964, which is the starting point.

Source: Central Statistical Office & International Financial Statistics, 1995, 1997 and March 1990.

APPENDIX A1 Concluded: 6/6

GROSS DOMESTIC PRODUCT - 1964 TO 1998 (BY ECONOMIC ACTIVITY)

(AT 1990 CONSTANT PRICES)

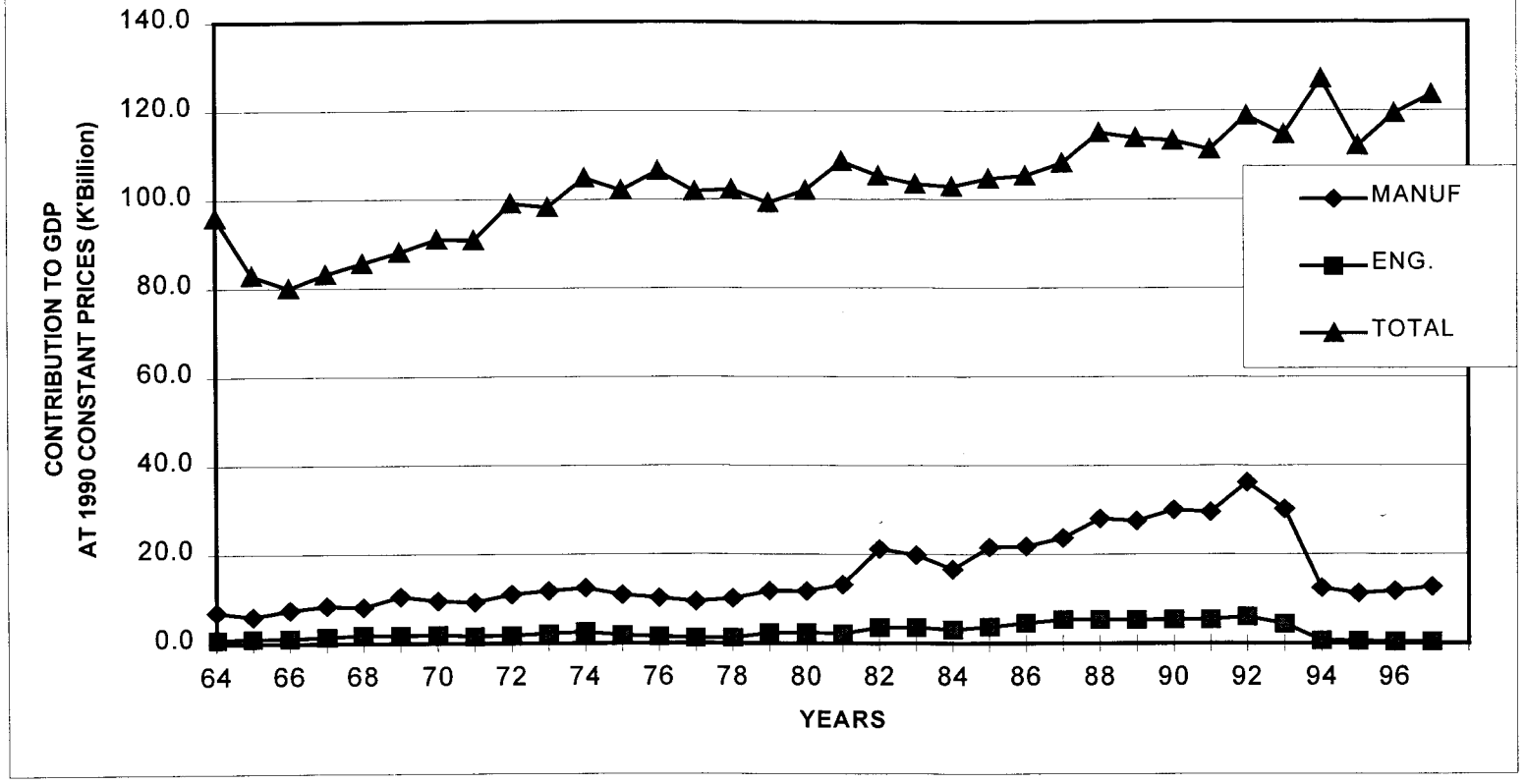
TYPE OF ECONOMIC ACTIVITY / YEAR	1995		1996		1997	
	K'Billion	%*	K'Billion	%*	K'Billion	%*
Agriculture, Forestry and Fishing	20.62	18.4	20.50	17.2	19.80	16.0
Mining and Quarrying	13.87	12.4	14.22	11.9	14.56	11.8
Manufacturing	11.22	10.0	11.84	9.9	12.71	10.3
Food, Beverages and Tobacco	7.21	6.4	7.39	6.2	7.36	6.0
Textile and Leather Industries	1.13	1.0	1.39	1.2	2.01	1.6
Wood and Wood Products	0.95	0.8	0.93	0.8	1.00	0.8
Paper and Paper Products	0.23	0.2	0.25	0.2	0.37	0.3
Chemical, Rubber and Plastics	0.83	0.7	1.05	0.9	1.15	0.9
Non-Metallic Mineral Products	0.23	0.2	0.24	0.2	0.21	0.2
Fabricated Metal Products	0.52	**0.5**	0.40	**0.3**	0.41	**0.3**
Other Manufacturing	0.12	0.1	0.19	0.2	0.20	0.2
Electricity, Gas and Water	3.64	3.2	3.44	2.9	3.80	3.1
Construction	5.52	4.9	4.83	4.0	6.47	5.2
Wholesale and Retail Trade	15.21	13.6	20.43	17.1	21.15	17.1
Restaurants and Hotels	1.91	1.7	2.06	1.7	2.25	1.8
Transport, Storage & Communications	6.66	5.9	7.05	5.9	7.10	5.7
Financial Institutions and Insurance	11.16	10.0	10.24	8.6	10.11	8.2
Real Estate and Business Services	6.26	5.6	7.23	6.1	8.13	6.6
Community, Social & Personal Services	9.04	8.1	9.35	7.8	9.38	7.6
Import Duties	13.41	12.0	14.10	11.8	13.96	11.3
Less: Imputed Bank Service Charges	-6.41	-5.7	-5.89	-4.9	-5.81	-4.7
Total GDP at Market Prices	**112.1**	**100**	**119.4**	**100**	**123.6**	**100**
Real GDP Growth Rates**	**-11.8**		**6.5**		**3.5**	

Notes: * Percentages for each activity are of the Total GDP for that year.

** Each Real GDP Growth Rate is compared against the previous year, except 1964, which is the starting point.

Source: Central Statistical Office & International Financial Statistics, 1995, 1997 and March 1990.

APPENDIX A2: MANUFACTURING AND ENGINEERING CONTRIBUTION TO TOTAL GDP (1964 - 1997)



APPENDIX A3: 1/3

ESTIMATED POPULATION OF ZAMBIA AND PER CAPITA GDP - 1964 TO 1998

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
POPULATION (IN MILLIONS)	3.59	3.68	3.77	3.86	3.96	4.06	4.16	4.40	4.52	4.65	4.70	4.84
PER CAPITA GDP												
ENGINEERING (K'000)	0.25	0.28	0.31	0.38	0.48	0.44	0.47	0.37	0.40	0.47	0.54	0.38
MANUFACTURING (K'000)	1.96	1.64	1.98	2.18	2.05	2.60	2.29	2.11	2.44	2.53	2.65	2.26
TOTAL INDUSTRY (K'000)	26.77	22.54	21.22	21.54	21.62	21.71	21.87	20.65	21.91	21.13	22.32	21.10
Per Capita Production Indices (1990 = 100%)												
ENGINEERING (%)	36.4	40.7	44.6	55.6	69.2	64.0	68.4	54.0	57.6	67.9	78.5	54.7
MANUFACTURING (%)	50.7	42.6	51.4	56.5	53.1	67.2	59.4	54.6	63.2	65.7	68.5	58.6
TOTAL INDUSTRY (%)	183.8	154.8	145.7	147.9	148.5	149.1	150.2	141.8	150.5	145.1	153.3	144.9

APPENDIX A3: Continued **2/3**

ESTIMATED POPULATION OF ZAMBIA AND PER CAPITA GDP – 1964 TO 1998

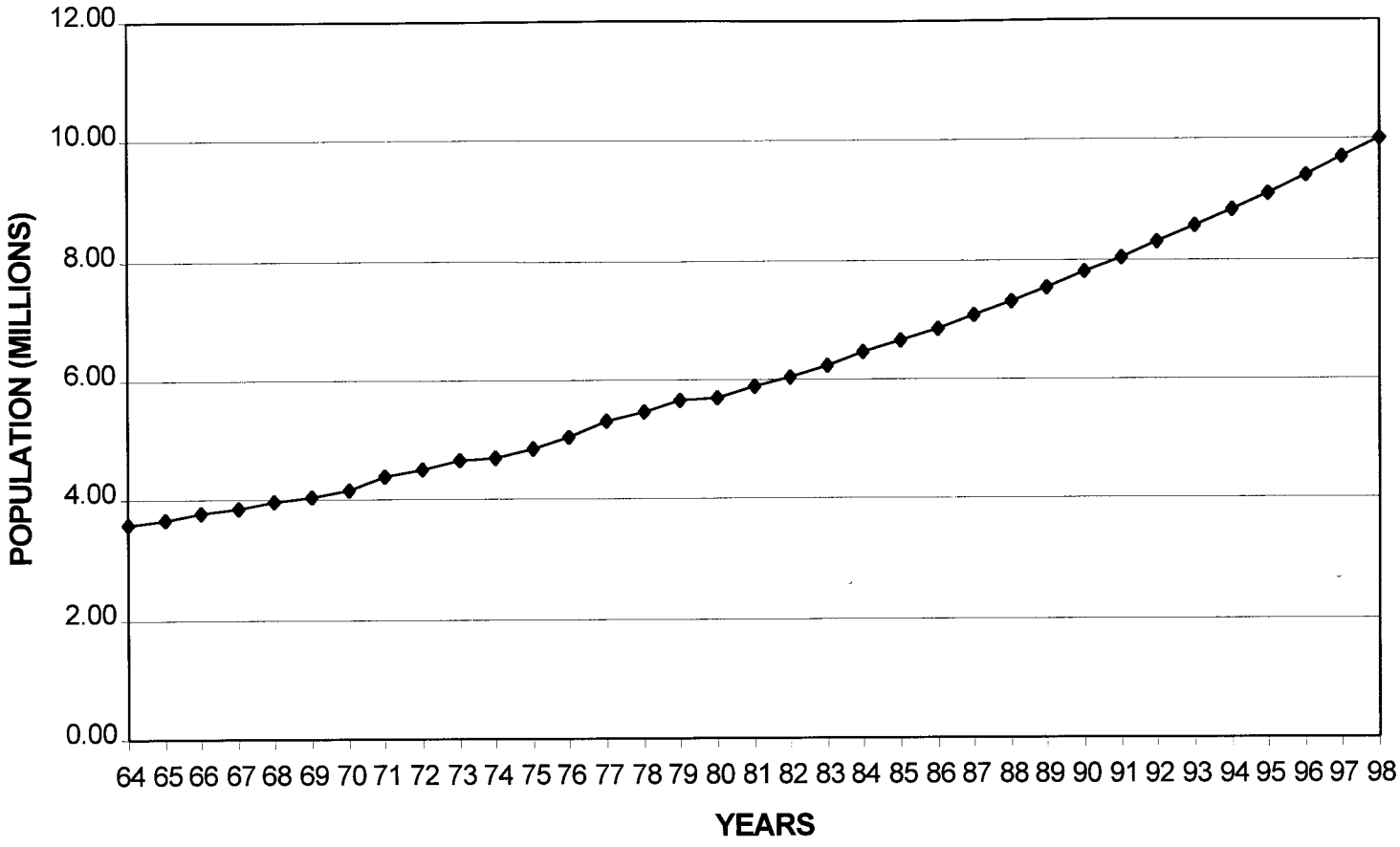
YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
POPULATION (IN MILLIONS)	5.06	5.30	5.47	5.65	5.68	5.87	6.05	6.24	6.44	6.65	6.86	7.08
PER CAPITA GDP												
ENGINEERING (K'000)	0.29	0.23	0.22	0.42	0.42	0.37	0.59	0.56	0.48	0.56	0.66	0.74
MANUFACTURING (K'000)	2.02	1.78	1.85	2.09	2.07	2.24	3.50	3.17	2.58	3.25	3.17	3.35
TOTAL INDUSTRY (K'000)	21.05	19.22	18.70	17.57	17.98	18.50	17.42	16.58	15.99	15.76	15.37	15.30
Per Capita Production Indices (1990 = 100%)												
ENGINEERING (%)	42.9	33.3	31.8	60.9	60.4	53.4	85.5	82.1	69.7	81.4	96.0	108.3
MANUFACTURING (%)	52.3	46.0	47.8	54.2	53.5	58.1	90.7	82.1	66.8	84.2	82.2	86.8
TOTAL INDUSTRY (%)	144.6	132.0	128.4	120.7	123.5	127.1	119.7	113.9	109.8	108.3	105.5	105.1

APPENDIX A3: Concluded 3/3

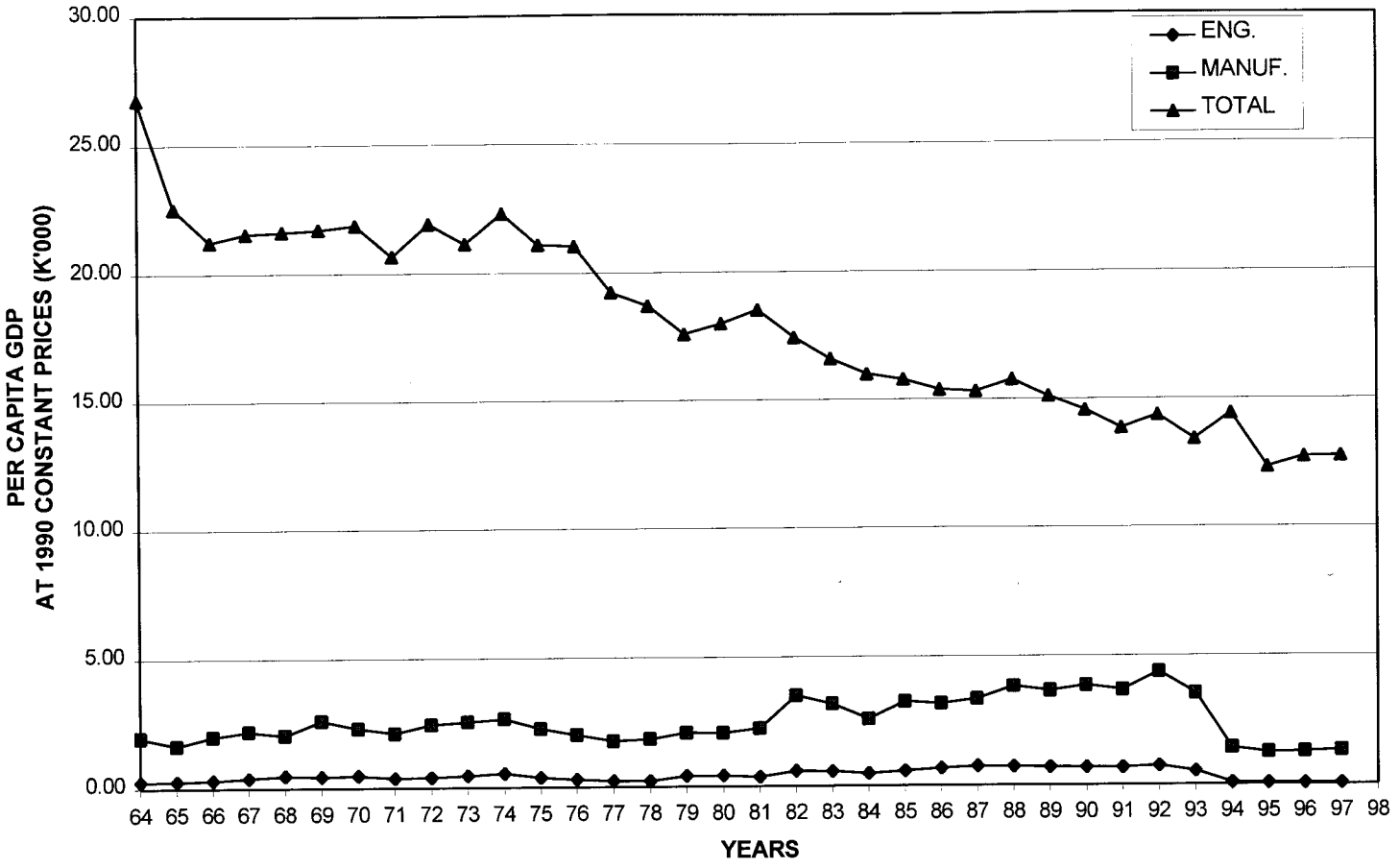
ESTIMATED POPULATION OF ZAMBIA AND PER CAPITA GDP - 1964 TO 1998

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
POPULATION (IN MILLIONS)	7.30	7.54	7.78	8.03	8.29	8.55	8.82	9.11	9.40	9.70	10.01
PER CAPITA GDP											
ENGINEERING (K'000)	0.72	0.70	0.69	0.67	0.73	0.52	0.06	0.06	0.04	0.04	
MANUFACTURING (K'000)	3.84	3.65	3.86	3.67	4.37	3.53	1.41	1.23	1.26	1.31	
TOTAL INDUSTRY (K'000)	15.76	15.11	14.56	13.86	14.35	13.41	14.41	12.31	12.70	12.74	
Per Capita Production Indices (1990 = 100%)											
ENGINEERING (%)	105.1	101.6	100.0	97.3	105.9	75.7	9.1	8.3	6.3	6.1	
MANUFACTURING (%)	99.4	94.7	100.0	95.2	113.3	91.6	36.6	31.9	32.6	34.0	
TOTAL INDUSTRY (%)	108.2	103.8	100.0	95.2	98.6	92.1	98.9	84.5	87.3	87.5	

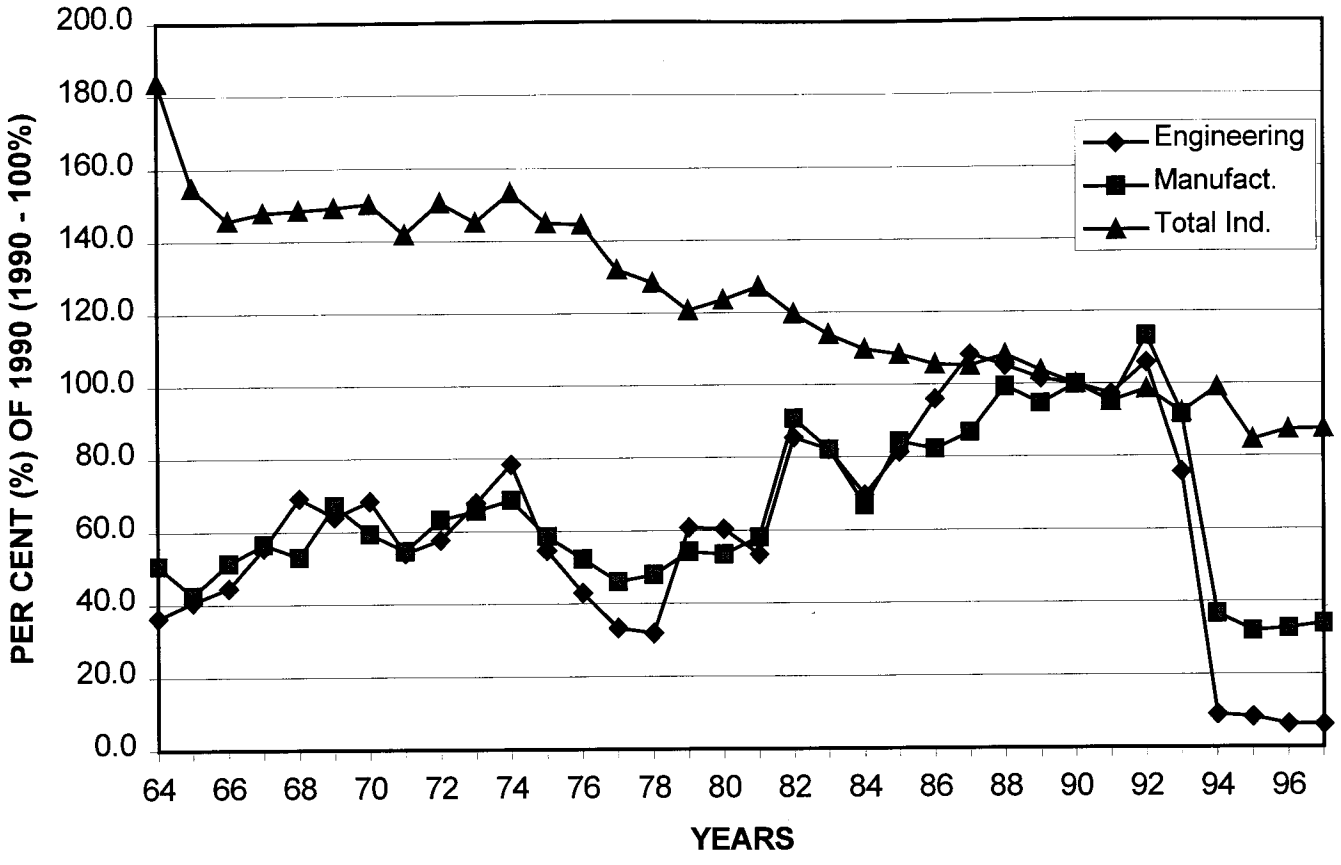
APPENDIX A4: ESTIMATED POPULATION INCREASE OF ZAMBIA (1964 - 1998)



APPENDIX A5: PER CAPITA GDP - ENGINEERING, MANUFACTURING AND TOTAL (1964 - 1997)



APPENDIX A6: GRAPHS OF PRODUCTION INDICES FOR INDUSTRY TOTAL, MANUFACTURING AND ENGINEERING (1964 - 1997)



APPENDIX B: LABOUR AND CAPITAL FORMATION

APPENDIX B1

THE ZAMBIAN INDUSTRY (TOTAL)

TOTAL LABOUR NUMBERS/COSTS AND CAPITAL FORMATION FOR THE YEARS 1964 - 1998

	PRICE	AT CURRENT PRICES				AT 1990 PRICES			SHARE OF	
YEAR	YEAR	LABOUR		CAPITAL		LABOUR (L)		CAPITAL (K)	Labour	Capital
		Number	K'Million	K'Million	Inflator	Number	K'Billion	K'Billion	*sl*	*sk*
1964	64	268,700	537	78	151.52	268,700	30.14	11.82	0.72	0.28
1965	65	298,360	619	138	107.53	298,360	24.65	14.84	0.62	0.38
1966	66	301,990	739	195	94.34	301,990	25.82	18.40	0.58	0.42
1967	67	312,050	845	246	86.96	312,050	27.22	21.39	0.56	0.44
1968	68	318,600	926	288	85.60	318,600	29.36	24.65	0.54	0.46
1969	69	328,290	1,150	277	67.11	328,290	28.58	18.59	0.61	0.39
1970	70	342,970	1,099	372	74.63	342,970	30.38	27.76	0.52	0.48
1971	71	365,550	974	393	76.92	365,550	27.75	30.23	0.48	0.52
1972	72	360,130	1,069	445	73.53	360,130	29.11	32.72	0.47	0.53
1973	73	377,640	1,294	423	61.73	377,640	29.58	26.11	0.53	0.47
1974	74	386,270	1,582	502	55.56	386,270	32.55	27.89	0.54	0.46
1975	75	398,840	1,269	602	64.52	398,840	30.32	38.84	0.44	0.56
1976	76	379,400	1,522	445	56.18	379,400	31.67	25.00	0.56	0.44
1977	77	372,630	1,607	483	51.28	372,630	30.52	24.77	0.55	0.45
1978	78	369,310	1,809	437	45.45	369,310	30.45	19.86	0.61	0.39
1979	79	371,670	2,124	450	37.31	371,670	29.35	16.79	0.64	0.36
1980	80	381,490	2,496	558	33.33	381,490	30.81	18.60	0.62	0.38
1981	81	373,720	3,004	610	31.15	373,720	34.66	19.00	0.65	0.35
1982	82	367,510	2,870	618	29.33	367,510	31.18	18.13	0.63	0.37
1983	83	363,800	3,508	615	24.75	363,800	32.16	15.22	0.68	0.32
1984	84	407,860	3,926	623	20.88	407,860	30.36	13.01	0.70	0.30
1985	85	383,200	5,430	725	14.81	383,200	29.78	10.74	0.74	0.26
1986	86	360,540	8,400	1,386	8.05	360,540	25.04	11.16	0.69	0.31
1987	87	356,530	14,400	1,931	5.47	356,530	29.17	10.56	0.73	0.27

APPENDIX B1 - *Concluded*

THE ZAMBIAN INDUSTRY (TOTAL)

TOTAL LABOUR NUMBERS/COSTS AND CAPITAL FORMATION FOR THE YEARS 1964 - 1998

	PRICE	AT CURRENT PRICES				AT 1990 PRICES			SHARE OF	
YEAR	YEAR	LABOUR		CAPITAL		LABOUR (L)		CAPITAL (K)	Labour	Capital
		Number	K'million	K'million	Inflator	Number	K'Billion	K'Billion	*sl*	*sk*
1988	88	382,500	15,500	2,381	3.84	382,500	22.04	9.14	0.71	0.29
1989	89	435,400	43,400	3,643	2.06	435,400	33.11	7.50	0.82	0.18
1990	90	506,700	89,600	15,271	1.00	506,700	33.19	15.27	0.68	0.32
1991	91	544,200	151,900	24,973	0.51	544,200	28.69	12.74	0.69	0.31
1992	92	545,900	425,200	60,187	0.21	545,900	33.07	12.64	0.72	0.28
1993	93	520,000	866,000	170,000	0.08	520,000	25.66	13.60	0.65	0.35
1994	94	496,000	1,518,800	512,100	0.05	496,000	28.13	25.61	0.52	0.48
1995	95	484,970	2,227,400	794,400	0.04	484,970	33.00	31.78	0.51	0.49
1996	96	68,950	3,396,400	1,719,600	0.03	468,950	37.74	51.59	0.42	0.58
1997	97	453,250	4,437,300	1,928,600	0.02	453,250	32.87	38.57	0.46	0.54

APPENDIX B2

THE MANUFACTURING INDUSTRY IN ZAMBIA

LABOUR NUMBERS/COSTS AND CAPITAL FORMATION FOR THE YEARS 1964 - 1998

	PRICE	AT CURRENT PRICES				AT 1990 PRICES			SHARE OF	
YEAR	YEAR	LABOUR		CAPITAL		LABOUR (L)		CAPITAL (K)	Labour	Capital
		Number	K'Million	K'Million	Inflator	Number	K'Million	K'Million	*sl*	*sk*
1964	64	20,940	13.68	10.52	151.52	20,940	768	1,595	0.32	0.68
1965	65	26,850	21.16	17.20	107.53	26,850	843	1,850	0.31	0.69
1966	66	29,770	25.40	23.30	94.34	29,770	887	2,198	0.29	0.71
1967	67	32,310	31.43	27.20	86.96	32,310	1,012	2,365	0.30	0.70
1968	68	33,100	36.37	43.97	85.60	33,100	1,153	3,764	0.23	0.77
1969	69	34,540	39.94	24.57	67.11	34,540	993	1,649	0.38	0.62
1970	70	38,160	46.51	40.29	74.63	38,160	1,286	3,007	0.30	0.70
1971	71	42,020	53.75	23.52	76.92	42,020	1,531	1,809	0.46	0.54
1972	72	43,300	55.85	50.56	73.53	43,300	1,521	3,718	0.29	0.71
1973	73	43,600	63.20	48.12	61.73	43,600	1,445	2,970	0.33	0.67
1974	74	44,070	63.73	44.49	55.56	44,070	1,311	2,472	0.35	0.65
1975	75	44,330	64.06	71.64	64.52	44,330	1,531	4,622	0.25	0.75
1976	76	43,080	74.36	50.29	56.18	43,080	1,547	2,825	0.35	0.65
1977	77	46,450	86.35	51.20	51.28	46,450	1,640	2,626	0.38	0.62
1978	78	48,030	100.26	45.45	45.45	48,030	1,688	2,066	0.45	0.55
1979	79	50,700	119.45	46.75	37.31	50,700	1,651	1,744	0.49	0.51
1980	80	54,934	143.71	60.33	33.33	54,934	1,774	2,011	0.47	0.53
1981	81	55,621	168.48	69.00	31.15	55,621	1,944	2,149	0.47	0.53
1982	82	54,807	180.59	73.54	29.33	54,807	1,962	2,157	0.48	0.52
1983	83	55,839	205.71	63.26	24.75	55,839	1,886	1,566	0.55	0.45
1984	84	56,181	229.56	56.09	20.88	56,181	1,775	1,171	0.60	0.40
1985	85	57,371	306.65	62.85	14.81	57,371	1,682	931	0.64	0.36
1986	86	56,521	376.49	132.79	8.05	56,521	1,122	1,069	0.51	0.49
1987	87	55,591	455.07	212.41	5.47	55,591	922	1,162	0.44	0.56

APPENDIX B2 - *Concluded*

THE MANUFACTURING INDUSTRY IN ZAMBIAN

LABOUR NUMBERS/COSTS AND CAPITAL FORMATION FOR THE YEARS 1964 - 1998

	PRICE	AT CURRENT PRICES					AT 1990 PRICES			SHARE OF	
YEAR	YEAR	LABOUR		CAPITAL			LABOUR (L)		CAPITAL (K)	Labour	Capital
		Number	K'Million	K'Million	Inflator		Number	K'Million	K'Million	*sl*	*sk*
1988	88	55,698	581.32	249.29	3.84		55,698	827	957	0.46	0.54
1989	89	56,238	1,028.82	451.82	2.06		56,238	785	931	0.46	0.54
1990	90	57,318	2,656.64	1,816.84	1.00		57,318	984	1,817	0.35	0.65
1991	91	75,400	3,881.05	3,308.92	0.51		75,400	733	1,688	0.30	0.70
1992	92	73,600	8,720.85	8,966.66	0.21		73,600	678	1,883	0.26	0.74
1993	93	67,600	15,700.58	21,194.41	0.08		67,600	465	1,696	0.22	0.78
1994	94	57,100	26,685.32	34,075.40	0.05		57,100	494	1,704	0.22	0.78
1995	95	55,654	34,146.04	41,193.08	0.04		55,654	506	1,648	0.23	0.77
1996	96	54,510	46,496.72	54,564.72	0.03		54,510	517	1,637	0.24	0.76
1997	97	52,710	58,439.24	79,971.10	0.02		52,710	433	1,599	0.21	0.79

APPENDIX B3

THE ENGINEERING MANUFACTURE SUB-SECTOR IN ZAMBIA

LABOUR NUMBERS/COSTS AND CAPITAL FORMATION FOR THE YEARS 1964 - 1998

	PRICE	AT CURRENT PRICES				AT 1990 PRICES				SHARE OF	
YEAR	YEAR	LABOUR		CAPITAL		LABOUR (L)		CAPITAL (K)		Labour	Capital
		Number	K'Million	K'Million	Inflator	Number	K'Million		K'Million	*sl*	*sk*
1964	64	5,011	3.72	1.20	151.52	5,011	209		68	0.76	0.24
1965	65	5,588	4.67	1.97	107.53	5,588	186		79	0.70	0.30
1966	66	5,740	5.80	2.24	94.34	5,740	203		78	0.72	0.28
1967	67	6,049	6.70	2.40	86.96	6,049	216		77	0.74	0.26
1968	68	7,100	9.90	3.65	85.60	7,100	314		116	0.73	0.27
1969	69	6,230	7.66	3.62	67.11	6,230	190		90	0.68	0.32
1970	70	6,810	8.99	4.49	74.63	6,810	248		124	0.67	0.33
1971	71	8,319	11.48	7.98	76.92	8,319	327		227	0.59	0.41
1972	72	9,514	14.95	6.27	73.53	9,514	407		171	0.70	0.30
1973	73	9,374	17.02	3.45	61.73	9,374	389		79	0.83	0.17
1974	74	10,577	20.09	4.85	55.56	10,577	413		100	0.81	0.19
1975	75	10,141	21.88	6.10	64.52	10,141	523		146	0.78	0.22
1976	76	9,084	24.43	4.43	56.18	9,084	508		92	0.85	0.15
1977	77	8,881	27.51	5.00	51.28	8,881	522		95	0.85	0.15
1978	78	8,762	28.88	5.87	45.45	8,762	486		99	0.83	0.17
1979	79	9,261	31.01	5.94	37.31	9,261	429		82	0.84	0.16
1980	80	10,034	33.55	6.12	33.33	10,034	414		76	0.85	0.15
1981	81	10,216	39.56	6.98	31.15	10,216	456		81	0.85	0.15
1982	82	9,976	36.14	7.32	29.33	9,976	393		80	0.83	0.17
1983	83	9,958	40.53	7.77	24.75	9,958	372		71	0.84	0.16
1984	84	10,027	44.35	8.02	20.88	10,027	343		62	0.85	0.15
1985	85	10,439	60.78	8.45	14.81	10,439	333		46	0.88	0.12
1986	86	10,285	74.56	13.99	8.05	10,285	222		42	0.84	0.16
1987	87	10,057	102.04	18.42	5.47	10,057	207		37	0.85	0.15

APPENDIX B3 - *Concluded*

THE ENGINEERING MANUFACTURE SUB-SECTOR IN ZAMBIA

LABOUR NUMBERS/COSTS AND CAPITAL FORMATION FOR THE YEARS 1964 - 1998

	PRICE	AT CURRENT PRICES					AT 1990 PRICES				SHARE OF	
YEAR	YEAR	LABOUR		CAPITAL			LABOUR (L)		CAPITAL (K)		Labour	Capital
		Number	K'Million	K'Million	Inflator		Number	K'Million		K'Million	*sl*	*sk*
1988	88	10,085	122.56	23.47	3.84		10,085	174		33	0.84	0.16
1989	89	10,158	190.46	44.79	2.06		10,158	145		34	0.81	0.19
1990	90	11,284	475.88	197.76	1.00		11,284	176		73	0.71	0.29
1991	91	11,526	659.43	410.31	0.51		11,526	125		78	0.62	0.38
1992	92	10,967	1,370.74	1,184.13	0.21		10,967	107		92	0.54	0.46
1993	93	11,965	2,206.09	2,042.27	0.08		11,965	65		61	0.52	0.48
1994	94	11,165	3,792.25	4,258.35	0.05		11,165	70		79	0.47	0.53
1995	95	9,481	4,614.50	6,591.14	0.04		9,481	68		98	0.41	0.59
1996	96	7,736	5,353.07	7,856.74	0.03		7,736	59		87	0.41	0.59
1997	97	7,063	6,345.62	9,235.18	0.02		7,063	47		68	0.41	0.59

APPENDIX C - POLLUTION LIMITS

APPENDIX C1:

TABLE OF LONG-TERM EMISSION LIMITS FOR AIR POLLUTION BY TYPE OF INDUSTRY/PROCESS
(Third Schedule of Regulation 4 of Statutory Instrument No. 141 of 1996)

	Industry/Process	Parameter	Long-Term Emission Limit
A.	**Copper Production**		
1.	Smelters and Converters	Sulphur dioxide (SO_2)	1000 mg/Nm^3(1)
		Dust	50 mg/Nm^3
2.	Coal preparation	Dust	50 mg/Nm^3
3.	Concentrator dryer	Sulphur dioxide (SO_2)	500 mg/Nm^3
		Dust	50 mg/Nm^3
4.	Heavy Metal Content in Dust	Arsenic (As)	0.5 mg/Nm^3
		Cadmium (Cd)	0.05 mg/Nm^3
		Copper (Cu)	1.0 mg/Nm^3
		Lead (Pb)	0.2 mg/Nm^3
		Mercury (Hg)	0.05 mg/Nm^3
B.	**Cement And Lime Production**		
1.	Cement production	Dust	50 mg/Nm^3
2.	Lime production	Dust	50 mg/Nm^3
C.	**Nitric Acid and Sulphuric Acid Production**		
1.	Nitric acid	NO_X as NO_2	100 - 1400 kg/day
2.	Sulphuric acid	SO_2	700 - 4300 kg/day
D.	**Fertiliser Production**		
1.	Ammonium nitrate production	Dust	500 kg/day
2.	Coal treatment	Dust	150 kg/day
3.	NPK production	Dust	100 kg/day
E.	**Combustion Units**		
1.	Oil fired < 50 MW(2)	Dust	50 - 150 mg/Nm^3 (3)
		SO_2	850 mg/Nm^3
		CO	100 mg/Nm^3
2	Coal fired, < 10 MW(2)(4)	Dust	150 mg/Nm^3
		SO_2	2000 mg/Nm^3
3.	Coal fired, 10 50 MW(2)	Dust	50 mg/Nm^3
		SO_2	1000 mg/Nm^3
		CO	175 mg/Nm^3

Source: Environmental Council of Zambia.

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(1) The limits are normalised to 237K, 101.3 Pa and 3 Vol. - % O_2

(2) The limits are normalised to 237K, 101.3 Pa and 3 Vol. - % O_2

(3) More strict limits for light oil, less strict limits for heavy oil. Smaller combustion units need limits less strict than larger units. For these reasons, the Inspectorate will prescribe limits based on this range on a case to case basis.

(4) CO limits are not necessary for oil combustion units < 5 MW and coal combustion units < 1 MW.

APPENDIX C2: CLASSES OF INDUSTRIES IN TERMS OF POLLUTANT EMISSIONS

CLASS OF SOURCE	POLLUTION EMMISIONS
CLASS I	Very heavy pollution emissions
CLASS II	Heavy pollution emissions
CLASS III	Relatively low pollution emissions
CLASS IV	Low pollution emissions

Source: Environmental Council of Zambia.

APPENDIX C3:
TABLE OF STANDARDS (LIMITS) FOR EFFLUENTS AND WASTE WATER

(Regulation 5(2) of Statutory Instrument No. 72 of 1993
The Water Pollution Control (Effluent and Waste Water) Regulations, 1993.)
(Abridged)

Column 1 **PARAMETER**		*Column 2* **EFFLUENT AND WASTE WATER INTO AQUATIC ENVIRONMENT**
	Physical	
1.	Total suspended solids (Gravimetric method)	100 mg/l must not cause formation of sludge or scum in receiving water
2.	Total Dissolved Solids (Evaporation @ 105 °C and Gravimetric method)	3000mg/l. The TDS of water must not adversely affect surface water
3.	Settleable matter sedimentation in 2 hours (Imhoff method)	0.5 mg/l in two hours. Must not cause formation of sludge in receiving water.
	Chemical	
4.	pH (0-14scale) (Electro-metric method)	6.0 – 9.0
	Organic	
5.	Total hydrocarbons (Chromatographic method)	10.0 mg/l
6.	Oils (Mineral and Crude) (Chromatographic method and Gravimetric method)	5.0 mg/l
7.	Fats and Saponifiable Oils (Chromatographic method and Gravimetric method)	20.0 mg/l
8.	Detergents (Atomic) (Atomic Absorption Spectrophotometric)	2.0 mg/l (Detergents should contain at least biodegradable compounds)
	Metals	
9.	Aluminium compounds (Atomic Absorption Method)	2.5 mg/l
10.	Antimony compounds (Atomic Absorption Method)	0.5 mg/l
11.	Arsenic compounds (Atomic Absorption Method)	0.005 mg/l
12.	Barium compounds (water soluble concentration) (Atomic Absorption Method)	0.5 mg/l
13.	Berrylium compounds (Atomic Absorption Method)	0.5 mg/l
14.	Boron compounds (Spectrophotometric method-curcumin method)	0.5 mg/l
15.	Cadmium compounds (Atomic Absorption Method)	0.5 mg/l

APPENDIX C3: *Concluded*

TABLE OF STANDARDS (LIMITS) FOR EFFLUENTS ANS WASTE WATER

(Regulation 5(2) of Statutory Instrument No. 72 of 1993
The Water Pollution Control (Effluent and Waste Water) Regulations, 1993.)

(Abridged)

Column 1 **PARAMETER**		*Column 2* **EFFLUENT AND WASTE WATER INTO AQUATIC ENVIRONMENT**
16.	Chromium Hexavalent, Trivalent compounds (Atomic Absorption Method)	0.1 mg/l
17.	Cobalt compounds (Atomic Absorption Method)	1.0 mg/l
18.	Copper compounds (Atomic Absorption Method)	1.5 mg/l
19.	Iron compounds (Atomic Absorption Method)	2.0 mg/l
20.	Lead compounds (Atomic Absorption Method)	0.5 mg/l
21.	Magnesium compounds (Atomic Absorption Method and Flame photometric method)	500 mg/l
22.	Manganese compounds (Atomic Absorption Method)	1.0 mg/l
23.	Mercury compounds (Atomic Absorption Method)	0.002 mg/l
24.	Molybdenum compounds (Atomic Absorption Method)	5.0 mg/l
25.	Nickel compounds (Atomic Absorption Method)	0.5 mg/l
26.	Selenium compounds (Atomic Absorption Method)	0.02 mg/l
27.	Silver compounds (Atomic Absorption Method)	0.1 mg/l
28.	Thallium compounds (Atomic Absorption Method)	0.5 mg/l
29.	Tin compounds (Atomic Absorption Method)	2.0 mg/l
30.	Vanadium compounds (Atomic Absorption Method)	1.0 mg/l
31.	Zinc compounds (Atomic Absorption Method)	10 mg/l
	Radioactive Materials	
32.	Radioactive materials specified by International Atomic Energy Agency accepted	No discharge permitted or accepted

Source: Environmental Council of Zambia

APPENDIX D - COMPANY RESPONSE PATTERN

APPENDIX D1: Companies Included In The Survey (Total = 23)

1.0 LARGE SCALE COMPANIES

1.1 LUSAKA AREA

(a) Amalgamated Steel Manufacturing Limited
(b) Engine Reconditioners of Zambia
(c) *Engineering Services Corporation (ESCO) Limited*[1]

1.2 KABWE AREA

(a) *Zambia Railways Workshops*

1.3 COPPERBELT AREA

(a) Boart Longyear Limited (NLA)
(b) *Drum & Can Company Limited (NLA)*[2]
(c) *Monarch Limited (KIW)*
(d) Non-Ferrous Metal Foundry Works Ltd (NLA)
(e) *Techpro Zambia Limited (KIW)*
(f) Gilmer Engineering Limited (LYA)
(g) *ZAMEFA Limited (LYA)*

2.0 MEDIUM SCALE COMPANIES

2.1 LUSAKA AREA

(a) Danyan Engineering Limited
(b) Elmar Engineering Limited
(c) Knight Engineering Limited
(d) Kudu Engineering Limited
(e) Turning & Metals Limited

2.2 COPPERBELT AREA

(a) EB Jones Machinists Limited (KIW)
(b) Metalock Zambia Limited (KIW)
(c) Kitwe Foundry Limited (KIW)

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[1] Companies in *Italics* are former or still parastatals.
[2] NLA = Ndola, KIW = Kitwe, LYA = Luanshya, LVI = Livingstone, MAZ = Mazabuka, CIP = Chipata.

3.0 SMALL SCALE COMPANIES

3.1 LUSAKA AREA

(a) Akaal Engineering Limited
(b) Alro Engineering Limited
(c) Markweld Engineering Limited
(d) Rasma Engineering Limited

APPENDIX D2: Companies That Did Not Want To Be Included In The Survey (Total = 02)

(a) *Scaw Limited (KIW)* - Large Scale
(b) Saro Agricultural Equipment - Large Scale

APPENDIX D3: Companies That Responded But Had Closed Down (Total = 03)

(a) Kaleya Agricultural Engineering Limited (MAZ) - Medium Scale
(b) Pfeiffer Engineering Limited (LVI) - Small Scale
(c) Tata Zambia Limited (NLA) - Large Scale

APPENDIX D4: Companies Selected But Did Not Respond (Total = 07)

(a) Copperbelt Steel Manufacturers Limited (KIW) - Large Scale
(b) Crown Cork Company Limited (NLA) - Large Scale
(c) Foundry and Engineering Limited (LYA) - Large Scale
(d) Hardware Manufacturers of Zambia Limited (LVI) - Large Scale
(e) *Luangwa Industries Limited (CIP)* - Large Scale
(f) Ndola Engineering Company Limited (NLA) - Large Scale
(g) Record Engineering Limited (NLA) - Medium Scale

APPENDIX D5: Total Number Of Companies Contacted = 35

APPENDIX D6: Definitions

In this study, Small-, Medium- and Large- Scale enterprises were defined (as at 1997) as:

(a) **Small-Scale Enterprise**: With up to 20 employees **OR** annual turnover below K100 million.

(b) **Medium-Scale Enterprise**: With between 20 and 50 employees **OR** annual turnover between K100 million and K250 million.

(c) **Large-Scale Enterprise**: With over 50 employees **OR** annual turnover above K250 million.

APPENDIX E

SAMPLE CALCULATIONS

APPENDIX E1: Per Capita GDP Profile (Figure 3.3)

The GDP figures in Figure 3.1 were divided by the country population for the corresponding years. For example for 1964 (from Appendix A1):

Total Industrial Output	=	K96 Billion (at 1990 Constant Prices)
Total Manufacturing Output	=	K7.02 Billion (at 1990 Constant Prices)
Total Engineering Output	=	K0.90 Billion (at 1990 Constant Prices)
Country Population	=	3.59 Million (Appendix A3)

Total Industrial Output per Capita	= K96,000,000,000 / 3,590,0000	= K26,770
Total Manufacturing Output	= K7,020,000,000 / 3,590,0000	= K1,960
Total Engineering Output	= K900,000,000 / 3,590,000	= K250

APPENDIX E2: Per Capita Production Indices (With 1990 = 100%)

All the GDP figures are divided by the corresponding 1990 figures and then multiplied by 100% For example for 1964 (from Appendix A3):

a) Total Industrial Output per capita in 1964	= K26,770 (at 1990 Constant Prices)
Total Industrial output per capita in 1990	= K14,560
Production Index for Industry Total	= (K26,770 / K14,560)*100%
	= <u>183.8%</u>
b) Manufacturing output per capita in 1964	= K1,960
Manufacturing output per capita in 1990	= K3,860
Manufacturing Production Index	= (K1,960 / K3,860) = <u>50.7%</u>
c) Engineering output per capita in 1964	= K250
Engineering output per capita in 1990	= K690
Engineering Production Index	= (K250 / K690) = <u>36.4%</u>

APPENDIX E3: Total Factor Productivity Growth (TFPG)

This sample calculation illustrates how Tables 3.3 to 3.5 were built.

a)(i) Consider Average Annual Growth of Total Industrial Output for the period 1964 to 1969 (from Appendix A1):

Industrial Output 1964 = K96 billion

Industrial Output 1969 = K88.2 billion

Length of period = 5 years

Average Annual Growth of Industrial Output = ((ln 88.2 - ln 96.0) / 5) * 100%

= -1.69%

(ii) For average annual growth rate of labour (from Appendix B1):

Labour in 1964 = 268,700

Labour in 1969 = 328,500

Period = 5 years

Average Annual Growth Rate of Labour = ((ln 328,500 - ln 268,700) / 5) * 100%

= 4.01%

(iii) Similarly for Cost of Labour: Average Annual Rate = -1.06%

(iv) And Capital: Average Annual Growth Rate = 9.06%

(v) For share of Capital (sk) and share of labour (sl) in 1969 (Appendix B1) at 1990 prices:

Cost of Labour = K28.58 billion

Capital Formation = K18.59 billion

Total Capital & Labour = K47.17 billion

Share of Labour, sl = (28.58 / 47.17) * 100% = 61% or 0.61

Share of Capital, sk = (18.59 / 47.17) * 100% = 39% or 0.39

Finally TFPG = (-1.69 - (0.39*9.06 + 0.61*4.01) = -7.69

APPENDIX F
SAMPLE QUESTIONNAIRE

PART A: GENERAL CHARACTERISTICS

A1. GENERAL

1.1 Company Name:

1.2 Address:

Road: **Plot No:**

P O Box: **Town/City:**

Telephone:

Facsimile:

E-mail:

1.3 Date of Establishment: Day: **Month:** **Year:**

1.4 Type of Activity:

- ☐ Vehicle Assembly
- ☐ Machine Shop
- ☐ Forge
- ☐ Other (Specify).....
- ☐ Machine Parts Assembly
- ☐ Foundry
- ☐ Fabrication

1.5 Growth Pattern:

Year	Turnover (K)	Year	Turnover (K)
1964	.....	1982	.....
1965	.....	1983	.....
1966	.....	1984	.....
1968	.....	1985	.....
1969	.....	1986	.....
1970	.....	1987	.....
1971	.....	1988	.....
1972	.....	1989	.....
1973	.....	1990	.....
1974	.....	1991	.....
1975	.....	1992	.....
1976	.....	1993	.....
1977	.....	1994	.....
1978	.....	1995	.....
1979	.....	1996	.....
1980	.....	1997+	.....
1981	.....	1998*	.....

+ Either 1997 actual or estimate for 1997.
* Estimate for 1998.

1.6 Products' Contribution to Turnover from 1964 - 1988.

Product Name	Contribution to turnover in %					
	1964	1967	1970	1973	1976	1979
A.....	.....	.....	.....	.....	.....	.....
B.....	.....	.....	.....	.....	.....	.....
C.....	.....	.....	.....	.....	.....	.....
D.....	.....	.....	.....	.....	.....	.....
E.....	.....	.....	.....	.....	.....	.....
F.....	.....	.....	.....	.....	.....	.....

Product Name	Contribution to Turnover in %					
	1982	1985	1988	1991	1994	1998
A.....	.....	.....	.....	.....	.....	.....
B.....	.....	.....	.....	.....	.....	.....
C.....	.....	.....	.....	.....	.....	.....
D.....	.....	.....	.....	.....	.....	.....
E.....	.....	.....	.....	.....	.....	.....
F.....	.....	.....	.....	.....	.....	.....

1.7 Production Capacity

1.7.1 1964

Product	U/M	Possible Cap.	Actual Prod.
A.....	.....	.....	.....
B.....	.....	.....	.....
C.....	.....	.....	.....
D.....	.....	.....	.....
E.....	.....	.....	.....
F.....	.....	.....	.....

1.7.2 1967

U/M	Possible Cap.	Actual Prod.
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

1.7 Production Capacity

1.7.3 1970

Product	U/M	Possible Cap.	Actual Prod.
A.....	.....	.....	.....
B.....	.....	.....	.....
C.....	.....	.....	.....
D.....	.....	.....	.....
E.....	.....	.....	.....
F.....	.....	.....	.....

1.7.4 1973

U/M	Possible Cap.	Actual Prod.
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

1.7 Production Capacity

1.7.5 1976

Product	U/M	Possible Cap.	Actual Prod.
A.....	.....	.....	.....
B.....	.....	.....	.....
C.....	.....	.....	.....
D.....	.....	.....	.....
E.....	.....	.....	.....
F.....	.....	.....	.....

1.7.6 1979

U/M	Possible Cap.	Actual Prod.
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

1.7 Production Capacity

1.7.7 1982

Product	U/M	Possible Cap.	Actual Prod.
A.....	.....	.....	.....
B.....	.....	.....	.....
C.....	.....	.....	.....
D.....	.....	.....	.....
E.....	.....	.....	.....
F.....	.....	.....	.....

1.7.8 1985

U/M	Possible Cap.	Actual Prod.
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

1.7 Production Capacity

1.7.9 1988 Product	U/M	Possible Cap.	Actual Prod.	**1.7.10 1991** U/M	Possible Cap.	Actual Prod.
A.....	.....	.....	.....	.....	.....	.....
B.....	.....	.....	.....	.....	.....	.....
C.....	.....	.....	.....	.....	.....	.....
D.....	.....	.....	.....	.....	.....	.....
E.....	.....	.....	.....	.....	.....	.....
F.....	.....	.....	.....	.....	.....	.....

1.7 Production Capacity

1.7.11 1994 Product	U/M	Possible Cap.	Actual Prod.	U/M	**1.7.12 1998** Possible Cap.	Actual. Prod.
A.....	.....	.....	.....	.....	.....	.....
B.....	.....	.....	.....	.....	.....	.....
C.....	.....	.....	.....	.....	.....	.....
D.....	.....	.....	.....	.....	.....	.....
E.....	.....	.....	.....	.....	.....	.....
F.....	.....	.....	.....	.....	.....	.....

1.8 Organisation Structure

A2. ENVIRONMENTAL FACTORS

2.1 Major Economic Activities in the District (Area) in which the enterprise is located:

- ☐ Agriculture
- ☐ Commerce
- ☐ Tourism
- ☐ Mining
- ☐ Manufacturing
- ☐ Other (Specify).....

2.2 Raw Materials/Major Inputs

Name/Type of Material	Source		Transportation			Average Cost per Unit of Production (US$ Million)	
	Local	Imported	Air	Rail	Road	Material	Transport
Primary Raw Materials							
.....	☐	☐	☐	☐	☐	.....	.....
.....	☐	☐	☐	☐	☐	.....	.....
.....	☐	☐	☐	☐	☐	.....	.....
.....	☐	☐	☐	☐	☐	.....	.....
Secondary Raw Materials							
.....	☐	☐	☐	☐	☐	.....	.....
.....	☐	☐	☐	☐	☐	.....	.....
.....	☐	☐	☐	☐	☐	.....	.....
.....	☐	☐	☐	☐	☐	.....	.....
Consumables							
.....	☐	☐	☐	☐	☐	.....	.....
.....	☐	☐	☐	☐	☐	.....	.....
.....	☐	☐	☐	☐	☐	.....	.....
.....	☐	☐	☐	☐	☐	.....	.....

If imported, please indicate source country .....

.....

.....

What has been the general percentage increase in costs over the years, for both material and transportation?

Material: ..... Transportation: .....

2.3 Please indicate major source of energy:

☐ Oil ☐ Electrical ☐ Coal

☐ Gas ☐ Other (Specify).....

2.4 Source of Water:

☐ Local Council ☐ Borehole

☐ Other (specify).....

2.5 Land:

☐ Owned ☐ Leased

2.5 Buildings:

☐ Owned ☐ Leased

2.7 What wastes does your company produce?

.....

.....

2.8 Does the company have a waste management/disposal system?

☐ Yes ☐ No

If "Yes," describe the system.

.....

.....

.....

IF "No," describe how waste is managed/disposed of.

.....

.....

.....

PART B: TECHNOLOGY

B1: TECHNOLOGY LEVELS

1.1 Technology:

How do you assess the level of production technology used over the years?

Type of Technology	Years From	Years To
Manual work performed without tools or with the simplest of tools	.....	.....
Manual work performed with the aid of mechanical (power-driven) tools	.....	.....
Work performed with the aid of machinery, but with a predominance of manual work for feeding production machinery with material, or the feeding of material handling equipment	.....	.....
Work performed with the aid of machinery and with the predominance of manual work for the direct control and regulation of equipment	.....	.....
Control of more complex equipment, the whole process taking place without manual intervention, except to effect corrections in the process or deal with emergencies	.....	.....
Complex and highly automated process with modern technology (such as CNC)	.....	.....

1.2 Give a simplified scheme of the production process

1.3 What is the average age of the equipment? Is it a replacement of some other equipment? Why the replacement?

Average age	Proportion of Equipment in this age group (%)	Replacement? Yes	Replacement? No	If replacement, why?
Less than 5 years	.....	☐	☐	.....
6 - 10 years	.....	☐	☐	.....
11 - 20 years	.....	☐	☐	.....
21 - 30 years	.....	☐	☐	.....
Over 30 years	.....	☐	☐	.....

B2: QUALITY STANDARDS

2.1 Quality Management

Indicate Method(s) of Quality Management used in the enterprise

- ☐ Control Charts
- ☐ In-line Inspection
- ☐ Off-line Inspection
- ☐ Other (specify).....
- ☐ Incoming Quality Assessment
- ☐ Outgoing Quality Assessment
- ☐ ISO 9000

2.2 Quality Certification

Is the company aware of the ZABS Certification Scheme?

☐ Yes ☐ No

Does the company hold a ZABS Certification mark?

☐ Yes ☐ No

Does the company wish to be part of the Certification Scheme?

☐ Yes ☐ No

What other Certification Schemes are in use?

☐ British Standards ☐ ISO 9000

For how long has the Quality Certification been in use? ..... Years.

2.3 Standards

Do you manufacture to any certified quality standards? Yes ☐ No ☐

If "Yes," indicate the standards.

☐ National (ZABS) Specify .....

.....

.....

☐ International Specify .....

.....

2.4 Standardisation

Is there a programme of standardisation in the company?

☐ Yes ☐ No

If "Yes," please give details.

.....

.....

.....

.....

PART C: HUMAN RESOURCES

C1: AVAILABLE MANPOWER

1.1 How many people has the Company employed?

Category of Employees	Actual Numbers					
	1964	1967	1970	1973	1976	1979
A. Senior Management	.....	.....	.....	.....	.....	.....
B. Middle Management	.....	.....	.....	.....	.....	.....
C. Skilled	.....	.....	.....	.....	.....	.....
D. Semi-skilled	.....	.....	.....	.....	.....	.....
E. Unskilled	.....	.....	.....	.....	.....	.....
F. TOTAL	.....	.....	.....	.....	.....	.....

Category of Employees	Actual Numbers					
	1982	1985	1988	1991	1994	1998
A. Senior Management	.....	.....	.....	.....	.....	.....
B. Middle Management	.....	.....	.....	.....	.....	.....
C. Skilled	.....	.....	.....	.....	.....	.....
D. Semi-skilled	.....	.....	.....	.....	.....	.....
E. Unskilled	.....	.....	.....	.....	.....	.....
F. TOTAL	.....	.....	.....	.....	.....	.....

1.2 How many Technical personnel has the Company employed?

Category of Employees	Actual Numbers					
	1964	1967	1970	1973	1976	1979
Technical						
A. Engineers	.....	.....	.....	.....	.....	.....
B. Technologists	.....	.....	.....	.....	.....	.....
C. Technicians	.....	.....	.....	.....	.....	.....
D. Craftsmen	.....	.....	.....	.....	.....	.....
E. Operators	.....	.....	.....	.....	.....	.....
Administrative						
F. Production	.....	.....	.....	.....	.....	.....
G. Marketing	.....	.....	.....	.....	.....	.....
H. Finance	.....	.....	.....	.....	.....	.....
I. Personnel	.....	.....	.....	.....	.....	.....
J. TOTAL	.....	.....	.....	.....	.....	.....

Category of Employees	Actual Numbers					
	1982	1985	1988	1991	1994	1998
Technical						
A. Engineers	.....	.....	.....	.....	.....	.....
B. Technologists	.....	.....	.....	.....	.....	.....
C. Technicians	.....	.....	.....	.....	.....	.....
D. Craftsmen	.....	.....	.....	.....	.....	.....
E. Operators	.....	.....	.....	.....	.....	.....
Administrative						
F. Production	.....	.....	.....	.....	.....	.....
G. Marketing	.....	.....	.....	.....	.....	.....
H. Finance	.....	.....	.....	.....	.....	.....
I. Personnel	.....	.....	.....	.....	.....	.....
J. TOTAL	.....	.....	.....	.....	.....	.....

1.3 Staff Development

Does the company have access to training facilities?

☐ Yes ☐ No

If "Yes," please indicate Type of training .....

Where? .....

If "No," please indicate Source of trained personnel .....

Type of training required .....

PART D: COSTS

D1. PRODUCTION, MATERIAL, MANPOWER &MAINTENANCE/CAPITAL COSTS

1.1 Costs (K'million)

Product	1.1.1 1964 Material	Wages	Maint.	1.1.2 1967 Material	Wages	Maint.
A.....	.....	.....	.....	.....	.....	.....
B.....	.....	.....	.....	.....	.....	.....
C.....	.....	.....	.....	.....	.....	.....
D.....	.....	.....	.....	.....	.....	.....
E.....	.....	.....	.....	.....	.....	.....
F.....	.....	.....	.....	.....	.....	.....

1.1 Costs (K'million)

Product	1.1.3 1970 Material	Wages	Maint.	1.1.4 1973 Material	Wages	Maint.
A.....	.....	.....	.....	.....	.....	.....
B.....	.....	.....	.....	.....	.....	.....
C.....	.....	.....	.....	.....	.....	.....
D.....	.....	.....	.....	.....	.....	.....
E.....	.....	.....	.....	.....	.....	.....
F.....	.....	.....	.....	.....	.....	.....

1.1 Costs (K'million)

Product	1.1.5 1976 Material	Wages	Maint.	1.1.6 1979 Material	Wages	Maint.
A.....	.....	.....	.....	.....	.....	.....
B.....	.....	.....	.....	.....	.....	.....
C.....	.....	.....	.....	.....	.....	.....
D.....	.....	.....	.....	.....	.....	.....
E.....	.....	.....	.....	.....	.....	.....
F.....	.....	.....	.....	.....	.....	.....

1.1 Costs (K'million)

Product	1.1.7 1982 Material	Wages	Maint.	1.1.8 1985 Material	Wages	Maint.
A.....	.....	.....	.....	.....	.....	.....
B.....	.....	.....	.....	.....	.....	.....
C.....	.....	.....	.....	.....	.....	.....
D.....	.....	.....	.....	.....	.....	.....
E.....	.....	.....	.....	.....	.....	.....
F.....	.....	.....	.....	.....	.....	.....

1.1 Costs (K'million)

Product	1.1.9 1988 Material	Wages	Maint.	1.1.10 1991 Material	Wages	Maint.
A.....	.....	.....	.....	.....	.....	.....
B.....	.....	.....	.....	.....	.....	.....
C.....	.....	.....	.....	.....	.....	.....
D.....	.....	.....	.....	.....	.....	.....
E.....	.....	.....	.....	.....	.....	.....
F.....	.....	.....	.....	.....	.....	.....

1.1 Costs (K'million)

Product	1.1.11 1994 Material	Wages	Maint.	1.1.12 1998 Material	Wages	Maint.
A.....	.....	.....	.....	.....	.....	.....
B.....	.....	.....	.....	.....	.....	.....
C.....	.....	.....	.....	.....	.....	.....
D.....	.....	.....	.....	.....	.....	.....
E.....	.....	.....	.....	.....	.....	.....
F.....	.....	.....	.....	.....	.....	.....

Thank you very much for your time

THE END