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An Approach to Technical Skill Development for Industrial Growth--A Way Forward for Developing Nations

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Abstract

The study started with the analysis to examine the performance work skill needs of engineering and technology education students of Nigerian universities such that they will acquire the necessary theoretical knowledge requisite for practical training for a typical Nigerian refinery project. The study developed the most effective method of producing the required technical and managerial kill for increase productivity in any industrial set up. The training program outlined was made to show how technical manpower skill should be structured as basis for efficient management and matching of skill development to needs for technological enhancement. With the foregoing as background, the study developed an engineering planning method for generating skill required for new projects and attempts to program them for industrial development. The designing system created here manages the issue of how to upgrade the way toward growing new abilities with the goal that they are accessible as required amid the way toward setting up new enterprises particularly in the division of creating economy. Planning of technical education right from universities and polytechnics is a vital ingredient for generation of efficient workforce. The study noted that most of the student in Nigerian universities and polytechnics lack the necessary tool with which to become skillful engineers and technologist. It was discovered that the education of engineers and technologist students in Nigerian universities require some basic vital ingredient such as complying with safety precaution when performing a task.

Keywords: education and training, industrial development and engineering & technology, performance skill, planning methods, technical and managerial skills

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INTRODUCTION

The planning of any industrial and technological development of any country should start right from the educational training of engineering and technology student. The technical skill requirement of engineering and technology student from Nigerian Universities are gradually going below standard and effort should be made to rescue the situation right from the training level. There is no gain producing large number of engineers and technologists on yearly basis from Nigerian Universities without providing them with the right technical skill, attitude to industrial work order, inculcating the right habits of mind that are adaptable to changing needs which are opened to technological innovation and to avoid assumptions. Educational training of engineering and technology student in Nigerian Universities should be restructured and planned to be productive such that students are equipped to be effective, adaptable and generally responsive to the desired needs.[1]

The performance technical skill of engineering and technology student should be embedded with creativity, dynamic and innovative abilities to develop further. The attainment of sustainable industrial development is predicated on the impact of skills acquired and its utilization in the national industrial sector.

Skill training and development is a prerequisite to student exposure to technical work skill performance, quality of skill acquired and adaptation of such skill is a key to sustainable industrial development.

The essence of engineering and technology education programmes is to assist individual student, to develop optimal and effective work attitudes, acquire the relevant knowledge and technical skills of an occupation to advance in the profession. The three major domains involved in engineering and technology education are constructive, productive and psychomotor. Performance work skills can be referred as non technical abilities, employability skills and work ethics. This employability skill includes understanding problem, solving, initiative skills and other skills, like adaptability, a positive behavior and other performance skills and impediments.

Building desirable work attitude is vital for success of any well meaning industrial set up. This is so because industries where these graduates work, make use of the complex machines, that require workers that are emotionally and technically stable, workers that are focus, loyal and are ready to learn and take instructions from the supervisors.

Studies have shown that one of the major reasons why young men lose their jobs is as a result of poor attitudes to work and lack of work related interpersonal skills, several young technicians in America are thrown out of jobs not because they are not practically or theoretically unfit, rather because they lack manners and interpersonal skills. And most of these young workers did come late to work drunk and demonstrate high level of stubbornness, as a result of this unproductive and disobedient behavior, many industries and factories are unable to meet desired productivity level. Many young workers today lack these non-technical competences that are associated with characteristics of occupation such as interpersonal relationship with peers and supervisors, work rules and job findings. It is based on these that a well planned technical education training should be embedded in our educational programs right from the onset Many developmental projects in the public sector of developing nations are now leveled up for lack of trained technical capabilities. The method demonstrated here will help to estimate the probable availability of skills required and plan to meet the shortfalls if any.

LITERATURE REVIEW

Education and Training Are Usually Associated With the Acquisition of Knowledge both Practical and Theoretical

According to British Foundry Industry Training Committee (1970) says that there is no doubt that effective educational training program for engineers and technologists must incorporate element of the forgoing; recognition and definition of problems, exploitation of the full range of technological methods, exploitation of available information, awareness of values and cost appreciation of the process of innovation, awareness of safety, appreciation of human factor, critical point of view based on science and logic, communication processes, self-development and development of others. In addition, the educational training program of engineers and technologist in

Nigerian Universities should have the following characteristics to ensure the availability of required technical skill for industrial development;

1. An inbuilt flexibility in the training program so as to allow for rapidly changing technology.
2. Success in modern engineering practices is achieved only through team work and good human relations. This must be noted.

In other words work ethics can be seen as some set of values based on normal virtues of hard work and diligence. It is also a belief in moral benefit of the work and its ability to enhance character. A work ethic may include being honest, having initiative or maintaining work orderliness and social skills. right and positive habit of mind when performing a specific task, exhibiting professional and positive attitude in the use and handling of tools and equipment, development of self confidence and emotional stability on the machine, ability to respect other people's opinion, ability to cooperate and work as a team.[2]

It has been noticed that estimation of profitable conduct is at present accepting accentuation in Nigerian Schools, for instance the Federal Government of Nigeria in the National arrangement gave two execution destinations of Nigerian training. This is on account of instruction ought to lead not just to the securing of subjective and psychomotor abilities additionally to the improvement of proper states of mind and Values. Knowledge or skill behavior through learning experience to achieve effective performance in productive activities. The teaching of appropriate values and behavior should form part of the technological education program

In view of the foregoing assertions, the study will in addition look into the understanding and perception of engineers, technicians and lecturers on effective or performance work skills requirement of engineering and technology education student of universities in Nigeria for industrial development especially in a typical refining plant.

The Problem of Technical Skill Development

The developing countries of the world are eager to achieve rapid economic development in order to lift the masses of their peoples from poverty. This, however, is easier wished than achieved. Development cannot occur without resources and not all developing countries are rich in natural resources. Happily Nigeria is a bit more fortunate than most countries in this regard. It has good agricultural potential and its mineral resources are not insignificant. As a result, some people believe that Nigeria probably has one of the best prospects for developing a modern and dynamic industrial economy in tropical Africa. But having the potential does not by itself ensure that potential will be realized. There must be a determined effort to make the necessary transportation.[3] This can only be done through the ability and skill of the people to organize and participate in productive activities. People are not born with skills; they acquire them. It is for the purpose of imparting skills (broadly defined) that education and training come into playing a vital role in economic development.

Today, Nigeria is poised for an industrial revolution. The government and peoples of the country are determined to develop modern industries as a solid base on which to erect a modern economy. The establishment of industries requires capital, technology and trained manpower. Capital in the form of foreign exchange is becoming less of a constraint thanks to oil revenues.

The major outstanding constraints are, therefore, technology and trained personnel. Technology can be bought up to a point but purchase technology without the trained workforce to utilize it is wasteful and ineffective. So the problem of modern industrial development in Nigeria reduces to the number and quality of valuable trained technical manpower. The point is that if Nigeria can afford to purchase modern industrial plants, it cannot operate them with masses of uneducated men. But if educated men are needed, what are the types and quantities required at any given time? This is a key question and most developing countries have not in general found an effective way to answer it.

Some countries consider the technical skill workforce problem so crucial that a special government unit is established to deal with it in the form of forecasting the need by categories and levels. Nigeria has a manpower board which is engaged in this sort of work. Its main approach to the problems is to make periodic surveys of existing industries, government services and public corporations to assess existing manpower levels, attrition rates and projected need. From the surveys and making allowances in some fashion for expected economic development and growth, it makes forecasts of global workforce requirements. There are so many handicaps in the way of global forecasts that it is always nearly impossible to isolate from the global figures, manning data for any of the specific development projects which the global estimate is presumed to comprehend. The manpower Board is in a difficult situation in this regard. If an industrial project is merely contemplated is being planned but non-existent, the Board cannot survey it in order to estimate the required manpower for its establishment.

If suitable provision is to be made for the industry either alternative method have to be found apart from surveys or recourse made to available published information on the manning of industrial projects. Published data on the manning of industrial project is almost completely non-existing. As Unido says, “The lack of solid data described the skilled labor requirements of industrial projects has been and continues to be an important factor which inhibits the effectiveness of the efforts made by the manpower expert. The problem of providing data on skilled manpower for specific industrial development project in developing countries is probably the most important obstacle to industrial development in most of these countries. For many projects, the types of skills required depend upon the type of technology employed.[4] So the problem of estimating skill requirement is intertwined with the study of various production technologies which in turn depend on available resources.

The technical skill required for a typical petroleum refining plant can be achieved by a well planned technical training program as described in the foregoing chapters which clearly illustrates the problem. It is maintained that studies of this type is vital in order to relate employment needs to the provision of skills for various planned industrial projects. But before we outline how this effort might be extended to a larger domain, let’s briefly discuss another aspect of the technical workforce problem.

It is a common knowledge that Engineers, Scientist, Technicians and Craftsmen are essential for modern industries even though the exact numbers and types for any given industry may not be known. Therefore, most governments in developing countries simply proceed to establish training schools, polytechnics

and universities for generating the above skill categories. In some countries because there has been no realistic basis for planning the establishment and output of these institutions, there have been cases of wrong and/or over production of the type of skills that were presumed to be required.

India provides several examples in this regard.[5] Soon after independence, India outlined very ambitious industrial development programs for which it was anticipated that a large number of scientific and technical skills would be needed. The country then proceeded to establish a large number of universities and various types of technical institutions but without a very careful appraisal of the expected manpower need both by type, quantity and quality. The expected rapid industrial development did not occur to the extent that was hoped for largely due to over-optimistic reliance on promised foreign assistance which failed to materialize in all essential aspects. Industrial development has taken place in India but not to the extent anticipated by the output of trained manpower. The result is that in some skill categories, there was massive unemployment to a degree that is hard to imagine outside the country. In cases where some attempts were made in manpower planning, the vagaries of economic life deriving from inadequate resources vitiated the results.

India's experience illustrates that manpower planning must take very careful account of economic factors and that rapid economic development cannot be achieved even with a large pool of trained manpower under conditions of inadequate natural resources. Effective manpower planning must take account of all relevant factors to the highest possible degree. Almost at the opposite extreme at the onset were Brazil and South African countries with large natural resources but whose realization of its vast potential was significantly impeded by inadequate supply of trained technical skill, For instance, Brazil plans to expand its coal output to 20 million tons per annum by 1980 from the 1971 production of about 6 million tons. It is feared that a major obstacle to the attainment of that goal is the expected non-availability of the requisite type of skills.[6]

Instituto Brasileiro de Siderurgia in one of her publication says that for the proposed expansion, "about 100,000 new jobs will be created and roughly half that figure will consist of skilled workers and medium or higher level technicians" It goes on to say that "it is not enough merely to define the quantity of personnel needed, more important is to define a method for mastering the required labor force within the time limits imposed by application of specific means and training measures. It should be noted here that oil refining industry already exists in South Africa and Nigeria, and identifying the required types of skills is no longer a great problem. Despite this, it is thought that the job of producing technical skill is still of formidable proportions: the types and quantities of skills have to be determined in order to estimate the type and number of training places to be provided with appropriate instructions so that the production of skilled personnel will be achieved where and when needed.

From study severe shortages may be seen from some certain skills which have to be balanced right from the training program. This type of problem can be solved from similar industry which already has a good foundation.[7] The simple thing is to collect data and do a simple calculation based on the capacity of the new industry and one would have an idea of the magnitude of the problem for the whole skill.

Nigerian present situation is a bit nearer to that of Brazil and South Africa than of India in the past. The Federal and state

government realized the vital need to expand education and training facilities. In respects of technical personnel, some state government are establishing and/or expanding polytechnic and technical institutions. What is critically missing in an otherwise commendable national effort is the lack of knowledge and planning regarding the approximate need for technical manpower according to type, quality and quantity. An uncontrolled and uncoordinated establishment and expansion of universities and technical institutions could very well create unwanted surpluses in some fields and glaring deficiencies in others. This is where the type of study undertaken here could play significant role by identifying and quantifying skills in respect of various industrial schemes to which firm commitments have been made or which the trend of the economy indicates are inevitable in the course of development in the immediate future. The method thus obtained would serve as a guide to the planning of technical training institutions.

In many developing countries, one common approach to the establishment of industries is to sign agreement with technical partners who provide the equipment, operational know- how and estimate the workforce required. If the agreements are properly structured to provide for effective participation by the developing country, there remains the fact that the workforce estimates are not usually supplied until the project is well underway such that even the agreed "effective" participation is not immediately possible because the types of personnel required may not be available. This means that the technical partners or contractors arrange to provide a large number of technicians at all levels over an extended period of time.

The cost of imported technicians is fantastically high. Hundreds of men descend on a poor country all demanding the most modern houses and other amenities which are scarce. If several large projects are being executed on this basis, it is easy to see that the cost of expatriate salaries alone could be quite large. According to Yesufu,[5] it is generally the case that the initial salaries of expatriates are higher than those of Nigerians in equivalent positions by as much as thirty to fifty percent. This has been explained by the necessity to attract the expatriates to Nigeria since they would normally be able to earn equally high if not better money incomes in their own countries. The same arguments are put forward in support of the more favorable fringe benefits which expatriates enjoy with respect to housing, car and family allowances. It is apparent that the cost of importing expatriates on a large scale would be prohibitive and could hobble the industrialization effort on account of the cost alone if nothing else. Usually there are a lot more which need not to detain developing countries. What is beyond doubt is that planned and coordinated technical skill development would yield very tangible benefits in developing countries and should never be joked with.

EDUCATION AND TRAINING OF PEROSNNEL

Sketch of the Training Problem

In this paper the training of technical personnel especially practical skill acquisition will be considered and as a way forward to achieve the requisite workforce for a typical industrial plant. There are many problems in these topics. The most difficult one is to find where the training should be done. Training is usually differentiated from education by associating it mainly with acquisition of practical skills. It is not absolutely essential to make the distinction between

education and training but it serves for the purposes of discussion to assume that training is to be offered in situations where facilities exist for imparting practical skills. Of course, we shall also be concerned with basic education in relevant technological fields, particularly in respect of courses not available in developing countries as yet. It is apparent that for a country without well structured technological programs for industrial development, the education and training of technical personnel poses severe problems.[8]

Assuming that places are available for offering training, it is a problem to select suitable persons to undertake the training particularly in fields where the basic technological education is not available in the country. In such situations it will be necessary first, to organize and restructure the basic education from primary to university level before arranging for the practical training appropriate for setting up new industries. It is immediately apparent that either institutions will have to be established at home or large numbers of students have to be sent abroad to acquire the basic technical education. Either way poses problems. It is not easy to find places for a very large number of students abroad and it costs foreign exchange to maintain them when admitted. On the other hand, it is always a slow process to establish well equipped new institutions at home due to problems of capital investment and staffing. All these factors combine to make it extremely difficult to programme the output of trained persons for a new developmental project to a tight schedule, lucky enough most of the developing nations today have improved, educationally with quality universities and polytechnics.

Assuming that the foregoing issues have been disposed of, how is the training be done? How would one determine what to teach the managers for instance, to enable them to operate a good industrial plant successfully especially in Developing Nations? The problems of management are affected by the socio-economic environment although there are bound to be issues of common interest, particularly between countries at similar stages of development. It is such similarities that this type of study can help to elicit. In developing training schemes for industrial employment in a developing country, it is necessary to bear in mind such problems as developing the right attitude to industrial work, inculcating the habits of mind that are adaptable to changing needs and are open to technological innovation so that it is not always assumed that all are problems, even in the long-established technology of petroleum refining plant, have been solved or that solutions will always emanate from somewhere else. There is a great danger that those who receive ready-made technology tend to take it for granted and do not strive to make local improvements on the assumption (wrong) that none are possible at the Local Level. It is here that South-African achievement in pioneering the Fischer tropisch process for coal refining should be noted as a salutary lesson to all developing nations. Those who receive ready-made technology must strive to develop it further or else will stagnate eventually and be displaced by dynamic technology. Progress is bound to be slow in this direction initially but it is the only sure way to achieve real technological development.

The petroleum refining industry is a complex one to operate successfully and such an achievement can only result from a full awareness of certain basic operational hazards and their effective evidence. Such matters as safety rules and regulations, good communication and smooth industrial relations between and within all levels, a sense of good team spirit and keen awareness of the essential operations of an integrated processing

plant. These should be emphasized in all aspects of training. The field of training for this industry is so vast that it is necessary to restrict the discussion. In this paper only to key training problems, we shall, therefore, be concerned only with outlining guiding principles or with developing brief outlines for training manpower in broad categories. There are five main categories of training, namely, management and supervisory, technologist, technician, craftsmen, and operative training. These are large areas and there is the danger of losing the substance in attempting to be brief or of being lost in detail in attempting to be comprehensive. The problem is to strike the right balance.

Management and Supervisory Training

The term "management" embraces the whole group of persons from the GM to first supervisor. These men are engaged in the direction and control of the enterprise and its employee. It is usual to designate managers as those who set the objectives and decide on the priorities. They also device and implement means for the successful execution of the objectives and the assessment of results achieved. In this chapter I have explicitly designated some posts as managerial but the term applies to others such as chief mechanical engineer or chemists who are clearly involved in managerial functions.

On the other hand supervisors are primarily concerned with the coordination and control of particular activities, devising and operation of routines of work with special emphasis on optimizing human effort.

The distinction between a manager and supervisor is not water-tight because their roles overlap in various ways. A manager may in his daily duties perform supervisory functions while a supervisor may similarly perform certain duties that are of a managerial nature. The distinction between managerial and supervisory personnel is, therefore, largely one of convenience handy for discussion purposes.

The main objectives of management are to ensure that the enterprise is operated in such a manner as to achieve the goals for which it was founded. Hence, the goals of an enterprise largely dictate in broad terms, the type of training suitable for its managers. A typical petroleum refining plant will have as its major goal the production of various products in quantities and qualities required by the economy at minimum national cost, i.e. maximum national profits. This means that the managers and supervisors have to be trained to optimize in accordance with national objectives; the use of men, machines and all other input resources. To achieve this is clearly a task of major proportions. The men will have to be not only technically competent in their chosen field but should also have a broad and up-to-date knowledge of all important tools of management.

Technical competence is the first major consideration. It is essential to select men who are well educated and if possible have practiced in any of the technologies associated with same industrial plant. This is hard to fulfill in a country without prior well established high technology industrial plants. There are few experienced technical personnel from developing countries working abroad in similar companies but these cannot amount too much even if they can be persuaded to return home to efficiently manage and operate the new ones at home. There are two ways to tackle the problem.

(i) In such fields as mechanical, electrical and civil engineering where there are quite good Indigenes in practice either

in government or industry, suitable inducements should be offered to attract them into the refining plants; such persons should after selection be sent abroad to acquire experience in the operation of petroleum refining plant or any other industrial plant relative to the project especially in technologies to be employed in the proposed plant. They should first be exposed to the whole range of processes in a petroleum processing and refining plant or any other industrial plant to acquaint them with the interconnected nature of refining processes and all associated products production in an integrated plant. Thereafter, in the case of oil refinery they should concentrate on some chosen aspect such as the distillation plants process or ammonia plant. The training should be practical, i.e., they should actually participate in the operations assuming appropriate responsibilities rather than as mere observers. They should be assigned tasks or projects in which verbal and/or written reports are obligatory. Such training can be arranged with the technical partners in the petroleum processing project or through Governments of appropriate friendly countries.

(ii) In areas where they are extremely few Indigenes already qualified such as mechanical, electrical and petro-chemical engineering, a crash program should be initiated without delay to send young persons abroad to acquire basic technological education and to be followed by the sort of training outlined in (i) above. There will be more to say about the education of petroleum and petro-chemical engineers under the section on technologists.

The above program applies with equal force to supervisors as well as managers but with special emphasis on the peculiar responsibilities at each level. The problem of recruiting practicing technicians in mechanical, electrical and civil engineering is likely to be much less than that of engineers since all polytechnics offers technician courses in these fields. We shall deal with this problem under technicians training. The next aspect of the problem of training managers and supervisors is that of the art of management and supervision. This is a large topic and only the main guidelines will be indicated.

First prerequisite in management, supervisory or any other training is to define the duties of each post very carefully and to assess whether individuals occupying or likely to occupy each post have the required qualities of character and training to discharge those duties. Training should then be designed to either inculcate or reinforce the necessary skills according to the degree of deficiencies determined from the assessment. With this broad guideline as a starting point, one then proceeds to consider other important general aim of training. For instance the essence of management or supervisory training is to ensure through a process of planned and constructive development that individuals are equipped to be effective, adaptable and generally responsive to the needs of the enterprise in the areas of that responsibility. Managers or supervisors have to be flexible in outlook not only in tackling present problems but in foreseeing future ones. They should be aware of their responsibilities for the training needs including safety and welfare at work for those under them.

The necessity for managers and supervisors to be fully responsive to the needs of their subordinates is a crucial one in any industrial processing plant. Nowhere probably in all industry, is team spirit and cooperation more important than in an integrated processing and refining plant because of the inter-dependence of

the sections. Hence, managers and supervisors must be trained to develop in the work force all those habits of mind and body conducive to the safe and effective operations of the plants at all levels.

From the foregoing it is apparent that the selection of men who not only have the right education but also the right qualities of leadership including clarity of mind, stamina, diplomacy, enthusiasm, drive, sympathy and patience is extremely important. Training cannot be effective if the quality of men selected for training is poor. Careful selection reduces the task of training to developing discernible intent qualities or correcting a limited range of deficiencies. It is far better to reject individuals during the selection stage particularly in a public enterprise than to attempt to sack them after employment for it may be quite impossible to do so. Hence, careful attention to the selection process is essential if future efficiency is to be assured. This is true at all levels of training but more so at the top levels because of the crucial role of managers and supervisors in the effective operations of an enterprise. Poor management and supervision could perhaps irreparably ruin an enterprise particularly at the nascent stage.

The importance of training as a continuous process should be emphasized to managers and supervisors at all stages of their careers. This does not only mean their own training and development but that of all others in the enterprise. This point has been mentioned before but it can bear repetition because it is extremely important to any enterprise in this age of rapidly advancing technology. Training is a wide concept and embraces all aspects such as inculcating, "coaching and counseling" skills in all those who occupy superior positions. These two skills are rarely employed in practical management because they require rather uncommon talents. The successful development of a good manager or supervisor largely depends on the ability of his superior officer to coach and counsel him. This requires considerable tact and patience for it demands detailed discussion between a subordinate and his superior on the daily operational problems and how to overcome them. It is a continuous process which requires an up-to-date awareness of subordinate's performance on everyday situations so that suitable guidance and help can be offered. This is particularly true when a new industry with a sophisticated technology is being established. Therefore, the inculcation and reinforcement of this type of coaching and counseling skill should be an important goal of the training program.

Another vital aspect of training which should be emphasized in developing managers is that of encouraging technological innovation. Managers should be trained to be capable of assigning challenging tasks to engineers and providing them with means of accomplishing those tasks. All too often one hears of bureaucratic management in a developing country which stifles the imagination and creativity of talented men. Merely importing technologies without developing the talents that will not only sustain them but will also develop new ones; can only end in a technological and industrial desert in the long run which may not be too long. It is easy enough if a country has the resources to establish car assembly plants but such investments can only lead to aridity if there is no careful plan for the system to rejuvenate itself. The neglect of such a vital built-in, self-regeneration can end up in stagnation and death of the industry within a few decades.

There are a large number of management tools which training should cater for. In devising a training program all factors

likely to affect management training needs should be considered. Some such factors are the objectives of the enterprise; market, production and manpower forecasts; technological changes; financial resourcing; required managerial performance and available managerial resources. Detailed analysis of all these factors is unnecessary here. Suffice it to say that a careful consideration of the role of each is important to the development of an effective training program.

Education and Training of Technologists

This section will consider the training of highly qualified group of persons designated as technologists in any manpower system. The technologist is defined as a person who is competent to apply scientific principles to the analysis and solution of problems of a technical nature. Technologists should be capable of continuously following progress in science and of making their own contributions to developments in the function in which they are employed. In the main, technologists deal with practical problems but the work is predominantly intellectual and varied, requires the exercise of original thought and judgment and involves personal responsibility which may include the supervision of the technical and administrative work of others. Their initial employment is within specialist functions but they gradually begin to take on responsibility for the work of others and to make decisions about the way in which the work is planned, organized and controlled. When this time arrives, the technologists will be more closely involved in management functions and it is from the performance of such functions that suitability for advancement to managerial status may be assessed.

In fact most managers are developed from technologist so the treatment here will overlap with the previous section but the main emphasis will be on the scientific and technological aspects.

It is seen from the brief description of a technologist in the previous section that he has to perform many functions. One of the most important is to optimize the use of materials, processes and systems. This responsibility involves aspects of cost, manufacture, product life of the output in terms of their reliability and acceptability. It is here that the work of process and inspection technologists and chemists become crucial to the output of a petroleum refining plant or any other industrial plant.

The range of abilities and skills required by a technologist in his entire career is large and it is neither practicable nor desirable to list them all. But as the British Foundry Industry Training Committee says, there is no doubt that effective training programs for technologist must incorporate elements of the following: recognition and definition of problems, exploitation of the full range of technological methods; analysis of available information; awareness of values and costs; appreciation of the processes of innovation; awareness of the safety and health implications of new processes; appreciation of human factors; critical point of view based on science and logic; communication processes; self-development and development of others. These covered the broad range of factors that training must carter for, but before dealing with the specific training of various groups, it is desirable to emphasize certain important general principles that may apply to technical training.

Most country's objective is to be industrialized but even if this is done at the fastest rate possible. It will be a matter of at least a decade before real take-off can occur in this sector. Now technology is not static; it is highly dynamic and by the time Nigeria or other developing Nation begins

to effectively use the technology of today, new techniques will have multiplied all over the technologically advanced countries. For instance, in synthetic fuels production Fischer tropisch process has been famous for over fifty years but it is not static. The South African are developing a synthetic process reactor of the Fischer Tropisch which is claimed to be much faster, economical and more efficient than the tubular fixed bed reactor. The Germans, originator of Fischer Tropisch technology have developed and are still developing another version called the Advanced Synthol Reactor. In the field of machine tools, numerical control machine tools, catalysts and heat exchangers have been properly selected to suit the developed and developing countries raw material rank.

The rational from the above brief survey and previous analyses are that the training of all technical manpower in Nigeria and other nations must have the following basic characteristics:

(i) A built-in flexibility in the training system so as to allow for rapidly changing technology;
(ii) A broad-based education for trainees so as to make them adaptable to changing industrial practices.
(iii) An emphasis on the fact that industrial problems rarely have a unique solution and therefore training must provide experience with which to make the right choice of alternatives.
(iv) Emphasis on the fact that success in modern engineering practice is achieved only through team work and good human relations. Nigerians and indeed Africans are highly individualistic but individuals making arbitrary decisions cannot operate an integrated refining plant.

These basic principles must be applied at all levels of training from technologists to craftsmen and operatives.

Training has various facets which pertain to the objective in view. The major objective is to prepare technical personnel for manning an existing and non-existent plant so we must by-pass certain facets of training which are more appropriate to an existing plant. The main task is to outline a scheme for producing the various types of technologists needed to establish the plant. The most important technologists are mechanical, electrical, metallurgical, chemical and mining engineers. In addition, there are a few physicists and chemists. Some mechanical engineers specialized in fuel technology, lubrication and industrial engineering. Let us briefly state how these various types may be given the initial There are a large number of management tools which training should cater for. In devising a training program all factors likely to affect management training needs should be considered. Some such factors are the objectives of the enterprise; market, production and manpower forecasts; technological changes; financial resourcing; required managerial performance and available managerial resources. Detailed analysis of all these factors is unnecessary here. Suffice it to say that a careful consideration of the role of each is important to the development of an effective training program.

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It is seen from the brief description of a technologist in the previous section that he has to perform many functions. One of the most important is to optimize the use of materials, processes and systems. This responsibility involves aspects of cost, manufacture, product life of the output in terms of their reliability and acceptability. It is here that the work of process and inspection technologists and chemists become crucial to the output of a petroleum refining plant or any other industrial plant.

The range of abilities and skills required by a technologist in his entire career is large and it is neither practicable nor desirable to list them all. But as the British Foundry Industry Training Committee says, there is no doubt that effective training programs for technologist must incorporate elements of the following: recognition and definition of problems, exploitation of the full range of technological methods; analysis of available information; awareness of values and costs; appreciation of the processes of innovation; awareness of the safety and health implications of new processes; appreciation of human factors; critical point of view based on science and logic; communication processes; self-development and development of others. These covered the broad range of factors that training must carter for, but before dealing with the specific training of various groups, it is desirable to emphasize certain important general principles that may apply to technical training.

Most country's objective is to be industrialized but even if this is done at the fastest rate possible. It will be a matter of at least a decade before real take-off can occur in this sector. Now technology is not static; it is highly dynamic and by the time Nigeria or other developing Nation begins to effectively use the technology of today, new techniques will have multiplied all over the technologically advanced countries. For instance, in synthetic fuels production Fischer tropisch process has been famous for over fifty years but it is not static. The South African are developing a synthetic process reactor of the Fischer Tropisch which is claimed to be much faster, economical and more efficient than the tubular fixed bed reactor. The Germans, originator of Fischer Tropisch technology have developed and are still developing another version called the Advanced Synthol Reactor. In the field of machine tools, numerical control machine tools, catalysts and heat exchangers have been properly selected to suit the developed and developing countries raw material rank.

The rational from the above brief survey and previous analyses are that the training of all technical manpower in Nigeria and

other nations must have the following basic characteristics:

(i) A built-in flexibility in the training system so as to allow for rapidly changing technology;
(ii) A broad-based education for trainees so as to make them adaptable to changing industrial practices.
(iii) An emphasis on the fact that industrial problems rarely have a unique solution and therefore training must provide experience with which to make the right choice of alternatives.
(iv) Emphasis on the fact that success in modern engineering practice is achieved only through team work and good human relations. Nigerians and indeed Africans are highly individualistic but individuals making arbitrary decisions cannot operate an integrated refining plant.

These basic principles must be applied at all levels of training from technologists to craftsmen and operatives.

Training has various facets which pertain to the objective in view. The major objective is to prepare technical personnel for manning an existing and non-existent plant so we must by-pass certain facets of training which are more appropriate to an existing plant. The main task is to outline a scheme for producing the various types of technologists needed to establish the plant. The most important technologists are mechanical, electrical, metallurgical, chemical and mining engineers. In addition, there are a few physicists and chemists. Some mechanical engineers specialized in fuel technology, lubrication and industrial engineering. Let us briefly state how these less detailed but it must acquaint them with the objectives of the enterprise and the means to attain them. Such matters as safety, team spirit, good human relations, etc. which have been outlined should be emphasized. The specialist training has to be offered abroad if the plant is non-existent or if it is thought the best experience is available in some foreign countries. The problem of keeping a log of training assignments and supervision are identical with those in (i).

(i) These groups may require some training in some particular aspects of the industrial plant, in addition to the induction training as in (ii). The special training should be devised in accordance with the principles which have been stated.

The training program envisaged is bound to be expensive but it should be considered a necessary investment which the Government must undertake. If the processing plant is to be operated efficiently by Indigenes,

There is no alternative to an intensive but well planned training scheme. The importance of training has been emphasized all along but the matter is so crucial, it can bear repetition.

Education and Training of Technicians

The role of the technologist as the person who uses his scientific or technological knowledge to conceive new ideas with which to solve practical problems and of the craftsman as the person who employs competent manipulative skills with tools to transform the technologists' ideas into reality as known from very early times at the dawn of industrial technology. The occupants of the territory between these two manpower categories were not fully recognized or their role very clearly defined until resent years particularly after the Second World War It is now generally recognized that this intermediate manpower category plays a very important role in modern industrial practice and that they should be accorded adequate recognition. The title "technician" is now almost universally employed to designate

this group. In some industries, however, the role of the technician is still somewhat vague in connotation and it is desirable for our purpose to be a bit more precise. According to the British Coal Research Training Institute technician is an employee in the industry who is competent to apply in a responsible manner proven techniques which are normally understood by those who are expert in a branch of technology or techniques specially defined by technologists. Technicians should have theoretical knowledge and practical experience to enable them to diagnose problems, organize details of a task or operation, implement the work themselves where necessary and in some situation, exercise supervisory or advisory duties. This definition which is an abridged version of that adopted by the conference of the engineering societies of Western Europe and the U.S.A. (EUSEC) is adequate for the purpose at hand. It is apparent that the technician combines a sub-professional knowledge of applied theory with some of the practical skills of the craftsman. It is this dual nature of his training that makes it expensive and most often difficult to achieve rapidly. Nevertheless, the education of technicians in some developing nations especially Nigeria has come a long way from pre-independence days, although technicians still constitute one of the major bottlenecks in the manpower system, facilities for their education are developing rapidly. In the content of the petroleum processing and refining process there will be no problem, however, there are certain types of technicians whose education has not been fully established in some countries therefore, the main concerns here will be on how to generate these types of technicians. The general principles of training are essentially the same as those we have stated for the training of technologists except in the nuances which differentiate the special role of a technician. Hence, rather than rehearse the emphasis already made elsewhere, it would be more economical and fruitful in effort to deal with the special features particularly in the areas where severe scarcity is envisaged. In most developing countries today, two types of technicians are being educated in mechanical, electrical and civil engineering: the ordinary and higher technicians. The ordinary technician follows a two-year course after the West African School Certificate or GCE-O Level in appropriate subjects. The higher technician follows a further two-year course after the ordinary course usually with an intervening year or more of practical industrial employment. The author has certified this system and proposed an alternative scheme whose details are given elsewhere and it is therefore necessary to go into details here. In essence, it is suggested that the functions of the technician in a given field of industrial activity in any country should be carefully determined with a view of devising a suitable program of education and training rather than to perpetuate the pattern of two levels in every field. It is maintained that such a pattern is another neither necessary nor desirable and that the dichotomy unnecessary blurs the status of the technician and tends to hinder recruitment into and stability within this important manpower category. A broadly based technical education is advocated and specialization should be gradually introduced and narrowed to one specialty only towards the end of the course.

In the case of Petro-chemical instrumentation ceramic, foundry and forge technicians course only exist in few institute and there is no indication that they are soon to be spread. There are no immediate plans to produce these types of technicians' in spite of the clamor to start industries in which they are vital; this is a serious disorder and mark of ignorance. This type of ignorance of need is what this research work is meant to correct. These technicians, especially petro-chemical and instrumentation are vital to a petroleum

processing industry. Apart from importing them, there is no alternative than to embark on an immediate program of education and training. There are two approaches to the problem: short term and long term

i. Short term for example petro chemical technician, the short term solution is to select chemical technicians from existing course for an intensive course in petro chemical, especially in those aspects of Petroleum processing within the purview of technicians functions. Except for differences in level, this program is similar in every respect to that outlined for petro chemical technologists. In the case of instrumentation, some mechanical and electrical technicians should be selected and sent for training abroad. India has developed technician courses in instrumentation technology in at least three good colleges and I was assured that admission would be available to any country in these colleges on application. Foundry and forge technicians are especially important in view of our suggestion that as many spare as possible should be manufactured in the central mechanical workshops. Suitable candidates should be selected and sent abroad for training. Chemical and fuel technicians are also special group in that they have to be educated and trained almost from scratch. Holder of WASC or GCE-O level with Mathematics, Physics, and Chemistry should be selected and sent abroad for training. The number of chemical assistants to process chemical is quite large in a typical refining plant and their program should start immediately.
ii. Long term Training. In long term, the obvious solution is to develop suitable courses in all these fields at home. However, organizing these courses is bound to be expensive and it would not be justified except if the numbers are large and continuous demand is assured in view of the top priority, which developing countries is according rapid industrialization, great demand for these technicians in the industrial sector is foreseen. However, experience has shown that, it is not always easy to quantify the need. This is an area in which consideration in manpower research effort should be directed for the technical training center as a pioneer producer of these technicians. Indeed the funding of a special technical training especially for the training of craftsmen and technicians. The problem of training center will be dealt with later in this paper.

Some specific areas of emphasis in Technician training are

i. Safety And Health Measures

Most technicians will be supervisors directly responsible for overseeing the activities of subordinates either in operation or maintenance. Hence, they should be thoroughly grounded on safety rules and regulations. Every technician should be saturated with the dictum that the safe way to work is the normal way. Accidents in Industrial processing plants are one of the major hazards and can cripple a plant not only in the number and frequency of casualties but by the psychological effects on the mass of workers.

Accident prevention should be a major goal of training.

ii. Team Spirit And Human Relations

As supervisors, technicians come in daily contact with the workers and their attitudes are bound to influence the overall feeling of those under them in matters pertaining to good team spirit and human relations. Hence, the importance of inculcating the

right attitudes and approaches in these matters should be regarded as basic to technician training.

iii. Proficiency In Practical Skills

In those activities in which the technician has to supervise or direct the work of skilled men, it is important that the technician should have acquired enough experience and knowledge so that in case of doubt his ability to work out details of a task in the light of well-established practice can be relied upon by those who may seek his advice and guidance. There is no room in industrial plant for leaders who cannot guide correctly when things go wrong for they often do.

Education and Training of Craftsmen

The group of highly skilled men designated as craftsmen are responsible for maintenance work in industrial plants. Their education and training is basically practical and skilled and consequently takes a long time to complete if a high level of competence is to be achieved. In view of the necessity for high competence, the training of a craftsman has always been narrowly specialized and spread over a long apprenticeship. Recent trends in technological development tend to favor a broader approach to technical training with less specialization at the outset.

The pattern envisaged for craftsman training is, therefore, going to be somewhat radically different from what now exists in most countries and some developing countries of the world.

Mainly the range of skills required in a typical industrial plant is mechanists, millwrights, filters and electricians, the numbers are usually quite large. Fortunately there are courses for these skills in existing technical training schools, at least for imparting the basic skills of the trade. Instrument mechanics courses are available in most technical schools and can generate the required craftsmen in that field. In the foundry trades such as molders and pattern makers. Courses do exist in most Government Trade Centers in some trades, e.g. experienced men from the railways and ports Authority or National Electric Power Authority.

There will be, therefore, three types of trainee:

i) Those with basic general education but with no previous technical training.
ii) Those with previous technical training (e.g. from existing Government
iii) Trade Center) but with little or no industrial experience.
iv) Experienced craftsmen (e.g. millwrights) given direct appointments.

Each will be dealt with separately in order to emphasize their special features

Trainees with no previous technical education

At present young boys and girls with at least nine years of schooling are admitted into Government Trade Centers for a three-year period of skilled training. The student chooses his specialty at entry and at the end of the three-year course, if he passes the appropriate examination; he goes out to seek employment. He is not usually accorded craftsman status until he has worked in his trade for at least another two years, after leaving the Trade Center. A new approach to this pattern should be developed for those in group (i) above. This is particularly important for those skills not presently centered for in existing trade centers. In this case It is expected that a technical training school will be established by the petroleum refining plant to pioneer the development of these skills at home. The following pattern is proposed:

(a) Entry qualifications should be the WASC with English, Mathematics, Physics or Chemistry and technical drawing. This is particularly essential for instrument mechanics, electricians,

pattern-makers, molders, toolmakers, machinists and millwrights.

(b) The training should be based on a group of related skills, e.g. welders and pattern makers, molders and toolmakers will form the foundry trades; machining for tool making; turning, mechanical fitting, milling and grinding will form the mechanical engineering trades; and instrument mechanists should be treated as an electromechanical trade covering both electronics, pneumatic, hydraulic and mechanical instruments.

The development of the skills should be done in stages as follows:

i. Basic Training

This training should be common to a group of skills, e.g. the foundry trades. Here induction training is given on such matters as safety and health rules and regulations, conditions of service and welfare, the aims of the refining plants, the basic principles underlying the group of skills is given including the tools, machines and their uses in broad terms. As a matter of general principle, this stage should be broad and general. It should be diagnostic and probational in the sense that it is a means of assessing aptitudes and further training will not be available to a trainee if no discernible aptitudes are shown or if the right attitude to work is not exhibited. This stage should be institutional.

ii. Initial Specialization

The second stage should permit specialization but only in a broad group of skills, e.g. the would-be pattern-maker has to have a thorough grounding in the theory of molding for only by understanding the problems of the molder can he learn how best to construct his patterns. Another example, the welder at this stage must do general welding and cutting, oxy-fuel gas cutting and gouging, tungsten arc gas shielding welding, metal arc gas shielded welding; manual-metal-arc welding and oxy-acetylene welding. The future machinist should do all types of mechanical fittings and machining.

iii. Final Specification

It is at this stage that a trainee is channeled to one specialization but with the provision that he should combine two skills at the early stage of this phase. This phase starts in the institution and gradually transfers to the actual production work in the main workshops on a specialist basis.

At every stage there should be a clearly defined set of skills and knowledge to be acquired. The producers and means of assessing acquired skills should be very clearly set out. This should include a good record of jobs done. The student should keep a log book of all his jobs and activities at all stages. He should be guided on how to do this early in the course. All work should be promptly assessed and guidance given as appropriate. The direction of training should depend upon the nature and complexity of the courses. Certificate of craftsman should be awarded only after satisfactory completion of all stages.

Training should be regarded as life-long and continuous rather than a one-shot affair. This means retraining, upgrading skills should be created, continuously revised and provided.

Trainees with Previous Technical Education

A large number of persons will be recruited from existing trade centers. These people will not have the type of education specified in Section 3.5 but they will have acquired a narrow technical training in some skill, e.g. electrical installation, fitting and machining, auto mechanics and general welding. Further training for this group will be:

Induction training to provide orientation for the industrial plant. Practical training

on specialist's equipment in any processing and refining plant which most of them will not have seen before. This group will be put to work as soon as possible and they will learn from experience under good supervisors and charge men.

Experienced craftsmen on direct appointment

It is anticipated that some electricians, filter/mechanists, millwright and diesel mechanics will be recruited from existing industries by offering suitable inducements. This group will receive mainly induction training together with suitable further experience in the aspects of their skill peculiar to a refining plant. The special experience will be minimal for a good millwright to learn about any mechanical installation very rapidly. Some very good men from this group and the previous one should be selected and sent abroad in each of the key trades where they are available. They should work under normal conditions for about a couple of years in plants with similar equipment to be installed in the country. The numbers have to be small but adequate to make an impact on the maintenance services. Some such men will be charge men or supervisors. The basic principles of craft skill formation have now been outlined.

Training of Operatives

The term "operatives" embraces all those employees not otherwise specified in the previous sections who man various items of equipment and plant. Operative's jobs ranges from general labor to highly skilled operators and their assistants. Production team in products processing team, machine operatives of various types is included. Also included are semi-skilled workers in maintenance departments such as lubrication attendants and workers in service departments like laboratory assistants, non-destructive testing operatives, and locomotive and crane drivers. The range of work varies from manual and routine operatives to jobs requiring a good deal of skill and knowledge. For instance the first operator in the fischer-tropisch process has to be highly experienced in order to work according to precision at each stage. At the initial period he has to be attached with an expatriate.

It is apparent that the range of basic educational qualifications required for operatives is as wide as the jobs covered. Some operatives such as plant furnace operations should be technicians while others such as loco drivers need not have more than the WASC.

It has been stated elsewhere that all workers in the refining plant must be literate with minimum of primary school or under-WASC education. The most important distinguishing feature of operatives training is that they are trained on the job. In all other respects such as clear determination of need, establishment of attitude training program and suitable means of assessment and evaluation, the training principles remain the same as those emphasized in other sections.

All operatives should receive induction training and among other things, the quality and quantity of work required of the operator should be made clear to him at this stage.

PROPOSED PLAN FOR TECHNICAL SKILL PRODUCTION

The main concern here is with the planning and training for the production of technical skills for industrial development through various techniques suggested in the previous chapters. The approach here is specific and strictly empirical. We are concerned with two broad types of industrial projects: (i) those projects for which there is a planned commitment of different nature, and (ii) those industries which the trend of development in the economy indicates, are inevitable in the

medium and long run such as the petroleum refining industry in Nigeria. The situation where there is a definite commitment to establish a group of industries is the most desirable because the development of the workforce must be related to the types and scales of the projects. A major handicap is, however, the time required to determine and train the personnel needed. In a five-year development plan, it may take just about a long time to determine all the types of skills and to train them in readiness for the commissioning of the projects.

One problem that could produce very sad results is that of failure to implement projects for which manpower training schemes have been embarked upon. This danger is very real in an economy that depends on foreign aid for the implementations of developments projects. Happily, Nigerian dependence on foreign aid for major public-sector projects is becoming increasingly small. Private – sector projects are determined on the basis of economic profitability and under conditions of stable and assured economic operations, finance is usually forthcoming. Hence on the average, failure to implement would likely to be due to inadequate technical manpower planning rather than financial obstacles. Therefore with good planning, the spectacle of large numbers of trained persons becoming unemployed as a result of failure to implement projects for which they have been trained would be minimal. For instance Nigerian government gave amnesty to the militant of the Niger Delta Youths and they were sent to abroad to acquire training on various skills. Today most of them have completed their training programs only to return back without job, this may lead them to go back and start carrying arms again

In a dynamic economy such as Nigeria; trained technical manpower can only be a glut in the market in the absence of the sort of planning we are advocating. We do not have this planning now and so there are instances where some carpenters cannot find jobs while fitter-machinists are inadequate to meet the demand. Examples of similar imbalances abound. I believe these imbalances can be greatly reduced or eliminated from the implementation of this study.

Projects of a highly technical nature should be planned over a long time perspective and implemented sequentially in shorter planning periods. That is a major development effort that could be spread over, say a period of twenty years with well laid out segments that make up the overall project. The segments are then implemented in five-year plans over the long time span. This sort of thinking is not yet very evident in present Nigerian plans but as the country becomes surer of where it is headed, taking a long time perspective is essential in order to devise appropriate steps to get there.

CONCLUSION

In the foregoing chapters, an approach to technical skill development plan has been outlined, analyses and strategy for achieving it fully demonstrated. It is hoped that this approach would be effective in reducing or eliminating the technical skill bottlenecks which impede large industrial projects in developing countries. The difficulties that have been mentioned show that in the industrialization process there are no painless panaceas. The process of seeking to industrialize traditional societies is one that is dogged by severe problems every inch of the way. Some of the problems are inherent in the societies themselves while others derive from the world setting. The natures of these various problems are becoming increasingly well

understood in the developing countries. Industrialization is not going to be achieved without pains nor is it going to be handed over from some source free of charge. There will be many obstacles some of which will be of formidable proportions. The author recommended among others that performance work skill, Industrial safety, professional works esthetics and values including occupational health education be incorporated into the existing curriculum of Engineering and technology based programmes for increased productivity in industrial organizations**.**

To be fully aware of this searing reality is a great step forward. One hopes that this study will in some modest way contribute to the attainment of this forward step in Nigeria and other developing nations of the world.

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