SOME STRATEGIES FOR IMPROVING THE PRESENT STATE OF QUALITY CONTROL METHODS IN VENEZUELAN METALWORKING INDUSTRIES

by

GERARDO ZAID MORILLO

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This thesis is especially dedicated to the one and only friend, José Chiquinquirá - my late father. Also I would like to dedicate this volume to my beloved mother, Omaira, and my late mother-in-law, Carmen. Last, but not least, to my wife, Brunilda, and my daughters, Milva and Zaida.

"Father, like falling leaves time drifts by,
but my love for you will never die.
Words are too little. They'd never quite start
to show the affection for you in my heart.
Nevertheless, truly I am sincere whatever
I say or write to you.
I love you and always will.
Father thanks for everything."

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Especially deep is my indebtedness to five significant people in my life: my wife (Brunilda) and daughters (Milva and Zaida) whose love and encouragement was, and is, indispensable; and above all, my parents, from whom my education has always been their first priority - and to some extent their happiness.

DECLARATION

No part of the work described in this thesis has been submitted in support of an application for another degree or qualification of this or any other University or Institution of Learning. It gives an account of the author's own research work performed at the Department of Production Technology and Production Management of the University of Aston in Birmingham and field work undertaken in Venezuela as described in the thesis.

It is a well-known fact that in any work of this nature the researcher must rely extensively upon the wide and ever-growing body of already published and unpublished research evidence, and this work is no exception.

The material referred to in the text has been gathered from many sources and over a period of years - much from the author's experience in metalworking industries, some in plants visits and discussions with quality control personnel, some from public and private institutions with interest in quality assurance, and much from technical literature. Moreover, special reference is made in the text to publications and papers presented at conferences by the author during the course of this investigation (October 1978 - June 1981). As a result, a complete list of all the references cited, works published by the author, as well as a bibliography of useful readings on quality control in developing countries, is given in an Appendix to the thesis.

G.Z. MORILLO

THE AUTHOR

Gerardo Zaid Morillo was born in Caracas, Venezuela, in 1948. He received a Mechanical Engineering degree from the Central University of Venezuela in 1972, and a Postgraduate Diploma in Manufacturing Technology and a M.Sc. degree in Mechanical Engineering from the University of Manchester Institute of Science and Technology in 1976 and 1978 respectively.

His work experience in Venezuela includes academic positions at the Instituto Universitario Politecnico de Barquisimeto, and a position as a Research Engineer at the Siderurgica del Orinoco C.A. (Steelmaking industry). Morillo's professional activities also include being Industrial Manager and Consultant to a number of Venezuelan companies on quality control and related subjects. He is the author of several papers on the problems of quality assurance in developing countries. His current research interests include the management of technology transfer, and corporate technological strategies in the quality field.

In October 1978 he was sponsored at the University of Aston to carry out an investigation to determine some strategies for improving quality control in Venezuelan metalworking industries, out of which work this thesis is derived.

Mr. Morillo is a member of the Venezuelan Institute of Engineers, the Venezuelan Society of Electrical and Mechanical Engineers, the Venezuelan Society for the Advancement of Science, the British Numerical Engineering Society, and the Institute of Quality Assurance of the United Kingdom.

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SUMMARY

The title of this thesis seeks to indicate its objective. In fact, it is basically intended to explore the problems that arise from designing, developing and introducing Quality Control (QC) systems in the Venezuelan metalworking industry and to examine the method by which managers deal with such problems. Particular attention is given to the analysis of the quality problems in the smaller industries.

Due mainly to the interdisciplinary and complex nature of the research project undertaken - in which a comprehensive study was made of the interrelations and constraints of the technical, human and economic factors in the design of a national strategy on quality - it was found appropriate to adopt the "systems approach" in this study. Firstly, it was applied to define QC as an integral part of Production Management and secondly, to formulate some strategies on quality in the Venezuelan metalworking sector.

Apart from the lack of quality consciousness, adequate educational and training programmes, skilled manpower, shortage of energy and other natural and financial resources, among others, the choice of technology is the most critical problem facing any developing country. After analysing the appropriateness of the concept of Intermediate Technology (which in essence is that the increasing, complex, highly sophisticated, capital-intensive, large-scale and labour eliminating technologies of the highly industrialized countries are generally inappropriate for many developing countries) as a means to pursue industrialization in developing nations, it is argued that a new approach is needed in order to meet the new demands and to establish an effective and economic control of quality of manufactured products, which are obtained by using such technologies. The practical implications of the term 'Intermediate Quality Control' are discussed, and later it is shown that in most of the cases this quality technology stands between inspection-orientated QC and total QC.

On the basis of such analytical study, and also taking into consideration the results of a field work study carried out by the author in Venezuela, some recommendations are made on the appropriate aims and content of management QC improvements and development strategies for raising the level of quality in Venezuela's manufacture and production.

Key Words: QUALITY STRATEGY - METALWORKING INDUSTRY - TECHNOLOGY TRANSFER - DEVELOPING ECONOMY

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CHAPTER 1

INTRODUCTION

1.1. Preamble

In the manufacturing Quality Control (QC) field, from the beginning of this century, there have been basically five stages in its evolution to the present, namely: Operator QC, Foreman QC, Inspection QC, Statistical QC, and Total QC (see Figure 1-1).[1] All these quality techniques have been developed in accordance with the advent of new manufacturing and management systems, which have occurred in the industrialized nations. From this situation has arisen the need to facilitate and increase the international flow of quality technology for improving the productivity and living standards of all countries, so as to increase their partici-pation in world production and trade.[2]

We live in a dynamic and competitive world where market competition is met at inter-firm level and inter-country level. For a manufacturing industry to survive it must keep pace with change, and each and every firm must be efficient in achieving its objectives. Efficiency in terms of return on capital employed, or profit, has to be achieved these days in the face of increasingly complex interactions and constraints of a technical and social nature.[3] Prac-tically this means that in order for an enterprise to pursue its ultimate purpose of 'continuing with prosperity' it must effectively utilize its available resources (people, matters, energy and information). Starr [4] suggests that any measure of effectiveness must take into account: (1) Costs of running the system; (2) quality of output; (3) production rate and production capacity; (4) flexibility to adjust to changing circumstances; and (5) social value of the system.

From the foregoing it is clear that, in today's industrial climate, 'money profit' is no longer the ultimate measure of business performance. In fact, various other measures have been developed during the past twenty years, such as: product quality, service, cost of production, working conditions, etc.,[5] which are of equal importance to the success and perhaps even the survival of any company in a competitive market. For all these reasons, it is advised that firms, in practice, may follow a 'play-for-safety' attitude rather than make the calculated risks necessary to earn maximum profit. More likely, they will obtain a 'satisfactory' level of profit, but in order to enhance their own positions and salaries, seek to expand the firm by maximising sales rather than profits.[6] In this sense the long-term surivival of any industrial enterprise depends critically on its ability to sell manufactured goods that are competitive in both domestic and export markets, in terms of price, delivery and quality. Increasingly competitive markets have shown that in the ultimate, the quality and reliability of products play a major part in long-term profitability.

The three main objectives of production which should always be paramount are known as the 'three rights': (1) to produce at the right cost; (2) to produce at the right quality; and (3) to produce at the right time. Obviously, the cost objective has to be met if profit is to be made. The quality standard must be attained if sales are to be perpetuated and after-sales problems minimised. Finally, if delivery dates are not achieved, there is always a competitor lurking around the corner ready to take advantage and step in.[7] Thus a manufacturing firm's success depends greatly on its reputation for supplying sound products that will give customer satisfaction in the price range offered and at the right time of delivery. We might further note that there are three main ingredients in any customer/manufacturer relationship: price, delivery and quality. By considering the basic requirements of product quality i.e. customer value for money, the ability of a product to continue to give customer satisfaction, and the means by which these two things are achieved at minimum overall business operating cost; we would conclude that by far the most important of the three principal factors in a purchasing decision - price, delivery and quality - would be the last mentioned, quality, and that price and delivery are in themselves characteristics of good quality.[8] However, it is virtually important to note that when any proposals for the control of quality are considered by the manufacturer, they must be sufficiently elastic to accommodate all three of the customer's interest: quality, cost and delivery. No one is going to pay excessively or wait interminably for a specific quality.[9]

Growing product complexity and increasing demands for quality and reliability require not only technological improvements in design and manufacturing, but the integration of design, manufacturing, and reliability/quality assurance operations as well. Achieving this integration requires the solution of many organizational and human relations problems and the establishment of a real uniformity of purpose throughout an organization.[10] Quality and reliability is only one aspect that needs careful consideration if higher productivity and profitability are to be achieved, but in terms of return for effort employed it is potentially the most rewarding in any business where serious attention has not yet been focussed upon it. It has been rightly said that good QC is essential to some and desirable for all, with equal emphasis placed upon 'too much' as well as 'too little'. It will always cost least in overall terms and is achieved more by awareness and attitudes of mind than by anything else.[11]

Accepting the fact that a well-balanced prosperity of the nation is not a matter in which the final say rests exclusively with the individual producer and consumer, we have widened the scope of QC by aiming at: (1) strengthening the economic power of the nation by the production of goods and services of optimum quality and minimization of waste; and (2) sufficient production to satisfy collective needs closely connected with the quality of everyday life to promote well-being for all. A last widening of the scope of QC is represented by the assistance of the highly industrialized countries to the developing countries.[12]

In recent years, much has been written about the principles and techniques of QC. There have also been many developments in the history of QC from the era of the craftsman to the era of Quality Assurance (QA) and the current Product Liability push. However, too little has been said regarding the problems associated with the introduction of modern QC techniques into developing countries, and even more, the tools for dealing with these problems have not been developed yet.[13] So it is hoped that the present work should be looked upon as an effort to make an additional contribution to all that has been already done in the area of QC in developing economies.

It is the intention of this thesis to present as complete a picture as space will permit of the knowledge and skills needed for the efficient design and introduction of modern QC systems in industries in developing nations. Throughout the thesis, the intention has been to emphasize the practical reasons for the choice of criteria, for the assessment, as well as the methods of choosing 'appropriate' quality technologies. Strictly speaking, this thesis is likewise not empowered to take decisions but only to formulate some strategies for the improvement of the prevailing quality situation in the Venezuelan metalworking industry.

1.2. The Methodology Used in this Study: The Systems Approach

It is widely recognized that the formulation and implementation of strategy attempts to focus attention on each and every possible aspect of a given situation on a project and arrive at an integral, all-round solution. In this investigation the 'strategy formulation process' is applied to QC. Due mainly to the interdisciplinary and complex nature of the research project undertaken (in which a comprehensive study was made of the interrelations and constraints of the technical, human and economic factors in the design of a national strategy on quality), it was found appropriate to adopt the 'system approach' in this study.

The subject matter of this thesis is QC in Venezuela. Throughout this study the systems approach will be mainly applied, firstly, to define QC as a subsystem of the

Production System, and secondly, to formulate some strategies for improving QC methods in the Venezuelan metalworking industry. Recognizing the space restrictions in this general introduction, Chapter 7 of this volume is exclusively devoted to present a summary of recommendations and proposals for future work in the quality field in Venezuela. Thus, in this section an attempt is only made to define the firm as a system and its environmental factors, the production system, and then QC as an integral part of production management.

Before going further, it is necessary to define the terms systems and systems engineering. In terms developed by the ASQC (American Society for Quality Control) Systems Engineering Committee, a system is "a group of interacting human and/or machine elements, directed by information, which operates on and/or directs material, information, energy and/or humans to achieve a common specific purpose or objective". In operational terms, a system is the most effective work structure or pattern of men, machines and information for the entire customer order to customer delivery scope of the principal activities of the enterprise. Systems engineering then, is the analysis, design and implementation of such a system. As noted by D.S. Feigenbaum[14-16] this systems application engineering process basically involves six iterative technical phases: systems analysis, programming, design, development, installation and implementation, and systems audit and service. The systems engineering process incorporates experience, theory, the most suitable equipment, manpower, procedures and environment to establish the optimum balanced systems structure that most economically achieves the company's control objectives.

Generally speaking, a system is a set of co-ordinate components. It accepts inputs and engages in processes which yield outputs.[17] According to Churchman[18,19] the study of systems involves five basic considerations: (1) The total system objectives, purposes and measures of performance; (2) The system's resources: the means used for performing the system's tasks and yielding its outputs; (3) The system's environment: the fixed constraints; (4) The components (elements) of the system including their activities, goals and measures of performance; and (5) The system's management which acquires the resources and allocates them in order to achieve the system's objectives. Management encompasses the system's decision processes. Figure 1-2 illustrates how the system designer starts at the highest echelon of the system and reaches a decision regarding the optimal manner of achieving the desired output with the available inputs.[20]

Today's economy has forced the definition of productivity away from the traditional factory-orientated attention to "more product output per unit of resource input", to a market-orientated productivity concept of "more saleable, good quality output per unit of input" - which is a fundamentally different management objective and managerial performance measurement, i.e. the only economically meaningful business indicator of productive input-output efficiency for company management in today's markets is the degree to which products and services output provides customer quality satisfaction - with the corresponding positive impact on product saleability.[21] Consequently, an understanding of the system's outputs is important for productivity analysis and quality improvements. Essentially the system's goals and objectives define the "functional class" of outputs which it is the purpose of a system to produce.[18,22]

In production terms the systems approach requires that all the factors - human, market, technical - should be considered collectively when dealing with a management problem. It takes the 'total' point of view and is a great improvement over the treatment of management issues in terms of isolated problems for solution by individual techniques.[23] The systems approach is a way of thinking about the job of managing. It provides a framework for visualizing internal and external environmental factors as an integral whole. It allows recognition of the function of subsystems, as well as the complex suprasystems within which organizations must operate. Systems concepts foster a way of thinking which, on the one hand helps to dissolve some of the complexity and, on the other, helps the manager to recognize the nature of complex problems and thereby to operate within a perceived environment.

It is important to recognize the integrated nature of specific systems, including the fact that each system has both inputs and outputs and can be viewed as a self-contained unit. But it is also important to recognize that business systems are a part of large systems - possibly industrywide or including several, maybe many, companies and/or industries, or even society as a whole. Further, they are created, operated, revised and often eliminated. Thus, the systems approach is at once: (1) a way of thinking, (2) a method or technique of analysis, and (3) a managerial style.[24] It takes into consideration the fact that a system is an organized or complex whole, an assemblage or combination of things or parts forming a complex or unitary whole. As Ackoff has pointed out, it is a 'set of interrelated elements.'[25] The sequence of terms is significant because the system approach emphasizes wholeness (set) first, then moves to consideration of parts and subsystems (elements), including interactions (interrelationships) among them and between the parts and the total.

We can now look at a firm as a system. The firm viewed as an economic organization is engaged in convertion of input resources obtained from a supply market into output products offered back to the demand market.[26] The convertion process is composed of several elements as shown in Figure 1-3.

In treating the firm's environment, in this work a distinction is made between the two aspects (1) direct environment (demand and supply markets, and direct socio-political environment) and (2) general environment (national economy, international economy, education, technology, population, etc.). The direct environment is an aspect of total environment which has a tangible input-output relationship with the firm. The general environment does not have such a tangible transaction with the firm, though it may exert a substantial impact upon the firm's behaviour.[27] In the industrial context the environmental factors encompassing the firm can be modelled as in Figure 1-4.[28]

The concept of the production function is general, it does not necessarily have any particular form and often cannot be expressed by an algebraic expression. The maximum product for any set of resources may be simply tabulated. Whether the production function is determined by formula, by detailed design, by complex simulation methods or other techniques as discussed by Walters,[29] its meaning is the same. It represents the limit on what can be achieved with available technology and a given set of resources.[30]

The production system is a subsystem of the firm system. Basically, a production system is the design process by which elements are transformed into useful products. A process is an organized procedure for accomplishing the convertion of inputs into outputs, as shown in Figure 1-5.[31] It is also essential that a production system interacts with its environment if it is to grow. Figure 1-6 illustrates how the Production/Operation Management (POM) system is a subsystem within its environment; and also it shows how the POM system is influenced by, and influences, its internal and external environments.[32]

Figure 1-7 represents an expanded view of the production system. It contains two subsystems: (1) the convertion subsystem; and (2) the control (feedback) subsystem, which is a component of any managed industrial system. The function of the production manager is that of putting together inputs of men, capital, materials, information and energy, and transforming them into products and services in the quantity, quality, time and location that will best meet the organization's objectives.[32]

Just as goals and objectives are needed in the design of a system, control is required in its operation. The purpose of control is to maintain the quality and quantity of the output so that it meets the goals of the system.[33] In order to control the performance in a system, measurements must be made on the pertinent aspects of performance (output) and these measurements are compared with desired performance. The difference between actual and desired performance is then interpreted and the 'effector' is commanded to adjust the process in order to correct performance. Thus, as shown in Figure 1-8, the important elements of a feedback loop are sensor, comparator, interpreter and effector.[34]

Information is the medium of control because it is the flow of measurement data and later the flow of corrective information which allows a characteristic or condition of a system to be controlled. Keeping in mind that information flow is the connecting link of any control cycle, the control characteristic, the means of measurement, the standard and the corrective unit should be designed in consideration of the total system.[24] As manufacturing systems are so complex in general, fully integrated control in the majority of the cases involves rapid and voluminous data processing, and for this reason will generally be dependent upon the use of a computer for complete application. Figure 1-9 shows schematically the levels of control typically found in a production subsystem and indicates how the following two areas of control have to integrate in practice: (1) process control - automated control of technological process to manual set points with overall management supervision; and (2) production control - control by people, based on information flow systems involving computers, of processes involving people and machines.[3]

In essence, an effective management control system requires the combining policies, procedures and information processing, to give direction to activities of the enterprise: (a) by clearly establishing goals; (b) by measuring progress towards these goals; (c) by indicating or initiating corrective action, (d) by displaying the potentials for further improvements.[35]

Traditionally, management control systems are most viewed as flow charts and block diagrams - showing the input, convertion process, output and control elements as well as the operational and feedback information (see Figure 1-10). The latest approach to management systems is based on the 'Quadrille' concept, which embodies the principle that successful management involves continuous co-operation and interrelation between four main operations: Marketing - Manufacturing - Finance - Personnel. Thus the 'quadrilles' of integrated management for an organization can be represented by Figure 1 - 11 which also stresses the planning information and feedback that should occur.

In this research work QC is considered an integral part of Production Management. A close look at Figure 1-11 shows that the first quadrille within the 'manufacturing quadrille' is made up of production planning and control-manufacturing-quality control-costs. The supporting quadrille is comprised of technical services-research and development - procurement or purchasing-labour and plant utilization. The hub around which all these revolve is the production management team. The implications of the adaptation of the 'Quadrille' concept to manufacturing for the other three main divisions or departments of a company are indicated in Figure 1-12.[36]

For the purpose of this study, the word control means a feedback cycle, which is composed of planning and assurance - as indicated in Figure 1-13. The planning side of the QC function consists of: (1) decision (about plans and specifications); (2) ordering/instituting of plans and specifications. The assurance side of the QC function consists of: (1) inspection (measuring and registration); (2) preparing bases for new decisions for taking corrective action by analysing and evaluating conformance to specification and plans. According to O. Hartz,[37] the new decisions for taking corrective action can be improvements in the conformance or improvements in the former decisions about plans and specifications. The application of feedback control concepts for the quality aspect of an industrial enterprise is well explained by D.E. Fyffe[38] in his paper: 'Control Concepts and the QC System.'

Before completing our discussion of general systems concepts let us look at the QC system. QC as a system has the same general characteristics as all other management control systems - an input, output, feedback, etc., with an aim that is self explanatory - the control of quality. In common with other systems the controlling is done by means of management decisions, not by the system; the system provides management with information of the right kind at the right time, in order that the decision taken will be more certain. QC is a system for measuring and recording the variables that affect quality in a methodical manner, so that the values and trends can be compared with standards and thus act as a means of control.[39]

The quality system is the network of administrative and technical operations required to manufacture a product of specific quality standards. This concept of quality system is illustrated graphically in Figures 1-14 to 1-16. In

Figure 1-14 we see an entire quality system, composed of two subsystems: (1) the subsystem S_1 which is regarded as a communication system closed on the consumer's quality requirements; and (2) the subsystem S_2 which is a communication system closed on the quality-planning function. As noted by E.G. Kirkpatrick,[20] from the standpoint of quality decision making, S_2 is really a network of feedback systems. The communication input to the QC operations are those from quality planning, manufacturing operations and installations and data from the field.

All pieces of the quality picture have to be fitted into a functional entity, or it can degenerate into sporadic campaigns of hectic activity founded on a pile of inspection reports. As represented in Figure 1-15, the quality subsystem is intimately linked with the governing production system.[31] A quality product is the result of careful design specifications (quality of design), conformance to specifications (quality of manufacture), and feedback about product performance (quality of sale/service). The crucial position of the customer is evident from the design that seeks to satisfy his wants and the performance feedback that checks whether he is indeed satisfied. The relation between customer demands,product design and production is illustrated in Figure 1-16.[40,41]

Let us now proceed to look at the <u>Quality Assurance (QA) System</u>. A QA system is an effective method of obtaining and maintaining the desired quality standards. It is based on the fact that quality is the responsibility of all functions. These interrelated functions can be broken down into 10 subsystems, as illustrated by Figure 1-17.[42] The QA system is an evaluation or audit of each one of these subsystems to determine how effectively the functions are being performed.[43] QA can be said to be all activities and functions concerned with the attainment of quality (referred to by some as Total Quality Control), rather than in the more narrow sense of the provision of proof associated with the word assurance. As such it is involved with all quality tasks from market demand through to and including post-delivery services which can involve various forms of external liaison, co-operation and involvement with purchasers and subcontractors or surveillance by independent certification authorities. QC is defined as, "a system for programming and co-ordinating the efforts of various groups in an organization to maintain or improve quality, at an economical level which allows for customer satisfaction." Defined as such QC is a subset of QA, i.e. a substantial integral part of it and not a separate addition to it.[44]

Broadly, QC has to do with making what it should be, and QA has to do with making sure quality is what it should be.[45] Another definition is that QC deals with the problem of "Are we doing the things right?" and QA deals with the question "Are we doing the right things?"[46] Figure 1-18 shows some basic elements involved in and possible interrelationships of a quality management system, correlated in terms of: (1) design/specification adjustment; and (2) process/procedural operation.[47] This aspect will be discussed in more detail in later chapters, particularly in the introductory section of Chapter 6, but it should be mentioned here the advantages of the application of the system approach to the management of quality.

Very generally, in applying the system approach to the management of quality, the quality objectives or missions are defined for each project phase and subphase. The characteristics of the inputs to and the outputs from each quality system (or subsystem) are described. Timing and other system's constraints are considered by means of requirements analyses to determine what systems' capabilities must exist to satisfy given quality missions. The systems are optimized and 'noise' is reduced. The main advantages of the systems approach, summarized by Marguglio,[48] are as follows: (1) the systems are oriented objectively which, in themselves, tend to weed out extraneous, non-profit efforts; (2) a somewhat scientific approach is employed to assure, to begin with, the adequacy of systems' inputs and constraints rather than trying to design systems under inadequate ground rules; (3) the systems are optimized for maximum control value with cost constraints or for adequate control value at minimum cost; (4) the systems tend both to 'unburden' the human elements for maximum control consistency and to 'quicken' feedback on the effects of human responses thereby proving partial build-in test mechanisms; (5) the systems approach tends to assure complete and adequate coordination and interface of the various quality efforts.

We now come to the last subsystem: the Standardization System. This is not independent from the former systems: the firm, production, QC and QA. In fact standardization may be looked on as a system of systems, which interrelation is direct as indicated in Figure 1-19. A simplified view of the feedback interlinks between components of a standards system is shown in Figure 1-20.[49]

Standardization and QC are two activities which are complementary to one another. In this chapter, no attempt is made to describe the procedures which are commonly referred to as 'standardization'. Ample literature is available to which reference can be made. Nevertheless, it is important to stress here that it is not unusual to find that standards organizations in a developing country are not only responsible for standards development but also for the national QA, QC, metrology and testing facilities.[50] For this reason, Chapter 3 of this thesis will describe the history and current state of Standardization and QC in Venezuela, in particular the work now being carried out by the Venezuelan Ministry for Development through the COVENIN (Comision Venezolana de Normas Industriales).

1.3. Aims, Scope and Limitations of Research Programme

More than ever before quality now plays a fundamental role in international trade and product liability. Nowadays, most of the developing countries are becoming increasingly aware that improved quality can lead to better competitivity in the market place, increased profitability, higher production, lower costs and above all, the conservation of precious materials. They are deeply concerned with keeping abreast of new developments in the quality field.

Unfortunately, we have little knowledge of what is happening in Quality Control (QC) in the Third World, and to date there has been little in-depth discussion on the major problems arising from the introduction of modern QC systems in developing countries. This thesis is intended to fill this gap and to stimulate such a debate. It not only examines the new QC technological breakthroughs, the reason why they are occurring, and where and how their impacts will be most directly felt, but also presents some practical proposals to help in solving QC problems in developing economies.

The central question is: "Can developing countries use effectively those QC technologies which have been evolved in the industrially advanced countries in accordance with their industrial development?" Ultimately this question involves the entire globe and the distant future. The author has chosen however, to concentrate on industrial QC in Venezuela.

The general theme of this thesis is QC in a developing country - a case study of Venezuela. The purpose of the thesis is to provide the reader with a better understanding of the main problems militating against the implementation of QC in the Venezuelan metalworking industry. It is also hoped that the reader will gain some thoughts, ideas, and insights that will be useful in transferring or adapting modern quality technology from advanced to developing countries. In fact, the over-riding objective of this work is to help the reader, whether he will be a QC practitioner or policy-maker, to be an effective planner in identifying priorities to define a national strategy for quality in any developing economy.

In short, the central aim of this thesis is to determine some strategies for the improvement of QC methods used in Venezuelan metalworking industries. Particular attention is given to analyse the quality problems in the small and medium-scale industries.

The scope of the research project therefore is:

1. To carry out an investigation into the history and current state of standardization and QC in Venezuela, with

special reference to the metalworking industry.

2. To study the causes of major QC problems facing today the small and medium-sized metalworking industries in the country.

3. To examine the validity of the concept 'Intermediate Technology' as a means to pursue industrialization and to alleviate QC problems in developing countries.

4. To provide some guidelines for the formulation and further implementation of a national strategy on quality in this industrial sector.

It will not be possible to cover every aspect of the problem, so those items mentioned above should be considered as most essential, for quite a number of points that could be raised are common in most research works. In other words, it is necessary to make some limitations in the scope of the research project in order to draw practical and viable conclusions, as well as to suggest some proposals for future work.

It should be pointed out that the metalworking sector of the manufacturing industry plays a key role in Venezuela's industrial production and development (as explained in Chapter 2). The control and assurance of product quality is crucial in this industrial sector. This is the reason why the researcher has taken up this subject as an important technical programme. Recognising the fact that the small and medium-scale industries account for more than 92% of the manufacturing industries in the country, of which it has been estimated that 15% of these companies belong to the metalworking sector. Also, they contribute to 25% of the total national output, to about 23% of the manufacture added value, to about 8% of the

Gross National Product, and even more important, these industries employed about 42% of the labour force of the manufacturing sector.

In view of the aforementioned facts, this research work has been biased, deliberately, to these industries rather than to large-scale metalworking companies, for it is in the former sector that there is the greatest lack of published information and an urgent need for quality improvements.

The title of the thesis makes itself some limitations within the scope of this work. These limitations can be summarized as follows:

1. The word 'strategy' is used instead of the term 'policy'. Strategy is often confused with policy and with tactics. Policy decisions often remain valid for a decade or more. Strategy decisions may remain valid for a period of several months to several years. Tactical decisions usually refer to a period of less than one year; these time-spans can only be an approximate guide. While policy decisions can include the setting of overall company objectives and constraints as well as means, strategic decisions usually refer only to means.[51] The time-span is very important here due to the fact that the proposed plan for action is for short and medium-term, rather than long-term. It is worth mentioning here again that this work is aimed at defining strategies on QC rather than to implement them. The very multidisciplinary nature of this investigation required a team work effort to make possible the crystallization of such strategies.

2. The basic principles of QC are general, and thus applicable to small companies as to the large. Implementation

of these principles, however, must change with the size, product, location, resources and 'cultural' environment of the organization. In other words the techniques are different, but the principles are general. Hence, this work deals with QC methods rather than QC principles.

In particular, special attention has been given to the problems confronting industries in developing countries, when 'inappropriate' QC technologies are transferred from industrialized to developing countries. In Chapter 6, a new approach, called Intermediate Quality Control is discussed, which is based on the concept of Intermediate or Appropriate Technology: Technology with a Human Face.

Furthermore, there are many other limitations in compiling this thesis on QC as a key factor in the industrial development of Venezuela. For instance, the author has omitted discussion of the underlying fundamentals of the physics and techniques currently used in the metalworking industry. The omission is justified by the need to conserve space and by the availability of such information in text books, journal articles and other sources. The same applies, with perhaps greater force, to the statistical principles and techniques on which QC is based; it treats QC as part of the management framework. Finally, it is worth adding at this stage that this study points to the need for better information on which to base an improved assessment, not only of the prevailing QC situation in the nation's metalworking sector, but also of the likely future demands on higher-quality products from other branches of engineering and manufacturing industries. To do so, it is required to overcome one critical limitation, that related to the scarcity and unreliability of available data on standardization, quality and related subjects (QC, QA, reliability, etc.) as well as on the industrialization process in the country. The lack of this information is explained in part by the relatively short history of industrial QC in Venezuela and the low degree of specialization existing in many metalworking plants.

1.4. Work Undertaken

The general framework of the thesis has been outlined in previous sections, as well as the basic philosophy of the methodology used to undertake the research work. In the preceding section, the aims, scope and limitations of the research topic are defined. Then this section will deal only with a description of the work undertaken during the course of this investigation.

The title of the thesis seeks to indicate its intention. In fact, it is basically intended to explore the problems that arise from designing, developing and introducing QC systems in the Venezuelan metalworking industry and to examine the method by which managers deal with such problems. On the basis of such descriptive analytical study, some recommendations are made on the appropriate aims and content of management QC improvements and development strategies for raising the level of quality in Venezuela's manufacture and production.

The Venezuelan metalworking industry is today experiencing a strong "technological push" situation, and there are being made continuous efforts in this industrial sector to achieve higher productivity, better quality products, to reduce material waste and improve job satisfaction and working conditions for the operating personnel. To the best of the author's knowledge this work represents the first systematic study to investigate the ways in which these companies have analysed and decided which QC activities they should have, how these should be organized, which QC methods should be used and the extent of the resources which should be allocated in each QC activity.

The following assumptions were formulated in order to design the research project.

1. The increasing development of the metalworking industry has changed the pattern of foreign trade in the country. It also has brought into sharp forces the urgent necessity of quality improvement and cost reduction in order to compete successfully in the overseas markets, particularly with Latin American countries.

2. The process of technology transfer in the quality field must respond to the needs and expressed wishes of the developing countries; and in turn will often require of them difficult internal decisions, including inevitably some socio-economic and political changes.

3. A remarkable degree of progress has been achieved in the process of industrial standardization in the country, mainly through the COVENIN. However, very little time and effort has been devoted to promote QC; so it must be emphasized that QC is a vital factor for the survival of the nation's economy, and consequently the standardization activities must be complemented by other activities in the area of QC and its related subjects, QA, reliability, etc.

Under the above assumptions, the researcher conducts the investigation by using the basic steps of the "scientific approach", i.e. to start by identifying the problem, then investigate the causes and propose solutions. In other words, the following steps have been followed: (1) defining the need (problem); (2) collecting the data; (3) analysing and organizing the data; (4) the strategic process (strategy formulation, implementation, evaluation); (5) follow-up actions.

To accomplish the objectives that have been stated, this investigation was carried out in accordance with the following plan:

1. A study of the history and present status of QC in Venezuela, with special reference to metalworking industries;

2. The determination of strategies to be followed;

3. Case studies: assessment of the effectiveness of the QC methods used in the Venezuelan metalworking industry. Design and implementation of appropriate QC systems to small and medium-scale industries; and

4. An appraisal of the preliminary recommendations given to the COVENIN (July 1979, ref.52). Also an evaluation of the improvement of the QC programmes introduced in the companies selected to conduct the experimental part of this work.

During the course of the research work about 25% of the time was spent in Venezuela. A first visit took place in 1978 (October - December). On this occasion an investigation was done to assess the progress and problems of QC in Venezuela, and to select two medium-sized metalworking industries in which the experimental work was to be carried out.

During the second visit, which took place in 1979 (October - December), an in-plant experimental work was conducted at the two industries previously chosen (described in Chapter 5). Finally, a third visit was paid to the country in order to update the information and data obtained in previous visits (August - October 1980).

As mentioned earlier, the cross-disciplinary nature of this research suggested the use of a wide framework and the application of the 'systems' approach. In doing this investigation the relationships between technical-socio-economic and cultural factors, and other elements of the quality system (as shown in Figure 1-17) were considered. Thus, the systems concept provided a basis for considering other critical factors which may lead to improvement in the quality field.

A schematic view of the main topics covered in this thesis is shown in Figure 1-21 and explained in Chapters 2 to 6. Broadly speaking, this thesis has been organised in the following order: Chapter 2 describes the factors shaping the Venezuelan economic growth and development, and also the economic dimensions of the Venezuelan metalworking industry are indicated. The next chapter then reviews the evolution of standardization and QC in the country. In Chapter 4 an in-depth study is presented on the major factors militating against effective QC in Venezuelan metalworking industries. The results of the field research work peformed in two medium-sized industries are given in Chapter 5. 'Intermediate Quality Control for Developing Countries' is the title of Chapter 6, which examines the validity of the concept of 'Intermediate or Appropriate Technology' to define ways to transfer or adapt QC technologies from advanced to developing countries. The final chapter contains recommendations and some suggestions for future work.

In order to give all essential information and yet not to burden the main text with over-tedious detail, rather liberal use has been made of Appendices and many figures to illustrate some basic concepts relevant to the thesis.

It should be noted that factual material has been gathered from many sources and over a period of years - much from the author's experience in metalworking industries, some in plant visits and personnel interviews with QC staff, some from government and private agencies with interest in QC, some from consumers and much from technical literature.

This study on QC in Venezuela reveals that there is an urgent need to launch a nationwide quality campaign to create an awareness in all sectors, government, manufacturers and consumers, of the benefits of QC. Although the significant work now being carried out by the COVENIN must be recognised, there is an ever-increasing need to unify and co-ordinate all the efforts if it is desired to obtain the maximum benefits of the large amount of money now being spent,both by government and industries, in favour of the consolidation of the process of standardization in the country. It is equally necessary to improve the existing QC methods or introduce other QC systems much more modern and adequate to the present industrial climate and in accordance with the socio-economic-cultural environment surrounding these industries.

In doing so, the manufacturing of goods which can provide quality satisfaction and economic benefits for all - government, industries and customers, can be assured.

CHAPTER 2

ECONOMIC DIMENSIONS OF THE VENEZUELAN METALWORKING INDUSTRY

2.1. Introduction

As Juran [53] says,"The goal of high quality is common to all countries. This common goal must compete with other national goals amid the massive national forces - political, economic and social - which determine the national priorities." Thus, it is important to examine these national forces and their effects on the problems of attaining quality.

This chapter mainly deals with some economic aspects of Venezuelan metalworking industries. Limitations are made here in considering only the developments of these manufacturing industries in relation to the process of industrialization in Venezuela, i.e. the current problems of Quality Control in the Venezuelan metalworking industry will be studied in Chapter 4 of the thesis.

Furthermore, this chapter is not concerned solely with the latest developments in the national metalworking industry, but with the basic facts and trends in the Venezuelan economy. In other words, the author believes that the first step in defining the strategies required to improve the prevailing situation in the field of Quality Control in Venezuela, must be to examine both the national and international panorama of the country's economy, especially those factors closely related to the process of industrialization. Hence, this chapter begins by presenting a brief review of the principal factors shaping the Venezuelan economic growth and development, also some comments are made on the new strategy for industrial development.

The next section first looks at the historical development of the Venezuelan metalworking industry, then analyses the structure, scope and its significance in the country's economy, with particular reference to the role of smaller industries in the metalworking industrial sector. It also discusses the participation of these industries in the Sixth National Plan (1981-85).

Finally, the importance of the Venezuelan metalworking industry in the Andean integration is indicated. After a presentation of the basic principles of the Andean Group Market and the scope and limitations of various industrial programmes, the prospects for economic co-operation in Latin America are described in some detail.

2.2. Venezuela in Perspective

This section presents Venezuela at a glance. Firstly, it gives an account of some geographical and related factors of the country. Then the Venezuelan economy is surveyed in detail, followed by analyses of Venezuela's role in international affairs. It is important to point out here that the present study is mainly extracted from recently published information on Venezuela. It is not the intention of this section of the thesis to make a comprehensive study of the country's economy. Conversely, it is orientated to give a background information on the nation as a whole. Nevertheless, some vital statistics and facts of the Venezuelan economy are given in Appendix 2. This Appendix also contains some maps of the country, in which its geography, resources and industry are well illustrated.

2.2.1. Geographical and Related Factors

Venezuela is on the north coast of South America. It covers an area of 912,050 Km^2, with a coastline on the Caribbean Sea and Atlantic Ocean; Colombia is to the west and south, Guyana is to the east and Brazil is to the east and south. The country has four main geographic regions: The Andean Highlands, The Maracaibo Basin, The Llanos and the Guyana Highlands (Map A2-1).

Venezuela had an estimated population of 13 million in 1977, of which three quarters lived in urban areas. However, some indicators, such as the consumption of basic products and high usage of public services, lead us to conclude that there exists an illegal immigration from neighbouring countries, which brings the actual population to approximately 16 million inhabitants.

From 1971 to 1976 the population grew at an annual rate of 3.1%. In accordance with 1979 figures, 37% of the population was under 34 years old and over 58% was under 21 years old. In general terms, the intensive petroleum industry, which employs only 1% of the labour force, produces 95% of the total value of exports from which Venezuela derives 70% of its income.[54]

While the average population density is 14 people per Km^2 (1976), more than 80% is concentrated in the northern coastal region. The population of Caracas (capital) was estimated at 2,664,000 in June 1977, and the next four largest cities are Maracaibo, Valencia, Barquisimeto and Maracay.

Venezuela is a Federal Republic, which became independant from Spain in 1821 (forming part of Great Colombia until 1930). Since 1958, the nation has had democratically elected governments. In fact, the constitution of 1961 provides for a federal state with a democratic and representative form of government, and with universal suffrage at the age of 18. This provides for all individual, social, economic and political rights.

National territory consists of 20 states divided into districts and municipalities, a federal district (capital area), two federal territories and various island dependencies (Map A2-2). Executive power of a state is exercised by a Governor, who also serves in the state as the "agent" of the national executive power - which is vested in the President, who is elected for a term of five years. In turn, the Ministers, who together constitute the Council of Ministers, are appointed by the President and head various executive departments of the government.[55] A comprehensive study of Venezuelan political institutions and policy-making processes from 1959 to the present, is presented in J.D. Martz and D.J. Myers's book: "Venezuela - The Democratic Experience."[56]

2.2.2. The Venezuelan Economy - Present and Future

Venezuela over the past sixty years has had one of the most dynamic economies in the world. The Venezuelan oil industry began in 1917. Since the 1920's an economy that was rural and agricultural has been transformed into one that is predominantly urban and industrial. This change can be considered as the most responsible for the Venezuelan economic growth and development of its underdevelopment.

Even today, the country's economy depends basically on the wealth currently received from the exportation of oil. With a crude production of some 2.2 million barrels per day, oil overshadows every other economic activity by generating for the nation - as it did in 1980 - an income of 56,000 million bolivars (say £1 = Bs10), equivalent to over 75% of the total fiscal income and close to 95% of its currency revenues. Oil has been, and will continue to be, the determining factor in economic growth (see Table A2-1, Venezuela: Composition of Gross Domestic Product).[54] A more detailed analysis on how the Venezuelan oil industry began, how it flourished, how it floundered, and what its foreseeable future is, can be found in Luis Vallenilla's book entitled "Oil: the making of a new economic order."[57]

Summed up, since the 1920's Venezuela has mainly been an oil producing country and this has established a basic element in the economic question, especially since 1974. The most important characteristic of Venezuela during the 1970's was the radical change in its economy, due to the large increase in petroleum prices. Between 1972 and 1975, Venezuelan economy reflected an extraordinary change in its dimensions. In real terms the gross national product (GNP) was doubled, national income trebled, foreign exchange income increased four-fold and international reserves of the Banco Central de Venezuela increased five-fold.[54]

In 1974, former president Carlos Andres Perez declared, "In Venezuela the only great fortune is that of the State. In Venezuela, the rich, the powerful, is the State and this wealth does not depend on taxes but on the fact that the oil, and in general all the mineral wealth, is the property of the Venezuelan State. Therefore, the democratization of wealth is possible here perhaps more rapidly than in any other country of Latin America. The policies which are advancing, directed towards the remitting of the accumulated debt of all campesinos (peasants) of our country and towards supporting small and medium industry, are leading towards a better distribution of wealth - both on a regional scale to place wealth in Venezuelan provinces and on a human scale to improve the well-being of all the sectors of the community."[58] Without doubt, it can be said that the Venezuelan evolution, especially in the form it has been taking since 1958, is perhaps unique in Latin America for its rich endowment of natural resources. These provide the justification for Venezuela's future industrialization and agricultural development, just as they tend to determine the areas in which the greatest industrial and agricultural potential lie. Thus, among the major resources and principal related activities, Venezuela has one of the largest potential reserves of hydrocarbons in the world which, including the Orinoco bituminous (tar) belt, has been estimated to contain up to two to three trillion barrels of oil. Having just been passed by Mexico, Venezuela is now the second petroleum producer in Latin America and the sixth largest exporter in the world. Venezuela also has substantial reserves of bauxite and iron ore based on which Venezuela is presently the leading producer of aluminium in Latin America and fifth in the world; and Venezuela is the fourth largest producer of steel products in Latin America. Further, Venezuela has one of the greatest hydroelectric potentials in the world; it is at present completing the largest hydroelectric project (Guri) in Latin America, which is the ninth in the world. Also Venezuela possesses large expanses of, as yet, uncultivated, agricultural lands (see Maps A2-3 and A2-4).[59]

From the preceding paragraph, it is clear that the administration of public affairs in Venezuela follows the customary Latin American pattern of major State involvement. In fact, the Venezuelan state controls the major portion of economic activities in basic industries, e.g. crude oil, iron ore, aluminium, steel, petrochemical, etc. In 1979 there were 230 state-owned institutions in which the Venezuelan State invested more than 85,000 million bolivars. In short, the State is the first capitalist and industrial magnate in Venezuela.[60] Additionally, the Venezuelan State is the major employer in the country, e.g. in 1977, one out of six Venezuelans were employed by the state (542,000 persons). Consequently, the other economic activities, which are owned and operated by the private sector, depend to a large extent on the national budget.

The interests of labour are contested in various ways by a large number of pressure groups, only a few of which can be listed briefly in passing. Most concerned with economic policy is FEDECAMARAS (Federación de Camaras de Comercio e Industria, the National Chamber of Commerce) representative of the private business sector. With increasing frequency an amicable collaborator with the CTV (Confederación de Trabajadores de Venezuela, national confederation of unions) in labour-management discussions. FEDECAMARAS represents business and industry on the highest level. Its activities also include occasional consultation with the government and numerous economic studies of various sorts. (See references 61,62).

Prior to the nationalization of iron (1975) and oil (1976), some well-known international firms had an oligopolistic competition - which created market restraints. Thus, the national monopoly added to the oligopoly of some large and a few giant corporations which had become the pattern of much of Venezuelan business enterprise. Consequently, business decisions were governed not by the reactions of buyers but by the reactions of those companies to one another directly and personally - as opposed to reactions to impersonal market forces of pure competition.

In general terms, we can say that the country has a mixed economic system in which both public and private sectors are active. Owing to the fact that there are evident inequalities of income and differences in culture, we can identify "dual" societies and economies. As Jose Antonio Gil Yepez [63] pointed out in his excellent book "El Reto de Las Elites", in Venezuela the most powerful economic groups are only in the hands of a few families, who also control the financial activities, i.e., a small number of economic groups control all the industrial activities, and the most powerful are those who are self-financing.

In Venezuela, as in other Latin American countries, at the present time we find many forms of co-operation existing and growing between the private and the public sectors. This includes tripartite forms of association between foreign and national private investors together with public capital in various countries. There are also intermediary financial institutions operating at both national and subregional levels that co-operate with private capital.[64]

Due to the fact that the industrialization of the country began relatively late, in the late 1950's, it is clear that this situation led to an increase of importations.

However, during 1974-77 the manufacturing industry grew at the rate of 11.1% and its contribution to GNP increased from 13% in 1973 up to 15% in 1976.[60]

In order to speed up the process of industrialization, since 1960 the Venezuelan government has been supporting those industries which could promote import substitution and foreign currency savings.

Because of the problem of poverty (mainly in rural areas), consumerism and low productivity, especially in the agricultural and industrial sectors, the country has recently shown balance of payments difficulties.

Nowadays, increasing immigration - mainly from neighbouring countries and from the Caribbean - has led to many new socio-economic problems in Venezuela, such as: unemployment, inflation etc. The problem has arisen because the government has not been able to control the quantity and quality of immigrants which the country needs for its development. Immigrants are flowing into Venezuela in record numbers, and the sad truth is that today nobody knows exactly how many of them are illegally living in the country - even more, the nation still lacks a workable immigration policy.

During 1974 - 78 the Public Debt of Venezuela had reached the highest value of all time. The National Congress reported that the Venezuelan Public Debt increased from Bs 18,718 million on March 31, 1977 to Bs 38,031 on March 31, 1978, that is an increase of 103.17 per cent. During the same period the Foreign Debt increased by 31.16 per cent.[65] It was for this reason that President Luis Herrera Campins said when he began his government on March 12, 1979 "I am receiving an indebted country."

Venezuela's political and social democracy today, Luis Vallenilla wrote, represents the most solid system in Latin America and possibly even throughout the Third World. However, where the system still openly fails is in its administration, which is so alarmingly inefficient notwithstanding the ever-increasing oil bonanza. Thus great social and economic problems still overwhelm a high proportion of the population. Therefore an administrative revolution should take place without further delay.[57]

Hence, it is evident that there is a need for improvement in the planning activities in Venezuela. Since 1958 the Central Office of Co-ordination and Direction (CORDIPLAN) has been responsible for overall national economic and social planning, and for providing four-year plans. Attached to the presidential office and concerned more with co-ordination and implementation of existing plans than with initiating programmes of its own, CORDIPLAN has assumed major policy-making responsibilities, supported and strengthened as it has been by the Chief Executive himself. According to the latest economic indexes and the opinions of well-recognised economists, it is widely believed that the fiscal and financial measures taken by the past government (1974-79) were not sufficiently effective and wise. Consequently the goals stated in the Fifth National Plan (1976-80) were not reached. Nevertheless, the foreign policy (Table A2-2), the decentralization policy in both industrial and administrative public sectors, the democratization of capitals through the Venezuelan Development Corporation (CVF) and CORPOINDUSTRIA in favour of the smaller industries, the conservationist policy on non-renewable resources, the 'Gran Mariscal de Ayacucho'

Scholarship Plan; and the last steps taken for the nationalization of the oil industry and iron ore, are among the achievements of the past administration.[66]

In December 1978, when the present administration was elected, the economic cabinet took steps tending to cool down the economy, which was then considered to be overestimated, by reducing monetary liquidity and taking steps to reduce bureaucratic expenses. Unemployment, the rate of which was 4.8% in 1978, increased to 6% in 1979 and in 1980 reached the figure of 7.3%. GNP reflected a figure under 1% over the year 1979. As a consequence of this, the new economic policy as stated in the Sixth National Plan, is oriented to: stimulate private investment; increasing industrial efficiency by stimulating competence through the reduction of state protection; complete the infrastructure projects presently being developed; improve the quality of public services; and combat inflation.[54] A summary of the basic goals of the Sixth Plan is given in Table A2-3.

After increasing at an average rate of 8½% per year in the period 1976-77, output of nonpetroleum sectors rose at a more modest 3.7 per cent in 1978. There was almost no growth registered in 1979, with output in every important sector in the nonpetroleum economy virtually flat, with the exception of the primary sector. The 1979's growth rate of 0.2% was the lowest recorded since 1968 when the present system of national accounts was introduced in Venezuela (Table A2-4).[67]

Imports into Venezuela have also risen substantially after two years of stagnation and the rise in oil revenues has been comparatively small because of weak demand, particularly for heavy crude, from the United States. Thus the balance of payments on current account may have recorded its fourth consecutive annual deficit last year although the rate of increase in the money supply has been reduced very sharply since 1977 and more recently price inflation has also shown signs of slowing down after reaching 24% at consumer level between the third quarters of 1979 and 1980. GDP growth average was just over 6% a year between 1973 and 1978 with relatively little fluctuation, but restrictive policies reduced it to 0.7% in 1979 (Table A2-4) and there was probably a fall (perhaps 2%) in 1980. A bigger budgetary deficit (8% of GDP) should, however, provide some stimulus in 1981 and growth of 4½% is officially predicted. The Sixth National Development Plan envisages an annual rate of 6% for 1981-85 in spite of unchanged oil production. Though the main emphasis is on the social sector, job creation and housing in particular, major mining, energy and infrastructure projects imply that rapid growth of imports is likely to continue.[68]

It can be seen from the foregoing that beginning in 1978, the economy has been allowed to decelerate somewhat from 1979 to 1980. This period of readjustment will terminate at the end of 1980, so that starting in 1981 the economy will again attain reasonable growth rates in the 6% range overall which should continue throughout at least the decade of the 1980's. Then it is hoped that the present Government - The Promoter State as it is being called - could lead the country in a better way, so that the country's economy will continue its upwards trend towards less dependency on the wealth of Venezuelan subsoil deposits, with the resulting improvement of the process of industrialization and the agricultural sector, which will contribute to increase the quality of life of the population.

Further reading on the principal factors contributing to the actual situation of the nation's economy are indicated in references 69 to 84. A detailed information on the history and political system, principal economic and social indicators, territorial expansion, population, GDP, international trade, factors of economic stability and the new economic policies which began to be implemented in 1979 in Venezuela, are given in Appendix 2, section A2.2.

2.2.3. Venezuela's Role in International Affairs

To understand contemporary Venezuela's international role, it is essential to begin by considering the linkage between domestic, political and economic concerns and the conduct of the nation's foreign policy (Table A2.2). Since 1958, Venezuelan foreign policy has been strongly influenced by domestic, political and economic goals and by the distinctive development strategy adopted by Venezuela's leaders in pursuit of these objectives. Four development goals have been pursued: institutionalization of the democratic political system, control and eventual nationalization of the petroleum industry; economic growth that is less dependent on oil earnings; and greater equity in the distribution of the benefits of economic development.[85] The development strategy followed relied upon a constant flow of oil income to ease the transition to a democratic, industrialized Venezuela. The realities of the Venezuelan development process result in the following cluster of Venezuelan foreign policy objectives: (1) the maintenance and maximization of government oil revenue; (2) the achievement of Third World demands for a 'new international economic order'; (3) the extension of Venezuelan influence in Latin America beyond strictly security measures; and (4) accommodation with the United States.

This special configuration of development goals and strategy has strongly influenced, and continues to shape, the style and substance of Venezuelan foreign policy. In addition, the fact that the objectives of economic growth - less dependency on oil and greater equity in the distribution of the wealth that growth creates, have not yet been achieved - has important implications for the future orientation of Venezuela's regional and international diplomacy. An overall assessment of the origins, conduct and probably future of the Venezuelan foreign policy has been made by R.D. Bond in 'Contemporary Venezuela and Its Role in International Affairs'.[86]

Venezuela is a member of the United Nations and its related agencies, the Organization of American States, the International Bank of Reconstruction, the Organization of Petroleum Exporting Countries (OPEC), the Andean Group, the Andean Development Corporation, the Latin American Free Trade Association (now the Latin American Integration Association, LAIA), and other hemipheric organizations.

In the international sphere Venezuela has generally been a force for regional cohesion. Despite the mistrust of many of its businessmen for the Andean Pact, Venezuela has maintained its membership of that bloc. It has assisted the process of economic integration and has understood, often more clearly than larger Latin American countries, to what extent the economic fate of the whole of Latin America is dependent on joint action vis-a-vis with the rest of the world, particularly the developed world.[71]

President C.A. Perez, inaugurated in March 1974, took full advantage of favourable international circumstances and the influx of petro-dollars to propel Venezuela decisively onto the international scene. At home, the Perez Administration selfconfidently nationalized the iron ore and petroleum industries and initiated an ambitious industrialization programme. In Latin America, Venezuela moved to assert its claims to continental leadership by championing the formation of the Sistema Economico Latino-Americano (SELA), by promoting the reintegration of Cuba into the Latin American community, and by dispersing most of its official development assistance (over 3 percent of GNP in 1974) to neighbouring countries to offset the higher price of petroleum. On the wider international scene, Venezuela gained recognition for its prominent role both in establishing OPEC policies and as spokesman for Third World demands for redistribution of international, economic and political power. In 1975 Venezuela was elected co-chairman of the Paris Conference on International Economic Co-operation (CIEC), which subsequently became the principal North-South negotiating forum.[86]

Venezuela today offers a highly attractive environment and market for foreign investment. Among the more salient of these positive features may be mentioned a stable and openly democratic political system; an increasingly free market economic orientation with an ever greater radius of action for private enterprise, a superabundance of natural resources, including hydrocarbons, iron and bauxite ores, hydroelectric capacity, and fertile lands and waters; a strategic geographic and trading position, bordering on both the Caribbean and the Atlantic, as well as Colombia and Brazil, and being an active member of both the Andean Group and the new Latin American Integration Association (LAIA), a long history of relatively steady economic growth, combined with a dynamic internal and rapidly expanding export market; a highly stable currency and modest rate of domestic inflation; the highest per capita income at around £1,500, in Latin America for its youthful and increasingly middle class population of about 16 million, sparcely inhabiting its fairly extensive territory; a relatively well developed basic physical infrastructure, and absence of exchange and currency controls; attractive, moderate income tax rates; and many others, not least of which is a Government favourably disposed towards foreign investment consistently applying a set of equitable regulatory norms.[54]

It is also worth adding at this point that on the level of national averages, Venezuela appears to be fairly advanced in the amount of basic needs goods available to its people. Table A2-5 presents comparative data for Venezuela, for developing countries as a whole, for developed countries, and for Latin America. In virtually all the measures, to the extent that the often fragmentary data is valid, Venezuela is more advanced than the developing countries and than Latin America, and in a number of instances is rapidly approaching the levels of basic needs that are enjoyed by developed countries.[87]

All the positive features above-mentioned indicate that Venezuela will indeed have a propitious economic future in the

1980's and beyond. During all of this period it will remain a major exporter of petroleum and refined hydrocarbon products, of aluminium and increasingly of a wide variety of manufactured goods, based largely on our petrochemical and metallurgical resources, as well as of our various traditional agricultural products (see Appendix 2, section A2.1). These activities will continue to generate a high rate of domestic demand growth for many other goods and services, so insuring a dynamic national market which, during much of the 1970's and in many sectors, especially consumer goods, was one of the fastest growing in the world.

2.3. Metalworking Industry in Venezuela

This section looks at the economic dimensions of the Venezuelan metalworking industry. After a historical introduction, the section then comments on the concept and significance of the metalworking sector in the country's economy, particularly the role of smaller industries. The analysis of the future focuses on the participation of metalworking industries in the Sixth National Plan.

2.3.1. Historical Survey

Over the last sixty years, the basic economic pattern of Venezuela has been transformed from agriculture and trading to banking and real estate and, most recently to industry.

For Venezuela, the starting point for industrialization was World War II and to some extent also the Thirties, when first the Great Depression and afterwards the necessity of war economy led to a breakdown of the world trade structures, since the industrialized capitalist countries were unable to provide the Third World with most of the basic finished goods which Venezuela before could purchase abroad from the oil royalties and taxes. When they were no longer obtainable on the world market, autonomous industrialization followed slowly in a process of import substitution. Although Venezuela's exports consistently exceeded the dwindling imports throughout the 1930's, finally, in 1939, by the enormous sum of 516 million bolivars in one year, the country apparently did not use its favourable balance of trade to invest into productive sectors for the internal market, but rather spent it on spectacular construction programmes to Gomez' linking or transferred it on a number of accounts in Switzerland or the U.S. in the case of the commercial bourgeoisie. One example is the attempt at establishing a petrochemical industry which was not subsidised by the government and obviously seemed no object for investment to the bourgeoisie either, because its production came to a halt when the oil companies who had run it on a small scale for their own purposes, could not maintain it in the crisis after 1935. In the war, however, there were some attempts to build up national industries based on a labour intensive technology, since by then, capital had become scarce and expensive, plus the fact that increasing numbers of migrants to the urban areas required new jobs in the industrial sector.[88] Consequently at this time, some metalworking industries were installed in the country, and later in 1943 the Asociacion de Industriales Metalurgicos de Venezuela (AIM) was created by a group of industrialists, most of them Spanish technicians, who joined efforts to promote, maintain and develop this industrial sector.

Although the government in 1936 created the Venezuelan

Economic Council, it is not until 1946 when this Institution and the Venezuelan Development Corporation (CVF) were reorganised in order to promote and co-ordinate all the industrial activities. According to President R. Betancourt[89], the Venezuelan economic panorama in 1946 was as follows: in the trade sector the number of enterprises increased from 22,586 in 1936 to 32,950 in 1943, and 34,978 in 1944.[90] Also, in Caracas the total sell of 75 companies was approximately Bs 135m and BS 469m respectively. At this time, the Venezuelan economy did not have at its disposal conditions favourable enough to assimilate the impulse of the petroleum activities. The state of underdevelopment, which could be observed in the low operative capacity of the public sector, the quantitative and qualitative limitations of entrepreneurial groups, the obvious scarcity of technical and managerial personnel and low levels of technology and skilled labour, were factors which resulted in a low capacity to absorb resources.[91]

In contrast, from 1950 to 1968, the value of industrial production rose a total of 437 percent, or at an annual rate of 9.7 percent. From 1950 to 1958, the absolute value increased from Bs 997 million to Bs 3,145 million. In the following decade the total worth of manufactures climbed to Bs 6,850 million. Large-scale industries (100 or more employees) grew in number from 196 in 1961 to 325 in 1966. Middle-scale enterprise (21 to 100 employees) increased in the same period from 1,119 to 1,351.[92]

A comprehensive analysis of Venezuelan industrialization has been done by M.A. Falcon Urbano in his book: 'Desarrollo e Industrializacion de Venezuela'[93] In his work, he divided the country's industrialization into two stages: (1) from 1950 to 1957 - a period in which the economy was fully based on the oil revenue, and consequently imports into the country were mainly consumer goods (outward growth); and (2) from 1958 to 1965, a period in which the country tended to pursue development through a process of import substitution (inward growth).

In Venezuela it has been generally accepted that the time process of industrialization began in the late 1950's. In fact, since 1959 the CORDIPLAN has been in charge of the co-ordination and implementation of the national development plans.

Until today, six plans have been elaborated by CORDIPLAN (the Sixth Plan corresponds to the period 1981 - 1985). However the goals established in them have not been reached in the practical sense.

Because of the lack of knowledge in Venezuela about planning, the First Plan (1960-64) was rapidly substituted by the plan of economic and social development in 1962. After then, the Second Plan was elaborated at the end of 1962, for the period 1963-66. From 1959 to 1963, the industrial policy was basically concentrated on the import substitution. Also in this time the Comision Venezolana de Normas Industriales (COVENIN) was created by the Government through the Decree 501 on December 30, 1958, in order to promote and organise, first of all, the industrial standardization process in the country.

The achievements gained during the first two years (1963-64) of the Second Plan are given in the Third National Plan.[94] During this time, the value of manufacturing production growth was at an annual rate of 10%. At this time, the increase of the manufacturing industry was at 10.4% per year, but excluding the petroleum-refining activities, the annual growth rate was at 12.2%.

In the early 1950's the metallurgical industry began to supply the needs of the home market and provide additional industrial employment. These new metal-producing industries were established to supply mainly the demand of the construction and petroleum industries. The steel-making industry also began to take off with the creation of Siderurgica de Venezuela, S.A. (SIVENSA), a private national steel producer. By this time, the metalworking industry was able to produce simple machinery, tanks, bridges, storehouses, etc. In 1952, the AIM took part in one of the most important construction works in Caracas, the Centro Simon Bolivar, in which the metalworking sector produced 7,000m^2 of sets of windows.

During 1950-64, the Venezuelan metalworking industry growth was at an annual rate of 17.2%. Another aspect related with the importance of this industrial sector was the fact that its product value increased more than 9 times during this period.[94]

In 1962, imports of the products of metalworking industries amounted to 309,000 tonnes, with a value of 1,731.4 million bolivars and an average price of £0.8 per kilogram. In determining the priority of new industrial development activities, the Second National Plan had specified that the policy to be pursued primarily be one of import substitution and that "in this connexion the sectors producing intermediate and capital goods hold out the best prospects."

The year 1962 was chosen as the base year for the analysis of substitution possibilities. A preliminary selection of products to be included in the programme was made, taking into consideration not only those cases in which import substitution would be possible almost at once, but also those in which it would be desirable because of the technical processes and know-how that would be brought into the country through the manufacture of the article concerned. To facilitate the selection, imports in 1962 were reclassified into the following ten groups: (1) Containers and tinware; (2) Hot-forged and metal products; (3) Wire products; (4) Small products primarily stamped; (5) Small products primarily machined; (6) Boiler shop products and metal structures; (7) Sheet-metal work, with or without metal spinning; (8) Light machinery and machine parts; (9) Medium-weight and heavy machinery and machine parts; and (10) Other products.

The preliminary selction of products from these classifications was then made as follows:

(1) Comparatively simple metal-transforming products then can be manufactured by relatively labour-intensive procedures;

(2) Products for which manufacturing processes are used that are not yet familiar in Venezuela or that require perfecting, to the extent that such techniques can be introduced through medium and small-scale enterprises;

(3) Products that are more difficult to manufacture, but are essential for the integration of other activities, i.e. as input in more complex metal-transforming processes.

In terms of the International Standard Industrial Classification (ISIC), the import levels in 1962 and possible substitution levels are shown in Table A2-6. As seen in this Table, the extent of possible substitution considered desirable amounts to 77,540 tonnes, and their value to 398.1 million bolivars giving a unit value of about £0.7 per kilogram. This potential output corresponded to about 25.1% in weight and to 23%, or about £50 million, in terms of the value of metal products.[95]

In order to promote the development of both - the metalworking and the basic metallurgical industries - the National Metallurgical Council was created in October 1963. To speed up the basic development in these industries, some various important programmes were achieved by the Government through the Venezuelan Guayana Corporation (CVG) and the Venezuelan Development Corporation (CVF). These development programmes are well described in the Third Plan.[94] The CVG presented some programmes for the development of the following sectors: iron, steel, aluminium and heavy machinery (the Bolivian State Metal-mechanical complex). In 1963, the CVG Siderurgica del Orinoco (SIDOR) started to produce steel, with a working capacity of 700,000 tonnes. On the other hand, the CVF prepared a development programme mainly orientated to promote the creation of 76 metalworking industries with an investment of approximately Bs 164 million, and an annual production of Bs 263 million and with a labour force of 5,000 persons.

In the Third Plan, the creation of an automotive industry constituted a great incentive for the development of mechanical plants. This automotive programme was defined as a means to promote a full-employment economy, the fabrication of national parts of vehicles, the total assembly of them, and the implementation of industrial standards and quality control methods (aimed at securing interchangeability; to allow for the planned introduction of simplification or variety reduction, better servicing and maintenance; improved production, productivity and profitability; and above all, to provide an assurance of quality through the kite-mark).

Furthermore, it was in the 1960's when the Government decided to approve a policy of tariff and quota protection in order to promote the growth of the native industry and the establishment of new enterprises. Of particular importance to the industrial sector was a series of decrees issued by the government (e.g. Decree 512 'Buy Venezuelan'; Decree 255 for exoneration from duty of some machinery and raw materials; Resolution 3790 by which an Advisory Committee for the Automotive Industry was created, etc.), and some financial facilities for new industries.

During the 1960's the external sector of the Venezuelan economy displayed great dependence and considerable vulnerability to the world economy and in particular to those economies with which Venezuela has traditionally been linked. This external sector greatly influenced the development of the country. At the same time Venezuela did not possess an internal market sufficiently large to allow efficient production. On occasions this led to structural inflationary problems which offered little room for manoeuvre. Increases in demand were met not with increased production of goods but with increased prices.

It was realized during the 1960's that the internal market needed to be complemented by the external market. If the market was expanded in this fashion, then production could be increased thus enabling producers to offer more at lower prices to the domestic consumer while, at the same time, increasing Venezuela's foreign exchange earnings. By the end of the decade Venezuela's commercial policy had begun to evolve along these lines towards the diversification of exports and the reduction of dependence on oil as the principal and only source of foreign exchange earnings.[96]

In spite of the fact that the ambitious, physical and financial targets of the Third Plan were not fully reached, this plan may be considered as the first move to pursue industrialization through the exportation of manufactured goods. In fact, the industrial policy of President Leoni (1964-69) was mainly orientated to export promotion and the consolidation of Latin American integration. In 1966 Venezuela became a member of the Latin American Free Trade - LAFTA (now the Latin American Integration Association - LAIA), whose main purpose was to create a free trade zone among its members.

Foreign investors penetrated manufacturing between 1950 and 1970, the two decades during which import substitution was the touchstone of economic development policy. Excluding petroleum, iron, petrochemicals, and aluminium, foreign capital represented 22% of manufacturing investment by 1966. The greatest concentrations are found in electrical equipment (86%), tyres (43%), tobacco (38%), automotive products (60%), and textiles (21%).[97] In contrast, foreign capital is relatively unimportant in most of the areas in which indigenous groups have concentrated their activities. The percentages of foreign ownership are 8% in cement, 5% in metallics, 5% in industrial machinery and 2% in beverages. Foreign participation is higher in human and animal food (16%), chemicals (29%), and paper (17%), where large national groups are also present.[98]

The Fourth National Plan (1970-74) was launched in the early 1970's during the Caldera administration (1969-74). Export promotion became the key element of the new administration's economic policy. In spite of ten years of discussion, the country had no coherent export policy. Also, as the highly publicised Merhav Report[99] revealed, the Venezuelan economy in general, and especially industrialization efforts, were slowing down. Industry had saturated the local market while functioning at approximately half of its capacity. The growth of manufactures as a share of GNP during the late 1960's was approximately half of what it had been during the early part of the decade. On the issue of regional integration, the Caldera administration inherited the problems of implementing LAFTA and the decision on membership in the Andean Pact. During the first two years of his administration, Caldera followed his predecessor's strategy of lobbying for private sector support to join the Andean Pact.[92] Finally, in 1973 Venezuela became a member of the Andean Group (Andean Subregional Pact or Andean Common Market - ANCOM), a group of five LAFTA members.

The Caldera administration created two basic instruments for promoting exports, the Institute of Foreign Trade (ICE) and the Fund for the Promotion of Exports. Also an organized movement (La Conquista del Sur) took place towards the development of the Region of Guayana in the south-east of the country, which is just over half of the total territory of Venezuela. This region possesses important resources - abundant, accessible, and of high quality - the exploitation of which is the basis of the so-called Guayana Industrial Programme which has been in charge of the CVG. During the same period a policy for the 'democratization of capital' was applied by the government in order to improve the relationship between the State and the industrial private sector.

In the field of Standardization and Quality Control the tasks and functions of the various departments of the COVENIN were defined by the Decree 1195 (January 10, 1973). Between 1971 and 1972 the first three-year plan for Standardization was elaborated. In 1971, the Venezuelan Productivity Institute (INPRO) carried out a national survey on QC. Furthermore, in 1973 the Fund for Standardization and Quality Certification (FONDONORMA) was created, and also the programme on Quality Certification (laboratory approved, batch certification and mark NORVEN) began to be applied in the Venezuelan industry.

During the Perez administration, Venezuela was definitively committed to all the plans for Latin American economic integration. The ICE expanded its activities as a result of Venezuela's membership of the Andean Pact, the setting up of SELA and the resurgence of the LAFTA. Since his inauguration in the early 1974, President Perez had followed the style of presidential politics initiated by his predecessor. Within a month of taking power, for example, he decreed nationalization of the iron industry and a significant increase of salaries and wages, without any known consultation with the private sector. Subsequently, he named two mixed commissions to define the new iron policy and to advise him on how - not if - nationalization of the oil industry should be implemented. President Perez, supported by AD (Accion Democratica party) majorities in Congress and inflated petroleum revenues, enjoys a much stronger position than his predecessor.[92]

The Venezuelan Investment Fund (FIV) was established in May 1974, for two basic purposes. Initially, the main function was to sterilize a part of the additional oil revenues and thus enable the country to accumulate and conserve foreign exchange reserves for future use. At the same time, the Fund was to have a second but rather different function: namely, to act as a development bank for the large diversification projects in the public sector. For instance, in 1975 the Fund has lent and partially disbursed £240 million for the SIDOR steel expansion project, £45 million for the ALCASA aluminium project, and £100 million for the expansion of the Venezuelan Shipping Company.[86]

Throughout the 1970's advances were made in the definitions of industrial policies by sectors: metallurgic, metalmechanics, automotive, etc. In any case, the definitions have included the role of the different instruments: prices, customs tariff protection, subsidies, quality standards and credit facilities. Of particular importance to the metalworking sector were the following protectionist measures: the creation of the National Siderurgical Council; the Industrial Credit Fund (FCI); the National Registry for Industrial Projects; the Regulations for the Export Incentives Law; the application of tariff exemptions for the importation of various metallurgical products and machinery needed for activities designed for exportation; Import Licenses for products already manufactured in the country; the national Decrees 746 and 2442 on technology licensing in Venezuela along with the Decision 24 of the Andean Pact; the

Corporation for the Development of the Small and Medium Industries (CORPOINDUSTRIA); the policy of industrial decentralization; etc. An invaluable statistical source and analytical information on the industrialization process in Venezuela up to the late 1970's can be found in references: 100-104.

Other important aspects of the present status and future perspectives of the metalworking industry, as well as its concept and significance in the country's economy, mainly its participation in the Fifth Plan (1976-80) and Sixth Plan (1981-86) are highlighted in the next sections.

2.3.2. Concept, Structure and Significance of Metalworking for the National Economy

In general terms, it may be said that 'metalworking' is the science, art, techniques and processes of working with or shaping metals (and alloys) to produce finished metal products. Accordingly, in the case of metallic products, metalworking processes are regarded as not only the basic manufacturing methods (casting and moulding, cutting, forming and assembly) but also the material finishing processes which are used to obtain the final quality desired.

Metalworking production exhibits a combination of many features which are unique to this industry.

- The variety of different products which may be produced in one establishment.

- The large number and variety of components which go into those products.

- The number of different operations which each component has to undergo.

- The number of different basic types of machine needed to produce the components.

- The variety of size and capability of machines within each basic type.

- The high level of skill required to operate the machine.

- The low utilisation of machines due to short runs and comparatively long set-up times.

- A machine/employee ratio which is above average and probably only surpassed in the textile industry.

- Uncertainty about the type, size and mix of products and components which any given machine or group of machines will be required to produce during its lifetime.

One effect of all this is to put a heavy responsibility on those who have the jobs of organising the workflow and managing the operation - a responsibility which is not always sufficiently recognised and rewarded. Another is to give a quite different approach to capital investment in plant and machinery from that which is usual, for example, in the process industries.[103] In short, the problems associated with the subject of metalworking production embrace aspects of technology, the mechanics of metal forming and cutting, the technology of joining processes, etc., on the one hand, and of administration and management (investment and sales policies, labour relations, time and motion study, etc.) on the other. The aim of all these varying aspects is to create the means for manufacturing products which are both functionally efficient and economically competitive.[104]

The field of metalworking engineering encompasses a wide variety of industries. It is mainly concerned with the hardware industry, which now includes the manufacture of automobiles, aeroplanes, electronic devices, machine tools and other large products. For the purposes of this study the sector is defined as including classes 35 to 39 of the International Standard Industrial Classification. Table A2-7 contains this classification, and the corresponding classes of the Standard International Trade Classification.

Metalworking industries account for almost 30% of the world's industrial production, measured in terms of value added. Among the major branches of industry, metalworking has shown the greatest increase in production since 1938. In most developed countries, this industrial sector represents about 25 to 33 per cent of all manufacturing. When it is realized that metalworking also plays an important part in both building and motor vehicles, it will be seen that the performance of this industry can have a very important bearing on the whole economy of any country.

The typical structure of the engineering industry in an industrialized country, with percentages estimated for individual branches, is as follows:[95]

Simple metal products	6%
Machinery except electrical	33%
Electrical machinery	24%
Transportation equipment	33%
Instruments, watches and clocks	4%
Total	100%

As far as the metalworking industries are concerned, the categories can be considered as successive stages of industrial development each having its special problems which require special measures for the development of engineering industries in general, and for the manufacture of industrial equipment and machinery in particular.

In developing countries, like Venezuela, whose engineering production is in an intermediate stage, the share of simple metal manufacture is higher (typically by 30 to 40 per cent) than in industrialized countries, but tends to decrease as engineering production increases. It is also found in these developing countries that the production of electrical machinery is twice that of non-electrical machinery. In the case of industrial machinery and equipment, they are chiefly under the sectors 'machinery except electrical' and 'electrical machinery'. These, of course, produce for other sectors of the economy as well, mainly for agriculture, commerce and household. The share of industrial machinery is generally higher in more developed countries.[95]

The relative importance of the metalworking industry may be assessed in terms of their percentage share in the total manufacturing output, their contribution to employment and the value added in the process of manufacture.

The metalworking industry which accounted for only 9% of Venezuelan industry in 1960, had increased its share to 13.9% by 1969. Table A2-8 shows the percentage growth rates for overall industry, the metalworking industry and the various components of the metalworking industry, from 1960 to 1969. In the period 1965-69 there was a noticeable decline in the growth rate of industry as a whole and in every sector of the metalworking industry. The metal products sectors showed the smallest decline while automotive equipment showed the greatest. The highest average growth rate was in the machinery sector.

With regard to the metal products sector, it was expected that the manufacture of laminations would be started by 1974, but basic piece parts, such as ball bearings were still being imported. Construction material and coupling elements and fittings for the petrochemical industry were the main items in this sector.

With respect to the machinery sector, agricultural machinery (with the exception of tractors) was manufactured for local consumption; tools and simple machines were also produced, mainly for the mining and petrochemical industries; and a diesel motor plant was at the planning stage.

The main items manufactured in the electrical sector were batteries, dry cells, distribution and connexion elements, cables and wire. During this time (1960-69) the country did not yet produce electric motors or telephones.

In the automotive sector, local manufacture and assembly had reached 40% of the weight of the finished product (motor and transmission gear excepted). The volume of production-assembly of motor vehicles was about 80,000 units per annum, distributed among 14 plants.

There were no enterprises engaged in the manufacture of machine tools for commercial purposes in Venezuela. However, some units that manufactured non-electrical machinery occasionally produced special machine tools for their own need. The machine tools most widely used in Venezuelan industry were: lathes; drills; surface grinding machines; guillotines; saws; and machinery for planning, shaping, shearing, folding, boring, slotting, threading, wire-drawing and profiling. Equipment for soldering, oxyacetylene cutting, and zinc, nickel and chrome plating was also used a good deal.

In 1970 some 48,500 persons were employed in the metalworking sector.[105]

A comprehensive work dealing with the actual situation and perspectives of the siderurgical (primary metal-working processes used to produce what are known as the wrought metals), mining and metalmechanical industries has been recently elaborated by the Asociacion de Industriales Metalurgicos y de Mineria de Venezuela (AIMM). In Venezuela, according to the estimates by the AIMM, the value of the annual industrial production in the metalmechanical sector, including manufacturers of metal products, machinery and equipment, as well as electrical and transport products, increased from Bs 6,500 million in 1976 to Bs 10,000 million in 1980. In terms of employment, during the period 1976-80, the labour force increased from 70,000 persons to 110,000 persons. As a matter of fact, the total financial investment made in the mechanical industries (including SIDOR) until August 1980, reached an accrued total of 28,000 million bolivars.[107]

Value added at constant prices in the mechanical industries group, which represents about 16 per cent of total manufacturing, grew at an average rate of 16 per cent per annum in 1976-77 (see Table A2-9). This rate fell to only ½ of 1 per cent in 1978. The reduction in both government capital expenditure and private investment in 1979 apparently affected the mechanical industries the most and value added declined by 4.5 per cent. Within this group the transport industry was the one to suffer most, declining by over 15 per cent in real terms.[67]

During 1974-78 the policy of industrial and administrative decentralization was iniciated in the country. Also, the small and medium sized industries were promoted and financed by the State through the CORPOINDUSTRIA. The programme carried out by CORPOINDUSTRIA in the 1974-78 period is by far the highest in all the country's history. So, we can see that in the 1959-73 period the total financing granted by the State to this sector. Moreover, the public credits given by CORPOINDUSTRIA during 1974-78 were of 2,400 million bolivars, which were distributed into 13,202 public credits and consequently 49,278 new jobs were created. In order to provide machinery, equipment and raw materials to the smaller industries, a multinational company - called Insumos Industriales de Venezuela - was established in 1975. Also, the 'Instituto de Asistencia Integral para la Pequena y Mediana Industria' was created by CORPOINDUSTRIA with the purpose of providing the required technical assistance and training schemes to this sector. It is important to point out that a large number of these benefits have been given to those industries concerned with the fabrication of parts and equipment for the metalmechanical and automotor sectors.[108] For an analysis of the significance of the smaller industries in the Venezuelan economy, see references 109-112, especially the consultive document "Carta de Caracas" - in which FEDEINDUSTRIA (Federacion de Artesanos, Pequenos y Medianos Industriales de Venezuela) describes the present position in Venezuela of the smaller enterprises and goes on to describe a new pattern for industrialization through intermediate technologies.

Recognising the fact that thousands of smaller industries are playing an increasingly important role in engineering and other industries (see Chapter 1, pp 19-20), the

Government that took place in early 1979 is being committed to encourage and give support to the small industrialist. According to President Herrera[69] the 'Bank for Small and Medium Industries' will be created during his administration. In the field of QC, he has declared that a special programme will be organised through COVENIN in order to establish adequate industrial standards and QC systems in these industries, and provide technical assistance which will contribute to the assignment of the Venezuelan quality mark NORVEN to a great number of products manufactured in this sector.

On the whole, the manufacturing activity may be expected to grow, as it did during the last few years. The programme established for manufacturing industry in the Fifth National Plan was too ambitious - 13.7% average annual growth during 1976-80 with a combined public and private investment of Bs 38,134m (including Bs 20,000m in public sector steel and aluminium projects). Traditional industries were due to grow by 10% a year, intermediate industries (including basic metals) by 16.5% and mechanical industries by 14.9%. Some 50% of total investment was due to come from the private sector.

In this way it was hoped to supply 77% of demand with locally manufactured goods by 1980 and generated exports through the period rising from Bs 2,678m in 1976 to Bs 4,152m in 1980 (this includes oil derivates). The investment programme was aimed at improving productivity, achieving surpluses for export and stimulating small and medium sized industry.[73]

In 1978, in addition to export by private industry, the production of government-owned industries included in the SIDOR's Plan IV (steel) and the ALCASA and VENALUM aluminium plans, among others, started yielding foreign currency to help fulfilling government obligations.

SIDOR's Plan IV consists of raising crude steel capacity from 1.2m to 4.8m tonnes per year (t p y) by the end of the 1979-80 period, building a new set of facilities next to the existing complex and extending the area from 100 to 1,000 hectares (see Table A2-10).[74] The government was sinking the largest proportion of the Fifth Plan's industrial investment into SIDOR - Bs 15,000m out of a total of Bs 55,000m - in an all-out attempt to meet expected steel requirements in the expanding industries, notably automotive, oil and construction (see Table A2-11, Plan V: timetable of key projects). The Fondo de Inversiones de Venezuela (FIV), which is investing a total of Bs 9,300m in the project, estimates that by the time Plan IV becomes fully operational in 1984 it will have generated exports worth Bs 3,000m in three years, though some observers believe SIDOR will have its work cut out supplying the local market - even supposing the world market improves. But the FVI estimates the project will generate import savings of Bs 7,500m in semi-finished products between 1980-84 and that SIDOR's contribution towards manufacturing sector GDP will jump from 8% to 20%.[73]

The steel plan is undoubtedly the cornerstone of the government's effort to diversify the economy away from oil, and providing the present high-quality management at SIDOR can restore productivity, the company should start eliminating costly steel imports by the 1980-81 period. On conclusion of Plan IV, SIDOR's steel production capacity will have increased four-fold and with the construction of the Zulia steel mill, designed to produce 1.3m (t p y), the nation will produce eight times more steel than at the present time. With the expansion of ALCASA and the new VENALUM plans, aluminium output will reach more than 400 thousand tonnes. Meanwhile, the recent discovery of bauxite deposits in Guayana that could eventually yield 500m tonnes of high-grade ore has given an enormous boost to the government's aluminium industry plans.

Construction of a graphite electrodes plant in Guayana was undertaken in 1978. Graphite electrodes play an important part in the steel production in electric furnaces. The plant was built at an approximate cost of £ 90m and has a capacity of about 50 thousand tonnes. Scheduled to operate from 1980 on it will fully meet the demands of the local market as well as the Andean subregional market. Moreover, the construction of a £ 46m foundry for iron modules and grey iron at the Bolivar State metalmechanical complex, was scheduled to start by the end of 1978. It was designed to produce spare parts for tractors and construction machinery, as well as heads and blocks for diesel motors at the Ciudad Bolivar diesel complex. Part of the foundry production will be exported to plants in the United States as high value products rather than simply as iron ore. This is a significant development in view of the short time since the iron mines were nationalized.[74]

2.3.3. Metalworking Industries in the Sixth Plan

The establishment of an efficient, modern metalworking industry is a vital factor in the industrialization of a developing country. Contrary to the trend followed by the major Latin American countries, Venezuelan industry did not begin development based on a strong light metalworking support, which in turn created demand, for the construction of heavy industry to be viable. It began with heavy industry, and iron ore mining, steel mills and aluminium smelting plants were designed to provide a basic infrastructure which, though it provides structural steel, construction rods and tubing for local industry, were designed primarily as a means of production to balance the country's export package and to increase national added value. The metalworking industry, apart from a few large concerns and specialized manufacturers, has had little opportunity to develop.[54]

Generally speaking, the new economic strategy as stated in the Sixth National Plan (1981-85), is oriented: to increase the potential for economic growth of the country, by means of key investments in such basic sectors as petroleum, iron, steel, aluminium, and petrochemicals; to encourage private investors, both national and foreign; to increase efficiency and productivity; and to restructure the functions of the public sector. As indicated in Table A2-12, the most highly committed sectors will be agriculture and the manufacturing industry accompanied by the electricity and construction sector and by the sectors in charge of trade, transport and communications. In this outlook, the agricultural sector will grow at an average annual rate of 5.5%, the manufacturing industry at 8.5% and the rest of the sectors mentioned at interannual rates above 6%.[75]

With regard to industry, the emphasis will be on the dynamics of the substitution process of imports of consumer and intermediate goods and the manufacture of capital assets associated with the oil investments programme, the increase in the production of essential assets and construction materials and the diversification of exports.

The argument most frequently cited by the Government in favour of accelerated development of Venezuela's oil industry (mainly the Orinoco belt) - apart from maintaining production and export levels - is that it would boost the development of the capital goods industry. But the oil companies are more cautious, since they tend to prefer to buy their equipment abroad.

The oil industry's association reckons that expenditure in technological goods and services has been increasing at an annual rate of 10% over the last four years. For instance, in 1979 Venezuela spent abroad some Bs 10,000m on goods and services for the oil industry. Though local participation in supplies has increased from 33% in 1977 to 40% in 1980, local industrialists are worried about the creation of a seventh subsidiary of Petroleos de Venezuela, Bariven, which will be devoted exclusively to buying materials and equipment abroad. They are now asking the Government to apply to this state-owned company the provisions of the "Buy Venezuelan" decree (No. 2023) which gives local suppliers a 20% handicap in calls for tenders.[113]

President Herrera's Plan of Government[69] mentioned that the industrialization process through import substitution could be of relevance once again, namely if the metalmechanical sector is oriented towards the substitution of capital goods. In this way, the Herrera administration has promised to carry out the following activities:

- To develop the establishment of the 'Metalmechanical Industry Fund' in order to get maximum benefits from the products which come from SIDOR and aluminium plants. To do so, a number of state credits will be given to all the industries connected with this project, such as the transportation programme including a 1,500 kms highway programme and 2,000 kms of railway lines.

- To construct the Zulia State metalmechanical complex (including the Steel-Coal Project) in which the production of parts, spare parts, and equipment required for the petroleum industry will be made.

- To build industrial conglomerates, and to promote and finance the small and medium metalworking industries to be established in these conglomerates.

It is well known that the policy of import substitution brings a number of problems, among others, transfer technology, labour absenteeism, job rotation, price and quality control, etc. So, it is important to promote a policy of export promotion, mainly in the basic metalworking industries (iron, steel and aluminium plants), at the same time as the process of industrialization based on import substitution. The next step is the final one to be reached to consolidate the country's development, i.e. fabrication of parts, and the complete assembly operation.

During 1978-80, the public and private sectors have been taking some important steps aimed at strengthening the nationalistic aspirations of developing the internal production of capital goods and intermediate products, to provide sound, steadfast growth to the economy and to develop export lines that will allow the diversification and progressive substitution of local industry products for the present-day mono-exportation of oil. For example, in 1978 the Government created the Productivity Commission, which substituted in part the last Institute of Productivity; also, the National Council for the Development of Capital Goods Industry was created last year. In December 1979, the Law of Industrial Standards and Quality Control was approved by the Congress. Accordingly, productive efficiency and product quality are key determinants, as well as policy goals (see Table A2-3). For the private sector, the general outline of the new policy may be summarized as freeing entrepreneurial decisions by eliminating most price controls, reducing excessive protectionism by lower tariff barriers, implementing an antitrust policy to assure domestic competition, the adoption of new industrial guidelines oriented towards efficiency of production and quality, and the implementation of measures to orientate investments into the priority sectors. These priority sectors are broadly defined as those related to the country's natural resources and comparative advantages that fulfil the social development objectives with respect to quality of life and human resource improvement, and the strengthening of the agricultural sector, which is being given equal importance to industry. With respect to all of these objectives, an important corollary is the stimulation of new foreign investment and technology transfer, which are seen as elements of strategic significance in accomplishing these goals.[59]

Further impulse to exportations has been achieved through technical exhibitions. Since 1978, EXPOMETAL has been organized by the AIMM; EXPO-MOTRIZ has been sponsored and organized by the Camara de Fabricantes Venezolanos de Productos Automotores (FAVENPA), and in 1979, the First Exhibition of Non-traditional Export Products was held in

Caracas, organized by the Foreign Trade Institute (ICE). It is worth adding at this point that agreements for technical assistance in the quality field have been signed by COVENIN, AIMM and FAVENPA.

2.4. The Venezuelan Metalworking Industry and the Andean Group Market

Reference has been made to the salient features of the Venezuelan metalworking industry. This picture should now be completed by examining the importance of that industrial sector in the process of Latin American integration, especially in the Andean Group Market.

2.4.1. Introductory Note on the Andean Integration

Beyond geopolitical and security concerns, however, there has been a new emphasis within Latin America itself during the past 25 years. This has taken the form of regional economic integration and trade movement under four regional groups: the Andean Group, the Central American Common Market (CACOM), the Caribbean Economic Community (CARICOM) and the Latin American Integration Association (LAIA) - which has recently been created to replace the Latin American Free Trade Association, LAFTA.[64]

The Andean Group (sometimes known as the Andean Subregional Pact or the Andean Common Market - ANCOM) was set up in May 1969 when Bolivia, Chile, Colombia, Ecuador and Peru signed the Cartagena Agreement. Venezuela joined in 1973 and Chile opted out in 1976. The Group thus cnnsists of several economically medium and smaller size countries (see Table A2-13) which were intent upon forming a more intensive and dynamic integration programme than was possible under the

LAFTA, as it was then structured, thereby enhancing both their collective industrial and development capabilities, as well as their economic and political bargaining strength with the three large countries of America (Argentina, Brazil and Mexico) and with other industrialized countries.

The five countries of the Group have a combined population of about 70 million (one fifth of the population of Latin America), with a per capita income in 1977 of £550, slightly less than the Latin American average of £610. Compared with other developing countries, the Andean Group as a whole is in fourth position for trade, after Saudi Arabia, ASEAN and Iran, and in seventh place for GNP, after India, Saudi Arabia, Iran, Brazil, ASEAN and Mexico. In addition to exporting oil of which Venezuela is one of the biggest producers in the world, the Group is a major supplier of raw materials and its mineral resources (copper, iron, zinc, tin, gold, silver, molybdenum, tungsten and antimony) are considerable.[114]

2.4.2. Progress in Industrial Programming

Apart from dismantling tariffs and establishing a common external tariff, Andean integration aims at industrial planning, with programmes for each sector, and the regulation of external investments. The agreement also lays down preferential treatment for the least developed members (i.e. Bolivia and Ecuador), for which a special programme of measures has been planned. In short, the five nation Andean Pact has sought to promote industrial growth by shared investment programmes and schemes in which each country is allocated a portion of the industrial development pie.

The Pact's motor programme for example, has assigned the assembly of different vehicle types to each member nation, while the metalworking programme provides for joint development, financing and marketing. Manufacturing accounts for about one fifth of the combined GNP of Venezuela, Colombia, Ecuador, Peru and Bolivia.[115]

In 1970 the Cartagena Convention Committee reserved some 1,500 items for Industrial Programming. The list covers production which altogether represents more than 30% of the present demand for manufactured products of the Andean Group and includes practically all the dynamic industrial sectors characterized by demands rapidly increasing and by modern productive processes.[54] The principal sectors reserved for programming were machine tools and metal products, petrochemicals, fertilizers, automotive, steel, electronic, telecommunications, inorganic chemicals and pharmochemicals. The development of these programmes provides ample joint investment opportunities, particularly in the metalworking and petrochemical programmes. These sectors furthermore constitute priority areas of investment in the VI Development Plan of the nation, i.e. among the priority areas for foreign investment are energy related industrial and metal products which include a wide range of machinery, tools, metallic parts and other goods.

2.4.3. The Outlook for the Future

The metalworking programme was the first of the existing three Andean Pact industry development programmes to be approved in 1972. Unfortunately this has not been an advantage because products allocated to the countries have since been reassigned twice - once when Venezuela joined the Pact in 1973 and again when Chile withdrew. In 1977, the Proposal 89 was approved by which most of the Chilean assignments were transferred to Venezuela. Since then, Venezuela's private industry has not been supporting the conditions stated in the metalworking programme. For instance, in 1978 the AIMM and other Associations of the country's private sector declared before the ICE their disagreement with the Proposal 89. At this time, the ICE accepted the points noted by the private sector and brought them to the Cartagena Agreement Commission for discussion. Because it was believed that the new Proposal 100 - which substituted the Proposal 89, in 1978 - could be signed in December 1978, a nation-wide campaign took place against this proposal.

Prior to the updated Andean metalworking programme which was approved by Decision 146 in October 1979, the Venezuelan government and private sector joined efforts in order to avoid the signature of this industrial programme, as it was defined in Proposal 100. But surprisingly, the government, through the ICE, decided to sign Decision 146 without any known consultation with the private sector. The major argument against this decision, as it has been stated by the CVI and the AIMM since 1977, is the fact that Venezuela holds about 67% of the Andean metalworking market, but only 27% of all the assignments have been offered to the country, i.e. it means that most of the metalworking products which are today manufactured in Venezuelan industries will be substituted by products imported from the other Pact members - which are countries without the industrial infrastructure, machinery and technology that guarantee that imports comply with appropriate conditions of volume, quality and prices of the national markets.[116] Also, as has been indicated, there are problems associated with the failure of the Commission to reach agreement on rules of origin (which identify a product as Andean), the common external tariff and the implementation of quality standards.[117]

The latest decision requires countries producing parallel products to agree not to expand production but instead to convert to other products. Alternatively they may reach a co-production agreement. There are, for instance, already agreements between Ecuador and Venezuela to manufacture hydraulic systems assigned to Ecuador; drilling equipment by Peru and Venezuela and conical crushers by Peru and Bolivia. Additionally, many of the items included in the programme are assigned to more than one country. Officials say they are now preparing proposals for countries to reach agreements for joint production or else to convert gradually to other products.[118]

In the new version of the metalworking programme 76 main products groups, which include 323 items, have been allocated exclusively to one country, mainly in the case of Bolivia and Ecuador, while others, as in the case with most products allocated to Colombia, Peru and Venezuela, are shared with at least one other country. Insofar as the assignments received by Venezuela are concerned, there is broad scope for investment in products such as semi airtight compressors, mounting and filling machines, apparatus for cutting and sectioning with motors of over 1,000 volts, machines for plastic industry, foundry equipment, surface finishing machines, machines for the ceramics industry, mechanical presses, forging machines, drills and crowns. Under these headings national production is insufficient or does not exist.[54] However, the status of only four products exclusively allocated to Venezuela is of little significance to its industrial development (e.g. taximeters, forging machines, compressors for air conditioners of cars, and drills and crowns) while the other 31 products allocated to the country are shared with Colombia and Peru.

Bearing in mind that the metalworking sector is the key producer of capital goods and thus a strategic agent for growth, it is clear that there is a discrepancy between the creation of the Venezuelan Council for Development of the Industry of Capital Goods, in 1980, and the adherence to the Andean metalworking programme, according to Decision 146. AIMM officials say that the Venezuelan metalworking industry can manufacture more than 75% in value in the construction machinery industry; more than 75% in value in the chemical processing machinery and equipment industry. They also say that about 60-80% of all imported capital goods can be manufactured in Venezuela. Due mainly to the lack of imports control, industries are today employed to about 50% of their installed capacity.[119] While industrial growth is still pretty high, thanks notably to high public investment and incentives, basic productivity in the metalworking sector is disturbingly low as a result of absenteeism and job rotation.

Investment required in the metalworking industry is estimated at £150m, of which £40m is supposed to be invested by Venezuela. The investments are meant to create 45,000 jobs in the Andean region. Demand for metalworking products in the Andean area totals £454m of which £167m (37%) is supplied by regional production, according to Andean Pact figures.

The preceeding facts clearly show that Venezuela is fully committed to all plans for Latin American unity. Undoubtedly, the Andean Pact is one of the ways to speed up the integrationist movement in Latin America and the consolidation of a new bloc in our modern world, in which a group of developing economies may have the opportunity to obtain a true independence by increasing mutual cooperation in technology, industry and commerce. Nevertheless, the Venezuelan government must be careful in preventing the possibility of making decisions which could compromise the course of the country's industrial development, as in the case of the new Andean metalworking programme. In order to promote and regulate investment in new regionally-based industries that enjoy economies of scale, so as to meet the combined demands of member countries more economically, the following problems must be solved: (1) the problem of ascertaining the scope for profitable specialisation; (2) the creation or strengthening of appropriate production structures; and (3) the equitable distribution of the benefits of integration among the member countries.[120] Consequently, it is necessary that all five countries work together to promote the creation of metalworking plants, to negotiate jointly for international technology and to arrange joint financing and marketing.

CHAPTER 3

THE HISTORY AND CURRENT STATE OF QUALITY CONTROL IN VENEZUELA

3.1. Introduction

It is well known that history and progress go hand in hand. Man has the ability to record events as they happen, the capacity to analyse the worth of these events, and an inherent capacity to change things for the better. These factors account for his progress from a primitive animal to the highly civilized social being he is today. Our technical and social progress is certainly marked by historical events recorded over the centuries. Hence, it appears that a sense of history is essential to satisfactory progress.

Accepting the fact that an awareness of the development of Quality Control (QC) thought can highlight key characteristics of today's quality problems and offer valuable perspective, we can justify this chapter which is mainly devoted to tracing the history of QC in Venezuela and its existing state. In addition, this chapter describes the recent advancements in the professional development and the achievements of the Venezuelan Commission for Industrial Standards (Comision Venezolana de Normas Industriales - COVENIN) at both the national and international levels in the quality field.

Finally, it may be useful to say that this chapter has been organized to present some general aspects of the QC movement in the country: industrial standardization, education and training, quality certification and labelling, legal and organisational aspects, international collaboration, among others. The next chapter will deal with the present status of the QC methods used in the Venezuelan metal-working industry.

3.2. Industrial Development and Quality Control

Regardless of social and political systems, in either developed or developing countries, industrially speaking, it is a well known fact that any national strategy for systematic improvement of production quality has to be designed and implemented in accordance with the country's economic development plan. For this reason, in the previous chapter a comprehensive study of basic facts and figures related to the Venezuelan economic growth and development has been made in order to provide the reader with a broader understanding of the economic dimensions of the process of industrialization - as it has been taking place in the country during the last three decades.

Industrialization, optimum utilization of the resources and balanced trade have been the declared policies of all the developing nations. Industrial development usually follows some recognizable phases, from a primitive agricultural subsistance economy to sophisticated products sold in the international market. Standardization and QC play an important part in the development of the industrial economy of a country. It has been said that industrial standards are the organizational backbone of the modern industrial economy. They ensure the uniformity and interchangeability of consumer and industrial products, and they are the measure of industrial product quality. Quality Control is the activity itself responsible for the testing, while metrology sees to it that the measurements are accurate.[121]

The relationship between industrial development and QC development is summarized briefly in Table 3-1. The discussion which follows will elaborate the nature of these phases and the steps taken to enable progress in quality to keep pace with progress in national development.

3.3. A Short History of Quality Control in Venezuela

Quality is not a new concept. In fact, the origins of quality can be traced back from the earliest days of man's history. However, the science of QC is of very recent origin. QC principles developed during the 1920's were not accorded widespread application until World War II created an urgent need for more efficient methods of production. Since then QC has attained nearly universal recognition both in Government and industry.[122] Broadly speaking, the evolution of quality responsibilities has been closely associated with the different industrial forms which have evolved from the days of one-man shops (usufacturer) up to today's unmanned manufacturing systems. Table 3-2 depicts how the technical and the managerial activities of the quality function have been carried out to date.[123]

In his classical Work 'Total Quality Control', A.V. Feigenbaum sets out a somewhat arbitrary time scale for the evolution from operator-controlled quality to what he terms 'total quality control' (see Fig.1-1). However, it has taken a long time to evolve from the Stone Age man who designed, made, used and judged the effectiveness of his club, to the operator as quality judge, to the foreman as jury, to the statistical expert and finally, to the Quality Management System Assessor.[124] The Feigenbaum's time scale was elaborated in the early 1950's, and from this date up to now there have been some advances in the field of QC. Thus, it is necessary to up-date this graphic representation. An attempt to complete it has been made by B. Bruni [125], who added the symbol 1970's to identify the era of systems engineering. The integrated study of the 'systems' in QC which is currently developing, provides in the meantime an analytical process and a synthesis which allows for adjustment with precision the different phenomena concerned in controlling quality and the corresponding reduction in the cost of production, i.e. this technology is a major factor in the design and installation of genuine total QC systems - the quality planning "software" as well as the test equipment "hardware".[14]

Looking back, it is now possible to distinguish several distinct phases in the development of QC in Venezuela. In general terms, the successive epochs in the Venezuelan QC evolution can be divided into three phases, as follows: (1) Initial period: 1949-1958; (2) Promotion period: 1959-1969; and (3) Development Period: 1970 - Date.

3.3.1. Initial Period: 1949 - 1958

In practical terms, the quality function is to ensure that the customer receives a product which conforms and functions in accordance with specification requirements.[126] Thus, it is clear that the application of standards affects the degree of quality of a product; more exactly, we can say that there is a reciprocal relationship between the level of quality of a product and the standards which must be met by the product in order to enhance - in the most economical way - the customer requirements, i.e. standardization and QC are integrating functions.

A major objective of standardization is to establish and/or improve the quality of products, services, procedures, and so on. This objective is better achieved if the standards themselves are of a high quality. For this reason, it is normally found, in most countries, that the process of standardization has been initiated prior to that of QC. And, Venezuela is no exception.

More than 30 years have passed since the standardization activities began in Venezuela. In 1949 it was stated that a nationwide standardization programme needed implementing. It was mainly due to the initiative of a group of Venezuelan professionals and industrialists who started seeing 'standardization' as an important means of achieving industrialization and economic progress in the country.

At the beginning it was hard to make a clear statement of what had to be done in order to initiate a systematic control over the industrial and economic processes. In other words, it was difficult to draw aims and objectives to achieve during the standardization process, mainly due to the lack of technical knowledge, human and financial resources and even more to the unawareness of how important standardization was for successful industrialization and other fields of human activities.

From the beginning of the 1950's a great many conversations were in progress in order to promote the establishment of a National Standards Board. In 1952, the first ideas and draft projects came forth. Six years later, in December 1958, these ideas were materialized when COVENIN was created by an enactment of the Venezuelan Government (Decree 501). But many years passed before this Institution took charge of their responsibilities. The delay was mainly due to some legal and technical factors, such as: (1) lack of an operative body to carry out all the activities which were programmed by COVENIN; (2) the government did not provide means to motivate the industrial sector to take part in and fulfill the new policy of standardization; (3) few participants of the private sector were members of COVENIN (e.g. technical committees and commissions); (4) they limited their activities to their own human and financial resources, ignoring other related institutions which would come forth; (5) lack of suitable technical personnel to carry out standardization and quality certification programmes; and (6) lack of testing laboratories and very narrow policies which did not allow use to be made of those testing facilities already installed in the country, mainly in universities, research centres and private enterprises.[127]

The foregoing clearly illustrates that in the early days of standardization in Venezuela, standards had assumed the form of sub-regulations. This was due to the lack of industries and senior staff capable of taking part in standardization work, to the need for such work to be financed entirely by the state, and perhaps to the desire of standardizers to identify themselves as closely as possible with those responsible for providing salaries as well as status.[128]

As indicated in Table 3-1, from 1949 to 1958 the Venezuelan economy was fully based on the oil revenues, and consequently imports into the country were mainly consumer goods. This outward orientation of the country's economy had a negative effect on the early stages of industrial development. In fact, it is widely recognised that a country's endowment of natural resources will benefit its industrial development by providing domestic markets and investible funds for manufacturing industries, as well as materials for further transformation. For several reasons, however, it is a mixed blessing: the availability of primary exports may lead to the postponement of domestic policy change; high wages in natural-resource industries raise wages and hence production costs in manufacturing industries; and natural-resource exports give rise to an unfavourable exchange rate for industrial activities. So oil earnings have adversely affected the international competitiveness of manufacturing industries in Venezuela.[129]

Moreover, selling the raw materials derived from these natural resources (mainly crude oil and iron) in the world market requires that they meet international quality standards, which are normally much higher than domestic standards. Meeting these international standards becomes a major first step in the evolution of the national programme to improve quality. In Venezuela, as in most developing countries, the contracts for export of raw materials usually incorporate the quality specifications to be met and the tests to be used, along with related criteria for sampling, etc. In addition, the foreign importer may provide assistance in the form of technical know-how.[53] As a result of this situation, during the first phase of QC in Venezuela, the inspection process predominated. At first, inspection-oriented QC programmes were introduced in some manufacturing industries, i.e. these QC programmes had concentrated on the manufacturing phase of of operations, and consequently the quality function was only limited to separate the bad products from the good ones.

3.3.2. Promotion Period: 1959 - 1969

We have already seen that the post-war period and the recovery of the capitalist countries changed the nature of industrialization in Venezuela. It no longer was a means towards the purpose of an autonomous internal growth connected with the establishment of a modern industrial sector within the country's economy (the oil sector definitely is not), taking care of internal demands, on the labour market as well as in production. In an economy dominated by a foreign-owned extractive sector like Venezuela's these objectives obviously could not be achieved.[88]

In the post-war period (1950-70), Venezuela showed the characteristics of the classic Latin American model of 'outward-directed' development, with an import-substitution process partly prompted by government action and partly due to the initiative of international corporations seeking to defend their position in local markets by taking anticipatory action. In Venezuela this development model entered a critical stage in the 1960's, with a consequent decline in the rate of growth.[130]

During the first half of the 1950's, the Venezuelan domestic product grew considerably without a corresponding increase in the share of the industrial sector. In fact, Venezuela's industrial sector was expanding, but massive investment in the petroleum sector, whose inputs at that time were wholly imported, meant that the structure of the production system showed no appreciable change. Nevertheless, in the 1950's, particularly in the second half of the decade, the first-stage of import substitution (entailing the replacement by domestic production of import of nondurable consumer goods such as clothing, shoes, and household goods and their inputs, such as textile, fabrics, leather and wood) was undertaken in the country.

It is well known that in the course of first-stage import substitution, domestic production will rise more rapidly than domestic consumption, since it not only provides for increases in consumption but also replaces imports. Once the process of import substitution has been completed, however, the growth rate of output will decline to that of consumption. In Venezuela, awareness of these problems prompted efforts to bring about structural change with a reorientation of the development process. Thus, during the decade of populist reform in the 1960's, government action was directed mainly towards the application of an 'inward-orientated' industrial development strategy, entailing second-stage import substitution (see Table 3-1).

Between 1959 and 1969, the spending that occurred was concentrated in large-scale, capital-intensive projects such as steel and petrochemicals. Since the CVG (Corporacion Venezolana de Guayana) was created in 1960, and fairly rapidly a government-controlled group of basic industries was established in the Guayana region, which is rich in hydroelectric and mineral resources. Hence, it may be said that much of Venezuelan expansion in the early stages of industrialization has been along its primary lines of comparative advantage - capital-intensive manufactures - or nontraded items such as beer, cement and construction.

From the foregoing it is evident that the second-stage of import substitution involves the replacement of imports of intermediate goods and producer and consumer durables by domestic production. These commodities have rather different characteristics from those replaced at the first stage. Given the relative scarcity of physical and human capital in developing countries that have completed the first stage of import substitution, they are at a disadvantage in the manufacture of highly physical-capital-intensive intermediate goods and skill-intensive producer and consumer durables. By limiting the scope for the exploitation of economies of scale, the relatively small size of their natural markets contributes to high domestic costs in these countries. At the same time, net foreign-exchange savings tend to be small because of the need to import materials and machinery.

Furthermore, the smallness of national markets limited the possibilities for domestic competition in industries established at the second stage of import substitution, while import competition was virtually excluded by high protection. Consequently, the existance of sellers' markets provided little inducement to users' need. In the case of industrial users, it led to backward integration as producers undertook the manufacture of parts, components and accessories themselves in order to minimize supply difficulties. This outcome, observed in Venezuela during the 1960's, led to higher costs, since economies of scale were foregone.[129]

Also in sellers' markets, firms had little incentive to improve productivity. On the other hand, it is well acknowledged that in a developing country with a sellers' market sheltered by import restrictions, complacency has often prevented management from recognizing quality problems and the need to resolve them employing modern QC methods. Only pressure of crisis or a similar cause has compelled the attention of some of them to review their quality problems, programmes and policies.[131] Another consequence of the existence of a sellers' market is the lack of competition on the market, which creates an industrial climate with emphasis on the quantity rather than in the quality of the finished products. As the market competition does not fix the price of the product, and the manufacturer does not assess the cost of quality, at the end the customer has to pay an overprice due to the lack of quality consciousness of both the manufacturer and the customer himself.[132]

By and large, the lack of quality consciousness was the top-most problem in the way of speeding up the Venezuelan quality movement in the decade 1960-70. However, the industrial expansion, which took place in the country as a result of the inward-looking development strategy during the 1960's, created the need for an ever-increasing use of standards and QC methods in all industrial sectors. In the late 1960's, the first standardization organizations were created by the iniciative of the private sector: Committee of Reinforced Concrete (Comite Conjunto de Concreto Armado, CCCA) and Committee of Electricity (Comite de Electricidad, CODELECTRA). These Standardization Committees appeared as a consequence of the inefficiency of the COVENIN; and their valuable contributions helped greatly to promote and accelerate the standardization process in Venezuela.

Another important development for standardization and QC was the establishment of the NORVEN Kite-mark by the Decree 1043 (25.6.1963). Nevertheless, during the 1960's quality certification and product labelling activities were not conducted by the COVENIN, due mainly to the lack of technical personnel and test laboratories. In a word, the government QC did not tend to expand as industrialization grew.

Regarding the QC methods used in the Venezuelan industry, except from some statistical QC programmes introduced by foreign subsidiaries as a part of an array of know-how, it may be stated that most domestic companies followed the traditional approach of inspection QC, i.e. quality was still determined by post-production inspection, the post-mortem, which discovers defective work after manufacture.

3.3.3. Development Period: 1970 to Date

In the 1960-70 period, the Venezuelan industrial sector geared to the home market was expanded in an effort to replace, wholly or in part, goods previously purchased abroad. During the second stage of import substitution, the growth of native industry, existing and newly established, was fostered by a policy of tariff and quota protection. These industries, old and new, were expected to supply the needs of the home market and provide additional industrial employment. The policy was successful in that the number of those occupied in the manufacturing industry has almost doubled (from 260,000 to 496,000) in the decade 1960-70. But as many of the new industries aimed at import substitution, their growth potential was limited.

Another essential aspect, concerning the state directly, is the fact that almost two thirds of the entire state income, e.g. in 1968 over 6 billion bolivars out of a total budget of just over 9 billion, is derived from the external capitalist sector - the oil companies and their Venezuelan holdings in other sectors (taxes, royalties). Therefore, the outcome of populist industrialization policies in Venezuela has been a reduction of imports in some parts of the consumer goods area, but a triplication of the imports of capital goods instead, a feature of industrialization in dependent capitalism which makes it both profitable for the metropolitan countries and acceptable as a pseudo-progressive reform of the international division of labour that existed before. It represents, basically, another expansion of American exports and counteracts all the aims of national development.[88]

Since the early 1970's, Venezuela's new industrial policy, which aims to concentrate investment in basic industries geared to the export market, indicates that attempts are being made to circumvent the difficulties encountered by the country in its early stages of industrial development. In fact, the slowdown in economic growth that resulted from the pursuit of an inward-orientated development strategy during the 1960's led to policy reform in Venezuela. The reforms involved providing subsidies to manufactured exports; reducing import protection; applying a system of crawling exchange-rate pegs; adopting positive real interest rates; and introducing greater realism in the pricing of public utilities. More recently, the Herrera administration (1979-84) has been making increased use of the price mechanism and reducing price distortions. Evidence suggests that the government has every intention of continuing to remove price controls in order to avoid the distortion of output and input prices, and then market-place laws will prevail.

In essence, the new policy orientation represents a break from the protectionistic, import substitution industrialization policies of the past, and signifies the implementation of policies which are free trade and export stimulation orientated, based on productive efficiencies and broadly defined norms of comparative advantage. This change in economic philosophy is due to the conviction that while Venezuela, with its atypical petroleum-based economy, has not necessarily exhausted its development potential following the import substitution model, at the same time it has become necessary to modify that policy thrust in order to assure continued economic growth on a more self-sustaining basis.[59]

Recognizing the fact that the degree of competition and quality of industrial production had not kept pace with the development of the country in the decade 1960-70, since the early 1970's the government started an important process of reorganization of the standardization and QC activities.

Even at the end of 1969, COVENIN did not have the required qualified professionals. But in 1970, the creation of the Division of Standardization and Quality Certification of the Direction of Industries of the Ministry of Development, marked a great achievement since it became the "operative body" of COVENIN. From then on they started taking actions leading to the standardization and quality certification within the country.

In 1971, the then Venezuelan Productivity Institute (INPRO) conducted a national survey on QC, the results of which were presented at the First National Symponium on QC.[133] In view of the alarming results of the aforementioned survey, the Symposium made the following recommendations: (1) <u>at short-term</u>: to strengthen the standardization and quality certification activities in the country: and (2) <u>at medium term</u>: to carry out a study by the "Commission for Promoting QC" in order to present the guidelines for a national strategy on quality.[134]

From 1971-72 the Venezuelan government approached the United Nations Industrial Development Organization (UNIDO) and the Organization of American States (OAS) for technical, financial and legal assistance, and between October 1971 and April 1972 the first three-year standardization plan appeared. This plan contained an estimate of all the resources needed to go on with the study and implementation of standards in Venezuela from 1972 to 1974. In 1974, the 65% of the first plan had been fulfilled and the government had declared the COVENIN a legal organism. Now the COVENIN was able to cope with the industrial needs and it was in a better position to ask for more institutional and financial support from the public and private sectors. In fact, the Decree 1195 ('Normalizacion y Control de Calidad', 10.1.73) established the structure and functions of the COVENIN, the Division of Standardization and Quality Certification and the Fund for Standardization and Quality Certification (FONDONORMA).

In most developing countries the emergence of standards organizations has largely been on government initiative. In Venezuela, not before the creation of FONDONORMA in November 1973, did the private companies take an interest in participating in all standardization and quality certification activities. During the 1974-76 period, FONDONORMA financed about 40% of the COVENIN's annual budget. In 1975 a technical office was set up within FONDONORMA to provide, among other things, advisory services for manufacturers as to the type of standards and QC methods applicable to their products and to undertake the training of manufacturing staff in the quality field.

Since 1973 a marking and certification scheme has been used extensively in the country. In addition to the Kitemark schemes (COVENIN's certification trade mark first registered in 1963), the COVENIN has introduced a Batch Certification scheme (CERTIVEN) as well as a Laboratory Accreditation programme for testing and related services.

At the beginning of 1975 the Direction of Standardization and Quality Certification (Direccion de Normalizacion Certificacion de Calidad, DNCC) took the place of the Division of Standardization and Quality Certification. Since then, the DNCC is the operative body of the COVENIN and is in charge of carrying out all the activities programmed by the COVENIN.

In the mid-1970's the Venezuelan standardization process progressed to the Control of Quality of manufactured products. In effect, the COVENIN Standard 1000 (Manual de Evaluacion de los Sistemas de Control de Calidad de las Empresas) was approved in 1976. This Standard provides information and guidance to government QC personnel responsible for the evaluation of a company's QC system for compliance with COVENIN standards.

The results of the first evaluations of QC systems in Venezuela were very alarming, i.e. it was found that 85% of Venezuelan industries have not got adequate QC systems. Since then, the government has been taking some action in order to base the new plans for industrial development on the concept of quality. On the other hand, the Consumer Protection Law started being applied and supervised by the DNCC and the Superintendence of Consumer Protection.

Since early 1976, new standards have been applied in industry, both for internal consumption and export. This policy is the result of a project originally drafted by the COVENIN and presented to the former Minister of Development J.I. Casal. According to the standards, all goods made in Venezuela or imported to the country are undergoing strict control to ensure their quality under the NORVEN label which all articles must bear.

The project establishes that the Ministry of Development will be responsible for laying the bases for action on quality in the areas of manufacture and trade, services, and the introduction, distribution and sale of imported goods, as well as the exportation of Venezuelan goods and services.

Each company must set up its own internal QC system, in such a way that it will ensure that its products meet the quality and specifications explicitly offered to consumers on the labels, in pamphlets, publicity or any other means of information or advertisement. Likewise, all projects for the establishment of manufacturing companies are to include the full description of the QC systems that will be used and the companies will be responsible for installing them. The basic documents concerning QC such as manuals, standards, tests, sampling, must be written in, or translated into, Spanish.

Also, the Ministry of Development has introduced a system of quality certification for export goods. Consequently, all Venezuelan products consumed abroad will have their quality guaranteed by several specialized government agencies.[135]

Knowing the fact that only products with uniform quality and competitive price can hope to win the confidence of the customer and compete favourably in the foreign market, the government and the private sector have endeavoured to raise productivity and improve product quality. They have recently joined efforts to co-operate with one another in promoting total QC systems in the export-processing industries. Applying statistical QC has also been proven to be an effective method in attaining this goal, mainly in those enterprises orientated more towards the domestic market.

The Standards and QC Law, which provided the government with such options as Bs.500,000 fines and the closing of industries that refused to meet mandatory industrial standards, took effect two months earlier, on December 31, 1979. For instance, the recent cases involving milk with chemical additives and too many micro-organisms to meet health standards have prompted the government to make obligatory the standards for pasteurized milk from March 1980. Raw milk and powdered milk standards also became mandatory at that time.[136] Meanwhile in the light of the uncertainties about pasteurized milk, the government has been taking various measures in order to encourage the consumer not to buy products of inferior quality. In this sense, the Consumer Protection Agency will be given full support by the Ministry of Development in re-orientating its functions towards quality investigation, rather than prices.[137]

Undoubtedly there is a new emphasis on stricter control - for quality and efficient production - all over the country. As a matter of fact, the First National Congress on Technical Standards and QC was organized in February 1978, being the most attended meeting in Latin America.

3.4. Present Situation of Quality Control

3.4.1. Standardization as a Basis for Quality Improvement

Standardization is an important means of achieving scientific, technological and economic progress in all fields of human activity. The formulation and maintenance of standards for industrial purposes is essential for successful industrialization. Standardization is an effective means of ensuring the quality of industrial products, as it determines quality requirements for the whole range of industrial activity from raw materials, through semi-finished products to the finished goods. Standards facilitate internal commerce and also promote external trade.[138]

In practice, Standardization and QC are very closely linked. It is universally recognised that an adequate and efficient QC system at national level is dependent on the existence of national standards, particularly for some key products and services, to co-ordinate and balance the relations between the producers, consumers and governmental authorities. The national standards prepared must protect the consumer and the user and at the same time be consistent with the existing technological level of the country.[139]

For over 15 years the COVENIN has pioneered the cause of standardization and simplification in the Venezuelan industry. Today there are over 2,000 up-to-date COVENIN Standards in existence (see Fig.3-1). In addition, every year COVENIN formulates or completely revises approximately 250 standards (see Fig.3-2).

The COVENIN exists to co-ordinate the efforts of producers and users towards the standardization and simplification of engineering and industrial products; to simplify production and distribution; to eliminate waste of time and material involved in the production of an unnecessary variety of patterns and sizes of articles for one and the same purpose; to set up standards of quality and dimensions; and to promote the general adoption of Venezuelan standards.

Actually, standards are prepared by some 128 active working groups (19 Technical Committees, 96 Sub-committees and 13 Technical Commissions), which report to the Standards Committee and are required by the Bye-laws to represent the main interests concerned in the work referred to them. For example, some 1,800 technicians and engineers from different sectors (Universities, Private and Public Companies, Professional Institutions etc.) took part in the standardization work carried out in Venezuela during 1980 (see Fig.3-3). Also, some 372 technical visits were paid to public and private organizations in order to promote the use of COVENIN standards.[140]

3.4.2. Quality Certification and Marking

Standardization is very often combined with a certification programme. This includes checking and certifying that products comply with the standards. Such products are given a certification mark. Licences can even be limited to manufacturers having certain QC activities.[141]

In Venezuela the use of the Standard Mark is authorised by the Ministry of Development to a manufacturer, subject to approval of the manufacturer's QC in production and the satisfactory results of some independent tests arranged by the DNCC. But the Ministry's ability to ensure continual compliance of production with the required standards is somewhat limited, basically due to the shortage of specialised personnel to carry out the supervision and control of the already assigned certification marks and lack of reliable testing facilities. Delays on the development of adequate personnel and reliable tests followed - in part - as a consequence of the fact that although the NORVEN Kitemark was first registered in 1963, it was not until ten years later that the regulations and requirements to be fulfilled for the assignment, use and supervision of the standard marks were laid down by the Resolution 3939 (16.8.73).

Also, as could be expected, it was found that in 1980 there was a great difference between the number of COVENIN standards already approved (more than 2,000) and the NORVEN quality marks (69 in total) authorised by the government - as indicated in Figures 3-1 and 3-4 respectively.

Quality or certification marks indicate that a specific product complies with certain standards. Quality marks are based on published standards issued by COVENIN, and are the property of this organisation. A manufacturer is given the right to use the quality mark for a specific product on condition that the quality of the product complies with the minimum requirements stated. In order to check this, the product is tested by authorised testing stations.[142] In addition, COVENIN occasionally visits the plant where the product is manufactured to ensure that quality is maintained during production, and also to check it against test samples collected from the market.

Testing is, of course, crucial to the successful implementation of a certification programme. The guidelines for recognition of laboratories under the NORVEN certification marks schemes were established in 1974. It was intended that these guidelines, when adopted by the laboratory, become a manual of QA operations in the organization, primarily to assist and improve the laboratory's testing and inspection procedures. Secondarily, the manual would serve the purpose of providing support and proof of an existing QA programme in an audit by an accrediting agency. Therefore, the function of the QA system is to present an internal standard whereby laboratories can evaluate and attest to their reliability in making precision measurements in testing, analysing, and/or inspecting materials, products and systems, or in performing research.[143] As can be seen from Figure 3-5, a total of 66 national laboratories (Universities, Research Centres, public and private enterprises), have been approved by COVENIN during the 1973-80 period.

In early 1976, COVENIN introduced a 'batch' certification system (CERTIVEN) for quality conforming to national and international standards. Since then, a total of 64 quality marks have been assigned to Venezuelan products.

Another important aspect of the national certification programme is the evaluation of the effectiveness of the QC systems by using the COVENIN Standard 1000-76. This standard establishes the requirements for a company's QC system. It identifies each of the elements of a QC system to be assessed by the COVENIN's staff for the purpose of ensuring that products (or services) conform to customer requirements. In other words, this standard is basically a guide document dealing with the audit of quality - the system which has to assure that the quality of design, production and delivery of goods within its economic testing, is reliable. Figure 3-6 shows that from 1974 to 1980, a total of 2,234 companies have been evaluated for quality approval by the COVENIN staff. Most of these quality assessments have been made in the following industrial sectors: metalworking (metalmechanic), automotive, food, pharmaceuticals, pulp and paper, electrical components and textiles.

3.4.3. Promotion, Education and Training

Nowadays, the COVENIN is extensively engaged in propaganda activities pertaining to standardization and QC, that is, it publishes technical literature and standardization news, (COVENIN Bulletin, issued quarterly), conducts lectures, seminars, conferences and supplies material for newspapers, radio and TV. Another major activity for promoting QC in Venezuela has been the participation of COVENIN in industrial exhibitions, e.g. EXPOMOTRIX 80, CONSTRUCTION 80, etc. Still another important COVENIN activity has been the enquiry and advisory service on national and international standards publications, which has been provided since 1975 through the Centre of Information and Documentation.

Education and training courses are a major activity of COVENIN, conducted in co-operation with the FONDONORMA. Training programmes are opened to both government and industrial employees. In 1980, 22 courses and 4 seminars were scheduled which were attended by 1,234 persons. Courses held in the period January-December 1980 included such subjects as: Statistical QC; Engineering Dimensional Metrology; Organization and Management of QC; and Auditing QC Systems (see Table 3-3). For 1981, new courses have been designed on "Quality Costs" and "Reliability". Contract courses, given at manufacturing plants, and management seminars are also scheduled. It is also worth adding at this point that special courses on QC

Engineering are actually given at various universities and polytechnics in Venezuela.

In addition to local training, a number of engineers have been selected and sent abroad by COVENIN for observation or further training in QC and standardization.

Concerning FONDONORMA publications, the following two ought to be mentioned among many others: (1) a 127 page catalogue of the Venezuelan standards approved until December 31, 1979; and (2) a digest of the legal regulations and laws of standardization and QC in Venezuela, including the full text of the new Industrial Standards and QC Law.

In order to promote the use of the Venezuelan standards in the industrial sector and to encourage the consuming public to buy products with the NORVEN Kite-mark, in 1980 the COVENIN organized a nation-wide advertising campaign by printing more than 270 articles in newspapers and technical magazines, broadcasting 23 TV programmes and a film on COVENIN's activities. Moreover, a series of posters emphasizing quality (print out: 8,000) were widely displayed all over the country. The themes of these quality posters, which are shown in Figure 3-6, were based on ideas from the staff of the COVENIN submitted in a recent poster design competition.

Besides the efforts that are being made towards the education of consumers by the government through the COVENIN, the Venezuelan Institute of Consumers (Instituto Venezolano del Consumidor, founded in 1968) and the Consumer Protection Superintendence, it may be noted that the consumers have been organized into associations. Recently, the National Front of Consumers (Frente Nacional de Consumidores Organizados, FRENACONSUMO) was organized in Caracas city.[144] This Consumer's Association provides education, advice and information through its official publication FRENACONSUMO, which also reports on customer complaints and other information concerning product liability and the consumer's rights to demand his money's worth when he purchases any product.

3.4.4. Supporting Organizations

The Venezuelan Commission for Industrial Standards (COVENIN) is the national standardising organization of Venezuela and issues Venezuelan standard specifications and codes. The COVENIN has four main areas of activity:

(1) Preparation, publication and implementation of national standards;

(2) Centralization of standardization efforts in the country through the collaboration of all interests concerned;

(3) Co-operation with national standards bodies of other countries; and

(4) Representation of the country in international organizations for standardization and other related activities.

A key objective of the COVENIN is to co-operate with the government in improving the State standards in force and preparing annual Standardization Plans; to advise on tentative State standards that contain technical quality requirements and on analysis testing and QC methods, and to ascertain that all characteristics listed are at world level. In addition to this, the COVENIN provides advisory services to the Ministry of Development (Ministerio de Fomento) in all the quality certification schemes: NORVEN Kitemarks, CERTIVEN and Laboratory Accreditation.

The COVENIN has a board of directors, composed of representatives of government ministries, industry, trade, commerce, consumers, scientific and professional institutions. Standards are prepared by some 128 active technical committees - as mentioned in section 3.4.1.

COVENIN has an annual budget of some Bs 8 million (say, £1= Bs 10). Actually, the Fund for Standardization and Quality Certification (FONDONORMA) covers about 60 per cent of its annual budget, the remainder coming from the Ministry of Development.[145] FONDONORMA is a non-profit institution, whose income is mainly obtained from members' subscriptions, education and training courses, certification activities, consultancy services and from the sale of its publications.

The Direction of Standardization and Quality Certification (Direccion de Normalizacion y Certificacion de Calidad, DNCC) is the 'operative body' of the COVENIN. In other words, the DNCC is responsible for COVENIN's standardization and quality certification activities. The work of the DNCC is organized through three Technical Divisions: (1) Division of Quality Certification (Division de Certificacion de Calidad); (2) Division of Standardization (Division de Normalizacion); and (3) the new Division of Evaluation and Application of Standards (Division de Evaluacion y Aplicacion de Normas), comprising the Department of Verification of the use of Mandatory Standards and the Department of QC Assessment and Technical Assistance for manufacturers in developing QC systems for their companies.

Figure 3-7 shows the institutional infrastructure of Standardization and QC in Venezuela. It is clear from this organizational chart that the Director General of the DNCC is also acting as the Executive Secretary of COVENIN and the

Managing Director of FONDONORMA. Since early 1980, the DNCC and COVENIN report to the Direction of Technology (Direccion General Sectorial de Tecnologia) of the Development Ministry.

The creation of the Direction of Technology is a major step to promoting co-operation and sharing information among those government agencies directly or indirectly engaged in the promotion of QC. As indicated on the left of Figure 3-8 (The Organizational Structure of the Ministry of Development), the Direction of Technology brings together the DNCC, the National Service of Metrology, the Registry of Industrial Property and the Direction of Technology Assessment and Productivity. The latter Direction was recently established to carry out the activities of the former Institute for Productivity (INPRO) which ceased its functions in the mid-1970's.

3.4.5. Participation in International Activities

The objective of international standardization is to facilitate the international exchange of goods and services. The benefits of standardization are similar at national and international levels for communication between suppliers and consumers, interchangeability of components and equipment, and elimination of unnecessary variety. Developing countries have a substantial stake in international standardization since, as large importers of the products of advanced countries, they would benefit considerably if they could buy their requirements freely from a wide range of suppliers offering equipment on the basis of common international standards.[142]

As mentioned in the previous section, one of the main tasks of the COVENIN is to promote and co-ordinate the representation of Venezuela in international organizations for standardization and other related activities. COVENIN is a participating member in the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), the Codex Alimentarius Commission (CODEX), and a leading member of the Pan American Standard Commission (COPANT).

In 1980, the Executive Secretary of the COVENIN was appointed as a co-ordinating delegate for ISO's activities in Latin-America. At the same time, he was designated by the COPANT to represent this organization in the ISO.

Since then, Venezuela has increased its participation in ISO Council Committees. By the end of 1980, Venezuela became an active member of the following ISO committees: PLACO (Planning Committee); CERTICO (Committee on Certification); DEVCO (Development Committee, aimed at the needs of developing countries); and STACO (Standing Committee for the Study of Principles of Standardization). Also, Venezuela is an observing member of the ISO/INFCO (Standing Committee for the Study of Scientific and Technical Information on Standardization) and the ISO/REMCO (Committee on Reference Materials).[140]

During the last few years, COVENIN has been acting on behalf of Venezuela in the discussions for approval of the System of Standardization, Quality Certification and Metrology to be used in the Andean Common Market.

In addition to these important international standards bodies, the COVENIN also belongs to the Latin American Federation of QC Organizations (LAFQCO), whose main purposes are:

to promote the development and diffusion of the QC, to facilitate quality specialists experience and knowledge interchange and to strive for the reorientation of the educational systems and the establishment of integral policies of QC in the Latin American countries.[146]

Since the very beginning the UNIDO and OAS have co-operated with the COVENIN in training activities and technical assistance in standardization, metrology, QC and documentation procedures. External assistance in the quality field has also been given to the staff of the COVENIN by other Standards Institutions, in particular from the AFNOR (France), ISI (India), and IRAM (Argentina). More recently, Japanese experts have been visiting the country to promote the QC Circles' philosophy, and also some members of COVENIN's staff have been sent to Japan to receive in-plant QC training courses.

All the above-mentioned activities are co-ordinated by the COVENIN through its International Relations Office - which is directly attached to COVENIN Secretariat (see Fig.3-7). In order to encourage and facilitate the development of new standards having common requirements for use in international and national spheres, a special unit for co-ordinating international standardization has been created within the Division of Standardization of the DNCC.

3.5. Quality Challenges for the 1980's

During the 1970's, the COVENIN has confirmed its position as the chief organizing and promotion State agency for controlling implementation of standards and quality of products (and services). It has made headway in creating quality awareness among its personnel, as well as in other members of the quality triangle - the Government, the Manufacturer and the Consumer. However, this is only a prelude to the challenges of the 1980's. New efforts plainly are needed to inject fresh momentum into the quality movement in the country.

Although the COVENIN has made notable progress in the area of standardization, both at national and international levels, very little time and effort have been devoted to the area of QC. As a result, most of the existing QC systems in the Venezuelan industry are basically inspection-orientated. It is necessary to get rid of the common attitude of fighting the inspection instead of fighting the defects, thus eliminating the need for inspection. All defects have assignable causes and these causes always exhibit the phenomenon of vital few and trivial many. Nothing but defect prevention technology can keep a check on high quality cost and less product quality.[147]

The task and requirements of quality development must be in compiling the national economic plan, with the combined application of the means and methods. As a consequence, standardization and QC programmes have to be fully integrated into the overall objectives of the country's industrial policy.

As Venezuela enters the 1980's it is expected that the economy will be less dependent on the revenues obtained from exporting raw materials, mainly crude oil and iron ore. Clearly, manufactured exports will have to play a vital role in financing the imports of the future. The key elements in any such programme will have to be the improvement of productivity and quality in both agriculture and in industry and the development of the ability of both sectors to compete in a significant fashion in the world economy. According to the VI National Plan (1981-85), subsequent stages of the country's industrial development must be orientated towards the progressive development of some basic industries (steel, aluminium, petrochemical, etc.) and agricultural industries and also the manufacture of capital goods.

Venezuela's competitors have long recognized that quality and reliability are critical factors in efficient and profitable manufacturing, but the concept of total product assurance is only just beginning to be accepted in Venezuela. The 1980's should see a rapid progress in the development of QC systems acting throughout the life cycle of a product or service, right from its original realization through to its production and use. This is particularly important in the cases of export-processing industries.

Despite the claim of increasing competitiveness in world markets and complaints of home consumers, enterprises have thus far actually only been interested in the quantitative, and not the qualitative, enhancement of production. Indeed, no development can be expected until the economic environment becomes more rigorous and the system of economic management changes. Complex quality-efficiency indices must be applied instead of the present interest in volume. In addition, today's consumer continues to buy with strong attention to price, but his principal difference from the past is his increasingly high emphasis upon value in which he expects some acceptable level of quality at any price level offered to him.

From the foregoing it is evident that productivity and quality are of paramount importance for the health and prosperity of the nation's economy. For this reason, <u>Qualitability</u>

(or the activity of producing quality) should be the greatest challenge which quality practitioners and managers have to face in the coming decade.

Today there is a growing awareness that the economic problems of the country cannot be solved without a significant improvement in quality production. Nevertheless, much remains to be done to induce upper and middle management to accept training in modern QC techniques.

The problem of quality has come into the foreground of technological progress, and this makes it imperative to improve further the legal regulations and to utilize more fully the existing system of legal control to assure the high quality of Venezuelan products. In this sense, law must be placed at the service of quality.

At the present time, the government agencies and private enterprises are making an extensive use of the new standards and QC law. As a result of industry-government cooperation in standard work in recent years, the government is increasingly following the practice of using industrial standards as a base in procurement. In the area of QC, various schemes for technical assistance have been established among COVENIN, FONDONORMA and industrialist organizations (automotive, metalworking, food packaging, etc.). Greater industry-government collaboration in standardization and QC will cause further intensification of the drive to increase productivity.

In Venezuela, as in most developing countries, the government agencies are large consumers of goods and are thus in a position to insist on product quality. Standards for all governmental purchases should be established. Recently, a special technical committee (CTA 21 - Compras del Estado) has been set up in the COVENIN. It will be responsible for the establishment of obligatory standards for all government purchases, and also will act as an advisory body to the government in all standardization and QC decisions, including the storage and maintenance of all government acquisitions.

Undoubtedly, Venezuela is undergoing an exceptional period in its QC history. The last ten years have seen a rapid growth in the use of QC systems in private enterprises, large and small; in nationalized industries; and in government agencies. Nowadays there is a lot of talk about QC and its ability to reduce cost, increase profitability and improve productivity in all sectors of the country's economy. Whatever the different views of QC, one thing is certain - all QC methods have to be adapted to the national culture. This matter is analysed in some detail in Chapter 6.

To sum up, it may be said that Venezuela's quality problems are complex and urgent, but substantial responses will require careful planning and time. However, these problems cannot be left unattended, for, as they gain in intensity, they multiply in number. In Chapter 7, some recommendations and proposals for future work are given as a means to design and subsequently to implement a coherent national strategy on quality.

CHAPTER 4

PROBLEMS OF QUALITY CONTROL IN THE VENEZUELAN METALWORKING INDUSTRY

4.1. Introduction

Chapter 3 has outlined the general trends and developments which have taken place in the quality field in Venezuela during the past two decades or so. It has basically attempted to bring up to date an account of the activities undertaken under the Standardization and Quality Control (QC) programme of The Venezuelan Commission for Industrial Standards (COVENIN). It listed all the studies under way or completed under this programme. At the end it was pointed out that, although the COVENIN has made notable progress in the area of industrial standardization, very little time and effort has been devoted to the field of quality and related matters -- QC, Reliability, Quality Assurance (QA), etc.

The purpose of the present Chapter is to report some of the insights gained in studying the current QC problems in the Venezuelan metalworking industry. It starts by giving general information on previous studies conducted by the Government in order to assess the effectiveness of the QC systems used in the national industry. The next section gives an account of the results of a survey that shows the extent to which statistical QC and Acceptance Sampling are utilized by Venezuelan metalworking companies.

The role and importance of Standardization and Specification for production are discussed. Owing to the importance of the Machine Tool Industry to the country's economy, the need for quality in this industrial sector is reviewed in some detail. Also, a study is presented on acceptance testing and effective use of machine tools and other related aspects of quality management, reliability and maintenance, replacement policy, among others. Following this, the interrelationship between QA and Numerical Engineering is discussed. The concept of Computer-aided QA is briefly presented, and then some problems associated with the introduction of numerically controlled equipment and machines in developing countries like Venezuela are outlined. Finally, some comments are made on how to tackle the major problems militating against effective QC in the metalworking sector.

4.2. Background

There has been a wide range of research on the evolution of the Venezuelan industrial development, as indicated in Chapter 2. But when we come to trace the history of the process of Standardization and QC we observe that there is no evidence of significative or systematic studies on the quality field and related matters, and that it was not till 1965 that some studies of some standards were done, especially in the automotive industry, including some studies of acceptance sampling on steel bars.

In the area of industrial standardization, the rise of the first standards was found to be mainly due to the efforts and personal initiative of the Standards Technical Commissions rather than the result of a well organized work based on the country's needs.

Consequently there was not a defined methodology to prepare and inform the members of these Technical Commissions about the philosophy, aims and technical procedures to be followed during the formulation and approval of standards. Because of this, a large number of standards, which did not come up to the agreement established by the International Organization for Standardization (ISO), were granted.

Another limitation was the non-existance of a proper institution with the necessary technical, financial and human resources to support the promotion, elaboration and use of technical standards and standardization.

Moreover, the number of standards did not increase at the same rate as the quantity and diversity of new companies established in the country in the areas of metalworking (metalmechanic), automotive and industrial metallurgy.

The situation described above did not change until 1973 when an attempt was made to re-activate the initial efforts which had continuously diminished from lack of incentive due to the number of different obstacles faced during the last ten years or so.

Therefore, 1973 was a fruitful year and jobs started again with the establishment of the following Standard Committees: COVENIN/TC5 (Automotive), and COVENIN/TC7 (Ferrous Materials). Later in 1975 the COVENIN/TC8 (Non-Ferrous Metallic Materials) started operating and in 1977 the COVENIN/TC20 (Mechanical) came to light.

The existance of all these technical committees helped to promote the creation of a series of standards working groups in the COVENIN (see Section 3.4.1).

In 1971 the Venezuelan Productivity Institute (INPRO), carried out a national survey on QC. The INPRO study was based on a questionnaire survey addressed to a large sample of firms, asking them for details of their organizational and technical capabilities for controlling the quality of their manufactured products. Before drawing up the sample, the population, comprising mostly of the industrial sectors, was stratified into three-size-groups (according to employment). As shown in Table 4-1, the questionnaires were sent to 342 firms and replies were received only from the medium (21-100 employees) and large-sized (more than 100 employees) enterprises. It was found that 100% of the small firms (less than 20 employees) chosen were not able to answer the questionnaire because they did not have any kind of technical organization for QC.

After a careful analysis of the data gathered some conclusions were reached which were announced in the first National Symposium on QC (see - Actual Situation of QC in Venezuela, INPRO, 1971).[133] The study found that management did not consider QC as one of the most important activities, nor did it follow any quality standard in production; it did not even control the way in which the department of production fulfilled its job. If the specifications were hard or difficult to determine, they were ignored by management; and in those cases where some specification existed, their tolerances were not well defined. Moreover, it was found that the existing QC systems did not audit manufacturing operations; and in those cases where some inspection data did exist it was not utilized to initiate corrective action in the manufacturing cycle. In general, education and training for quality were needed at all levels of the company's personnel. Finally, the report pointed out that there was a widespread misunderstanding of the words 'standards' and 'standardization', and it was recommended to review the national standards and to promote their use in all sectors of the nation's economy.[134]

The work mentioned above and many other studies carried out by university and industrial organizations served to show that the findings of the INPRO Survey and also the consumers' criticisms on the low quality of national products, were well founded; since by that time most of the manufactured products were the result of the use of highly complex, automatically controlled, capital-intensive technologies and machinery which were not appropriate to the technical and human resources of the industrial sector, mainly in the field of QC.

As already mentioned in Chapter 3, the alarming results of the INPRO Study prompted the Government to organize a nationwide campaign to promote a greater awareness of the importance of quality in meeting market needs. In the mid-1970's the Development Ministry and the private sector (particularly the automotive industry) joined efforts to analyse in-depth the situation of QC all over the country. As a result, the COVENIN Standard 1000-76 (Guide to assess the effectiveness of companies' QC systems) was approved in early 1976; since then it has been used extensively in many branches of the country's economy. All these activities were supported by the enactment of new regulations and law concerned with the attainment and maintenance of quality, as well as the implementation of a quality certification and marking programme (see Section 3.4).

4.3. A Survey of the Present State of Quality Control in the Venezuelan Metalworking Industry

4.3.1. Previous Studies

In October 1975, the Venezuelan Association of Manufacturers of Automotive Parts (FAVENPA) conducted a survey of the quality function by using the draft of the COVENIN Standard

1000. The results achieved were compared with the following standards for comment:-

Range	QC Systems
70 - 100 marks	Acceptable
50 - 70 marks	Passable
0 - 50 marks	Defective

The results of the 91 firms evaluated are shown in Table 4-2. It can be seen that only 12% of the QC systems assessed were found 'acceptable'. In addition, the population was stratified into two groups (according to the capital employed). As shown in Table 4-2, 100% of the QC systems used in the smaller firms (capital less than Bs1 million, say Bs10 = £1)were found 'defective' and only 16% of the remaining companies (capital greater than Bs1 million) were ranked as 'acceptable'.

In 1977 the COVENIN presented a report to the AIMM (Asociación de Industriales Metalurgicos y de Mineria de Venezuela) in which an account was given on the effectiveness of 62 QC systems used in the metalworking sector. As indicated in Table 4-3, these results are very similar to those obtained in the FAVENPA Study in 1975. The overall results indicated that only 24% of the companies' QC systems were found 'acceptable'. They also stratified the population into two groups (according to the capital employed) by using the same criterion as FAVENPA. It can be seen again that 100% of the smaller firms did not have adequate QC systems, and only 35% of the remainder were found 'acceptable'.

By using the COVENIN Standard 1000, the effectiveness of the overall QC system of 71 metalworking industries was evaluated by COVENIN during the years 1975, 1976 and 1977. The results obtained were presented in the First National Congress on Standardization and QC (February 1978).[148] Table 4-4 indicates that in 1975, 85% of the QC systems evaluated were found 'defective', 15% 'passable', and none of them was found 'acceptable'. In the evaluations corresponding to the 1976-77 period some progress was made, but the percentage of 'defective' QC systems still remained too high (about 70%). On the other hand, Table 4-5 shows graphically how the specific requirements of COVENIN Standard 1000 were evaluated (a detailed description of this standard is given in Section 3.4 of the thesis). From these results it can be concluded that the companies had paid more attention to the control of the manufacturing process rather than those aspects directly concerned with the control of quality, such as: the control of incoming material (control de recepción); process control (control de proceso); and controlling final inspection and assembly inspection and testing requirements (control de producto terminado). In other words, it was found that the average score of these aspects of quality during 1975-77 accounted for 32%; whereas the manufacturing aspects (machinery, personnel, stores, etc.) accounted for about 64% of the overall evaluation.

The foregoing clearly illustrates that there has not been much improvement in the QC methods used in the metalworking industries, in spite of the efforts of the COVENIN and the private sector during the last few years to make this industrial sector quality conscious.

4.3.2. Present Situation

In the autumn of 1978 a field survey study was carried out by the author to investigate the effectiveness of statistical QC and acceptance sampling techniques employed in the Venezuelan metalworking industry.

To obtain the required information, various options were considered, but eventually the questionnaire shown in Appendix 3 of the Thesis was used. In addition, the survey's activities comprised a tour of the plant and personal interviews with QC personnel, in particular with upper and middle management.

The author's research interest was mainly to gain an insight into the major quality problems facing these industries. Also these activities were aimed at selecting two smaller metalworking industries in which the experimental part of the research programme could be carried out (see Chapter 5: Case Studies). Therefore, the population (15 companies in total) was not stratified as in previous studies and because of the variety of firm sizes, location, products, level of automation, turnover etc., there was no correlation between the complexity and comprehensive nature of the data obtained. Hence, no attempt is made to present a detailed record of all the information gathered by the questionnaire, although a summary of the main findings is given below:-

(1) Top management had not given definite policy and instructions regarding standardization and QC procedures and the majority of the companies under survey did not have Quality Manuals; just under 40% of the companies had a separate QC/Inspection department and in most of the cases the department which performs the quality function reports to the Technical Manager instead of reporting directly to the Managing Director.

(2) Just under 50% of firms used statistical methods to control/maintain quality levels. Sampling Plans and Variables Control Charts were the most widely used techniques being used by just over 30% of the firms. Among these, MIL-STD-105D plans are the most popular, i.e. sampling plans are normally based on the AQL concept. Apparently, acceptance sampling is more popular than control charts.

(3) Just under 30% of firms had recorded information but in most of the cases this information was not used to make decisions or corrective action regarding quality improvements. In particular, it was found that just under 20% measured Quality Costs and the average (relative to turnover) was estimated at 10%. Internal Failure Costs were estimated by 20% - 30% of firms.

(4) The actual techniques used in vendor rating are not known as most of the companies were not using it. Also it was found that most of the companies were not using acceptance sampling for incoming products. This is particularly critical due to the fact that these companies used imported raw materials in their manufacturing processes and also they depended to a large extent on the provision of spare parts and ancillary equipment to keep production running and these in most of the cases were imported from industrially advanced countries.

(5) Almost all firms inspected finished products and the majority of them used 100% inspection. Just over 30% of firms had been inspected/assessed for quality by or on behalf of customers.

(6) There is a lack of appreciation of the benefit of process capability studies. Just over 20% of firms applied

machine capability studies to their production facilities.

(7) Just over 30% of firms provided some training and education for quality personnel. Most of this training/education was internal, but it was found that at least one of the QC personnel had attended one of the COVENIN Courses on Statistical QC. Hence, it seems that there is a lack of appreciation of the benefit of QC at the top management level and consequently the top executive is not always prepared to support the introduction of any quality improvement programme.

4.4. Quality Requirements in the Venezuelan Metalworking Industry

4.4.1. The Special Problems in Metalworking Industries in Developing Countries

The poor quality of engineering products manufactured in the developing countries is the main factor preventing these countries from expanding their industrial production, import substitution and export promotion. Some developing countries have to buy the tools, dies, jigs and fixtures needed for production; others have to buy the steel needed to manufacture their own tools. Measuring instruments required for the production of replacement and spare parts are not always available and have to be imported. All these procurements require foreign currency, which is usually in short supply in the developing countries.[149]

At the heart of the problem of increasing profitability in the metalworking industry in developing countries we find five key facts:-

(1) In comparison with the United States and Europe, production methods in developing countries in this industry generally have more labour content and are less efficient.

(2) The limited size of the domestic market and lack of strong organizing power often make it difficult to achieve production economies through regional agglomerations of industry.

(3) There is widespread evidence of difficulty in financing new production equipment and tooling to launch new product designs.

(4) There are few people in most developing countries capable of original product design. The widespread practice of manufacturing new products by copying, with or without licensing and a know-how agreement from a foreign firm has allowed no opportunities for product design talent to develop. The domestic market often provides little incentive to improve present products or to develop new products, while entry into foreign markets seems virtually impossible so that no attempts are made to design products for export.

(5) In general, there appears to be little understanding among industrialists in developing countries of the role of marketing in a competitive economy. Serving a protected domestic market, they have not usually had to give much attention to marketing functions which are of great importance elsewhere. Thus, there has been little need for market research to identify requirements and estimate demand for new products, little pressure to determine the most suitable methods of marketing products and to develop distribution channels, little incentive to train salesmen and to conduct test marketing before launching full-scale production of new products.

Pricing policy, a key marketing variable, has usually been restricted by governmental policies.

There has been little need to discover a proper marketing mix for the domestic market, choice of distribution channels, promotion schemes, product design and pricing policies.

Any long-term solution to the basic problem of expanding the metalworking industry in developing countries must give proper consideration to all the dimensions of the problem outlined above. In order to compete effectively in home and foreign markets, the industry must (1) modernize its equipment and method of production; (2) develop new products and market them effectively; (3) organize supporting industry; and (4) acquire adequate financial resources for these tasks.[150]

4.4.2. Specification and Standardization for Production

Generally speaking, it may be said that technical progress is characterized by the inseparable bond between the designing of more perfected machinery and the development of more efficient processes for its manufacture.

Along with the development of production machines, the quality in manufacturing has been emphasized. Quality and accuracy in manufacturing operations demand that close dimensional control be maintained to turn out parts which are interchangeable and give the best operating service. For mass production, any one of a quantity of parts must fit in a given assembly. A product made of interchangeable parts is quickly assembled, low in cost and easily serviced. To maintain this dimensional control, appropriate inspection facilities must be provided.

The three fundamental criteria which determine economical production are:[151]

(1) A functional but simple design that has appropriate

aesthetic quality.

(2) A material choice that represents the best compromise between physical properties, appearance, cost and workability or machinability.

(3) The selection of the manufacturing processes that will yield a product that is produced with no more accuracy or no better surface finish than necessary and at the lowest possible unit cost.

Because there is such a close and interdependent relationship between the design of a product, selection of materials, processes and equipment, and tooling design and selection, it is necessary to carefully consider, plan and co-ordinate each of these steps if low-cost manufacture is to be achieved. This planning must be done before manufacturing starts. For complicated products, this 'lead time' may take several years and involve the expenditure of large amounts of money.

Figure 4-1 shows schematically the steps which were involved in getting one product from the original idea stage to the point where it was coming off the assembly line. It is important to note that most of the steps are closely related to the others. For example, the design of the tooling was conditioned by the design of the parts to be produced. It is often possible to simplify the tooling if certain changes are made in the design of the parts to be produced. Similarly, the selection of the materials to be used may affect the design of the tooling. On the other hand, it is frequently desirable to change the design of a part so as to enable it to be produced with tooling already on hand and thus avoid the purchase of new equipment. Close co-ordination of all the various phases of manufacture is essential if economy is to result. All mistakes and 'bugs' should be eliminated during the preliminary phases, because changes become more and more costly as work progresses.[152]

From the foregoing it is clear that the material specified for a part will influence the choice of process. Most materials can be shaped by a range of processes, some by a very limited range and others by a range wide enough to embrace most of the known processes. In any particular instance however, there is an optimum sequence of shaping processes. The main factors influencing this choice are the desired shape and size, the dimensional tolerances, the surface finish and the quantity required. The choice must not only be made on the grounds of technical suitability; cost is an important and frequently a paramount consideration. A diagram showing the interaction of factors affecting the choice of process for factory made parts is shown in Figure 4-2.[153]

Furthermore, it is well known that all forms of control require the establishment of standards, whether at company, national or international level. These standards should cover the determination of product or service requirements in a way which encourages rather than inhibits manufacture or performance, means of comparison and assessment of quality, reliability, safety, and value for money and the application of suitable corrective action when necessary. Figure 4-3 shows the fundamental role of standards and specifications in the determination and measurement of quality. In particular they provide a basis for management systems of project control, including the allocation of resources and agreement of price and delivery requirements with customers. As noted by Feilden[50]: Standardization and quality assurance are thus two basic functions of management which interact at several levels within the organization, irrespective of the type of product or service provided. However, as pointed out by Feilden[50], many people still think of standards and quality assurance in terms of manufactured products or hardware, rather than as the primary means of management control of both internal and external services, supplied in response to market demand.

4.4.3. The Need for Quality in the Metalworking Sector

A country developing its metalworking industry appears to go through three typical stages:[154]

(1) The installation, maintenance and repair of metal-working and other machines;

(2) The manufacturing of metalworking machines for local consumption; and

(3) The manufacture of complicated machines, for domestic use, for export to other developing countries and, ultimately, to the highly industrialized countries of the world.

For countries that are still at stage (1), the most pressing problems may be organizational rather than technical. Thus, when considering the conditions necessary for establishing a machine-tool industry in a country, the background of the country and its stage of development must be carefully examined. Co-operation with industrialized countries may enable the developing country to by-pass many trial stages, e.g. through the acquisition of manufacturing drawings and technical know-how.

The growth of industries using machine tools is one of the most important factors in the industrial development and in the increase of national income and employment in developing countries.

The vital role of the machine tool industry is illustrated in Figure 4-4. In the centre there is a small circle by which the machine tool is symbolically represented. The extreme outer ring indicates that machine tools are needed to produce machine tools and any mechanical/electric equipment and for maintenance. Then again, machine tools in an immense number of varieties are needed in industrial production directly for the manufacture of goods - left half ring - as for instance - tools, textile machinery, agricultural machinery, household appliances, construction machines, generating plants and equipment, war machinery - equipment and hardware - transport vehicle and equipment etc. On the other hand, machine tools are used in specialised industries for the manufacture of equipment - right first half ring - with which plants for production of goods - right second half ring - such as processing of elementary articles, leather and plastics, chemical products, pharmaceutical products, electronic components, steel, copper and similar metal products and so on are produced.[155]

From this illustration it is evident that the machine tool industry plays a central role in several capital goods industries. It is therefore proposed to include in this section a case study of production technology appropriate for the less developing countries to produce machine tools.

In the production of any metal working machinery, or machine tool, there are normally two main operations: one is manufacture of various components - cast or forged or weldment

- which are machined and the second operation is the assembly which includes testing and finishing. It is in these two main areas that the production engineering has undergone spectacular changes, revolutionising the designs of machines, machine tools, cutting and forming tools and allied production aids. Simultaneously, there have been tremendous advances in the design of metalworking machinery, machine tools etc. and the materials used and methods of manufacture and assembly.

Speaking of the developing countries like Venezuela, where there exists very little or nil in the way of capital goods or machine tool industry, there appears to be no alternative but to acquire designs and production know-how from outside. It is here one has to make a careful choice and avoid highly sophisticated designs since production technology to a great extent, depends upon the degree of sophistication of product designs. In the field of machine tools, what are needed are the general purpose, simpler designs like centre lathes, drilling machines, shaping machines and knee type milling machines etc. The production technology needed for the manufacture of the components of these machines would have to be simple,and extensive use of general purpose machine tools is normally the best way. Skilled labour being scarce in these countries, a lot more production aids like jigs, fixtures and similar assembly aids will have to be provided for achieving inter-changeability of parts. Strict quality control - each component to be individually inspected - would be necessary to avoid bad workmanship seeping through to assembly, causing numerous problems in the assembly and testing stages of machines.

Assembly operators like scrapers and fitters would have to be extensively trained so that they were able to build in machine accuracies by suitably correcting the inaccuracy of machining by scraping and fitting of mating parts. Inspection both at part manufacturing, unit assembly and final assembly stages has to be diligently carried through.

Sometimes, although laborious efforts are made in building high quality products, final care is not taken in painting and finishing machines. This is a common shortcoming with many developing countries. They lack 'cosmetics'; and a little more care in finishing and painting of machines could give attractive appearance to catch customers' eyes.[156]

When a programme of machine-tool production for a projected plant in a developing country is drawn up, the following requirements should be considered when the types of metalworking machines to be produced are determined:

(a) Compliance with domestic needs; this should make efficient and economic production possible; and

(b) Availability of indigenous raw materials, basic and intermediate products - cast iron and steel, electrical-drive motors, hydraulic elements, etc.

In countries with a developing metalworking industry, as in the case of Venezuela, the simplest types of metal-forming machines constitute an attractive market due to the fact that metal-forming operations are the basis for the production of a number of simple items. With these machines it is possible to attain reasonable quality levels more quickly than with metal-cutting machines. Nevertheless it should be kept in mind throughout the industrialization process that the time required for developing special types of machine tools can be considerably reduced by concentrating all manufacturing facilities of an individual plant on the manufacture of particular families of products, and by employing a carefully planned system of modular design. For example, turret lathes, automatic lathes, etc., can be included with the production of centre lathes, rather than starting production of totally different types of machine tools.[95]

4.4.4. <u>Effective Use of Machine Tools and Related Aspects of Quality Management</u>

It is difficult to specify what metalworking products should be manufactured first in developing countries. The technological conditions, the availability of materials, and the structure of demand are different for each country. The only statement which can be made with certainty is that no country, particularly no developing country, should attempt to make all types of metalworking products. From the economic standpoint, it is most advantageous to produce those products which have the greatest value added. This, however, is not always feasible technologically because such goods are often complex and require a larger base of capital and skill than is available in a developing country.

Speaking on the machine-tool requirements in developing countries, it is found that the process of industrialization cannot be accelerated unless the stock of efficient machine tools at the disposal of developing countries is increased. Approximately one machine tool is required for every two persons engaged in the metalworking industries.

The determination of the number of machine tools required by a developing country during a given period is a very complicated problem which involves the analysis of the whole programme of industrialization of that country. Regardless of the procedure and method used, a census of the metalworking industry and an inventory of the machine tools available in the country should be undertaken in order to provide a basis for an estimate of machine-tool requirements for the industrial development of the country.

As far as machine tools are concerned the question becomes rather complex in that their development is affected not only by the possibility which new processes offer for use in their design and manufacture but also by the requirements of new manufacturing processes which the machine tools themselves have to carry out. Moreover, in addition to the purely technological aspects, operational, organizational and human factors have influenced design trends to an ever increasing extent. Problems of material and workpiece handling, setting-up, measuring and tool changing as well as machine maintenance, consideration of manufacturing systems, especially those with flow line or cellular production using group technology approaches, job satisfaction for and safety of the operator, all play their part in the trends which can be either observed or fairly reliably forecast. Finally, the installation, operation and utilisation of machine tools must be economical. The ratio of operating cost to productivity must be low, not only in terms of investment, installation, running costs and maintenance but also with respact to utilisation of available time and working capacity.[157]

Hence, it can be seen from the above considerations that the efficiency of production depends upon the quantitative performance of the various operations and the quality of manufacture as related to the cost of installing, maintaining, and operating the machine tools on the factory floor. So that, in the design of the machines, the principal factors to be taken into account are:[158]

(1) the quantitative performance, i.e. the rate of removal and the speed of operation. These depend upon the power capacity of the machine, the available operating speeds, the strength and stiffness of the machine elements, and the efficiency of the control devices.

(2) the qualitative performance, i.e. the accuracy with which the workpieces can be produced and the degree of surface finish obtainable. These depend upon the stiffness and weight of the component parts of the machine tool, particularly the stiffness-to-weight ratios; the manufacturing tolerances to which these components have been made; the accuracy with which the components can be moved and positioned in relation to each other;

(3) the cost aspect referred to above.

The selection of machine tools may appear at first sight to present great difficulties for the developing countries, owing to the diversity of types and performance characteristics. In fact, the machine tools made in all industrially developed countries to perform a given task tend to be of the broadly similar design in major respects and this facilitates comparisons. However, it is necessary to establish an Information Centre which will deal with investigating and answering technological and economical questions related to the problems of metalworking, which are submitted by developing and developed countries. Also there is a need to implement an international multi-language classification system of all metalworking machines in order to eliminate existing confusion in terminology and misunderstanding in various countries. Such a classification system should be initiated under the auspices of the United Nations. This classification should be preceded by an international definition of a machine tool. A similar classification should be initiated for materials for metalworking industries.

The accuracy of a machined workpiece depends upon a number of factors, as shown in Figure 4-5. As far as the machine tool is concerned it is of paramount importance to recognise that its influence upon workpiece accuracy depends upon its basic geometric accuracy and a number of functional effects, which themselves affect the latter. The geometric accuracy includes the accuracy and displacement (or positioning accuracy),whilst the functional effects include deformation caused by weight and clamping effects, thermal conditions (machine generated and ambient), stick slip and forced vibration, and in the case of numerically controlled (NC) machines, a variety of control system errors which affect displacement accuracy. Cutting forces affect workpiece accuracy both directly (workpiece deformations) and by influencing machine tool accuracy (machine deformations). Workpiece clamping has a direct influence upon form error whilst tool geometry and tool wear affect both surface roughness and finished dimensions. The effects and interactions of the various factors present an extremely complex picture which might, at first sight, suggest that the only practical solution to the problem of assessing accuracy is to machine a workpiece and measure it.[159]

From the foregoing it is clear that today there is a need to carry out more investigations in the field of acceptance tests for new machine tools. These may include the updating of the Schlesinger and other accepted tests where required, taking into consideration developments in many countries. Type testing and grading of machine tools with United Nations assistance is likewise recommended for this investigation.

Developing countries like Venezuela must familiarize themselves with the latest technical developments, so that they can take optimum advantage of available resources; and to consider regional co-operation in setting up research centres, and in obtaining advantages from a common market, from common training and from the sharing of financing.[95]

In the formulation of replacement policy, the effectiveness of a machine is all too often measured merely by its age. It is not easy to determine when the efficiency of machinery has reached its limit. Inaccuracies beyond the control of the skilled operator can be assessed and, to some extent, corrected by routine maintenance. However, an increased tendency to chatter and tool wear can only be changed by removing the machine from production and giving it a complete overhaul. Over-all policy should include a prudent mixture of replacement by new machines of improved design, new techniques applied to old machines, and the renovation of old machines. In all probability, new techniques could be applied to a large number of older machines without too great an increase in capital cost. Older machines have to be replaced on a basis consistent with the available funds.

With the ever increasing use of new technologies in the manufacturing industries - notably computers, numerical engineering and robotics, production systems are advancing with increased impetus. The logical outcome of the introduction of these technologies and sophisticated machinery is the advent of Integrated Manufacturing Systems (IMS), and perhaps in the near future the technological dream of the Unmanned Factory. The IMS comprises two main sets of subsystems concerned with physical activities and procedural and control mechanisms, which are co-ordinated for management purposes by management information systems. These overall concepts are illustrated in Table 4-6. A review of the progress of subsystems and the framework for future development of IMS is given in reference 160. The concept of the computer-integrated manufacturing system is shown in Figure 4-6, and the manufacturing hardware and software required for such systems are illustrated in Figure 4-7.

Undoubtedly, we are in an era of CAD-CAM, i.e. computer-aided design and manufacture. Now we need CAQA - computer-aided quality assurance. Measurements can be made on a component as it is produced using a non-contact type of gauge based on optical or laser diode. With an appropriate configuration a central computer allows the connections for a greater number of different measuring instruments, roughness and firm testing units, laser interferometers, gear measuring instruments, sorters, size-controls, indicators at check points but also temperature measuring instruments and those for cutting forces in machine tools (Figure 4-8).[161] But the CAQA system should not just stop at the measurement stage. It should do two things: the first is to make a hard copy record so that the manufacturer has proof of quality, and the second is to use the measurement as a part of a closed loop system to correct the machine making the part. All this can be done without a human operator knowing, until perhaps later, what was done and that a correction was made before the part drifted out of the tolerance band. If a defective part is made, then the CAQA system should reject it and take it out of the manufacturing stream. The CAQA equipment can also monitor all the relevant functions on the metalworking equipment such as temperatures, pressures, and electrical requirements - all the time looking for departures from normal operation. A comparison between CAQA and more normal QA is shown in Figure 4-9. It is clear that the CAQA will emphasise "control of quality" as the part is produced rather than to "assure" quality after the fact.[162]

A prime object for the successful development of an IMS and its CAQA system must be that an overall view is maintained of the subsystems and their linkages so that adequate co-ordination of interactions and controls are established both with the system and in relation to its environment. Consequently, the introduction of such a system requires careful thought and planning, but many companies (both large and small), mainly in highly industrialized countries, recognize the rewards of increased productivity and efficiency, improved QC, lower labour and energy costs and are already committed to the implementation of integral systems. For instance, it has been predicted that by 1990 automation of QC by in-process inspection devices connected on line with a process-computer forming part of a larger manufacturing system will be a reality; also adaptive control of metal removal rate, finish and accuracy in grinding will be installed on 20% of all grinders. And later in 1995, in-process feedback control of the accuracy of the cutting process will be in use on more than 50% of all manufacturing operations.[163]

For this reason, in Chapter 6 of this thesis we will look in detail at the "criteria of a technology's appropriateness" for a developing country, and in particular, the problems connected with introducing high capital-intensive, complex and sophisticated technologies in their industries; and the level of appropriateness of a QC technology in accordance with the local resources and industrial programming in developing countries.

4.5. Concluding Remarks

The emphasis on a quality product is becoming more paramount throughout industry. Actually a high quality product, economically produced, is the goal of all manufacturing. In order to achieve this goal, adequate quality controls are needed during all phases of manufacturing.

Generally speaking, it is often stated that quality must be created, "designed into" and "built into" the product in every phase of the life cycle, from analysis of users' needs and product development, until the finished product is in use and subjected to service. Quality activities comprise appropriate patterns of actions which have to take place in nearly every department of the firm. Obtaining the right quality for the product - i.e. neither too high nor too low a quality - in the most appropriate way, therefore it is a question of interdepartmental co-operation. In small firms with the right personal potential, this active co-operation between departments on quality activities has a good possibility of functioning in daily practice - not only in theory.

A production system has been defined as 'an efficient integration of resources', and an efficient production system will allocate scarce resources more wisely, create less pollution, promote economic growth and help whip inflation.[164]

From the quality viewpoint, in every firm, one has to try to analyse and determine the correct - the 'optimal' - allocation of resources to quality activities in the various functions and departments and to determine the 'optimal' method of performing the activities. A firm should not use more resources on quality activities than is profitable for it, bearing in mind the following reasons, e.g: (a) reducing (quality) costs; (b) reducing the number of changes in product design, production methods and tools because of quality problems; (c) reducing the risk of product liability; (d) improve market share/improve income/less complaints; (e) creating better understanding and motivation among the employees in the firm; (f) observing possible quality system requirements from the buyer in contractual situations.[165]

The next chapter contains the results of the experimental part of the research programme undertaken by the author. There are two case studies on implementing QC programmes based on the socio-technical approach to quality improvement. It provides the best way to enable employees and technology to produce the best results, and to ensure a competetive position for the company at both national and international markets. Well designed quality systems have been proved to make substantial improvements to product quality and to provide a contribution to profitability.

It can be concluded from the aforementioned comments that to achieve high, consistent quality in any product, it is necessary to have a good understanding of human motivation and the ability to use the increasing power of advancing technology in the most intelligent way.

CHAPTER 5

CASE STUDIES IN QUALITY CONTROL

5.1. Introduction

Quality is gaining more and more consideration in company strategy. Price is no longer the only factor in competition: price is argued to be topped by the quality aspect which includes reliability and durability of the products as well as environment and economy of resources.[166]

Achievement and maintenance of product quality at favourable competitive levels is generally fully recognised by management as being critical to the profitability of the business. Rapidly exploding technologies, continually changing marking strategies, increased competition - these and other conditions require that management periodically, if not almost continuously, assess the capability, effectiveness and efficiency of their Quality Control (QC) system relative to present and future needs of the business.[167]

The chief purpose of this chapter is to gain an insight into practical, everyday problems confronting Venezuelan metalworking industries with regard to the design, development and introduction of effective QC systems. Here are actual cases of quality improvement in practice today in two medium-sized metalworking industries. They are based on an extensive period of study, by the author, of QC policies and practices in the companies concerned. The objective of writing the case studies has been to offer some factual data on which to base an improvement assessment of the effectiveness of QC methods as employed in the Venezuelan metalworking industry at this particular point in time.

5.2. Background Considerations

A literature survey undertaken during the early period of the research project indicated that relatively few major industrial investigations had been made in the field of QC in Venezuelan industry. Evidence shows that there is an urgent need to improve the present status of QC methods in the "smaller" metalworking industries (see Chapter 4).

It was with the foregoing in mind that a study of existing QC methods was conducted involving two medium-sized metalworking industries. These companies were chosen by the author during a survey in 1978 of QC practices in this industrial sector. An in-plant experimental work was then carried out in these industries during the autumn of 1979. The aim of the research was to make a study and appraisal of existing QC methods with the object of improving them and applying them to the industries selected.

It must be pointed out that during the course of the research (1978-81) contact with these industries was closely and constantly maintained in order to keep up-to-date the information and data obtained in previous visits, and to follow up the results of the recommendations given after an evaluation of the effectiveness of their QC systems.

In this chapter an attempt is made to present the results and conclusions of the field research work performed in these industries - the names of which have been omitted for obvious reasons. Each case study begins with an outline of the company (including its QC system) and the circumstances leading to the need to develop new quality strategies and concludes with a summary of the results so far obtained. The methodology used for data collection and analysis is explained in the next section.

Before discussing the findings of the case studies it may be useful to define just <u>what a small and/or medium-sized industry is</u>.

In Venezuela, as in many other countries, there is no single, generally accepted definition of small and medium-sized companies. According to the Corporation of Development for Small and Medium Industry (CORPOINDUSTRIA), from the economic viewpoint, small and medium-scale enterprises are defined as those whose capital employed varies from Bs 500,000 to Bs 8 million (say £1=Bs10).[168] On the other hand, the most widely used statistical definition of smaller firms in Venezuela is that used by the Central Office of Co-ordination and Direction (CORDIPLAN) and the General Direction of Statistics. They have defined a small-scale factory as an industrial undertaking having less than 5 or 20 employees, and a medium-scale factory is one employing 21-100 workers.[92]

Because some important factors such as: number of machines, level of automation, volume of sales, etc., are not taken into consideration in the above-mentioned definitions, they are by no means accepted nationwide. However, for the purpose of this study, the latter definition - which is based on the number of people employed - is used as a means to classify the company chosen. A detailed information of these companies is given in Appendices 4 and 5. After reviewing this data and by using the definitions chosen, it is clear that both companies can be categorized as medium-sized industries.

Small and medium-sized companies have the following general characteristics:

(a) Staff of 100 or less and limited financial and production resources;

(b) One manager who controls technical, administrative and commercial aspects of production (usually an expert in only one function, to which he devotes most of his time, thereby neglecting the others);

(c) A stimulating environment, which encourages the personnel to develop their own ideas and initiative.

In principle, there is not necessarily a connection between small companies and low profitability, but there is always an optimum size, which depends mainly on the manufacturing programme, the geographical location and the level of development of the country.[105] The contribution of smaller firms to the Venezuelan economy has been outlined in Chapter 1 (pp 19-20).

5.3. Methodology Used for Data Collection and Analysis

Quality Control is, amongst other things, a powerful management tool for assisting all concerned in the improvement of productivity and efficiency in the factory. It shows where inefficiencies lie and improvements are possible; it measures the effects of change.

Quality Assurance (QA) is not the same thing as QC - it is the work done to make sure that QC is being carried out effectively. It can be done by a manufacturer in his own QC organization, by a customer to satisfy himself that his supplier has an adequate QC organization, or by some independent third party. The technique can be followed through to various degrees of detail. It may be confined to the approval of a company's quality organization and procedures, with a regular audit to ensure that the procedures are being followed. It may extend to sample inspection of products, or even to continuous inspection of, say, an engine during manufacture.[169]

It is well known that the soundest way to obtain QA is to audit, or verify the effectiveness of the producer's own QC measures. This is sometimes known as quality surveillance. It is probably achieved most effectively by keeping the following criteria under continuous and critical review:[170]

(a) The effectiveness of the organization and the attitude of the people in it.

(b) Systematic, comprehensive and integrated planning, and control to plan.

(c) Process suitability and the effectiveness of process control.

(d) The development of proper QC techniques and their disciplined implementation and documentation.

(e) Effective communication down to all levels and laterally, particularly across departmental boundaries.

(f) The extent of study in value engineering and the control of cost effectiveness.

The basic philosophy of the methodology used to undertake the field research study has been described in Chapter 1 (see also Figure 1-2: the systems approach). It is not intended that a detailed account of methodology of quality data collection in the case studies is given here, but a brief outline is required as a basis to analyse the results.

Generally speaking, the basic steps of the "scientific approach" was followed during this investigation, i.e. to start by identifying the problem, then investigate the cause and propose solutions.

The <u>first step</u> was to gain the support of the company's management and supervision. It was necessary in order to outline the overall strategy and aims of the research programme, as well as to secure total involvement and co-operation of management, supervision and workforce.

The <u>next step</u> was to analyse and define significant quality problems. To this end, a Diagnostic Study Group was set comprising: QC personnel, the Production Manager and the researcher. The main task of this Group was to conduct an exploratory Quality Audit to identify areas for special studies in depth.

The <u>Quality Audit</u> was carried out in accordance with the criteria mentioned above. The evaluation of QC activities for the purpose of identifying the weak and strong points with respect to QC plans and procedures as well as adherence to them, was made by using the Venezuelan Standard COVENIN 1000-76. This Standard covers 9 major elements which collectively determine the company's quality system rating. They are: (1) QC-Organization (Organización de la Calidad); (2) Control of Incoming Materials (Control de Recepción); (3) Control of In-Process and Final Products (Control en Proceso y Producto Final); (4) Control of Non-Conforming Materials, Parts, Components and Assemblies (Disposición de Materiales y Productos Defectuosos); (5) Control of Inspection, Measuring and Test Equipment (Laboratorio de Materiales y Proceso); (6) Metrology Laboratory (Laboratorio de Metrología); (7) Manufacturing Control (Fabricación); (8) QC-Personnel (Personal); (9) Handling, storage and delivery (Almacenes).

The conception of this Quality Systems Evaluation

Procedure is based on the Spanish method "demerits". In-depth interviews are held with people at all levels of the organization. Familiarization with products, operations, and practices is gained through onsite observation. Once the quantitative evaluation of the company's QC systems is completed, then a 'quality profile' is drawn to indicate graphically the areas of the QC systems that required more more attention.

In addition, the Audit comprises a check list for company standardization, which has been used extensively in the Japanese industry for the purpose of facilitating self-examination with regard to internal standardization in an enterprise.[171]

The results of the Quality Audit are shown in Appendices 4 and 5. Based on these results, the strategic process (strategy formulation, implementation, evaluation) identifying the specific areas was drawn up and in-depth studies were launched.

The next section contains a summary of the main findings and recommendations, as well as the results so far obtained.

5.4. Case Study: Company X

5.4.1. The Company, The Products and The Problem

Company X is a medium-sized enterprise which manufactures screws, bolts, studs and nuts for the automotive industry, as well as other screw-thread components for standard and special applications. The Company was established in January 1976. Its capital employed was increased from Bs 500,000 in 1975 up to Bs 15 million at the end of 1980. Due to the increase in the demand for such products in the domestic market during the last few years, the Company has been considering the recommendations given in an economic study (which was carried out by an external consultant in July 1979) in order to assess the feasibility of any expansion plans in the near future.

In actual fact, at national level, the Company is ranked in second place amongst the Venezuelan metalworking industries which manufacture screws and nuts. In reality this Company is able to supply 20% of the internal market. The 1980 turnover was Bs 55 million. The Company is located near Valencia city (see Map A2-4, Appendix 2). It currently employs around 100 personnel (2 shifts), with expansion plans of up to 212 by the 1980's.

Throughout their first three years of manufacture there was a considerable difference between the plant capacity and the manufacturing capacity. For example, in 1978 only 35% of the plant capacity was used. The reason for this low value in the utilization of the capacity installed, was the acquisition of new manufacturing facilities in 1978. However, it is important to point out that prior to this date the Company was employing about 97% of its capacity. By considering one working shift of 8 hours/day, 22 days/month, i.e. 264 days/year, the actual plant capacity (1979) and the proposed plant capacity (with expansion plans) are as follows:

CAPACITY	INSTALLED kgs/year	USED
Actual (1979)	6,620,928	3,972,564
Increase	556,176	333,696
Proposed	7,177,104	4,306,260

From the foregoing figures it is clear that the monthly average of the total capacity employed is 358,855 kgs. The difference between the theorical (installed) capacity and the effective (used) capacity, which is about 40% is due to the following factors: (1) Changes in dies used in the machine tools for the manufacturing of a great variety of products; (2) Lack of planned maintenance; and (3) Low productivity of personnel.

Over the next few years it is hoped to obtain some improvements in the level of utilization of the plant capacity: 50.34% (1979); 60.38% (1980); 78.50% (1981); 100% (1982).

The Company's 9,100m^2 site includes seven main bays with specialist fabrication areas and the heat treating area. These are equipped with comprehensive cranage and facilities for screw slotters and threading, rolling, twin nut tappers, trimming, cold headers, punching, etc. There are test facilities for microstructural analysis, hardness testing, screw thread gauges and calipers, metallurgical microscope and optical projector. A large stock-yard contains an extensive range of steel wire rods and round bars. These raw materials are provided by three Japanese steel-making industries. There is indoor and outdoor storage available for finished products. Non-destructive testing and surface-coating are carried out by specialist sub-contractors off the premises.

Part A4.1 (Appendix 4) contains an outline of the Company with special reference to the features of its QC system, which is basically an inspection-orientated QC system (inspection records). In spite of the quality problems existing in the Company (e.g., lack of quality consciousness;

lack of technical knowledge in statistics tools to control the quality of incoming materials, in-process and final products; the top management is reluctant to accept new concepts or to adopt modern QC techniques, etc.), there is a QC manual in which most of the inspection procedures and responsibilities of the QC personnel are recorded.

In the next sections, the results of an in-plant survey performed by a Diagnostic Study Group (including the Chief Inspector, the Manufacturing Manager and the Researcher) are discussed. Also, a summary of the findings and recommendations is given. These sections have been organised in the following order:

Firstly, the results of the Company Standardization Survey are discussed. Secondly, the profile of the Company's QC system is outlined and also compared with the results of the first quality audit conducted by the Company itself in 1976. Thirdly, a summary of the recommendations given by the author is presented. Finally, a review is made of the results so far obtained.

5.4.2. Standardization at the Company Level

The company standardization (internal standardization) is to have the top policy known thoroughly to the last man of the employees; to define the responsibility and competency of each department and position in organisation; to set the best way of doing work and to establish a basis for QC, process control, cost control and safety control. It is an indispensable requirement for the promotion of rationalization of work in an enterprise.

The evaluation of the standards programme of Company X was carried out by using the Check List shown in Part A4.2 of Appendix 4. The audit system uses a method of weighting non-conformancies since it is not of equal importance in relation to the total programme. By using that weighting system, the problems revealed during an audit evaluation of a standards programme should be discriminated from each other on the following basis.

A: The company conforms perfectly to what is written in the check item.

B: The company is partly or imperfectly in conformity with the check item.

C: The company is totally below the standard of the check item.

Once the checks by the auditor are finished, the total marks are obtained in the following way.

The number of Os in the A column x 2 =	_____	Marks
The number of Os in the B column x 1 =	_____	Marks
The number of Os in the C column x 0 =	0	Marks
Total	_____	Marks

The following values are then used for comment:

Not lower than 71 marks:	Very good. Keep up the present conditions.
70 - 46 marks:	Pretty good. Make further effort to correct defects.
45 - 36 marks:	Passable, but more efforts are desirable in general.
Not higher than 35 marks:	Bad. It is necessary to thoroughly reconsider the system and make a new start.

For Company X, the following results were obtained:

16 (A) x 2	=	32 marks
10 (B) x 1	=	10 marks
15 (c) x 0	=	0 marks
		42 marks

By comparing these results with the reference values given above, Company X which is between 45-36 marks, can be ranked as 'Passable'. Consequently, it is recommended that further efforts are desirable in general to correct what is defective.

One of the main factors militating against the development and implementation of an effective internal standards programme in the Company, is the fact that the executive has not given definite policy instructions regarding standardization. Consequently the Company's proper techniques are not fully incorporated in the Company standards. However, it was found that company standardization has been regularly adjusted according to the development of new products, and also there is a close co-operation amongst all those in charge of promoting standardization from staff members to shop workers.

Regarding Technical Standards, they are established in systematic entirety, revised as required and always used effectively. In fact, the Company has a Manual which contains all the standards for manufacturing. Nevertheless, there is a need to simplify and rationalise them, mainly those standards related to products, parts and raw materials. For instance, in the case of Technical Standards for manufacturing, the following are currently in use: ASA, IFI, SAE, ANSI, DIN, etc. On the other hand, standards concerning manufacturing are well utilised by all the staff concerned and the manufacturing process is stable. Even though most of the standards for manufacturing are expressed by numerical values, diagrams, tables, limit samples or the like, these standards do not always contain requirements for QC, process control, cost control and safety control in a totalised and harmonious form. Thus, there is a need to employ scientific methods, including QC, which will be able to improve the standardization of the manufacturing processes used in the Company, as well as to standardize the preventive maintenance system for production equipment and to establish a preventive maintenance programme to control the accuracy of measuring facilities.

In the Sales Department, positive efforts are exerted for marketing standardized products, which are made at a lower price than specially ordered products. The area which requires more attention is the procedure of handling customer's complaints, which has to be standardized.

The Purchasing routines are standardized, and simplification and value analysis are introduced in the standardization of materials to be purchased. However, the way of appraising subcontract factories (e.g. coating of screws and nuts) and their guidance is not standardized. For that reason, it has been recommended that the COVENIN Standard 1000-76 be employed to assess the effectiveness of the QC procedures used in these factories.

In the case of the Warehouse and Packing Department, it has been found that routines of warehousing and delivery are standardized, as well as the way of packing. There have been some problems with the classification of the materials in stock, and the amount of stock of usual materials is not standardized.

Inspection procedures are standardized and well explained in the company's QC Manual. However, inspection is not always carried out in accordance with standards procedures and the inspection data does not provide the information required for standards revision in manufacturing, technical, purchasing and other related departments. One of the worst problems is the fact that standards for inspection are not examined from the economical viewpoint and improved. Hence, the development and implementation of a Standard Cost Calculation System and its related Control System are urgently required in order to make use of the economical benefits of standardization (more economical production, easy interchangeability of parts and components, etc.). The economical effects of standardization must be systematically appraised and the results must be used for promoting standardization in the future.

Education and training in standardization for each rank and each vocation are needed. Also, it is necessary to incorporate all those items related to safety control into standards.

On the other hand, it might be mentioned that the Company had developed its own system to identify its products, so that it is always possible to know the specifications (diameter, mechanical properties, hardness, material, heat treatment) of any product just by comparing its mark with those contained in the coding system.

5.4.3. In-Plant Quality Audit

Part A4.3 of Appendix 4 contains the results of the assessment of the effectiveness of the QC system used in Company X. The evaluation was provided by using the COVENIN Standard 1000-76. The following values are used for comments:

70 - 100 marks:	Acceptable
50 - 70 marks:	Passable
0 - 50 marks:	Defective

According to the researcher's evaluation, the Company has got 54.1 marks. Thus, the Company's QC system can be commented on with 'Passable'. On the other hand, the Company conducted an audit in 1976 to assess the effectiveness of its QC system, the score of which was 97 marks.

In spite of the discrepancy between the total marks of these quality audits, the quality profiles have shown that 'Education and Training in Quality Technology' is one of the areas which requires more attention. By reviewing the 'Demerits' corresponding to Section VIII (Personnel) of the COVENIN Standard 1000-76 and the results of the evaluation conducted by the author, it is clear that there is a lack of an effective method to select quality personnel, as well as the need for the implementation of an educational programme in the field of QC. Although the Company has shown interest in being a quality-orientated firm from its beginning, the personnel has not yet paid sufficient attention to the problems of quality. In other words, there is a lack of 'Quality Consciousness' in the Company. For that reason, it has been recommended to implement a company-wide motivational campaign in order to create the appropriate quality climate, and to establish a company participation programme to reduce defects. All this, of course, requires the implementation of a quality bonus scheme aimed at increasing workforce participation and responsibility in all those activities concerned with the attainment and maintenance of quality standards. The author strongly believes that these strategies will contribute to reduce the high level of personnel rotation and absenteeism of the labour force of the Company.

It is well known that the evaluation of a company's QC system would normally consist of an analysis of the following:

1. Is the facility producing an acceptable product?
2. Does the facility have the objective evidence to

support decisions regarding product acceptability?

3. Are written instructions available covering QC procedures, instructions or techniques?

Written procedures are necessary to assure uniformity of understanding. The formation of these procedures is the basis of the facilities QC Manual. Full details of the quality management system, organization and procedures should be recorded in a document such as the Quality Manual, which should be so designed and edited that the contents are reviewed and amended as contents:

The Quality Manual should include the following contents: [172]

1. A section describing the administration of the management functions, giving an organizational chart showing the Quality Manager and the head of the inspection department, and their relationship with the Board of Directors, other managers and heads of departments. The section should state in general terms quality control and assurance functions and other relevant responsibilities allocated to the various managers and departmental heads.
2. A section describing in detail the Quality Management functions during design and development, and stating the group of person(s) responsible for each.
3. A section describing in detail the QC methods and procedures, both before and during manufacture, and stating the group or person(s) responsible for each.
4. A section describing in detail the organisation, staffing, methods and procedures for quality assurance.

During this investigation it was found that the Company had not got an organisational chart showing the position of the QC Department in relation to the Board of Directors. Due to the fact that the Inspection Division used to report to the Technical Director, it was proposed to create a 'QC Department' which would report directly to the General Manager. Moreover, it is important to define the responsibilities of every one of the persons in charge of the Company's quality function.

Even though the QC programme of the Company is described in its QC Manual, there is a need to describe in more detail the QC methods and procedures, as well as the quality management functions, mainly during design and development. Also, it is required to up-date the plan of manufacturing facilities indicating the inspection stations.

The aspects of QC related to health and safety on the shop floor are very poor, also the plant is not clean enough. Generally speaking, the shop floor area is tidy, but working conditions must be improved (e.g. lighting, noise level, smoke reduction in the area of heat treatment, etc.).

In relation to the Acceptance Sampling Procedures, these are well defined in the QC Manual. However, it was found that in practice these procedures were not followed, mainly because of the shortage of quality personnel (only one inspector controls the whole production), and also because of the lack of quality consciousness in the Company. As a result, the quality level fluctuates and there are frequently bad batches. One of the most critical aspects of the Acceptance Sampling Procedures is the way of choosing the sampling plan. As indicated in the Company's QC Programme, the acceptance sampling schemes are based on the Acceptable Quality Level (AQL) concept, and $\overline{X}$ and R charts are plotted when acceptance sampling by variables is performed. Broadly speaking, an AQL of 2.5% (Level A) is used in most of the sampling plans, but it varies from the incoming material to the finished product. As stated in the Company's QC Manual, an AQL of 4% is used in the areas of Packing and Despatch. In other words, the producer's risk is too high. The frequency and sample size, and the criteria to accept or reject a lot are described in the QC programme. By reviewing these procedures, it was found that there had been an attempt to introduce a Double Sampling Plan. Nevertheless, the 're-sampling technique', which is currently exercised when the first sample is rejected, is rather empirical, i.e. the sample size is taken as twice the initial sample size, but the criteria for acceptance is kept the same. Thus, it has been recommended to implement and introduce Double Sampling schemes in accordance with the ABC Standards (MIL-STD-105D). It is also required to keep the records of the sampling inspection by variables and by attributes, as well as to use these records to make decisions and implement corrective actions aimed at reducing the defective lots, to maintain the quality standards and to obtain economic benefits from the inspection activities.

In the Company there is a shortage of precision measuring equipment, mainly gauges and NDT equipment. By analysing the quality profile of the Company, it can be seen that the lowest score (27.3%) was obtained in the assessment of the facilities of the Metrology Laboratory. An effective system of ensuring that all gauges, instruments and testing equipment are subject to standardized calibration schedules urgently needs to be implemented. Records of these calibration activities must be kept, as well as the laboratory temperature and humidity.

Product identification and handling are acceptable. The area of receiving inspection is tidy. However, one of the main pitfalls of the QC system is the fact that the raw material is not inspected to check the characteristics of the raw materials imported from Japan, i.e. there is not a

Supplier QA programme. On the other hand, the author has recently been informed that the area of Packing and Dispatch will be moved to another shop, so it is hoped that the packing environment and the storage of the packing material will be improved in the near future.

5.4.4. General Recommendations

In the previous sections some recommendations regarding the Company's standards and QC programmes have been given.

During the course of the in-plant quality study the researcher provided technical assessorship in preparing the Company for a Quality Audit carried out by the international companies Exxon and Fluor Caribbean Inspection. The purpose of the Plant Survey was to assess the possibility of considering Company X as an acceptable source of supply for bolting and nuts to these companies. This section is thus devoted to commenting on the main recommendations given to the Company after observations of work in progress and an evaluation of vendor's capabilities at the time of the survey.

Within the recommendations, special emphasis was given to the improvement of testing facilities and procedures (e.g. Proof Load Test, Tensile Test, etc.). It was also required to maintain records of all calibrations performed in measuring and control equipment. Of particular interest was the fact that the records of the ovens used in the heat treating operations are required, and copies of the results (control graphs) have to be periodically sent to these companies.

With regard to the aspects of quality organisation, it has been recommended to employ another Inspector and a Quality Engineer, who will be in charge of all the Quality Management functions.

An analysis of the Certificates of Quality of Raw Materials showed that the suppliers do not always specify the metallurgical and mechanical properties of their products. So it was recommended that the Company must ask these suppliers to give all the results of the inspection carried out in Japan. Also, it was recommended that the Company improve all the testing facilities, and buy a tensile testing machine to perform these tests in-plant. Finally, the auditors required a copy of the Company's QC Manual for approval.

Summarising, there is a need to "sell" quality control to the Company Management. And, to create a much better climate for quality at all the levels of the Company personnel.

5.4.5. Results So Far Obtained

The results of this study pointed out that there was an urgent need to reorganise Inspection as a QC Department with redefined functions and appropriate structure to step up its effectiveness.

The Company Management accepted the recommendations, and since June 1980, a Quality Engineer has been working in setting up a new Quality Policy and QC Organisation. A defects prevention programme is being implemented in order to foster the proper attitude with regard to the QC system at all levels of management and production. The QC Manager now reports to the General Manager, and the former Chief Inspector is only responsible for auditing the quality function. Because of the acquisition of new measuring and testing facilities, it was decided to employ a new Quality Technician, who is in charge of all inspection and testing activities.

Moreover, a 'Quality Improvement Team' has been formed that includes one key member from each department, i.e. the QC function has been decentralised. The Company's QC Manual is being re-written, and the design of sampling plans is based on considerations of losses and costs. Also, capabilities studies have been introduced on the shop floor.

Owing to the repetitive nature of the manufacturing operations and the variability in the mean values, the use of the CuSum chart as a 'Management Diagnostic Tool', and later as a basis to implement the Supplier QA Programme (purchased parts and raw materials) is being considered.

All these quality efforts have started to pay-off, by increasing the Company sales, reducing manufacturing and inspection costs, and even more important by improving job motivation at all levels of the Company. Recently, the QC system of the Company was evaluated for approval by a large automotive industry. The results of the assessment of the effectiveness of the Company's QC system yielded a very positive result, i.e. the overall score by using the COVENIN Standard 1000-76 was 77.57%, that ranked the Company's QC system as "Acceptable".

5.5. Case Study: Company Y

5.5.1. The Company, The Products and The Problem

Company Y is a medium industry in the gear manufacturing business, located in Barquisimeto city (see Map A2-3, Appendix 2). It is a Venezuelan-American enterprise, in which the Venezuelan group holds 51 per cent of the issued employed capital (Bs30 million). On the other hand, the parent company provides technical, quality and process information and assistance. In fact, there are two agreements between the American firm and its Associate in Venezuela, one agreement for Technical Assistance and one related to the US Patent and Trademark Licence. As a part of these agreements, the QC and Reliability Department of the parent company conducts periodic quality audits of the manufacturing facilities of the Venezuelan subsidiary.

The purpose of the audit is to provide a continual check and evaluation of the QC function and provide technical assistance where desired. It will also make recommendations and request managerial commitments where the needs are indicated. In that sense, the QA Audit should be considered a support function rather than a disciplinary force.

Company Y started production of gears in December 1977 and since then has developed into one of Venezuela's leading producers of gears to the automotive industry. The number of gears produced each year include: crown and pinion sets (102,000), planetary gears (240,000), shaft-differential (240,000), and crossheads (156,000). The Company's major customer is a sister company, which is engaged in the manufacturing and assemblies of automotive rear axle drives and gearboxes. Another sister company supplies 70% of raw materials (forged components), whereas the other 30% is imported from the USA.

So far one of the greatest problems facing the Company today, is the low level of quality of the forged components supplied by its sister company. This situation has arisen the need for the implementation of a QA supplier programme in the Company.

The machine shop is the focal point of the activity of the Company. A modern purpose-built premises covering

$9{,}600m^2$ includes gear manufacturing, finishing, generating and testing areas and the heat treating area. Manufacturing facilities are ranked from manual to numerically controlled (NC) machine tools. Analytical (shapes, sizes and finishes) and functional gear testing are performed both on the shop floor and under laboratory conditions. There are test facilities for metallurgical and non-destructive testing and a well equipped metrology laboratory. However, there is not a test vehicle to test and develop gear sets. These functional tests are only performed in a sister company, which is located 200 kilometres away.

Basically, the shop floor has been arranged on a functional layout by skill types. Each group of machines (turning, milling, hobbing, shaping, shaving, burnishing, grinding, etc.) occupies a bay in the shop with a foreman and a group of operators running the bay. Work on jobs would progress from bay to bay and generally there would be a pile of work-in-progress within each bay. Also at the end of each bay there is an inspection station (7 in total), and a final inspection station in the packaging area. There is indoor storage available for incoming materials, in-process and finished products.

Part A5.1 (Appendix 5) contains an outline of the Company and its QC system. However, there have recently been some changes in the Company, mainly due to the fact that it is a relatively new industry, and consequently it is expected that some adjustments are being done in order to make some corrective actions to improve the productivity and quality of the products. For instance, since January 1980 only one shift (working time) has been operating in the Company. It is important to mention here that this decision was taken due to the establishment of the new Venezuelan law of wages and salaries, and the many problems confronting the automotive sector today as a result of some economic measures of the present Government which have been orientated to cool down the national economy (see pp 37-38).

The organisation structure is flat: all the major functional managers report to the General Manager. These include Plant Engineering, Personnel, Accounts, and Quality Control. Of the total of 58 staff (direct labour force) employed in the Company, about 30 per cent are direct QC staff reporting through foremen to the QC Manager. There is a very close liaison between the Production and QC Departments. It is the concern of all if anything goes wrong - from the operator to the General Manager. There is mutual consultation particularly in the working arrangements and layout, as well as inspection and QC procedures.

The next sections report on the main findings and recommendations given to the Company after an in-plant survey was carried out by a Diagnostic Study Group - including QC staff, Plant Manager and the Researcher. Finally, a review was made on the results so far obtained regarding the introduction of a QC system based on the well-known concept of "Operator Control".

5.5.2. Standardization at the Company Level

Part A5.2 of Appendix 5 contains the results of the reassessment of the Company standardization (the reader is referred to Section 5.4.2. for a description of the rating system). The total marks are obtained in the following way:

32 (A) x 2	=	64	marks
3 (B) x 1	=	3	marks
6 (c) x 0	=	0	marks
		67	marks

By comparing this result with the standard values for comment, Company Y which is between 70 and 46 marks, corresponds to the review "Pretty good. Make further effort to correct defects". Without doubt the economical aspects of Standardization are those which require more attention in the future. In effect, there is a need to establish a standard cost calculation system and a related control system.

Moreover, safety control has to be incorporated into standards. An effective feedback system to obtain and analyse complaints is also required. The researcher found that some drawings were dimensioned in the Imperial System and the inspection and control instructions were sometimes given in English. So all these technical documents urgently need to be translated into Spanish and the use of Imperial Units avoided, i.e. there is a need for "Metrication" throughout the Company (in Venezuela a new law of metrology is being approved which states that all the machinery and equipment to be imported into the country must be manufactured in accordance with the International System, which makes use of metric units).

5.5.3. Adequacy of Existing QC Methods

In Part A5.3 (Appendix 5), the results obtained of the assessment of the effectiveness of the QC system used in Company Y are presented. The 'quality profile' of the Company was obtained by using the COVENIN Standard 1000-76 (see Section 5.3). The following values may be used for comment.

70 - 100 marks:	Acceptable
50 - 70 marks:	Passable
0 - 50 marks:	Defective

As Company Y has 96 marks, it is worthy to be praised with the word "Acceptable". This is an excellent score for a Venezuelan metalworking industry, particularly if we consider the fact that in 1975, 85 per cent of the QC systems evaluated in this industrial sector were found 'Defective', 15 per cent 'Passable', and none of the 20 industries evaluated by the COVENIN, was found 'Acceptable'. Indeed, one of the main reasons for the achievements of the Company in less than four years of operation, is the efficient technical assistance given by the parent company.

After a recent quality audit conducted by the QA Manager of the parent company, he concluded that "overall, Company Y is a very clean, quality orientated firm, and from all indications produces very acceptable products".

5.5.4. General Recommendations

Before discussing the feasibility of introducing the operator control/self-control approach to the quality work-force participation in the Company, it would be useful to describe briefly the main features of the QC methods used in the Company at the time of this investigation.

Company Y has been established for more than three years. During most of that time, in respect of the quality of its products, the traditional approach of ensuring maximum customer satisfaction entailed the employment of a very substantial inspection labour force. 100% checks for various dimensional and other characteristics were not only commonplace but were duplicated and in some cases, triplicated. The inspection labour force existing in 1978 was approximately equivalent to the production labour force. In fact, in some cases, such as in the inspection of master gears, there were considerably more inspection and viewing personnel than there were production operators. Throughout the Organization, the idea persisted that for a given Production Staffing, there needed to be a proportional number of Inspectors and Viewers. It was genuinely believed that a thorough check of components after each operation and during the following assembly, was the only really satisfactory approach to meet the needs of such important products as that of gears for the automotive industry. Even today, when only one shift is operating, the inspection and viewing staff account for about two thirds of the total workforce.

Regarding the inspection procedures, they include: first-off inspection, operator control, patrol inspection and final inspection. Control charts are only plotted by the patrol inspection. Acceptance criteria and acceptance sampling are well defined and based on the AQL concept. The ABC Military Standards are used to determine the required sample size and the acceptance/rejection criteria for both single and multiple sampling plans once the lot size, the tightness of the inspection level and the tolerable fraction of defectives have been specified. In the course of this investigation some suggestions for improving the statistical QC techniques applied to control the quality of incoming material, in-process material and finished products, were given. In particular, recommendation was made to introduce a new multiple sampling plan to control the quality of incoming material. It was needed mainly because the incoming quality was very variable, and also because 70% of the raw materials and incoming parts are for provided by a sister company, which also operated in Venezuela. It was based on the AQL concept and the Master Tables for Normal, Reduced and Tightened Inspection (Multiple Sampling) as indicated in the MIL-STD-105D (ABC Standard) are in use today.

In November 1979 Machine Capability Studies were introduced into the factory. Initially, they were carried out on a NC lathe in order to assess the possibility of substituting a broaching machine in an internal broaching operation. It has been recognised that this concept is fully applicable to machining and assembly operations. Thus it has been suggested that in order to achieve maximum benefits from this QC programme, it should be applied to new machines in the 'as purchased' state as well as existing equipment now in operation. Correctly applied, this procedure will aid in determining the reason for variance in a process as well as a control technique for maintaining a process 'in control'. It can also be used as a factual basis for determining the amount and type of inspection necessary after the part is completed. If the machine capability is in the order of ⅔ or ¾ of the tolerance on the part, it is an acceptable condition and a sampling or control chart technique should be considered to control the operation.

As mentioned earlier, the Company sells mainly direct to a sister company and also the major supplier of raw materials is another sister company, both operating in Venezuela. As a result of this situation, the information and communication system is very efficient at both company and inter-company levels. However, this information is not used to make corrective actions. Furthermore there is no efficient system for cost registration and reporting. In this respect, the researcher provided technical assistance in the design of a scrap cost programme as well as some guidelines on the gathering and implementation of quality costs.

Recently, the Scalon Plan (an American forerunner of the quality circle) was introduced into the Company. As it is known, this is a method of motivating production workers based on the practice of participative management plus a company-wide incentive payment. The incentive payment system works as follows: a major proportion (50-100%) of any improvement in the value of work done by a production unit is paid to the workers in that unit. Improvement in the value of work may be measured in any appropriate or feasible way: one method is to establish a standard ratio of labour cost to the value of production; each month the actual ratio is calculated and if it is less than the standard then the saving is paid to the workers. The other important feature of the plan is a system of joint employer-employee committees to examine and evaluate suggestions for cost saving.[173]

From the foregoing it is evident that Company Y had realised the fact that an efficient, practical and economical QC Programme must basically be a Cost Reduction Programme. It was also found that most of the quality problems are still in the "operator controllable" category and not "Management controllable". Therefore, some consideration was given to the most suitable methods by which this Company could involve its workers in taking a pride in the quality of their work. Following this discussion, the Diagnostic Study Team decided to work out the possibility of introducing self-control/operator control.

The term self-control must be seen in the light of the ever-increasing efforts to give each individual operator a greater sense of engagement in his work, so that both the human and the product-orientated requirements are met. In other words, the purpose of establishing self-control is to increase the operator's job satisfaction through better utilization of personnel resources, to reduce inspection costs and reduce the number of defects.

This is achieved through: (1) greater quality consciousness; (2) better adapted QC activities; and (3) quicker fault-finding with subsequent quicker corrections.[174]

Self-control is an agreed inspection control system in which the operator is made responsible for ensuring that his work complies with the specification. In other words, the operator: (1) controls his own process; and (2) inspects and evaluates his own work in accordance with the instructions given.

As Figure 5-1 illustrates, every operator is entitled to: (1) a satisfactory method; (2) satisfactory tools, machines and other equipment; (3) satisfactory materials; (4) satisfactory instructions concerning: the method he is to use, and the quality standard he is required to achieve, and the inspection which will be applied to help him achieve it. The operator then does the job, and if patrol or other inspection is used, it must be impartial and to reasonable quality standards. As far as possible, such inspection should be done in full view of the operator but, if this is not practicable, then the operator must be told the results as quickly as possible afterwards. According to R.H. Caplen,[175] this will not only help the operator's interest, but it will also assist him in keeping his quality right.

In order for an operator to be able to exercise control, he must be: (1) trained in use of equipment; (2) familiar with product quality requirements; (3) in agreement with his control responsibilities; (4) instructed as to processing conditions; (5) instructed as to specific control assignment; (6) provided with a course of corrective action.[176]

Summarizing, before introducing self-control on a process which is considered suitable, the following conditions should be observed:[174]

- the responsibility must be clearly defined
- the operator must know the quality control requirements
- the operator must be able to decide whether the quality control requirements are observed
- the operator must know what action to take whenever the quality control requirements are exceeded
- the work must be arranged in such a way that the operator can take care of both the production programme and quality
- the operator is entitled to a feedback
- the operator must be given a good deal of knowledge about the product

Agreements for self-control are made by arrangement between the Production and QC Departments. The QC Department must contribute to: (1) an understanding of self-control; (2) fulfilling the conditions of the basic procedure. In addition the QC Department will audit the self-control and give advice on quality questions.

In the experimental work carried out at Company Y, all the above-mentioned instructions were followed. For a description of the methodology used for data collection and analysis, the reader is referred to Section 5.3.

Establishing an effective QC system is by no means a simple task. However, by processing in an orderly fashion, one step at a time, it would be possible to set up a successful programme. The approach that the Diagnostic Study Group used during this work involved four basic steps. Although in practice these steps overlap somewhat, the sequence is essentially as follows: (1) determine the causes of quality problems; (2) develop a programme for improvement; (3) establish controls to maintain improvements; (4) implement the programme.

5.5.5. Results So Far Obtained

The principles and techniques of self-control/operator control were firstly applied to a machining operation of the production line of pinions (finish turn head end). This particular operation was chosen after a careful evaluation of the manufacturing and inspection operations, and also by analysing the results of failures in this area, e.g. cost of non-conformance (scrap, re-work, etc.), audit reports, assembly and customer complaints.

The first question was to find out if the defects were operator-controllable. To answer this question the check list of Part A5.4 (Appendix 5) was used. This is a very important step since, before the operator can do the job properly, the following conditions must exist: (1) the production facilities must be adequate; (2) the 'producer' must want to do the job properly; and (3) the 'producer' must be given the appropriate time and facilities to check the quality of his work.[177]

The operator was then provided with suitable checking equipment and quality instructions. Visual aids were provided in order to give clear indications of the key features in the operation, i.e. those dimensions or points which are critical.

The chart also gives details of the operations, the tools and gauges to be used and the frequency of inspection.

Although the final responsibility of the correctness of parts falls on the operator, the introduction of an 'Operator Control' scheme requires some re-organization in the Company. It was made clear from the very beginning that this industrial experiment would involve re-deployment of labour force on the shop floor, so it was necessary to gain the support of the trade unions. Emphasis was given here to re-defining the functions and responsibilities of the operator-inspector team, rather than reducing the inspection force. In doing that it was found appropriate to make use of the general systems concept.

An <u>operator-inspector subsystem</u> is diagrammed in Figure 6-2. In this system, the operator has the following inputs for his subsystem: (1) the required machine setup; (2) the specifications for the output; (3) the quantity of output needed; (4) the raw materials to be processed. He sets up his machine and processes the materials. The operator's output is then given to an inspector whose inputs are: (1) the required work setup; (2) the product test specifications; (3) the quantity of output needed; (4) the output from the operator. The inspector tests the output and passes on the good products. In addition, he has the output that the operator must rework and the feedback information on the causes of rejects. This output is returned to the operator, where the rejects become material inputs and the feedback information serves as control information.[33]

On the other hand, self-control means that the operator takes over the responsibility which in reality has been his all the time but which for many years has been assumed by the inspector. In other words, the operator can, on the basis of well-defined quality specifications, control his own process independently and act according to fixed guidelines. Moreover, the system makes a greater flexibility in the work force since there is no division of the work force into two categories: operator-inspector.[174]

Getting back to Figure 5-2, it is clear that the proposed QC system lays emphasis on the fact that each operator is responsible for quality to the extent that he has an influence on it. While the operator is waiting for a sequence to be carried out, he could be checking the last part made or at least those dimensions for which gauges are available. Operation job cards could have a section for plotting a control chart. All this would not make the patrol inspector redundant, on the contrary, it would make his work more vital since no further checking of parts would be carried out. The standard of the whole batch would be based on his random checks and observations of the control charts. Thus, the proposed QC system, based on a modern conception of the craftsmanship theory, is a further aid to improve quality and productivity. It ensures a reduction in rejects, more consistent products and better workflow - results which are achieved as much through an increased awareness of quality at all levels as any other factor.

The operator-inspector subsystem shown in Figure 5-2 is a highly simplified case but quickly becomes more complex when we add such realistic details as the feedback of information on rejects from the inspector to the production foreman, to purchasing, and to engineering for product redesign. In addition, each subsystem usually yields other outputs, information that is needed by various departemnts; for example, information about work hours on the job is needed by payroll, cost estimating and the production foreman.

The operator-inspector system just described suggests the complexity of understanding any production system and why it is so difficult to discuss the entire production process. For this reason this section has been concerned only with a subsystem of the whole production system. Nevertheless, the Operator Control system can be considered to be the beginning of the 'systems approach' to QC.

According to R.K. Grunau,[176] the principles of the System of Operator Control can be applied to any industrial activity, provided that:

- A clear-cut specification is in existence which is toleranced
- The specification target is produced in a capable area (with some exceptions)
- Facilities are made available for checking the specification at the point of production
- Operators are required to check their production at a given frequency and stop to adjust the process according to instructions
- All the above facts are communicated, where possible in writing, to operators
- Adequate time is made available, and paid for, to carry out the checking operation
- An auditing function is introduced which will inform the producer and management of their performance (Performance Rating)
- A capability-testing procedure is introduced
- A training activity is introduced which will continuously aim for <u>total capability</u>

Much conscious effort over the last decade has been put into job enlargement and job rotation, and one feature of the enlargement programme is becoming very significant in the field of quality and reliability. That is, the move to make an operator responsible for his own inspection. This is a two-stage jump from the ubiquitous, autonomous patrol inspector.

The first stage would be to make the latter responsible to "production" personnel, but operator control goes one step further. It makes good motivational sense as well as economic sense in that it lines up areas of authority and responsibility. It also has the merit of taking an adult approach to the topic. Management control can be maintained by quality auditing, and the results of this must clearly be displayed.[179]

The Operator Control approach to quality improvement is directly concerned with the aptitudes, skills and motivation of the individuals who design, manufacture and inspect the product. Thus, it is evident that these goals can be accomplished through scientific personnel selection, specific on-the-job training and feedback of defect information.

Two basic approaches to improve human performance are illustrated in Figure 5-3. The first works directly to raise the quality of <u>people</u> by developing valid selection procedures, training techniques and methods of increasing employee motivation. The second is to improve the job environment through the development and evaluation of new procedures, tools and aids. While each approach deals with different aspects of the quality problem, they both have one thing in common - the need for valid, reliable measures of <u>human performance</u>. Detailed data on the type and frequency of operator error provides the information on which to base appropriate modifications of the job environment; comparable data after the change provides an index of the increase in employee effectiveness. In addition, performance measures provide criteria for validating new selection devices, objective bases for determining training needs, and tools for systematically studying employee motivation.[180]

To avoid the mistake of considering people as isolated beings, human performance should be investigated within the context of the system in which it exists. The system concept provides a basis for considering all the critical factors that may lead to improvement in the performance of people. The quality system is composed of people, equipment and information. The system performs operations directed towards the achievement of certain quality objectives for each set of quality characteristics. As shown in Figure 5-4, changes are introduced into the system as a result of human factors research and engineering activities. The changes are designed to improve human performance and thus ultimately to improve the performance of the system in attaining quality objectives. In so doing none of the elements of the system is considered to be permanently fixed.

Harry and Chaney[181] pointed out that the best solution might be the combination of a new inspection tool, a set of instructions for using it, and a brief period of on-the-job training to quickly develop skills in using the tool. This may suggest that the socio-technical approach to managing the quality function in a self-control/operator control system is the best way of obtaining improved human performance, improved quality and higher productivity.

As mentioned earlier, the Operator Control system has been introduced in a small area of the shop floor of Company Y. Although it will take time to create the adequate quality climate and the human and technical infrastructures which are required to apply operator control to other areas of the factory, there are some indications to suggest that they are moving in the right direction. For instance, there are today in operation in the Company an incentive scheme based on the Scalon plan and a system for measuring quality progress based on the quantitative assessment of scrap (Quality Index); capability studies have been applied extensively in the machine shop; a scrap cost programme is actually in operation and a QA Supplier programme is being implemented. Moreover, a Quality Manual for in-plant training has been completed and at the present time they are re-writing the Company's QC Manual, based on the principles of 'Operator Control' and the philosophy of 'Right the First Time'.

In July 1980, the effectiveness of the Company's QC system was evaluated by the COVENIN. The overall score was 89% and that ranked the QC system "Acceptable". On the whole, it can be said that the breakthrough in attitude towards QC has been achieved with great success in this Company.

5.6. Concluding Remarks

The findings from the industrial studies described in this chapter reveal that total QC of an entire process seems to be a more advanced concept than is understood and emphasized at most metalworking industries in Venezuela. Quality Control as an entire interlocking system is not understood. Instead, QC is much more apt to be seen as 'good inspection'. It may be agreed that what is needed in these industries is an 'intermediate' level of quality technology, say halfway between total QC and inspection QC. The next Chapter will deal with this matter in detail.

In conclusion, there are many applications of statistical methods and management techniques that can be applied successfully to smaller industries. In fact, the principles and techniques of industrial QC have been rather extensively developed and published - what remains is to apply what is known. In so doing it must be emphasized that each company has a different set of problems and resources, and anyone who is considering re-organization or launching a quality improvement programme should analyse his problems carefully and be prepared to tailor a system to meet his own needs.

In other words, it is of paramount importance to select for each situation the "appropriate" QC system which will be best-suited for any particular organization in accordance with its environment, its cultural patterns and its management style.

CHAPTER 6

INTERMEDIATE QUALITY CONTROL FOR DEVELOPING COUNTRIES

6.1. Preliminary Remarks

Technology available today is the consequence of the historical process in which technology evolves. The total of all techniques ever developed encompasses the whole historical process. The total may thus be viewed as consisting of a succession of techniques, developed at different times, say T1800, T1801, T..., T1980, where T represents the techniques developed in the year described by the subscripts. The characteristics of the technique depend as argued on the historical circumstances in the place where it was introduced - the techniques have to fit into the particular stage of the dynamic cycles that the economy has reached. Because most technological development, since the industrial revolution, has occurred in the developed countries, we may start by assuming that T1800...refers to techniques developed in and for the developed countries. With this assumption, world technology today depends on the techniques developed in the advanced countries, which in turn depend on the historic/economic circumstances of the advanced economies during this period, which conditioned their dynamic cycles.[182]

The importance of technology transfer in stimulating the industrialisation of developing countries can scarcely be overemphasized. The experience of many countries that have either, like Japan, already made the transition to an industrial state or, like many developing countries, are just now making it, demonstrates that the vast store of technical knowledge that exists in the industrialised countries can be successfully tapped. However, that experience has also disclosed many pitfalls and drawbacks. Among them are the cost of technology transfer and the counterproductive nature of much of the off-the-shelf transfer of technology that pays scant regard to the special circumstances of the technology-importing country. The whole subject has been widely debated for years, and the discussion in this chapter focuses on only some of the issues that have been raised.[183]

In other words, this chapter is about the role and importance of Standardization and QC in the process of technology transfer from advanced countries to developing countries. Due to the fact that technology is mainly transferred through people, the human factors associated with the transfer of quality technology are reviewed.

Apart from the lack of quality consciousness, adequate educational and training programmes, skilled manpower, shortage of energy and other resources, among others, the choice of technology is the most critical problem facing any developing country. After analysing the appropriateness of the concept of Intermediate Technology (which in essence is that the increasing complex and costly technologies of the highly industrialised countries are generally inappropriate for many developing countries) as a means to pursue industrialisation in the developing countries, it is argued that a new approach is needed in order to meet the new demands and to establish an effective control of the quality of manufactured products, which are obtained by using such technologies. The practical implications of the term Intermediate QC are discussed, and later it is shown that in most of the cases this quality technology stands between inspection-orientated QC and total QC.[13] Finally, some suggestions are given regarding the improvement of international co-operation in the quality field.

6.2. Basic Definitions and Terms

Before entering into details it may be useful to establish some terminology. A technique is a particular combination of inputs producing a particular output, i.e. a production process. The collection of all available techniques, e.g. a production function, is the technology.[184] The important point is that technology is a package, and the efficiency or otherwise of a particular technique depends not only on its own performance, and that of its immediate substitutes, but also on the surrounding technology. This means that a technique may survive from the past as efficient yet be obsolete in the context of the rest of the technology in use; selecting may often be impossible because of linkages throughout the system.[182]

The term technology transfer has been variously defined as: the process of information transfer between science, technology and actual utilization of scientific data and ideas, to wit: production of goods and services; the process by which science and technology are diffused throughout human activity; the transfer of research results into operations; the process by which technical information originating in one setting is adapted for use in another setting. Collectively, these and other definitions share a common theme which characterises the process as one of bringing technology into widespread use in solving mankind's problems in the shortest practical time.[185]

And now let us turn to the definitions of quality terms. For the purpose of this study, quality is defined as 'the totality of features and characteristics of a product or service that bear on its ability to satisfy a given need'; and quality assurance as 'all activities and functions concerned with the attainment of quality'. Quality control is defined as 'a system for programming and co-ordinating the efforts of various groups in an organisation to maintain or improve quality, at an economical level which allows for customer satisfaction'. Defined as such, q.c. is a subset of quality assurance, i.e. a substantial integral part of it and not a separate addition to it.[47]

What is quality technology? It is many things. It is the development and implementation of a quality system. In a broad technical sense, it includes the management of this system. It involves the planning and detailing of all actions necessary to provide adequate confidence that a product or service will satisfy given needs. It is the operational techniques and activities which sustain a quality of product or service that meets these needs. It is a body of application-orientated knowledge.[186]

6.3. Standardization, Quality Control and Technology Transfer

The process of technology transfer is a complex one, which is basically aimed at getting the knowledge from the generator into the hand of the user. Technology is transferred into the developing countries via such customary mechanisms as direct investments; export of machinery, equipment and products; industrial and trade fairs; licensing contracts; training arrangements; supervision or quality control at production sites or at home plants; and technological workshops.[187] Although, the method of transfer depends greatly on the technology to be transferred and the characteristics of the receiver, in all cases the transfer takes time as it is a matter of building up extensive capabilities at the receiving end. The curve in Figure 6-1 could represent the learning-curve as volume and local content is increasing. Figure 6-1 also indicates how the goal of the activity is broadened during the three stages of development: start-up (quality, too often overlooked); rapid-growth (quality, deliveries); and maturity (quality, deliveries, efficiency). The capabilities have to be established to meet these aims. The time for transfer can vary well up to 10 years and even beyond that.[188]

Developing countries are striving for self-sufficiency, a goal that is especially difficult to achieve in the field of quality and reliability assurance. The nation that recognised the need for quality management will have to import such skills until knowledge can be transferred to its own citizens. Only by substantial efforts for technology transfer can self sufficiency be attained.[189]

As has been the case in more industrialised countries, there are many advantages that society in a developing country can derive from standardization and industrial q.c. Just as members of a society depend on their norms, customs and moral law for an orderly social system, so industrially they are dependent on standards to improve production, encourage trade and provide for judicious use of goods and services.

Standardization, therefore, offers innumerable advantages, short as well as long term, to producers, consumers and the national economy as a whole.[138]

Even though the development of industrial standards play a vital role in the successful application and transfer of technology for the overall development (socio-economic, cultural, etc.) of a country, there are a large number of 'transfer barriers'. Some of these will always exist and, perhaps, can only be recognised in the design of future transfer programmes. Other barriers, once recognised, can be overcome by designing transfer methods that by-pass or surmount them. The three major barriers are (1) human resistance to change; (2) inadequate skills and narrow viewpoints of people who should be involved in the transfer process; and (3) poor producer-user relationship. Some of the barriers may not be surmountable under any conditions. One of these, the underlying psychological resistance to change, predominates as a human characteristic at any time and in any period. The two other barriers may be changed only on an evolutionary-time basis, but hopefully more rapidly.[190]

One obstacle in technology transfer is the tendency of one party to take advantage of the other. Recognising this problem UNIDO has published guidelines as to how this transfer could be effected to the mutual benefit of the parties involved. Unfortunately, no mention of standardization and quality control is made in such documents. However, standards organisations do play a significant role in the transfer of technology. Without buying technology, standards give guidance to transfer. International understanding is such that any country can adopt standards of other countries or international standards issued by ISO, IEC etc. Consequently a very useful transfer of technology takes place. Standardization calls for several requirements of a produced article, for example: material; tolerances and fits; surface finish; reliability and life expectancy; safety requirements; and code for maintenance or operation etc.

Thus provided the right infrastructure is available, the user of standards can attain the technological competence that exists in the country in which the standard for the product originated. Free availability of standards also provides a means of comparison of technological competence.[191]

6.4. Human Factors in the Transfer of Quality Technology

The process of technology transfer cannot be dealt with as an independent mechanical process. It is a human phenomenon and is highly dependent upon the technology in question, the donor, the recipient and the transfer mechanisms in place. Thus, to transfer a specific technology (say, an appropriate quality technology) from a certain party A to a certain party B, specific processes exist that can do the job with varying degrees of success, depending primarily on how well people do their part in the overall process.[192] In other words, a true transfer of technology is a people-orientated phenomenon, and its success depends upon close inter-relationships between the donor and the recipient. Consequently, it demands the existance of a high degree of motivation on the parts of both the donor and the recipient.

<u>Motivation</u> may be defined as the internal process that causes people to work toward goals that they feel will satisfy their needs. The strongest need at any given time tends to direct a person's activity toward the goal or situation that

seems most likely to satisfy that need. Motivation is clearly a matter of being attracted, not pushed, toward a goal or set of goals. One of the most effective ways to increase motivation is to allow employees to play an active role in decisions that affect their job, i.e. the emphasis on motivation through job involvement may lead one to conclude that motivation is the most powerful avenue toward improving quality performance. To translate employee motivation into improved performance, supervisors should actively involve their people in developing new methods, tools and procedures. This requires a joint consideration of the engineering and psychological factors that affect human performance. The concept is to establish <u>sociotechnical</u> systems that will enable employees and technology to produce the best results.[181]

In recent years, there has been a new and growing emphasis on human factors and motivational aspects in quality assurance. The present success of Japanese industry is universally recognised. One contributing factor to their success had been their adoption of Quality Circles, small groups of people meeting together to discuss and try to solve problems they had met with at work.[193] The basic background philosophy of quality circles has its roots in the theories of behavioural scientists, in particular those of Maslow, McGregor and Herzberg. In isolation these theories merit serious consideration but when linked practically to quality-circle programmes they become a powerful and effective technique for improving relations between employees and management.[194]

In spite of some human barriers associated with the transfer of quality technology from developed nations to developing economies (e.g. cultural differences, communication and language, etc.), there is no doubt that "people have always been the heart of quality. It is the whole process of knowing that what we are doing is right! Attention to detail! 'Doing it right' cannot be replaced with gimmicks - we must start with perfection. People are our vital ingredient and the individual will always be the most important link as far as quality is concerned".[195]

6.5. <u>The Concept of Intermediate Technology</u>

Before discussing the concept of Intermediate Technology or Appropriate Technology and its appropriateness to pursue development in developing countries, it will be adequate to make some comments on the significance of the term 'developing country'.

There is no single definition of a developing country, and even more there is no typical developing country. However, there are several basic characteristics that underdeveloped nations possess: (1) low productivity; (2) low per capita real income; (3) an 'unbalanced' economy; (4) natural resources that are either largely untapped or are being used by and for the benefit of the highly industrialised nations; (5) a traditional-orientated rather than a market-orientated economy; (6) small amounts of capital equipment relative to labour force; (7) structural underdevelopment; and (8) the widespread belief among people that it is underdeveloped.[196]

The objectives of most developing countries are: (1) to achieve a higher degree of economic growth; (2) to promote self-sufficiency, particularly in staple food items, in order to reach a balance of payment equilibrium; (3) to reduce unemployment; and (4) to achieve a more equitable income distribution.[197]

Because of the rapidly increasing labour costs and the pronounced shortage of skilled labour in the industrial sector in developed nations, the present trend of manufacturing technology is directed towards achieving bigger production with less production workers, as well as to increase the use of machinery of high technological levels. In fact, we are today witnessing the emergence of fully automatic unmanned machine shops. Bearing in mind the problems facing a developing country, as outlined above, then it is clear that the large-scale, capital-intensive technologies of industrialised countries are not always the best answer to those problems.

According to G. McRobie,[198] it was for these reasons that the late E.F. Schumacher argued that the choice of technologies was the most critical choice confronting any developing country. Schumacher's advocacy of an Intermediate Technology that would be more appropriate to the needs and resources of poor people in poor countries is now widely familiar.[199] Its essence is that the increasingly complex and costly technologies of the rich countries are generally inappropriate for the poor, who live in rural communities. To meet their needs a new technology must be discovered or developed; one that lies, so to speak, between the sickle and the combine harvester and is small, simple and cheap enough to harmonise with local human and material resources. In other words, it is desired that each country may be enabled to adapt and innovate industrial technologies appropriate to its endowment of natural resources, capital and labour.

The aim is not to apply inferior technology but to use modern knowledge in an integrated systems approach, so that the resulting processes and equipment are appropriate to the economic and social conditions of the developing country. In other words, Appropriate Technology is concerned with all aspects of the community leading to a 'total or integrated development' and hence to an improved quality of life for the individual members. Since most of the world's poor live in the rural areas, it is very much concerned with agriculture and agriculture-based activities. However, Appropriate Technology is not exclusively for the rural areas but is also applicable to the problems of the urban poor. According to P.D. Dunn,[200] Appropriate Technology aims include: (1) the provision of employment; (2) the production of goods for local markets; (3) the substitution of local goods for those previously imported and which are competitive in quality and cost; (4) the use of local resources of labour, materials and finances; (5) the provision of community services including health, water, sanitation, housing, roads and education.

It is important that such developments should be compatible with the wishes, culture and tradition of a particular community and not have a socially disruptive effect. Table 6-1 gives a list of 'criteria of a technology's appropriateness' for a developing country from the Brace Research Institute in Canada.[201]

6.6. Intermediate Quality Control and its Implications

In most developing countries the manufacturing sector can be divided into a modern component, a modernising component and a non-modern component. The technology to be used for these components differs (see Table 6-2). As noted by L. Sandholm,[141] the differences in the degree of industrialization of developing countries will of course affect the situation as regards quality and quality control in these countries. In developing countries with a structure similar to that of developed countries (where the modern industrial sector is important to the economy), we can find more managerial and technical tools for QC applied than in countries where the urban informal sector (largely small-scale industries and services) and the rural agricultural sector dominate the economy.

As shown in Table 6-3, there is a clear relationship between the industrialization level of a country and its kinds of manufacturing and quality technology. The term 'intermediate or appropriate' is used here to indicate the level of technology which is best suited to the socio-economic, cultural and political environment of a particular country.[2] Accordingly, an 'appropriate Technology' can be characterised by any one or several of the following features: low investment cost per workplace, low capital investment per unit of output, organisational simplicity, small-scale operations, high adaptability to particular social or cultural environments, sparing use of natural resources, and very low cost of final product. They may also be of an intermediate level of technological sophistication (i.e. somewhere between a traditional and modern technology) or particularly easy to operate and maintain by unskilled people.[202]

Accepting the fact that technologies are appropriate whenever they can make use of the existing resources, manpower, skills and capital of a country, and bearing in mind that they should satisfy the local consumers for whom they are intended as well as the foreign consumers identified in the export objective of the country,[203] it is necessary to design, develop and introduce appropriate and efficient QC techniques, say Intermediate Quality Control, which may be able to assure the manufacturing of goods that may provide quality satisfaction and economic benefits for all - government, industry and customers.

From the foregoing it is evident that Intermediate QC does not mean an inferior or incomplete set of quality techniques, as put another way, it is referred to as the standard of "appropriateness" which is required to control, in the most economical and efficient way, the quality of products which are being manufactured by using the most appropriate technology in a particular industrial sector. In this sense, it can be said that an absolute degree of appropriateness should be a system-based total quality programme covering every section from design through to production and performance tests, to packing and after sales service, not excluding material purchases. Such a system ensures quality, both to the producer and the consumer alike, small or big. It is only then that manufacturer and dealer can assure quality to the consumer since, after all, it is axiomatic that no dealer can assure any more than the quality built into the product by the producer.[204] On the other hand, the minimum degree of appropriateness should be assigned to an inspection orientated quality programme, in which the quality function is an inspection activity carried out by inspectors, at each stage of production, by sorting out good from bad.

Until now there has been little doubt that the Total QC concept has been successfully applied in the USA and other countries. Nevertheless, by considering the present state of QC in developing economies and knowing the fact that most of the nationally managed industries are technique orientated rather than quality or management orientated,[205] the author believes that the most appropriate quality technology for these industries stands between Total QC and QC by Inspection. Because the very concept of Intermediate Technology for developing countries is aimed to pursue all the development processes through low-cost and high-labour force technology, the Intermediate QC programmes must emphasise the motivational aspects of quality, i.e. Zero Defects, QC Circles, etc. Recently, some applications of the Japanese QC Circle concept in Brazil[206] and Mexico[207] have been reported. Also, it is important to draw attention to the potentiality of establishing Intermediate QC programmes based on the well-known 'Operator Control' techniques and the philosophy of 'Right the First Time'. As the whole 'Operator Control' system is based on the concept of total capability (machine, tooling and operator),[178] training and motivational programmes have to be devised with special emphasis on modern inspection techniques, capabilities studies, performance rating methods, statistical tools, among others.[208]

In short, Intermediate QC is not a new concept as in other words it means "appropriateness" of a QC programme,which has to be tailored in accordance with the human and material resources of an individual enterprise. Bearing in mind the quality problems facing today's Third World countries (e.g. lack of quality consciousness, the absence of competition in the market place, etc.), the Total QC concept is not practicable at least in the small and medium-sized industries. However, as the process of industrialisation advances in the semi-industrialised nations, they will require more complex and capital-intensive technologies, and consequently Total QC programmes will be necessary to carry out all quality function tasks from market research through to after-sales services.[13]

6.7. International Collaboration

Today more than ever before, there is a need for effective collaboration between standards organisations and governments of developing countries in order to acquire appropriate technology that takes into consideration their resources and capabilities. It is a well-known fact that successful industrialisation requires the acquisition and mastery of new technological processes and the development of capacity to adapt and innovate technical and organisational changes that will raise productivity.[209] Thus there is an urgent need to extend the freedom of technological choice among the over-developed and underdeveloped countries.

As already mentioned, the choice of technology is the most critical choice confronting any developing country. To help make the choice of technology more consistent with development goals, the economic and political incentives operating on policy decisions should be examined carefully. Technologies have to be assessed by the decision makers of developing countries, bearing in mind their own natural criteria, which often differ from one country to another. However, the two factors of employment and capital seem to be predominant in many developing countries. A classification of alternative technologies in relation to their consumption of the productive factors labour and capital for obtaining certain levels of production efficiency is given in Figure 6-2.

The concept of Appropriate or Intermediate Technology has gained momentum in recent years and has now become a world-wide movement. Published evidence exists to suggest that much of the technological change appropriate for developing countries will come in the form of Intermediate Technology whose capital intensive is less than that of the most advanced methods.[210-12] Thus the major thrust of Technology Assessment for developing countries would be the selection of Appropriate Technology on the basis of national development goals and sectoral/local community needs. Although Technology Assessment has not yet been widely practised or even understood by most developing countries, the early discussions certainly have pointed out in the direction of linking Technology Assessment with Appropriate Technology. Conceptually, this linkage may be represented by Figure 6-3, which may be compared with Technology Assessment for industrial market economies represented by Figure 6-4.[213]

In the concept of 'Appropriate Technology', factors other than economic efficiency and growth are included. Such factors as employment, working conditions and the provision of basic needs are also considered. This means that appropriate technologies will differ from country to country depending on the differences in the weights given to these various factors.[141]

There are several factors inhibiting the use of appropriate technologies: lack of information about available technologies, dependence on suppliers of equipment designed for use in industrialised countries, policies of foreign companies operating in developing countries, preference for shiny projects and for the latest technology, tying of aid of donor governments.[214]

Appropriate technology as a useful operational concept has gained increasing acceptance in developed as well as developing countries and also with governmental or non-governmental international organisations. However, despite the existance of efficient alternatives to technological choice in virtually all sectors of economic activity, inappropriate techniques continue to be used in many developing countries due to constraints on the demand, as well as on the supply side. It is agreed that increased funds and additional infrastructures alone are not sufficient conditions for the selection of more appropriate technologies; what is needed is a healthy selective climate in which technological capabilities and commitment to socio-economic progress are interwoven.[211]

As regards <u>technological information in the quality field</u>, during the last two decades the problems of QC in developing countries have received higher attention from both the Western and Eastern developed nations, as well as from Japan. For instance, the Proceedings of the ICQC'68-TOKYO Conference included about 40 papers from developing countries, and the ICQC'78-TOKYO Conference, with the theme 'International Co-operation to Solve Quality Problems', devoted a session which included the co-operation with developing countries. More recently, the 25th EOQC Conference (Paris, June 1981) devoted a full session, with 9 papers, to the topic 'Strategy of Quality in Developing Countries'. <u>Part A6.3</u> (Appendix 6) presents a brief guide to the literature on QC in developing countries.

<u>Training</u> on an international level is still limited but growing. The UNIDO/SIDA training programmes in the field of QC for developing countries, conducted in Sweden by L. Sandholm,[215] as well as the Journal and Newsletter (QC Development)

of the same organisation, are two relevant advances in the internationalisation of quality. These courses have stimulated the creation of regional training programmes, also for developing countries, and these have been most successful. The concept of sending teams to go abroad to study QC originated with the Japanese in the late 1940's. Now, 30 years later, they still send such teams abroad. More recently a reverse flow has begun, as in the case of a Mexican team which visited Japan. In addition, Japanese teams are increasingly invited by other countries to visit for consultation purposes.

As Juran[216] pointed out, much remains to be done to induce upper management to accept training in quality control. In addition, much remains to be done to inject into some of the existing training programmes, special contents dealing with international quality assurance. According to A.V. Feigenbaum,[217] three principal trends now make internationalisation an increasingly important dimension of professional quality practice. They are: (1) Growing worldwide scope and character of industrial corporations and of governmental programmes; (2) Demonstratable new importance of quality to success in international markets; and (3) Developing significance of QC in governmental policy and negotiations on international trade.

Recently, Technical Help to Exporters (THE)[218], the export advisory service of BSI, have published a document giving details of the major international certification and approval schemes in use over 90 countries. It is hoped that the developing countries will increase their participation in the ISO Committees, and especially in the ISO Committee on Certification (CERTICO), which can provide a major step towards the elimination of the so-called non tariff barriers to trade created by some certification systems.

Among the agreements concluded in the Tokyo Round of trade negotiations within the General Agreement on Tariffs and Trade (GATT) is the "Agreement on Technical Barriers to Trade" (also referred to as the "Standard Code"). This agreement, which came into force on 1 January 1980, is open for "acceptance by signature" by governments which are members of GATT, and for accession by any other government on terms to be agreed between that government and the parties to the agreement. So far twenty-one GATT members have signed the agreement, including the main industrialised countries and three developing countries (Argentina, Brazil and Chile).

As far as developing countries are concerned, the provisions on special and differentiated treatment indicated in the GATT Standard Code, may have the unfortunate result of encouraging certain developing countries to seek exemptions from obligations, the implementation of which lies in their own best interests, for development of indigenous technology and promotion of exports. It is to be hoped that developing countries will be able to make a careful analysis of their real interests in this area despite the appeal of current slogans. On the other hand, the provisions on technical assistance should result in the increased availability of technical expertise for strengthening regulatory agencies, standards institutions and certification bodies in developing countries, and in assisting in their integration in international work.[219]

6.8. Concluding Remarks

The movement of technologies in new contexts or technology transfer may be regarded as one of the most significant mechanisms which has helped to reduce the technical and managerial gap amongst the industrialised countries. On the contrary, it has contributed to widen the gap of comparative wealth of the richest and poorest nations. That is one of the reasons which has lead to negotiations on international codes of conduct for technology transfer and multinational corporations. In this sense, the UNCTAD and other United Nations agencies became the focus of developing countries' efforts to obtain a new international economic order in which they could acquire better terms of trade, increased access to technology, an increased flow of resources from industrialised countries, and a code of conduct regulating international technology transfer.[220]

Transfer of technology has so far remained an immitable rather than innovative process, except for Japan. The result is that most of the developing countries are saddled with the high cost, urban centred, high technology programmes, through the vehicle of international aid and trade because that is how Western technology is most easily transferred. The challenge today is to identify suitable technologies and develop target orientated, low cost delivery systems to maximize the human welfare by meeting basic human needs. The strategies for transfer of technologies are evolved to meet this objective.[221]

Technology, unlike science which is universal, is a commercial commodity which is culture and need specific. Technology involves development cost and cannot be expected without some form of payment. Developing countries should develop their own capability for generation and adoption of technology to suit their requirements.[191] Although there is the tendency of developing countries to adopt or copy the standards of the developed countries it is generally agreed that there is no alarm in adopting other countries' standards provided those standards suited conditions.

Developing countries have a lot to learn from the advanced countries in the field of QC but a blind copy of QC practices will not work. A nation has to develop its own QC movement consistent with its culture. Technical collaboration with advanced industrialised countries is beneficial but efforts must be made to integrate the production process depending upon local infrastructure. There are many practical ways of co-operation between developing countries and several alternatives are available. Mutual visit of experts, consultants, trainers are highly beneficial. There is a considerable scope for international standards in fostering exchange of goods across national frontiers. International conferences on QC are highly recommendable due to their beneficial inputs on better transfer of QC knowledge and international understanding and co-operation.[222] According to H. Bosch[223], "transfer and adaptation of technology and management knowhow" should be regarded as a learning process, in which two-way communication takes place. In this process management consultants and educators can play an important role. There should be: exchange of knowledge about technology and how to manage it for industrialisation; and knowledge about the local culture and infrastructure, by co-operation on an equal footing. To summarise this point: it may be said that the entire subject of technology transfer should be dealt with in terms of "people-orientated process".

It is also worth adding at this point that technology does not operate in a vacuum; it requires an economic, cultural and technical environment which cannot easily be replicated beyond the confines of the society in which it developed originally.[192] Thus, significant technology transfer can, and will occur only when the right people, markets and ideas coincide with usable technology at the right point in time. Technology, per se, may be the least important element in the overall transfer process.

The improvement of the quality of our products and services is a need, so that the Third World may not be seen any longer as an isolated region in the globe. The interchange of raw materials, technological knowledge, human resources and manufactured goods, are of vital importance today. This is a fact which has been recognised by all the nations of the world. The New International Economic Order is the way to bridge the gap between the developed and underdeveloped worlds. Thus, it may be said that quality is today every nation's concern, i.e. the internationalisation of quality is the key to survival.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

7.1. Needed: A National Strategy for Quality

The benefits of Quality Control (QC) can be summarised as follows:

a) To the industry: QC directly attacks waste - waste in raw materials, waste in processing and production, waste in packing, waste in storage, waste in transit, waste in marketing, waste in man-hours and waste of defective goods and thus reduces the cost of production and increases profits. Quality solves the marketing problem to a great extent. Quality packing and presentation go a long way to build up the clientele.

b) Labour: The savings by QC will be enormous and this benefit of savings will certainly go to the workers in one way or another and it builds up the morale and motivation of the employees.

c) People: They receive value for money in good materials and service. Their comforts will increase by using quality goods and their health and life will be safe.

d) Shareholders: They receive good return for their investment. Quality goods bring them a sense of pride.

e) Nation: These enormous savings will build up the wealth of the nation and in turn, help to build a welfare State.

Quality is:-

for the comfort,

to suit the needs, and

to meet the desires of the buyers.

QC has become a 'MUST' to the manufacturers to find a market and to the buyers to bring comfort, joy and safety.[224]

In order to achieve the maximum QC benefits stated above, it is necessary to design and introduce adequate and efficient QC systems in all sectors of the Venezuelan economy.

This study shows that a great deal of progress has been made in the quality field in Venezuela, but there is enormous scope for more. In fact, during the last twenty years Venezuela has made an impressive attempt to deal with quality problems, not so much as in other newly industrializing countries through the application of quality management methods and modern QC engineering techniques, but by promoting industrial standardization at both national and international levels. As a result, there is today a well-established system of standardization, quality certification and marking which has been expanded to different industrial sectors such as: metalworking (metalmechanic), automotive, petrochemical, food, pharmaceutical, pulp and paper, construction, electrical components, textile etc.

Venezuela's quality problems are complex and urgent, but substantial responses will require careful planning and time. As indicated in Chapter 3, these problems cannot be left unattended, for, as they gain in intensity, they multiply in number. Hence, the present study points to the need to use quality and standardization as motive forces in national economic efficiency. In short, the major conclusion that can be drawn from this investigation is that there is an urgent need for a unified national position or strategy for quality improvement in Venezuela.

In preparing this thesis, it was not the author's intention to present all the 'answers' to the numerous quality problems facing the Venezuelan metalworking industry today, nor to define the fundamentals of a 'National Strategy for Quality'. The purpose was rather to try to make a critical analysis of the prevailing situation of QC methods in Venezuelan metalworking industries at company, national and international level.

On the basis of such analytical study, and also taking into consideration the results of a field work study carried out by the author in Venezuela, some recommendations are made regarding the appropriate aims and contents of management QC improvements and development strategies for raising the level of quality in Venezuela's manufacture and production.

The remainder of this chapter contains a summary of the recommendations that resulted from the findings of this research, from the discussions held with the staff of the Venezuelan Commission for Industrial Standards (COVENIN) and other professional institutions with interest in QA, and from the preceding chapters of the thesis. These recommendations are directed to the metalworking industry, in particular, and to the nation as a whole. Furthermore, this chapter includes some proposals for future work. Needless to say here that these general recommendations and suggestions for future action are just given as some guidelines to formulate and further implement a <u>National Strategy for Quality</u> in Venezuela. The development and implementation of such a strategy will require a co-operative relationship between the Government and the private sectors to be established, to ensure that the nation's needs for standardization and QC are met in the most efficient and economic way for the benefit of the main parties concerned - industry, commerce, consumers and Government.

7.2. General Recommendations

7.2.1. At the National Level

The problems related to product quality in Venezuela, as in most developing countries, are of such a nature that they cannot be solved without a national plan for QC. This plan needs to have various ingredients: (1) Education, Training and Promotion; (2) Standardization and Certification; (3) Legislation; (4) External Assistance; (5) Institutional Infrastructure; (6) National QC Society.[141]

Moreover, it is fundamentally important that any strategy for quality improvement must be designed and implemented in accordance with the nation's economic development plan, as shown in Table 3-1.

It is evident from the foregoing that the "strategic formulation process" attempts to focus attention on each and every possible aspect of a given situation on a project and arrive at an integral, all-round solution. In this study the "systems approach" is adopted to make an analysis of the inter-relations and constraints of all factors - human, socio-economic, political, cultural, technical - which have to be considered collectively when dealing with a management problem such as the design and formulation of a national strategy for quality.

The principal objective of QC at national level is: to reduce and partly eliminate the wastage of resources, to provide improved satisfaction of consumers, to increase export through the introduction of a planned and co-ordinated QC strategy. For this reason, as a developing country it is necessary to lay a heavy emphasis on the infrastructure for the implementation and maintenance of an efficient QC strategy.

Since quality is the primary responsibility of the manufacturer, the Government should actively promote the philosophy of integral QC by the establishment of an adequate infrastructure as illustrated in Figure 7-1, including the services such as metrology, standardization, quality certification, education and training, perhaps also consultancy services for QC.[139]

Increasing recognition is now being given to the role of standards in Quality Assurance (QA). This is not only because of the trend towards fully integrated mandatory systems of standardization and QA in developing countries and the more centralized economies, but also because of the need for a more effective multi-disciplinary approach throughout organizations. As noted by Fielden,[50] this depends largely on the intrinsic quality of standards transcending all industrial disciplines (see Figures 1-19 and 1-20). Verman and Visvesvaraya[49] have systematically examined the functions of standardization and studied the various interactions of its components sub-systems, and external links (Figure 7-2). They use the "systems approach" to standardization by identifying four distinct areas of activities: research and development in standardization; formulation and establishment of standards; implementation of standards; and promotion of standards and services.

Because the "systems approach" represents a useful and effective way of thinking and managing the interdependence of standards and QA functions, it is strongly advised that the Government takes the 'total' viewpoint for programming and co-ordinating the efforts of all sections of society in the decision-making process of standardization, as well as in all those activities related to the attainment or improvement of quality, at an economical level which allows for customer satisfaction.

Today there is a need to rapidly make the Venezuelan industries, Government and the consuming public aware of the fact that their co-operation is essential to implement a National Strategy for Quality Assurance - as a means to enhance Venezuela's reputation for quality while at the same time reducing industry's quality costs, improved productivity and higher profitability.

In other words, the strategy formulation is itself a process of organization which requires the close collaboration of all the interested parties (industry, commerce, consumers and Government), rather than the masterly conception of a single mind.[225] Thus, the major function of such a national strategy would have to be the pulling together of concept and techniques, organizational and otherwise, that are known to and understood by only a few QC practitioners in the country.[226]

In order to establish a sound and workable National Quality Strategy, the first recommendation would be to design and carry out a "National Survey of the Quality and Reliability Function", it is also advised that the respondents should be balanced according to the nature, size, location of industries and other relevant characteristics.[227] From the results of this Survey, it is advisable that a "Consultative Document" be issued which would be delivered to most Venezuelan industries in order to obtain some comments on the proposed strategy and other matters related to the alternative means for its implementation. Following that, the COVENIN and the Central Co-ordinating and Planning Office (CORDIPLAN) must join efforts to include, within the National Development Plan's goals, the importance of producing goods and services that are competitive in terms of price, quality and delivery in the home and the foreign markets.

It is of paramount importance to assess the effect of Quality Costs on the country's economy. A section of quality cost evaluation must be included in the context of the COVENIN Standard 1000-76, which is used to evaluate the effectiveness of the QC systems of the Venezuelan Industry. The implementation of a Standards Committee on Quality Costs in the COVENIN would also be desirable.

At the Company Level, the introduction of programmes for reducing quality costs needs to be promoted, with special emphasis on the increase of prevention costs rather than on failure and appraisal costs. The BS6143:1981 (British Standard Guide to the determination and use of quality related costs) provides guidance on the determination of costs associated with defect prevention and appraisal activities, the losses due to internal and external failures and on the operation of quality related costs systems for effective business management.[228] It is suggested that this guide should initially be used in Venezuela as a means to obtain some useful quality cost data (particularly by using the check list of quality related cost included in Appendix A of BS6143) which will enable the identification of objectives and ways of managing an effective quality cost system within a manufacturing organization.

Broadly speaking, there are 12 basic steps in a quality cost improvement and control programme:[229]

(1) Agree on quality terminology.

(2) Obtain clear statement of management objectives.

(3) Obtain policy statements for management on the following six key functions: market requirements; contractual obligations and sales; servicing and warranty; new design and innovation; development and expansion; financial stringency towards capital expenditure and revenue improvement.

(4) Establish basis for quality improvement programmes, e.g. by failure patterns, profit drains and customer requirements.

(5) Initiate evaluation and audit of suspect areas, checking performance against recommended practice.

(6) Identify quality costs under three main headings, namely:- organization costs; failure costs; and evaluation and improvement costs.

(7) Initiate detailed quality cost gathering and recording in suspect areas.

(8) Analyse and evaluate recorded cost data using statistical techniques.

(9) Present cost patterns as part of action report.

(10) From collected data formulate improvement programme for implementation.

(11) Continue quality costing to evaluate results of programme.

(12) Report progress and final results regularly to top management.

Whilst there are many factors militating against effective QC in developing countries (non-availability of goods and therefore absence of competition among manufacturers, obsolescent technology, capital and foreign exchange constraints, incomplete infrastructure and inadequate knowledge absence of organized consumer bodies etc.), the lack of "quality consciousness" is the top-most problem in the way of implementing modern QC techniques and quality cost improvement programmes.

There is some evidence to confirm that a nationwide campaign for <u>Quality Consciousness</u> has to be planned and implemented by the Government.[134,148] Even though efforts have been made by the Promotion Department of the Direction of Standardization and Quality Certification (DNCC, see Figure 3-7), in developing an adequate climate for quality, today it is necessary to make a better use of the various publicity media. Good quality results from an attitude of mind, an attitude which does not allow any inferior product or service to be entertained - at any level. This then means that the primary objective of any national strategy for quality must be that of <u>education</u> by all possible means - press, radio, television, until everybody is thinking 'quality'.[8]

One possible solution to these problems is to organize a "Quality and Reliability Year" with the following aims:[230]

(1) To give fullest publicity to the outstanding achievements of Venezuelan firms in quality and reliability methods.

(2) To assist every firm that is not yet doing so to review its methods for obtaining improved quality and reliability.

(3) To make quality and reliability Everybody's Business; it must involve everyone in a firm, from the boardroom to the shop floor.

Chapters 4 and 5 of the thesis deal with the problems experienced and how they may be overcome by implementing QC systems in the metalworking sector in Venezuela, particularly in the smaller companies. The first, and major, conclusion drawn from this study is that promotion and development of "appropriate" QC systems in these industries is urgently needed, as well as the organization of adequate education and training for quality; also these industrial sectors need to be provided with the necessary technical assistance for designing and/or improving efficient QC methods. Other aspects of interest are: to make the companies aware of the importance of defining a "Quality Policy" which permits them to write their own QA Manual. Special attention must be given to the preparation of an adequate standardization programme at the company level. Since 1978 the Fund for Standardization and Quality Certification (FONDONORMA) has been organizing training courses on the development of Company Standards Manuals, and it would be desirable to promote these activities in the metalworking sector.

Furthermore, training courses on the metalworking sector must include some topics related to the evaluation and analysis of capability studies: process capability (including man, machine, material and measurement); machine reliability; and machine capability. It is widely recognized that a quality product can be produced only when the machine or process involved can maintain the specified tolerances. When equipment cannot meet these tolerances, cost is added in the form of scrap, rework, or both.[231] Process capability is achieved through the practical and realistic application of facilities, tools and equipment which provide for the consistent manufacture of parts and assemblies to engineering specifications at minimum cost. Process capability must be proven in a production capability run.[232] It is thus necessary to check that the manufacturing process is capable and stable before attempting to design and/or introduce any QC system to the shop floor. Further more, the assessment of total capability is the key to implementing a quality improvement programme aimed at increasing workforce participation.

Some guidelines in introducing QC into small and medium sized factories have been given by Huey and Wong.[233] They said that in the course of bringing QC to industries there are inevitably difficulties of a social character which need to be overcome to pave the way for introducing QC on a more practical and concrete level. These difficulties vary from country to country depending on the economical, social and cultural backgrounds (see Chapter 6). However, it may be said that there are similar features in the smaller firms of developing countries. So the general points existing in Hong Kong when introducing QC into the smaller industries are almost of the same nature to those found by the author in Venezuela, as mentioned in Chapter 5 (Case Studies). For instance, the top management is usually reluctant to accept new concepts or to adopt new techniques unless the need for such is immediate and most compelling; there is a lack of appreciation of the benefits of the concept of Total QC; education and training is required in inspection techniques and statistical methods currently used to control the quality of goods; there is a limitation of manpower; there is a need for adaptation rather than adoption of QC systems, etc.

Although some recommendations on QC in the metalworking industry have been given by the Government in a FONDONORMA publication entitled "Recomendaciones sobre Control de Calidad para Industrias Metalmecanicas"[234] it is advisable to review them by redefining their objectives in a more concise and practical way in order to obtain a widespread application which can yield better quality results in this industrial sector. Nevertheless, they are of great value as a means to self-assess the effectiveness of the QC systems used in these industries, and also it shows the special interest that the COVENIN is today giving to the quality problems existing in Venezuelan metalworking industries.

Today, the FONDONORMA activities have to be reviewed in order to assess the need to increase the professional and technical assistance in QC, which is one of the key factors to improving the prevailing situation in QC. To be competetive, the salaries of quality engineers in charge of consulting activities have to be levelled to those paid in the private sector. The same applies to the technicians of the COVENIN. The author believes that a possible solution would be to reduce the personnel rotation in such institutions.

The fact that the Law of Standardization and QC and the Law of Metrology have been recently approved by the Government, and that there is growing emphasis on the application of the Consumer Protection Law, has surely brought about a new advance in the QA scene in Venezuela, i.e. there is today an ever-increasing tendency towards Product Liability, Product Safety and Health all over the country.

To summarize, one may state that the breakthrough in attitude towards QC has been achieved, but much remains to be done in the field of providing technical assistance; education and training; motivational campaigns; and in developing an appropriate climate for quality mainly in the smaller industries, which are of vital importance to speed up the national industrialization process.

7.2.2. At the International Level

Throughout this study it has been emphasized that the task and requirements of quality developments and improvements must be determined in accordance with the national economic plan. Since the early 1970's, Venezuela's new industrial policy, which aims to concentrate investment in basic industries geared to the export market, indicates that attempts are being made to circumvent the difficulties encountered by the country in its early stages of industrial development (see Section 3.3.3. and Table 3-1). However, a quality strategy for exports has not yet been implemented.

Broadly speaking, Venezuela is a developing country with a sellers' market sheltered by import restrictions. For instance, the manufacturing sector has increased its participation in the country's economy from 14.9% in 1960 to about 20% at the present time. On the other hand, as has been reported in the previous chapters,the situation of the methods employed in the national metalworking industry for controlling the quality of manufactured goods, is very critical. Consequently it is evident that during the last few years priority has been given to volume of production rather than to quality.

To strengthen the competetiveness of the Venezuelan metalworking industry in overseas markets, it is first of all necessary to establish a quality strategy on exports - which demands a series of stages (education and training on Q.C., capabilities studies, investigation of products to export, standardization, etc.) prior to the certification of products.

In export it is imperative to co-ordinate the work of the Government with the specific entities in production and export. Studies must be made to identify which products are in a suitable condition to be exported; which products represent the greater volume for export; which products are to be promoted; which products have given rise to most complaints and dissatisfaction from customers; and where the present and future markets are. With these facts on the list of priorities the system of quality certification can be established.[235]

For these products, conditions must be established according to an International Quality Law which they must satisfy to qualify for export. It is not convenient, nor in many cases is it possible, to subject all exportable products to a system of certification in the first stage of the programme. Periodically, the list of products subject to obligatory inspection, will be revised so as to include new items and eventually, to eliminate those that are of no further interest.

Japan was the first country in the world to enact and enforce an Export Inspection Law. In fact, Japan had already adopted the Export Inspection System in 1948 and since then every effort has been made to improve the system and also competent inspection bodies have raised the status of the system to the high level it now enjoys. An outline of the Japanese Inspection System of Goods for Export was presented by

H. Kusakabe [236] in the 1969-TOKYO International Conference on Quality Control. At the same event, M. Tano [237] pointed out the main problems, as well as some solutions, of the purpose of export inspection in Japan.

According to M. Tano, the purpose of Export Inspection is to preserve and enhance the reputation of exports, and thereby assuring a sound development of the export trade. Although the Export Inspection Law stipulates mainly the enforcement of the inspection for the quality of specified commodities to be exported and prohibits the export of those commodities which fail to measure up to the stated standards of quality, it says that the aim is not to preserve and enhance the quality of export commodities themselves, but their reputation. That is, quality inspection is done as a means to accomplishing this aim, and the final aim is to preserve the reputation of the Japanese exports on the world market. Export inspection is thought necessary to be enforced by law in spite of the existance and capabilities of the many kinds of vuluntary or self inspections.

Generally speaking, merchandise to be exported may be inspected for quality by various different bodies:-

1) by the exporters or manufacturers themselves.

2) by the exporter's union itself or designated persons if the exporter or manufacturer is a member of the union.

3) by the buyer viz. foreign importer.

4) by the organs of the third party (governmental or private) by the request of an exporter or an importer.

In developed countries, the application of export inspection to industrial products was rather late, e.g. France in 1956, Switzerland in 1961, and U.S.S.R. in 1967. In the case of developing countries, India's Export Inspection Law was implemented in 1963 but it came into force with effect from 1st January 1964. The Indian Inspection System of Goods for Export is framed by and large on the Japanese model. It is understood that, other than India and Japan, such legislation for compulsory inspection of exports exists only in Iran and South Korea. Therefore, among the developing countries of the world, India has a unique place in this respect.

India's Export (Quality Control and Inspection) Act vests the Central Government with power to:-

a) notify commodities which shall be subject to QC or Inspection, or both, prior to export.

b) specify the type of QC or Inspection which will be applied to a notified commodity.

c) establish, adopt or recognise one or more standard specification for a notified commodity.

d) prohibit the export, in the course of international trade, of a notified commodity unless it is accompanied by a certificate issued under Section 7 that the commodity satisfies the conditions relating to QC or Inspection, or it has affixed or applied to it a mark or seal recognised by the Central Government as indication that it conforms to the standard specifications applicable to it under clause (c).

The Act also provided for the establishment of the Export Inspection Council who advise the Central Government on measures for enforcement of QC and Preshipment Inspection in relation to commodities for exports. A review of this QC System has been given by M.K. Unnikrishanan[238] in his paper 'Quality Control and Preshipment Inspection in India', which was published in 'QC Development' - a journal and newsletter for developing countries in the UNIDO/SIDA training programmes in quality control (Vol.1, No.1, Autumn 1978, pp.6-7).

Israel is one of the Third World countries who has made very good progress in the field of QC of export goods. Control over the quality of manufactured goods intended for foreign sale is based in Section 1.4 of the "Export Order (Merchandise Exportable without a Special Licence), 1962". This Act has been reproduced in the appendix 16 of the book 'Quality Control in a Developing Economy (a case study of Israel)' by E. Jacobson and A. Cohen,[239] which is published by the Centre of Policy Studies, Jerusalem, Israel. The value and need for an Export Control Law is well explained in Appendix 7 of this book (also reproduced in Quality 1976, No.1 EOQC).

In the general discussion of alternatives to the control system it was made clear that this system would, on the whole, include the following elements:

- examination of consignments,
- verification of the examiner's control system.

These activities can be placed in the hands of one of the following elements: manufacturer, manufacturer's association, public institution, laboratory, government ministry. The alternatives found less preferable are those requiring implementation and verification by the manufacturer, by a commercial laboratory and by a government ministry. The obvious conclusion is that the control system must be constructed in such a way that it will depend on the activities of public bodies, such as a manufacturers' association or a public institution (the Standard Institute or the Export Institute, for example)

Summarizing, the QC system for export goods can cover the examination of products only, the verification of control and approval of manufacturers only, or both aspects together. Figure 7-3 gives a logical chart describing the various factors connected with control and the interrelations between them. Undoubtedly, this study is one of the most comprehensive ever done in the field of QC in developing countries. Hence, the researcher strongly believes that it should be used as a basis to design and implement the Venezuelan Export (QC and Inspection) Law.

Although there are some benefits that could be obtained from the establishment of a National QA Service for controlling export quality, for example in improving the reputation of Venezuelan manufacture, in giving overseas buyers confidence in product quality, etc.; it will be necessary to estimate the cost of operating a verification scheme at the national level on the results of the returns from exports.

In view of the present state of the Venezuelan economy, which is basically a one-commodity exporting country (oil), it is hard to justify the cost of operating a verification scheme for export goods. However, as the economy enters a new period of accelerated industrial expansion and the exportation of manufactured goods increases; then the creation of a National QA Service for controlling export quality will be necessary. Meanwhile, such facilities should be applied to verify the quality of imported goods. According to Article No. 26 of the Venezuelan Standardization and QC Law (Dec.,1979), the Development Ministry is responsible for defining policies and establishing a national scheme for controlling export quality.

Recent International Relations among Latin American countries have become closer and wider in scope. Today, Venezuela is fully committed to all plans for Latin American integration. Of the many Latin American free trade zones and common markets, the Andean Group Market or Andean Pact is by far the one who has been making better progress during the last few years.

The participation of Venezuela in the Andean Industrial Programming, especially in the metalworking sector, has been severly criticised by the private sector. Besides the problems related to the uneven distribution of items and machinery to be manufactured by the Andean Pact member countries within the metalworking programme (see Chapter 2, Section 2.4), the problems of standardization and QC are the most difficult to overcome in the near future. The fact that the industrial quality standard should be established by the seller rather than by the buyer and/or an agreement between them, is one of the major limitations to improving international trade and facilitating the transfer of technology among the Andean countries and the world.

It is a well-known fact that Venezuela holds the biggest market, and also has the human and technical infrastructure to achieve at the most economical level, the goals defined in the Andean Metalworking Programme. Thus, the country must avoid financing the development of other developing countries, and also take some economic measures to protect the internal market as a means to promoting the establishment of more metalworking industries in Venezuela which will be able to provide customers with the products they are prepared to pay for at the right quality and at the right time, i.e. Venezuela must avoid the introduction of sub-standard metalworking products from other countries, even more today when the nation is able to produce economically the same items at higher standards of quality and reliability.

It is evident from the foregoing discussion that it is necessary to promote the development of adequate and efficient quality assessment and certification schemes at the regional and international levels. In a word, the establishment of the Andean Subregional System of Standardization, Quality Certification and Metrology (Sistema Andino de Normalizacion Tecnica, Certificacion de Calidad y Metrologia) is urgently needed.

Recently, the Venezuelan Industry Council (CVI) proposed to adopt the standards issued by the Pan-American Standards Commission (COPANT) as a means to eliminating the duplication of efforts and to increasing the international cooperation in solving the quality problems existing in the Andean Group Market. Where there are no appropriate COPANT standards, it is adviseable to employ the standards and QC system of the buyer (exporting country) and/or to reach an agreement between the two parties concerned: the seller and the buyer.[117]

A comprehensive review of the achievements made by the Government and the private sectors in the field of standardization, certification and control of quality of metalworking products, has been presented by COVENIN in the 1st National Congress for Industrial Standards and QC (February, 1978). By analysing the international participation of Venezuela in regional and international organizations for standardization and QC (e.g. COPANT, ISO, etc.) it is clear that it is necessary to increase the country's participation in the technical committees and working groups engaged in the elaboration of industrial standards and certification systems in the field of metalworking (metalmechanic) and related industries.

The machine-tool sector of the metalworking industry plays a key role in the expansion of world industrial production, since nearly all other products are manufactured by machine tools or by machinery that has been produced with such tools (see Figure 4-4). With the increasing sophistication of machine tool design and rising demands for closer accuracy and higher productivity, it is becoming difficult to select or evaluate machine tools on the basis of geometrical accuracy tests alone. Additional tests to determine their capability regarding productivity, accuracy and repeatability have been found necessary, both for the designer to compare his design with those of others and also for the user to select the most suitable machine to meet his needs.[240]

As a result of the absence of universally accepted standard specifications, difficulties in the international trade of machine tools have arisen. The "Schlesinger Acceptance Tests" and other tests used during the early stages of industrialization in some countries were designed to overcome such problems.[95] During the last few years the up-dating of the Schlesinger and other accepted tests have been taking place, although the rate of progress may be considered slow by those who are most likely to benefit from international agreement in this field. Foremost in this group are customers in the developing countries, since most of them have to import most of the machine tools they require.

It is notable that acceptance tests for machine tools do not explicitly take into consideration certain conditions that markedly prevail in many developing countries, such as a wide range of ambient temperatures during each 24 hours or a high level of humidity. Yet it would not be disputed that such conditions affect the performance of machine tools.[241]

In Venezuela, as in most Latin American countries, the establishment of standard tests and methods to assess the accuracy of both manual and numerically controlled (NC) machine tools are urgently required. There is a long way to go in this field prior to promoting foreign trade in Latin America. Standards to assess the capability of machine tools are of paramount importance, as well as the establishment of fundamental specifications and methods of evaluating the dimensional accuracy of machined components. It is also necessary to educate customers in general to judge machine tools on performance, not on appearance.

Increasing attention is now being given by developing countries to the problem of <u>metrication</u>. It is therefore adviseable to promote the use of the SI Metric System in the Venezuelan metalworking industry (as established in the Metrology Law), and to avoid the acquisition of machinery, tools and technologies which are rendered obsolete or are the results of the metrication process taking place in some industrialized countries with tradition in the use of the Imperial System. It is also recommended that the COVENIN increases her participation in the International Organization of Legal Metrology (OIML).

In view of the afore-mentioned facts it is evident that there is a need to create a special standards technical committee on machine tools within the COVENIN/TC20 (Mecanica). ISO has now published a handbook containing the standards published so far as a result of the work of ISO/TC39, Machine Tools, the scope of which is "Standardization of all machine tools for the working of metal, woods and plastics, operating by removal of material or by pressure". The ISO Standards Handbook 'Machine Tools' (totalling 500 pages) contains 51 standards. This publication can be used as a basis to orientate the activities of the proposed technical committee on machine tools.[242]

Another important fact to be mentioned here is the recent trend to promote the implementation of an international certification system. In response, CERTICO (the ISO Committee on Certification) developed the code of Principles on Certification Systems and Related Standards, which has since been adopted as a joint statement by ISO and the International Electrotechnical Commission (IEC). Adherence to this code can provide a major step towards the elimination of the so-called montariff barriers to trade created by some certification systems. ISO member bodies have been asked to endorse the code and to signify their intentions towards its use in their countries.[243] Therefore it is recommended that Venezuela, as well as other Latin American ISO member bodies, increases its participation in the CERTICO activities.

Based on the ISO-IEC code of principles on certification systems and related standards mentioned above, ISO and IEC take particular care to see that their standards are accepted to certification requirements and shall continue to offer their services for the implementation of the policy of "reference to standards" and for international acceptance of certification systems and arrangements. This code stated that where two or more ISO or IEC members or groups of members have developed or are developing two or more certification systems for the same product or group of products, they should seek to find suitable arrangements with one another based on equality of rights and obligations for each of them and aimed at eliminating discrimination related to disparity between standards or to product origin. If a suitable ISO or IEC international standard exists, it should be the technical basis for such arrangements. If not, any standard resulting from such arrangements shall be made available to ISO or IEC with a view to the development of a corresponding ISO or IEC international standard. Without doubt, this approach will contribute to solving some of the quality problems of today's Latin American economic integration. A review of CERTICO has been given by J.E. Kean[243] in the journal of the American Society for Testing and Materials, "Standardization News", December 1975.

Due to the gaps in expectations of quality between two countries having different conditions in national law and also due to deterioration of quality during transportation, there is today a tendency to propose the establishment of an international inspection system which would mean co-operative organization of Inspection Organs having both independent character and international status. According to M.Tano,[237] such a system would realize the international standarization of inspection and inspections may be mutually requested and information freely exchanged so as to conduct export inspection more satisfactorily and promote the sound development of international trade. A diagram based on the Felix von Ranke[244] concept of a worldwide integrated standardization system is shown in Figure 7-4. At each level, the immediate needs are satisfied by standards pertinent to those unique requirements. Often those needs are felt elsewhere and a standard developed at the bottom works up as needed. This proposal was adopted by COPANT to define their new objectives, which were presented at the COPANT Eleventh Assembly held in Caracas, May 1974.

A workable international system of QA that is both economical and responsible to all parties involved should ideally include uniform standards, certification of products to ensure that standards are being met, accurate measurement techniques that incorporate good calibration procedures and accepted standard reference materials, and assurance that whoever is performing the tests needed for certification is doing the job properly. And, acceptance of one country's test results by another country, with adequate inspection, will eventually be necessary.[245]

In order to accomplish the requirements of international quality it is necessary to design and introduce modern QC systems in the Venezuelan metalworking industry; to set up the legal basis and scope for multinational co-operation and to implement all the identification means (marks, quality certificates, etc.); to create an appropriate and reliable export inspection organization; to implement a workable method for laboratory approvals; to establish an efficient feedback system to obtain and analyse customers' complaints, among others.

Referring to the treatment of Imported Products it is recommended that the Government should ensure that those products are treated no less advantageously than national products in relation to standard and technical regulations, and that the latter should not constitute obstacles to the international trade standards of the importing country nor meet the requirements of standards that are more stringent than those set by the importing country.

According to the new Standardization and QC Law, the Venezuelan Development Ministry is responsible for laying the basis for action on quality in the areas of manufacture and trade; services; the introduction, distribution and sale of imported goods, as well as the exportation of Venezuelan goods and services. Today, the price, quantity and operating instructions of national and imported products must be shown on their packages. According to Article No. 29 of this Law, the manufacturer becomes liable to penalties (up to Bs500,000) when he cannot present evidence to prove that the quality of manufacture was set up to prescribed standards and specifications at every stage of production.

7.3. Future Work

Without doubt there are some open problems and questions which have not been discussed in this thesis, however, it is clear from the foregoing that there is a long way to go before "Made in Venezuela" should be accepted as synonymous with high quality in home and foreign markets.

Only if the COVENIN becomes involved with the Government at policy-making level in all matters related to the creation and control of quality, can it possibly regard itself as a national and professional institution claiming to take a positive part in the development of quality assurance. Any long-term solution to the basic problem of creating "quality consciousness" in Venezuela will require the participation and close collaboration among all the parties concerned; industry, commerce, consumers and Government.

A major recommendation from this study is for the enactment of legislation establishing a National Quality Board to serve as a national co-ordinating body of all the elements of the QC infrastructure shown in Figure 7-1, preferably by reconstituting the COVENIN under National Charter. This Board should also be an advisory board responsible for setting up the national quality policy and for determining the priorities in the fields of standardization, metrology and certification for improvement of their activities in order to promote and improve industrial quality control.

This Board, responsible for recommending the ways for better co-ordination between the elements of a QC infrastructure and for the improvement of their activities, should take into account the following considerations:-

(1) Government should clearly define a national policy for quality, and if necessary, prepare the appropriate legislation. This legislation should include both positive incentives and compulsory implementation requirements. In this respect, it is desirable that all sectors of the national economy should make better use of the existing legislation in order to create a better climate for quality improvement in all parts of the country. In particular, a widespread application of the new Standards and QC Law, the Metrology Law and the Consumer Protection Law is necessary.

(2) Co-ordination between standardization, metrology and quality certification and marking services should be realized at the national level. It should be done by the Ministry of Development through the new Direction of Technology (see Figure 3-8 and pp. 102-103).

(3) Adequate means should be made available to improve the quality consciousness, mainly by providing education and training in quality to all the members of the industrial

triangle: Government, manufacturers and consumers.

(4) An effective participation in international and regional activities in the field of QC and related matters should be increased, as discussed in Section 3.4.5.

(5) Adequate co-operation between industry and research centres (particularly universities) should be ensured in order to make a better use of the country's resources in testing facilities and other technical infrastructure related to technical innovation in the manufacturing field.

(6) Assistance to smaller-scale and sub-contracting industries with limited funds and resources should be provided by large-scale industries or by other means.

(7) A National QC Organization, responsible for the promotion and dissemination of the philosophy of integrated QC, should be supported by all sectors of the community. In other words, the creation of the <u>Venezuelan Society for Quality Control</u> is recommended. In 1976, a project to centralize the activities of the COVENIN, the Fund for Standardization and Quality Certification (FONDONORMA) and the Direction of Standardization and Quality Certification (DNCC) was submitted before the Development Ministry by I.Garmendia and C. Alvarez [246] (see - Hacia una nueva estructura para la Normalizacion en Venezuela). The author believes that this proposal will contribute to speeding up the process of standardization and industrial QC in the country, as well as reducing the administrative costs and facilitating communications between the public and private sectors, which have been participating in all the standardization and QC activities being carried out in the country during the last two decades.

Today, the greatest challenge in most branches of engineering of any enterprise, in a developed or developing country, is to be able to achieve substantially greater improvement in productivity through the use of a quality improvement programme. The close connection between quality and reliability and productivity can be clearly demonstrated, but it is only by increasing the manufacturer's awareness of this interrelation and the economies that can be achieved by paying attention to quality of conformity, to quality of design and to reliability, that real advances in productivity will be gained.[247] Hence, Qualitability (or the activity of producing quality) seems to be the greatest challenge which quality practitioners and managers have to face in the coming years.

Furthermore, it can be stated that any enterprise aiming to improve its competitiveness and profitability in national and international markets can make a three-pronged attack. It can: improve real productivity; plan and achieve successful innovation of products and services; improve the quality of its products and services. As pointed out by P.A. McKeown[248], this glimpse of the obvious is nothing less than the formula for wealth and creation, for halting economic decline and achieving economic growth. Of these three areas, product innovation is undoubtedly the most important, and by far the one which requires more attention in today's industrial climate. As indicated in Figure 7-5, product innovation starts with ideas and finishes with the introduction of a profitable product to the market. It is the sum of those actions by which a new/improved product is created and introduced to the market; the overall process by which invention is brought about and the product brought into successful usage.[248]

Without any shadow of doubt, it can be stated that the only sure way of improving the present status of QC in the Venezuelan metalworking industry, and in other sectors of the nation's economy, is by understanding the importance of the three-pronged attack strategy described above. To accomplish this task, the top management of an innovative company should realize that quality has to be created and controlled throughout all the phases of the product life cycle.

Summarizing, there are three characteristics needed to raise quality programmes to the necessary high effectiveness levels. Firstly, programmes must be clear and strong enough to deal with the modern reality that fundamental quality problems requiring improvement today are outside the scope of traditional QC departments. Secondly, programmes must be organized throughout marketing, engineering, production and service in the firm - as well as in QC and in general management itself. Thirdly, and perhaps the real nub of the solution, QC must be made one of the principal elements of the firm's strategic planning, its top organization structure, and its major action for achieving competitive economic strength in national and international markets.[249] There is the challenge in a nutshell; will we make quality a strategic issue as we plan our quality programmes in the 1980's?

To forecast the future is always a very difficult task, especially in a technical activity such as QC in which new concepts, philosophies and techniques evolve every day. The final recommendations of this investigation will only contribute to determine some short and medium-term solutions to the existing quality problems in the Venezuelan metalworking industry. QC is a dynamic activity, so it is necessary to keep our knowledge in the new advances in QA up to date, and also to work hard with a scientific approach in the design, implementation and introduction of appropriate and effective QC methods, which can be tailor-made in accordance with our basic industrial needs and by making full use of our technical, human, material and financial resources.

7.4. Concluding Thoughts

In ending, it would be worthwhile to say that this thesis is just the beginning - ideas that will never work unless we are able to adapt and innovate industrial QC technologies appropriate to our endowment of material and human resources. In conclusion it can be stated that nowadays the most important problem in quality level creation is creative invention and man's organizational ability because primacy of quantity calls for discipline and primacy of quality calls for culture.[250]

Hence, there is an urgent need to harmonize the activities of all parties concerned (Government, manufacturers, commerce and consumers) with the improvement of quality and productivity in the Venezuelan metalworking industry. Also it is necessary to make a united effort to crystallize a national policy for raising the level of quality of all goods and services, which are needed to satisfy the basic human needs of the people at the most economic price and at the right time. This is surely the only way to improve our quality of life and to increase the present standard of living and that of our future generations.

May I now conclude by quoting a remark attributed to

B.L. Hansen[251]: "Without willingness there can be no progress. In an encompassing sense, this means the willingness to accept responsibility, to take risks, to accept change, and to learn from experience. Willingness of this sort is all too uncommon in QC organizations, where a general atmosphere of forced acceptance prevails owing to the inability to sell or to influence major policy decisions. Now is the time for QC to be willing to stand up for itself; to speak out when challenged, in defence of quality and of value".

Let us get down to work!

APPENDIX 1

FIGURES AND TABLES*

* As indicated in the text of the thesis

FIGURE 1-1.[1]

FIG. 1-2. Systems Approach[20].

FIGURE 1-3.[26]

FIG. 1-4 Environmental Factors Encompassing the Firm.[28]

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FIG. 1-5. Block diagram and examples of a production system.[31]

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FIG. 1-6. Environmental interfaces with production/operations management system.[32]

FIG. 1-7. A simple system description of operating systems.[32]

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FIG. 1-8. Elements of feedback control loop.[34]

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FIG. 1-9. Levels of control and information flows in a production [3] subsystem.

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FIG. 1.10. An operating system.[24]

FIGURE 1-11. [36]

FIGURE 1.12. [36]

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FIG. 1-13. Control as a feedback cycle.[37]

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FIG. 1-14. Quality system.[20]

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FIG. 1-15. Functional responsability for quality within the total production system. 31

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FIG. 1-16. The relation between customer demands, product design and production. 40

MARKET DEMAND

FIG. 1-17.[42]

Major elements of a quality assurance system. [Reproduced by permission from "The Quality World of Allis-Chalmers," *Quality Assurance*, 9, No. 12 (December 1970), 13-17.]

FIG. 1-18. Layout sheet.[47]

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FIGURE 1-19 [49]

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FIGURE 1-20. [49]

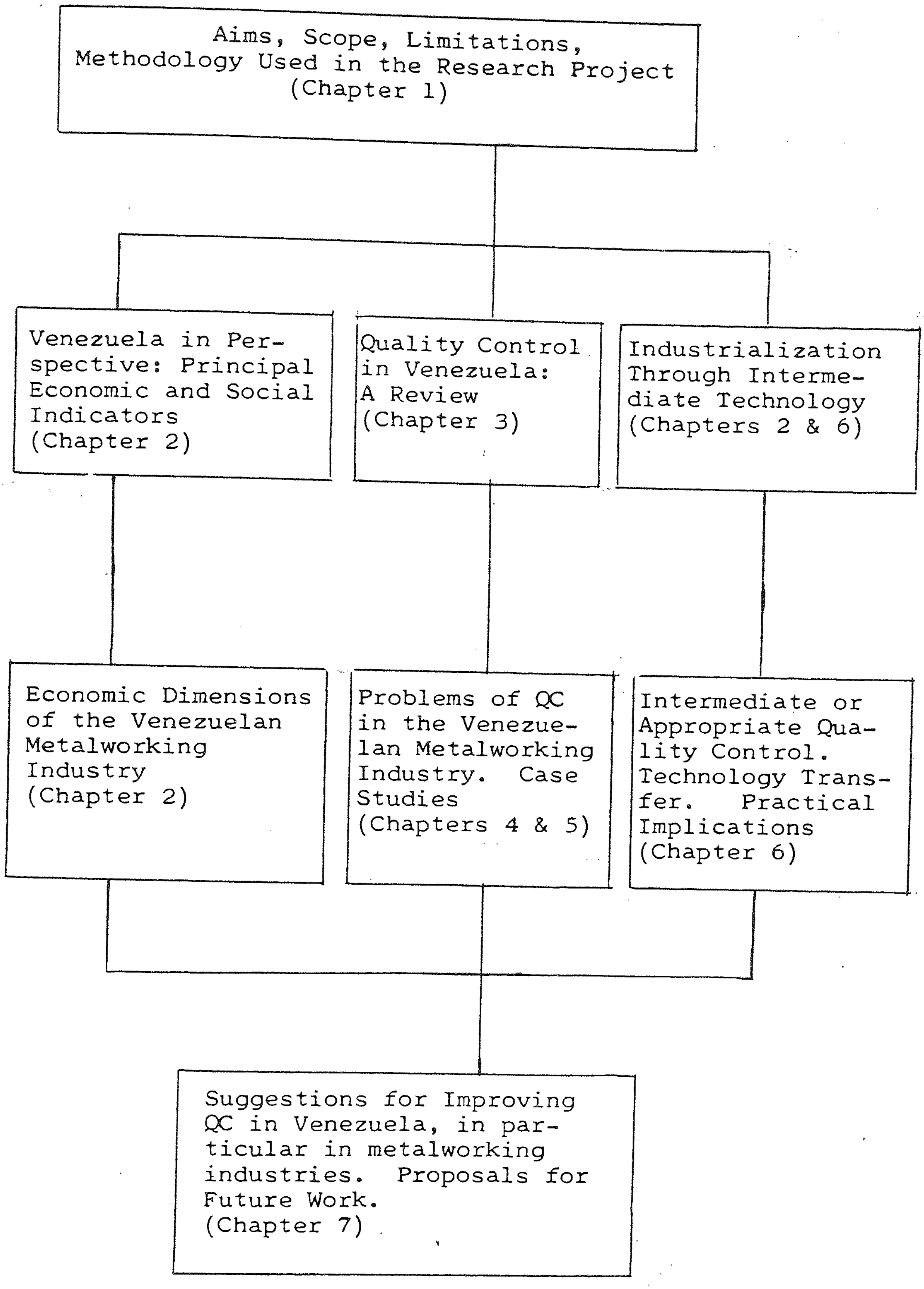

Fig. 1-21 The Plan of the Thesis.

Table 3-1 Stages of Industrial Development and Quality Control Development

Industrial Stage	Period	Priority of Industrial Development	Product Market	QC Development
Rehabilitation	1949-1958 before 1st national plan	1. First-stage Import Substitution 2. Labour-intensive industry	1. Domestic 2. Exports or raw materials (oil & iron) 3. Imports of nondurable consumer goods	Initial Period: 1. Inspection (Emphasis on Standardization)
Promotion of Industries	1959-1969 1st, 2nd & 3rd national plans	1. Second-stage Import substitution 2. Development of basic industries (steel, petrochemicals, etc)	1. Mainly Domestic 2. Export of Processed Materials 3. Imports of intermediate goods & producer & consumer durables	Promotion Period: 1. Creation of COVENIN 2. SQC Promotion by COVENIN & INPRO 3. NORVEN Kite-mark
Industrial Expansion	1970- 4th, 5th & 6th national plans	1. Development of Export-processing industries 2. Integrated manufactured for domestic use 3. Development of capital goods industries & other industries of high technological levels (metalworking, automotive, etc)	1. Mainly Domestic 2. Partly Export	Development Period: 1. Creation of DNCC & FONDONORMA 2. 1st 3-year Standardization plan 3. External Assistance (OAS, UNIDO, etc) 4. Certification & Marking programme 5. 1st National Congress on Standardization of QC 6. Legislation (QC Law) 7. Motivational Campaign 8. TQC Promotion by Government & Private Sectors

Table 3-2 Evolution of Quality Responsabilities.[123]

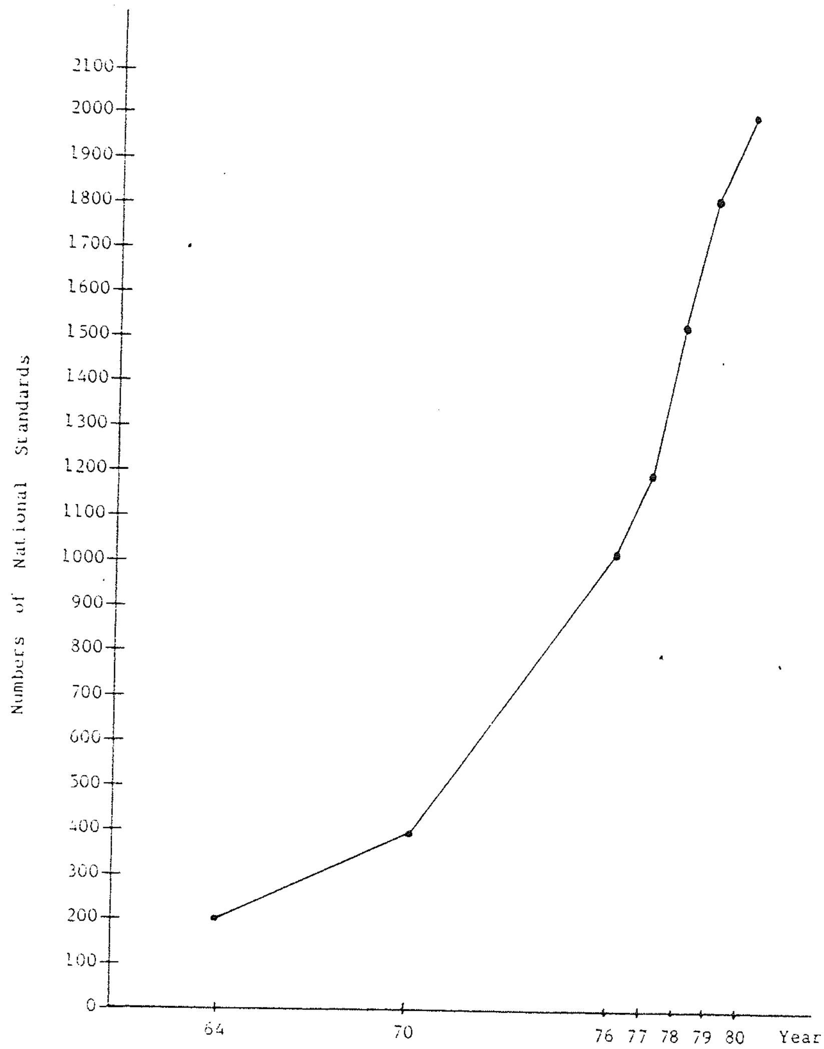

FIG. 3-1.- National Standards.

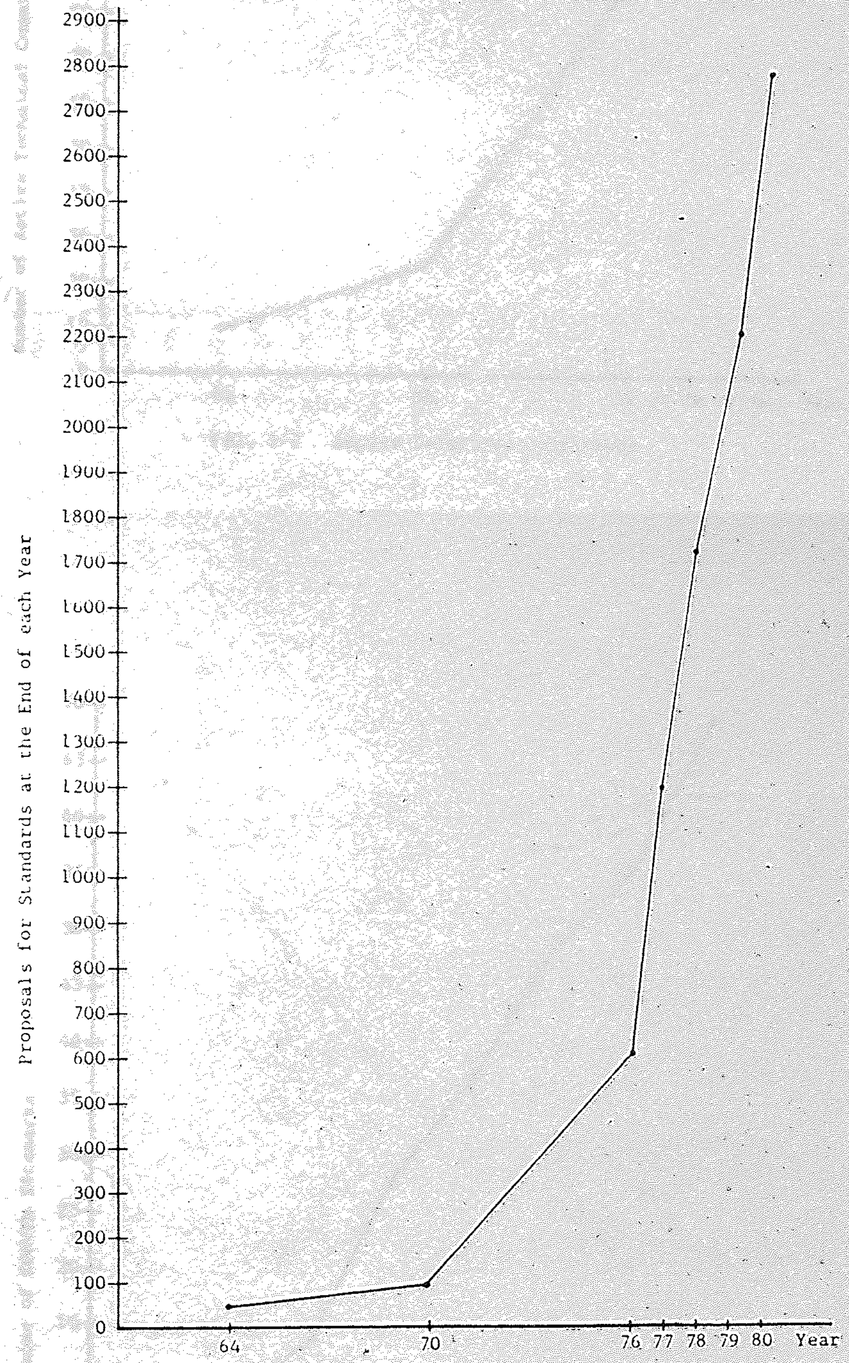

FIG. 3-2.- Proposal for Standards

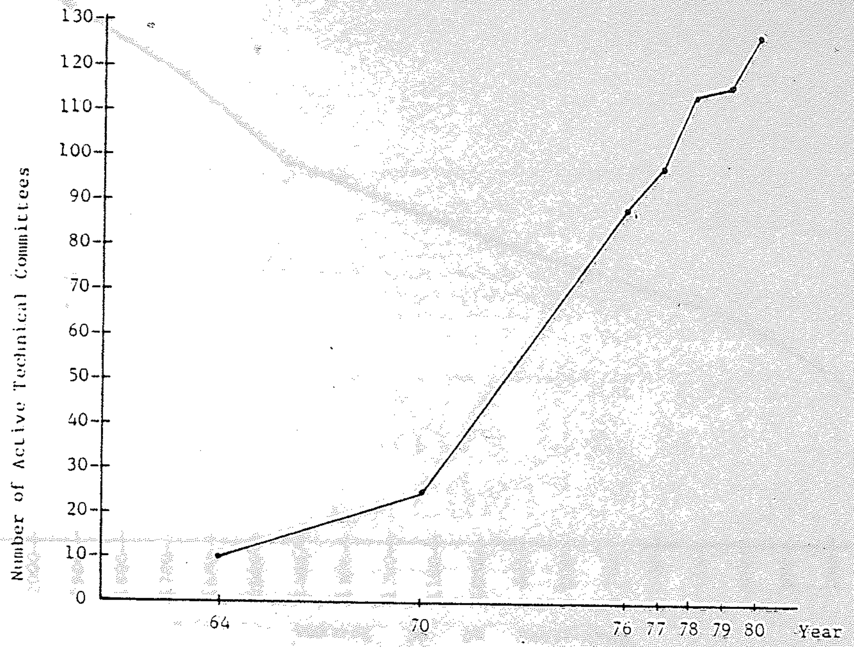

FIG. 3-3 Active Technical Committees

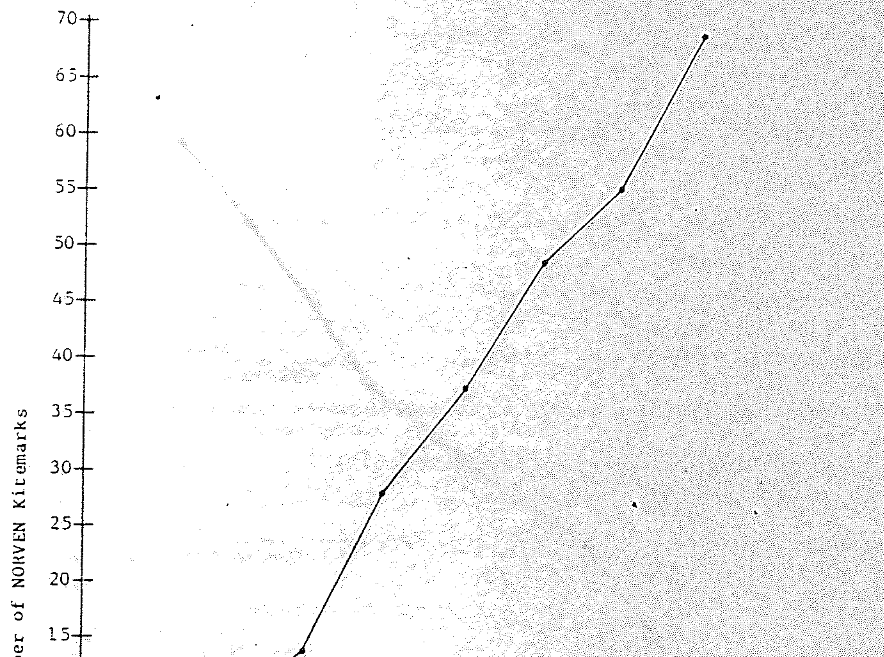

FIG. 3-4 NORVEN Kitemarks

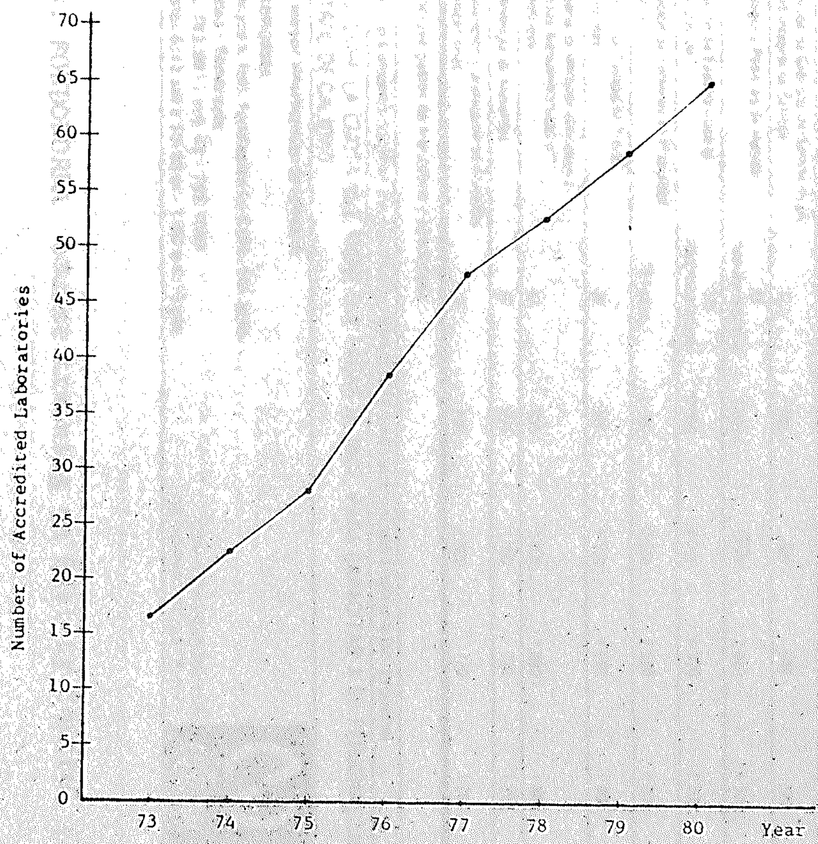

FIG. 3-5 Testing Laboratories

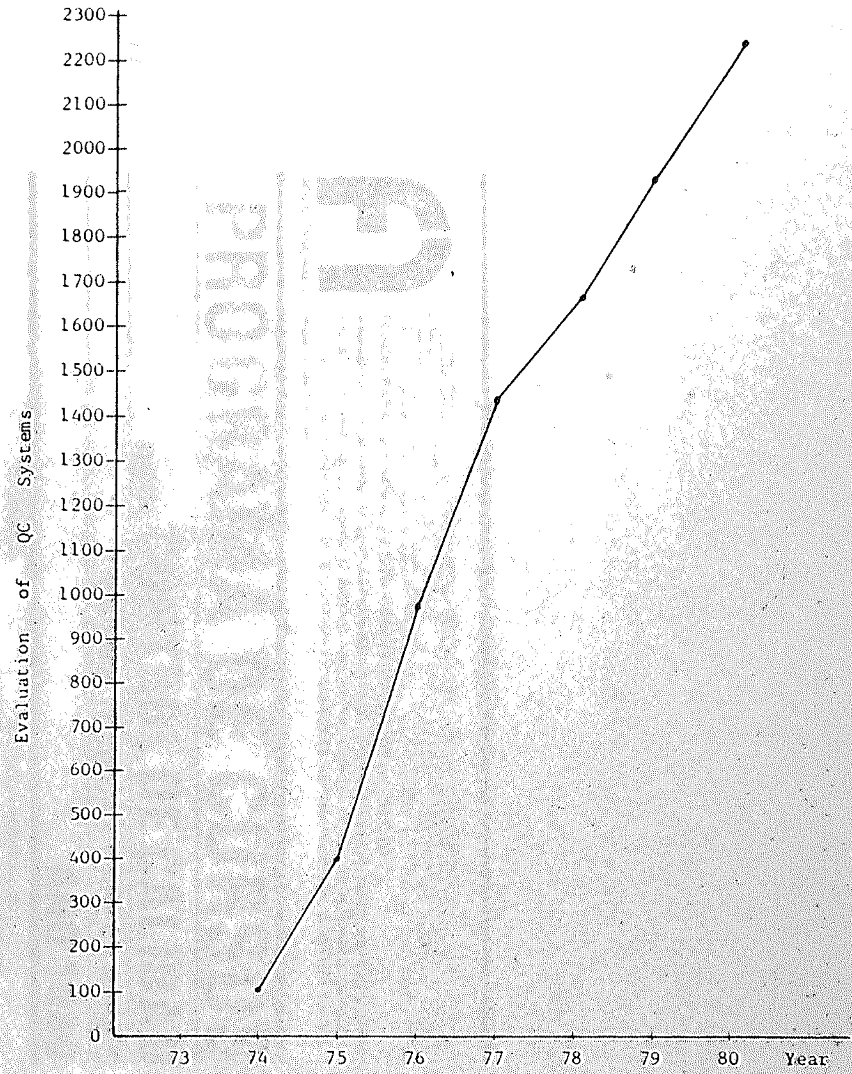

FIG. 3-6 Auditing QC Systems

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Table 3-3. FONDONORMA course training on Quality Control (1980).

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FIG. 3-6. COVENIN Quality Posters.

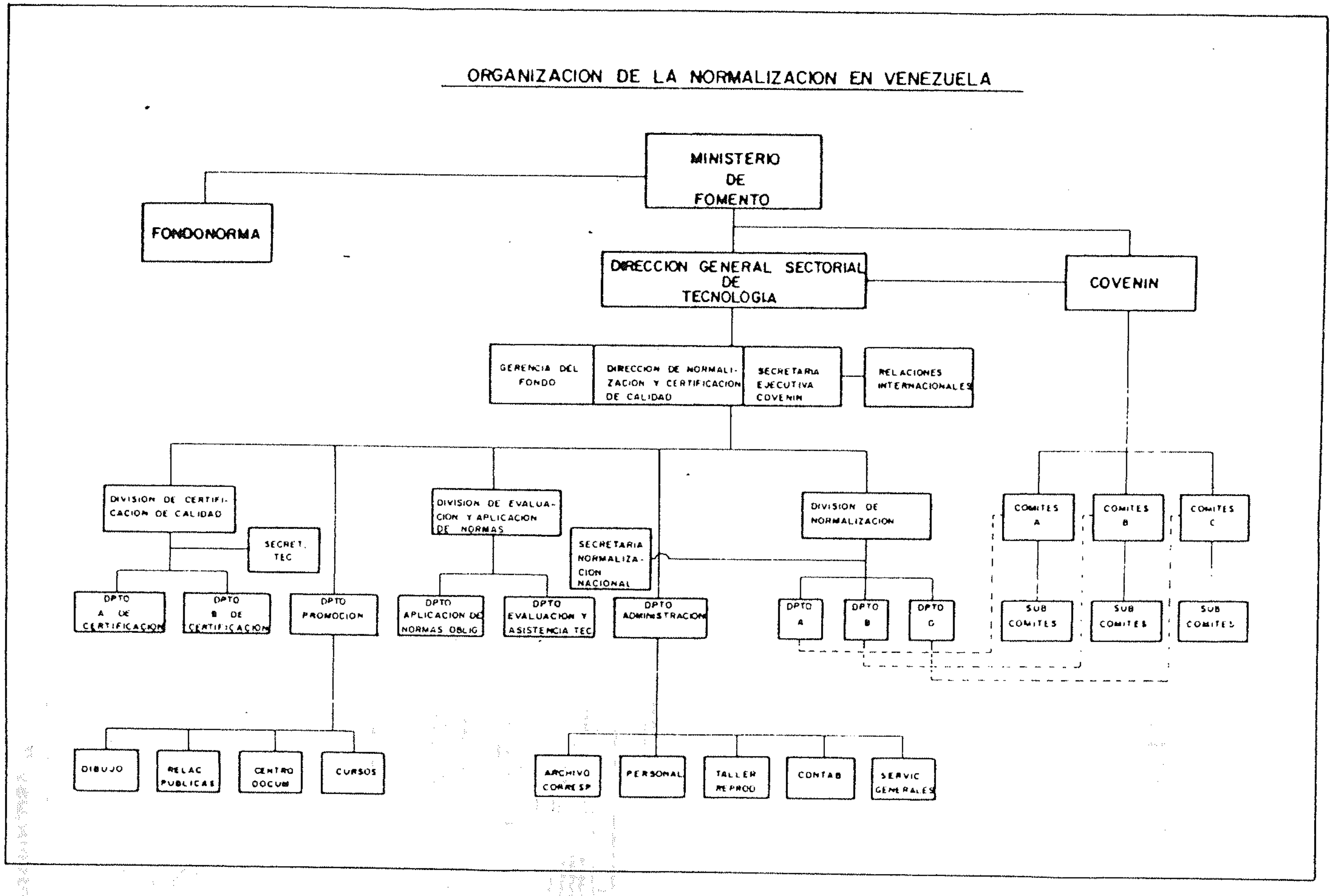

FIG. 3-7. Structure of Standardization and Quality Control in Venezuela.

Presupuesto 1980

FIG. 3-8. Structure of the Venezuelan Ministry of Development.

Table 4.1. INPRO Survey, 1971.

Table 4-2. COVENIN - FAVENPA Survey, 1975.

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Table 4-3. COVENIN - AIMM Survey, 1977.

Table 4-4. Results of Assessment on Quality Control Systems of the Metalworking Sector (1975-77).

Table 4-5. Quality Profiles of the Metalworking Sector (1975-77).

FIG. 4.1. Steps required to convert an idea into a finished product[152].

FIG. 4.2. Stages in specification process[153].

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FIG. 4.3. Some of the principal determinants and measures of quality[50].

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FIG. 4.4. Application of Machine Tools in the Industry.

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Fig. 4.5. Factors Influencing The Accuracy Of The Workpiece.

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Table 4-6. Integrated manufacturing systems - framework for development.

FIG. 4-6. The Computer-Integrated Manufacturing System.

Source: M.E.Merchant, CIRP. Vol. 6. 1977.

FIG. 4-7. Manufacturing Hardware and Software.

Fig. 4-8. Computerized measuring centre 161

Conventional Quality Assurance CAQA

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FIGURE 4.9.[162]

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Figure 5.1 .Giving the operator a fair chance to do the job correctly

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Figure 5.2. An operator–inspector subsystem[33]

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FIG. 5.3. Two Approaches to Improve Human Performance.[180]

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FIG. 5.4. The quality system concept.[181]

Fig. 6-1 Transfer of Technology Three Phases[188]

Table 6.1. A list of criteria of technology's appropiateness for a developing country.[201]

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Table 6.2. Components of manufacturing sector.[141]

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Table 6.3. Industrialization Level, Manufacturing and Q.C. Technologies[2]

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FIG. 6.2.— Productive Factors for Alternative Technologies

Source: G. Spur & G. Seliger. CIRP Seminar on Manufacturing. 1978.

FIG. 6.3. TECHNOLOGY ASSESSMENT FOR DEVELOPING COUNTRIES[213]

FIG. 6.4 Technology assessment for industrialized market economies.[213]

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FIG. 7.1. Quality Control Infrastructure at National Level.[139]

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FIG. 7.2. Conceptual components of the standardization system.[49]

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FIG. 7-3. Considerations for determining the quality control system for export goods.

FIG. 7.4. Worldwide integrated standardization - a global view from South America.[244]

FIG. 7.5. The product innovation spectrum: conception to birth of a new engineering product.[248]

A P P E N D I X 2

VENEZUELA - TODAY *

Contents

* An Appendix to Chapter 2

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* Source: The Economist. "The World in Figures" Macmillan Reference Books. 1978.

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A2-2. The Venezuelan Economy - Present and Future.

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MAP A2-1. Venezuela Physical Features.

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MAP A2-2 Venezuela Political Divisions.

MAP A2-3. Resources and Industry.

MAP A2-4. Venezuelan Industrial Centres.

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MAP A2-5. The Andean Countries.

Venezuela: Composition of GDP

(In per cent)

	1975	1976	1977	1978	1979
	(At constant 1968 prices)				
Total GDP	100.0	100.0	100.0	100.0	100.0
Petroleum GDP	11.0	10.3	9.4	8.9	9.3
Nonpetroleum GDP	89.0	89.7	90.6	91.1	90.7
Primary sector	16.8	14.9	14.0	13.7	14.5
Agriculture, livestock, fishing, and forestry	6.6	5.8	5.9	6.1	6.2
Crude petroleum and natural gas	8.9	8.1	7.3	6.9	7.5
Other mining	1.3	1.0	0.8	0.7	0.8
Secondary sector	24.4	25.6	26.1	26.9	26.7
Manufacturing	14.4	14.8	14.5	14.1	15.2
Petroleum refining	2.1	2.2	2.0	2.0	1.9
Construction	5.6	6.3	7.4	7.9	7.1
Water and electricity	2.3	2.3	2.2	2.3	2.5
Tertiary sector	58.8	59.5	59.9	59.4	58.8
Commerce	11.4	11.9	11.6	11.3	10.4
Transport and communications	11.9	12.0	12.6	13.1	12.5
General government	12.1	12.3	12.4	12.3	12.7
Financial and business services	13.1	13.2	12.9	12.8	13.4
Other services	10.3	10.1	10.4	9.9	9.8
	(At current prices)				
Total GDP	100.0	100.0	100.0	100.0	100.0
Petroleum GDP	29.1	27.0	24.7	20.6	26.6
Nonpetroleum GDP	70.9	73.0	75.3	79.4	73.4
Primary sector	31.7	28.5	27.0	23.9	28.1
Agriculture, livestock, fishing, and forestry	5.9	5.5	5.9	6.2	5.9
Crude petroleum and natural gas	24.8	22.2	20.4	17.1	21.6
Other mining	1.0	0.8	0.7	0.6	0.6
Secondary sector	22.3	24.1	24.5	25.4	24.7
Manufacturing	11.6	12.0	11.6	12.1	11.5
Petroleum refining	4.3	4.8	4.3	3.6	5.0
Construction	5.2	6.1	7.4	8.4	7.0
Water and electricity	1.2	1.2	1.2	1.3	1.2
Tertiary sector	46.0	47.4	48.5	50.7	47.2
Commerce	9.5	10.2	10.1	10.2	9.1
Transport and communications	9.4	10.0	11.0	12.7	11.4
General government	10.9	11.4	11.7	11.8	11.0
Financial and business services	8.4	8.2	7.8	8.4	9.0
Other services	7.8	7.6	7.9	7.6	6.7

Table A2-2. Strategy of the External Sector (1974-79).

Source: CORDIPLAN - Direccion General Sectorial de Planification Global

[redacted]

Table A2-3. Basic Goals of the Sixth Plan (1981-85).

Table A2-4 : Venezuela: Growth of Real GDP by Sectors[67]

(Annual percentage change)

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Table A2-5. Comparative Social Indicators[87]

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/a CORDIPLAN data - refers to "Areas Marginales".

Source: World Tables (World Bank 1980) and OSEI.

Venezuelan Import and Possible Substitution Levels in 1962 (ISIC)

	Imports		Possible Substitution		
	Tons	Value in bolivars	Percentage by weight	Tons	Value in bolivars
Metal products	139,660	336,001	29.4	41,104	140,289
Machinery except electrical	79,077	596,039	24.7	19,544	140,833
Electrical equipment	27,572	275,794	21.4	5,912	52,308
Transport equipment	59,702	417,155	18.4	10,900	63,381
Total	309,014	1,731,209	25.1	77,540	398,101

Table A2-6

The metalworking industries produce goods for the various sectors of the engineering industry that are classified as follows by the International Standard Industrial Classification (ISIC):

Manufacture of Machinery, except Electrical Machinery (ISIC 36)
Manufacture of Electrical Machinery (ISIC 37)
Manufacture of Metal Products, except Machinery and Transport Equipment (simple metal products or simple metal manufactures) (ISIC 35)
Manufacture of Transport Equipment (ISIC 38)
Manufacture of Professional, Scientific Measuring and Controlling Instruments (ISIC 391).

The corresponding classes of the Standard International Trade Classification (SITC) are:

Machinery, other than Electric (SITC 71)
Electrical Machinery, Apparatus and Appliances (SITC 72)
Manufacture of Metal, N.E.S. (SITC 69)
Transport Equipment (SITC 73)
Professional, Scientific and Controlling Instruments, Photographic and Optical Goods, Watches and Clocks (SITC 86).

Table A2-7

Source: ECLA studies.

Table A2-8

Table A2-9. Venezuela: Value Added of Manufacturing by Industry Groups 1/ at Constant Prices

Source: Central Bank of Venezuela.

1/ Excludes petroleum refining.

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Table A2-10

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SOURCE: LATIN AMERICA SPECIAL REPORT, a supplement to LAER, July 1978

Table A2-11

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Table A2-12. Plan VI: Most important programmes and projects.

A P P E N D I X 3

QUESTIONNAIRE FORM USED FOR THE FIELD SURVEY STUDY OF QUALITY CONTROL IN THE VENEZUELAN METALWORKING INDUSTRY

Contents

STATISTICAL QUALITY CONTROL AND ACCEPTANCE SAMPLING

A3.1 Acceptance Sampling Procedures

Check sampling plans both for:

(i) Incoming Product and
(ii) Quality assurance (Final product or intermediate stage of manufacture)

(i) Nature of product inspected

1. Does the quality level fluctuate?
2. Is there an occasional very bad batch?
3. Are records kept? By whom? What action is taken?
4. Obtain data if possible.

(ii) Choosing the sampling plan

1. Which concepts were used in choosing the sampling plan?

   (Acceptable quality level, producer's risk, lot tolerance, consumer's risk; or average outgoing quality limit; or based on other ideas?)

2. Who decided which concepts to use?
3. When were these plans introduced?

(iii) Types of scheme in use

1. Give detailed description of the relevant acceptance sampling schemes.
2. Are different inspection schemes used for different products? How many different schemes are used? Were they all determined by using the same concepts?
3. Are all sampling plans based on attribute (go-no go) sampling or are measurements used in any stage? If so, what scheme is used? (Quality control charts, Lot Plot, sampling schemes for measurements).
4. Is the intensity of the sampling increased or decreased based on the results of previous samples? How is this done?
5. Is sampling done from a continuous process?- If so what plans are used?
6. Are sampling plans used in any form to decide whether or not a process should be allowed to commence running?

(iv) Utilisation of Quality Information

1. Is the information gained from acceptance sampling fed back to the supplier and to the buying office?

2. Are quality bonus schemes based on results of sampling inspection? How is this done?

A3.2 Quality Control Procedures

I. How long has there been (i) system of inspection records?
(ii) Statistical quality control system?

II. How is control of quality exercised?

a. Use of operator

1. Does the operator on the machine carry out 100% or routine sampling or haphazard sampling?

2. (i) Does he measure the product (ii) Does he plot average and range charts or other charts relating to measurements?

3. (i) Does he gauge the product? (ii) Does he plot charts for percentage defective, number of defectives in the sample, or number of defects per unit?

4. If systematic sampling is carried out by the operator, how are the frequency and size of sample determined?

5. If charts are used, how are the control limits determined and plotted?

b. Patrol inspection

1. Does a patrol inspector check samples of the product?

2. Does he take measurements or gauge the product?

3. Does he plot charts for average and range; for percentage defective, number defective, or number of defectives per unit?

4. How were the frequency and size of sample and the control limits determined?

c. Supervisory staff

1. Does a member of the supervisory staff check the product or the production equipment?

2. What procedure is adopted? What is the frequency and nature of inspection?

d. How are customer and user department complaints utilised?

III. Recording and reporting quality information

1. Obtain details of:

   (i) Percentages defective, percentage returned, percentage rectified and percentage scrap on a periodic basis.

   (ii) The control procedures, the record cards and types of charts and departmental quality reports.

2. How is quality reported to management? Outline the nature and frequency of statements.

3. To whom and how often are they made?

4. How are machine capabilities determined?

5. How is this information used to allocate products to processes which can just hold the necessary tolerances?

A3.3 Organisation and Responsibilities for Quality Control

(a) Who is responsible in the organisation for:-

1. Specifying the standard of quality required?
2. Provision of adequate testing equipment?
3. Inspection to ensure that the specified standard is maintained in each case?
4. Reporting deviations from the quality standard?
5. Correcting deviations from the quality standard?
6. Training and education in quality control methods of:

   (i) Supervision
   (ii) Inspection staff
   (iii) Production operators?

7. Control and maintenance of:

   (i) Tools (Production equipment)
   (ii) Gauges
   (iii) Measuring equipment?

(b) To what extent do production, design and sales departments and customers co-operate in:

   (i) setting standards
   (ii) maintaining standards?

(c) 1. Is statistical quality control applied to jobbing work, or solely to products with long production runs?

2. Specify the organisational procedure for acceptance sampling. Obtain details of the type of records kept.

   (i) How is the sample chosen?
   (ii) Who inspects the rejected batches? (Inspection department; Supplier; Production Department - operator responsible or special staff)

(iii) What happens to the rejected material? (Replaced by supplier; rectified or scrapped without compensation)

(iv) If double sampling is used, what is the experience in organising for a fluctuating amount of inspection?

3. Specify the organisational procedure for control charting; obtain details of the type of records and charts in use.

(i) When is the sample taken?

(ii) How is it done?

(iii) Where are the control charts?

(iv) Who is responsible for determining and inserting the control charts limits?

(v) Is the information from control charts fed back to design or production planning departments? How is this done?

A3.4 Economics of Quality Control

I. Cost of Poor Quality

To what extent are the values of the following losses determined separately:-

1. Scrap at semi-finished stage
2. Scrap at final assembly
3. Loss of output due to defective tooling
4. Loss of output due to machine out of commission
5. Loss out output due to defective raw material etc.
6. Rectification and 100% check viewing
7. Quality guarantee
8. Cost of selling a good product in a lower grade (seconds)

If possible, consider each item separately.

II. Cost of achieving Better Quality

1. Are quality control costs dealt with as an overhead on production costs? What basis is used for allocating them to production departments?

2. Is there any record or can an estimate be made of the cost of control charting?

III. Savings achieved by Better Quality and Control Procedures

1. Have any savings in quality control costs been achieved due to reduction in the amount of inspection (a) within own plant, (b) within customers' plant?

2. Have any reductions in the losses listed in I been achieved during the period in which quality control has been operating? Consider each item separately if possible.

3. Has improved quality resulted in more efficient utilisation of the equipment in subsequent processes? Has this been evaluated?

4. Have savings occurred due to the correct matching up of processes and drawing tolerances, and the elimination of unnecessary precision?

5. Are there any instances of the application of control charts to weighing processes? Is any balance struck between the cost of the amount given away and the loss through giving too little?

6. Are there any examples of cost savings through widening drawing tolerances which were previously unnecessarily tight? Obtain details.

7. Were the cost savings due to:

   (i) technical action based on control charts or
   (ii) the psychological impact of the charts?

8. Is the cost of quality control recovered through cost savings?

IV. Miscellaneous

1. Are acceptance sampling plans based on cost considerations? If so, how, and is there a specific example?

2. Has any assessment been made of the cost of allowing a defective item to pass each inspection point? Consider (a) lost time in subsequent stages of manufacture (b) work done on a product which is already defective (c) damage to user (machinery, tools, personal injury).

3. To what extent is market research carried out to ensure that satisfactory product quality is being achieved?

4. To what extent are products guaranteed, and what is the nature of the guarantee?

5. Are engineering cost studies made to suggest cost savings either (a) by comparison with competitor's products, or (b) by analysis of reports of defective work?

6. If quality bonus schemes are in operation, what has been their effect? What amount of money is being spent on bonus schemes and what is the extent of the savings attributable to them?

7. Are operators paid (a) for producing good work only
(b) a bonus based on the percentage of good work produced
(c) on total output or
(d) day work?

Source: Department of Production Technology and Production Management, The University of Aston in Birmingham.

A P P E N D I X 4

CASE STUDY - COMPANY X

Contents

A4.1 An Outline of Company X*

Establishment:	January, 1976
Capital:	Bs.15 millions (approx.£1=Bs10)
Number of employees:	86 persons
Working time:	1st shift 6 am. - 2 pm. 2nd shift 2 pm. - 10 pm.
Main products:	Screws, bolts, studs and nuts for the automotive industry. Special and standard usage.
Q.C. System:	A system of inspection records was introduced in the company in 1976. This Quality Control sys-them includes: first-off inspec-tion, operator control, patrol inspection and final inspection. Acceptance sampling schemes are based on the AQL concept, and X and R control charts are plotted when acceptance sampling by vari-ables is performed. Sampling plans by attributes are also per-formed, but no records are kept. A re-sampling technique (no double sampling) is currently exercised when the first sample is rejected. There is no formal Quality Control Department. The technological and management quality functions are centralised. Quality control management (inlcuding quality cost), Quality Control engineering, and

*The name of the Company has been omitted for obvious reasons.

Quality Control information equipment engineering, are the responsibilities of the Director General. The Plant Manager gives technical assistance to shop floor operations, and also decides the corrective action to be taken after analysing the quality information reported to him by the Chief Inspector. Among the main problems, there is a lack of quality consciousness, in-plant education and a training programme is needed, as well as a company's standardization programme; Process capability studies must be carried out, etc. However, a company's Quality Control Manual has been written in which all the inspection and test procedures, as well as the responsibilities of quality personnel are described.

A4.2 Standardization at the Company X

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A4.3 **FICHA DE EVALUACION** (Quality Assurance Audit)

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APPENDIX 5

CASE STUDY - COMPANY Y

Contents

A5.1 An Outline of Company Y*

Establishment:	December, 1977
Capital:	Bs. 80 millions
Number of employees:	62 persons
Working Time:	1st shift 6 am. - 4 pm. 2nd shift 4 pm. - 1 am.
Main Products:	Gears for the automotive industry
Q.C. System:	Since Company Y started production of gears in 1977, there has been an ever increasing interest in preparing a statistical quality control programme. However, this quality control system has not been evaluated by COVENIN. At the moment the company's Quality Control Manual is being written. This is a Venezuelan-American company, so most of the company's standards have been adapted from the parent company. Manufacturing facilities are ranked from manual to N.C. machine tools. Inspection and testing equipment are periodically calibrated and records are kept. Inspection labour force accounts for about 30% of the total number of employees. Process-capability studies have been introduced. The inspection procedures include: first-off inspection, operator control, patrol inspection and final inspection. Control charts

* The name of the Company has been omitted for obvious reasons

are only plotted by the patrol inspector. The quality information is analysed by the Quality Manager, who reports directly to the company's Managing Director. As this company has only one customer, a company which also belongs to the same group, there is a good feed-back system for reporting customer complaints. Education and training in quality are the main problems. Also, a Quality Assurance Manual must be written in order to define precisely the responsibilities of quality personnel.

A5.2 Standardization at the Company Y

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A5.3 <u>FICHA DE EVALUACION</u> (Quality Assurance Audit)

A.5.4. ARE THE DEFECTS OPERATOR-CONTROLLABLE?

APPENDIX 6

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A6.2. Further Reading on Quality Control in Developing Countries

This list has been compiled to serve as a brief guide to the literature on Quality Control in developing countries. Thus, it should be noted that no attempt has been made to make it fully comprehensive, rather the intention has been to complement the many references cited in the preceding chapters of the thesis.

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