ESTABLISHING FIRM SCIENTIFIC AND ENGINEERING BASES FOR INDUSTRIAL DEVELOPMENT AND MANUFACTURING AFFORDABLE AUTOMOBILES IN NIGERIA.

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ABSTRACT

Automobiles that can be bought by many Nigerians cannot be produced in the Nigeria of today. This is because, the necessary general and specific skill-frameworks within which to produce the automobiles do not exist yet. The potentials for producing an affordable car exists, in Nigeria, but not the capabilities. This paper presents a twenty-year plan for transforming the potentials into capabilities and creating the necessary skill-networks, industrialization and manufacturing many high-technology products, including automobiles, at affordable costs.

An average automobile contains over 1500 (one thousand, five hundred) parts. Most of these are complicated high precision components. Some of these components are metallic, others are non-metallic components, while others are composites. There are also mechanical, electrical and electronic, and other systems in a modern automobile. All these require the acquisition of relevant production skills (RPSs) to manufacture. It is the measure of the RPSs which a nation possesses that bestows the relevant capabilities. Nigeria has not acquired any appreciable RPSs with respect to the production of automobiles.

The first ten years of the proposed plan will be devoted to developing the general skill-framework. The following five years will be devoted to building the more specific skill frameworks - metallurgical and materials manipulations, design and fabrication of systems, etc., and creating a production system compatible with the manufacture of automobiles. The present Nigerian production system characterized by hoe, axe, cutlass, etc. is not compatible with the manufacture of automobiles.

Some activities during the last five years would be the production of various automobile parts in many centres at affordable costs. Other activities in this phase would be spontaneous attempts to assemble the Nigerian-made components to produce affordable cars for Nigerians.

INTRODUCTION

The automobile technology is undoubtedly a key one which should be acquired by any nation seeking industrialization. This is because the automobile is a symbol of luxury, speed and power, and a basis for mobilising people for high productivity. The automobile engine is probably the most versatile single engine; it has the widest industrial linkages as a single product.

Apparently, Nigeria realises the importance of the automobile technology and she has been making attempts to acquire it.

In the attempt to prepare the framework for acquiring the technology and manufacture a Nigerian-adapted car, the Nigerian government reached agreement with several European automobile manufacturing corporations to set several automobile assembling plants in Nigeria. Several of these plants were set up more than two decades ago. These plants and other private firms for some time now, have made various breakthrough-claims in relation to automobile and its components.

But the issue should not be that of isolated claims of success, rather it should be the extent to which the intended objective of acquiring the automobile technology, has been achieved. In other words, is the objective of acquiring the automobile technology in Nigeria and building a reliable transport system for

mobilising people for high productivity, and adapting the automobile engine for mechanization and general industrialisation being achieved as desired?

The true situation in Nigeria is a public knowledge. The average price of cars which now stands at over ₦2,000,000 (two Million Naira), over 100 (one hundred) times the average household earnings in the year in Nigeria, and a current price tag of more than ₦10,000,000 (Ten Million Naira) on a locally-assembled 100-seater bus attests to the true situation in Nigeria. This situation is unhealthy and cannot be the desire of majority of Nigerians.

This unhealthy situation, is, however a reflection of the available relevant production skills (RPSs) for the manufacture of automobile and its components, the common conceptualisation of what it takes to make an automobile and the attendant policies geared towards making automobiles for Nigerians. However, all hopes are not lost. The past is a good experience.

This paper is, therefore, an attempt to contribute towards how to bring about true technological development and in the process make an affordable car for Nigeria.

THEORETICAL FRAMEWORK

The Concept of Technological Frameworks:

Some people have often been baffled by the observation that while Nigerians and other Africans perform excellently well abroad, they do very poorly when confronted with simple assignments in their home environments. In other words, a Nigerian who may have been a cornerstone in General Motors Corporation of America or the Mercedez Benz Corporation of Germany, on returning to Nigeria may find himself helpless in Nigeria's attempt to build a standard automobile for Nigeria. To many people, this is surprising; they do not understand why this happens. To others, the reason is environment, which may be climatic, socio-economic, political, technological, etc. Unfortunately this reason cannot be a basis for planning, because this answer further complicates the issue, considering the multi-faced nature of environment.

The observed difference in performance was explained recently by the concept of technological frameworks (Ogbimi, 1990). The concept states that technological development involves the establishment of two types of frameworks - the physical and the invisible frameworks. The physical technological framework, which many traditionally call infrastructure, is made up of all physical structures that can be erected readily. Examples of this include complex iron-and-steel plants, automobile assembling plants, road and railway and telecommunication networks, etc.

The invisible framework is made up of all the skills in a society. It can be likened to the spider's web. The single silk-thread which is the unit of the spider's web a weak structural material. But the completed spider's-web is an important tool used by the spider in achieving its most important objective.

Any single individual in any society, no matter how versatile, is like the single silk-thread, but the skills possessed by individuals can combine to form effective invisible technological framework in a society. In a technologically advanced society, the invisible framework has become established, because the individual skills' have been developed in depth and breadth, and the single individual and his skills become important components, just as the single silk-thread in the spider's web.

In a technologically backward society, even the versatile individual alone cannot constitute the desirable invisible technological framework; the individual and all his skills in isolation remain the single silk-thread, a weak structural material which fails when subjected to any stress. This is why it is neither the single super-being from anywhere that Nigeria needs, nor the establishment of complex structures.

The concept of technological frameworks not only explains the limitations of plans based on the capabilities of limited individuals but also shows that it is the development of skills to form the invisible technological framework that is important, because in societies where the developed framework exists, any physical structure can be erected at will. The existence of physical structure like automobile assembling plants, complex iron-and-steel plants do not automatically translate into the desired skills. While it is true that such physical structures may be used for acquiring skills, it is a very slow approach to acquiring technology, because of the nature of techno-

logical development which may be likened to a ladder-climbing process (Ogbimi, 1990b). Thus, a technologically primitive society may sell primary produce or borrow money to establish prestigious complex plants but will not be technological development.

Learning and Technological Development:

Technological development involves the acquisition of new experiences which bestow the capability of doing the things that were not possible hitherto. This, invariably, involves learning. Technological development may also be likened to the piano playing game (Ogbimi, 1990a)[3]. Even the talented person must first learn the ordinary nodes. It is after this that he can practice before composing independent tunes to demonstrate his talent in piano. The talented person who has no opportunity of practicing may never transform his potential into capability. Thus, innovation comes after learning. Building a Nigerian-adapted car, taking cognizance of the cultural and economic environments, would rightly be classified as an innovation, the automobile having been a well-known product notwithstanding (Ogbimi, 1989)[4]. The question then becomes, can a nation begin with innovation, can innovation be achieved independent of the level of technological development?

Innovation are encountered infrequently in the course of normal development. Innovation cannot be achieved independent of the level of technological development (Ogbimi, 1989a)[5].

With proper planning, however, innovations may be programmed in the course of development (Ogbimi, 1989b)[6].

This means that only societies growing technologically have high chances of achieving innovations. Technologically static societies cannot achieve innovations.

The Innovation Ladder:

Figure 1 shows what may be called the innovation ladder, otherwise the development ladder (Ogbimi, 1990c)[7]. The sketch shows what development entails; eight steps may be distinguished in the acquisition of any technology. This acquisition of any technology involves development of fundamental theoretical and practical skills, and combining them to facilitate independent thinking on the part of the acquiring person or society.

These steps, 1 and 2, constitute the first phase in the development of technological capabilities. This is also the slow and rate determining phase.

Fundamental theory and practical skills must be acquired to appreciable levels (Ogbimi, 1992)[8] to achieve the independent thinking status of development. Any society or individual who acquires theory or practical skills alone, is limited in scope. In terms of national development, the status of independent thinking is synonymous with the take-off point of development in Rostow's theory (1960)[9]. This is the level of development at which a society is able to carry on basic technological manipulations and solves the common problems which confront it without relying excessively on foreign assistance and capabilities.

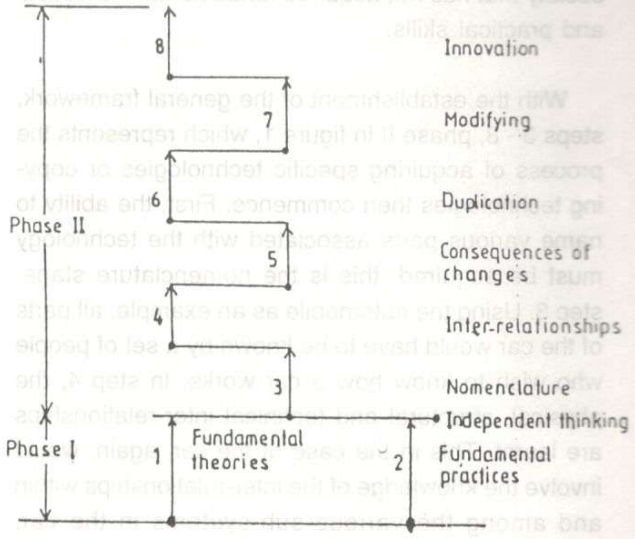


Figure 1: Schematic of the Technology Development Ladder:
Phase I is the slow, rate - determining step in which the foundations of technological development are laid.

Achieving the independent thinking status of development took Britain more than 700 (seven hundred) years after her colonial experience - the Norman invasion of 1066 (Sir Stenton, 1961)[10]. It took the Japanese over 1000 (one thousand) years after she started learning Chinese culture. For, Japan had long had some contact with Chinese civilisation; immigrants had brought the arts and science of the continental civilization together with Chinese writing which had become established in Japan by the fifth

century (Reischauer, 1970)[11]. Japan achieved Rostow's take-off status about 1868 - the Meiji Restolation period.

It took that long for Britain and Japan to reach that, level of development either because there was no conscious efforts, as such, at accelerating development as in the case of Britain, or while there was conscious effort, it came late, and the learning system was not sufficiently, elaborate to make the desired impact readily, the case of Japan.

Copying and Stealing Technology:

It is only after completing steps 1 and 2 or phase I that copying and learning rapidly from other societies become possible. This phase establishes the invisible technological framework discussed earlier-on. No copying and 'stealing' of technology is possible for a society that has not acquired fundamental theoretical and practical skills.

With the establishment of the general framework, steps 3 - 8, phase II in figure 1, which represents the process of acquiring specific technologies or copying technologies then commence. First, the ability to name various parts associated with the technology must be acquired, this is the nomenclature stage, step 3. Using the automobile as an example, all parts of the car would have to be known by a set of people who wish to know how a car works. In step 4, the physical, structural and technical inter-relationships are learnt. This in the case of the car, again, would involve the knowledge of the inter-relationships within and among the various sub-systems in the car. Reader's Digest (1981)[12] identified seven sub-systems in the automobile:- the engine; driving train; wheels, tires, and brakes; suspension; steering; electrical system; and body and chassis. The society in this step would have to understand the inter-relationships within and among these systems; all these have to be studied. This is the capability that is best acquired from maintenance services. This is the situation which provides opportunities for encountering faults, repairing and replacing parts, and uncoupling and coupling.

When the functions and inter-relationship of various parts of a system such as the automobile engine have become known, it becomes possible to work towards knowing the consequences of changes within the system and systematically discussing the system. It is after understanding the consequences of changes within a system that duplication or copying is possible. Complete reproduction or replication is usually expensive and not frequently attempted. This is because certain local circumstances do not permit replication of certain parts readily. But knowledge of functions and inter-relationships and consequences of changing various parts allow minor changes to accompany first-attempt duplication, step 6.

Again, it is when a society understands inter-relationships, the consequences of changes, and possesses the capabilities to duplicate the components of the car, for example, that the society can think of modifying parts and then making an adapted brand, step 7. It is the society which can modify systems that can also make various combinations. And it is among the various combinations that favoured combinations with wide applications, or innovations, are achieved. Innovation step 8 is, thus the best experienced in the course of development.

Planning for Affordable Automobiles in Nigeria

Automobile is a high-tech product which cannot be made in isolation of several other high-tech products. An average automobile is assembled from over 15,000 (fifteen thousand) parts, 1,500 (One thousand, five hundred) of them synchronized in movement, and many of them work with very low tolerance (Reader's Digest, 1981)[13]. Many different materials - cardboard, rubber, plastics, platinum, copper, iron-and-steel, composites, etc. are used in making a car. And these materials are transformed into various shapes including nuts, bolts, washers, clips, fasteners, gears, insulators, upholstery, etc.

Many of these are mass-produced. Mass production is the basis of making cars that can be afforded by many people. Mass production became possible with the establishment of the principle of inter-changeability by Eli Whitney, an American, in 1798. Interchangeability became possible with the combination of:- (1) standard units of gauging with uniformity of design and specifications, (2) standardized machine tools, and (3) power machinery worked under a system of specialized labour force (Gottschalk et al., 1969)[14].

How, then, can an affordable car be produced in Nigeria?

The discussion of the suggestions in this regard will be subdivided into three phases. Much of the discussion will be based on the theoretical framework provided earlier-on.

Phase I, Ten Years:

Of the 1 - 8 steps in the order of (1) acquiring fundamental theory, (2) acquiring fundamental practical skills and blending these to achieve independent thinking development, status, and then be able to copy others, through (3) nomenclature, (4) understanding of inter-relationships, (5) understanding the consequences of changes, (6) duplicating, (7) modifying and (8) innovating, Nigeria has only attempted acquiring fundamental theoretical and practical skills. Indeed, Nigeria's theoretical and practical skills have not been acquired to appreciable levels and there are no conscious efforts yet towards blending them. This state of affair precludes achieving independent thinking in terms of technological activities, readily.

And when a society is yet below the status of independent thinking, the tools are predominantly the crude ones like hoe, axe, cutlass, bow and arrow, etc., made through trial and error. But in today's masked by foreign investments that are largely high-tech operations.

No affordable high-tech products can be produced under this circumstance. First, mass production and the attendant low prices, which go with it are not in the interest of the foreign investors who are actually sales forces representing their home corporations. And their primary objective is to make as much profit as possible. High tariffs and other indefinite protective measures guarantee the profits. Second, this situation can maintain the relevant production skills (RPSs), the skills used in confronting the common problems of a society, at very low levels for a very long time, because the situation discourages indigenes from learning and acquiring new skills.

When the RPSs are not available, necessary raw materials cannot be sourced, or used effectively. It is the absence of the RPSs that is therefore crucial to the survival of a society, not the availability of raw materials or capital. Only good technological capabilities create raw materials and capital.

The case of Japan is an example, but it must be realised that Japan has existed for thousands of years and has gone through the development steps discussed above, and has become technologically matured.

Nigeria needs to expand facilities for acquiring theoretical and practical skills, but more so for practical skills. Current output of about 60,000 university/polytechnic graduates (NYSC, 1997)[15] is low to yield the desired results within a reasonably short time. Only about twelve per cent (National University Commission, NUU, 1992)[16] of those who applied for admission are being admitted for a long time now, in Nigeria.

Efforts during the first ten years would be made to increase in take to enable graduate output during the period grow by 13 (thirteen) per cent and reach 200,000 (two hundred thousand) by year 2007. Estimates suggest that N120 billion (one hundred and twenty billion Naira) would be required for building more universities and expanding the existing ones.

To develop practical skills and lend theory and practical skills, on-the-job training will be given equal emphasis as building educational institutions and encouraging literacy. To this end, a national on-the-job training network will be established. All fresh engineering/science graduates must undergo a minimum of 3 (three) years job-training to become certified for their degrees. This Programme is to bridge the gap between theory and practice which is the bane of Nigeria education today. This training which will involve studying and analysing industrial practices would enable graduates of science/engineering areas see the relevance of the theory they required in universities. This Programme will involve industry, particular the repair, craft and factory floor on one hand, and universities on the other.

This is also to create a forum for conscious interactions between education and production. This has always been absent in Nigeria.

In this on-the-job training Programme, all those involved would be adequately paid to develop interest and discipline in the training. Payment would also be regular. It should be realised that the emphasis is on university graduates who have acquired advanced theory. This would ensure that individuals with

adequate theoretical and practical skills and who can think independently are produced.

Estimates show that a back-log of a large number of science/engineering graduates unemployed have existed since 1983 and all this will be taken as fresh graduates. Estimates also show that of the 60,000 (Sixty thousand) graduates produced in Nigerian Universities/Polytechnic today, about 16,000 (Sixteen thousand) or 27 per cent (NUC, 1992) are science and engineering graduates. This number is to grow in line with increase in admission. On-the-job-training over the first ten years of the plan is estimated to cost about N200 (two hundred) billion naira.

This phase is an attempt to develop the invisible technological framework within which efforts directed at developing automobile manufacturing skills can be meaningful, for such a framework does not exist in Nigeria yet. The framework in question should not be confused with isolated individual efforts supported by untold high cost. Of course, such could not be the basis of producing affordable automobiles for Nigerians.

The predominant practical skills in Nigeria remain the traditional skills acquired by trial and error. And it is these skills which still come into play in very trying situation as has been experienced in Nigeria since 1985. The more common input into repairing the imported automobile in terms of metal components remain only products forged by hammer pressure. There are no skills for making angular products like notch wheels (gears), let alone, more complex shapes and precision products. The result is that the sector gear for car window winder in the existing imported car in Nigeria is often replaced with a permanently welded rod. There are many other examples to show that only very low capabilities exist for manipulating metals and materials in Nigeria. This is not compatible with making automobiles. Experienced Nigerian engineers acknowledge the absence of engineering design and fabrication capabilities in Nigeria (Makanjuola, 1977; and Odigbo, 1992),[18,19].

This phase of the plan would improve the available skills in this regard. And the activities and programmes initiated in this phase will remain in place as standing framework as the plan move into the next phase.

Phase II, Five Years:

In this phase, scientists and engineers who have completed the certification training, would be engaged in more specific areas of interests. Engineers/Scientists interested in automobile manufacture could then begin programmed maintenance services and to provide opportunities for nomenclature, uncoupling and coupling, embarking on detailed theoretical and practical studies of inter-relationships, and consequences of structural and physical changes in automobile engines.

Similar studies will be carried out to develop metallurgical and materials' manipulating capabilities. High skills in manipulating iron, steel, copper, glass, plastic, rubber and other materials would be consciously and aggressively acquired. Efforts at studying machinery and equipment and mechanization will be embarked upon too.

The foregoing is all that industrialisation involves, and no industrialisation can be achieved without supporting developments in energy, water and other infrastructure requirements. These would be developed in tune with the level of demand. Intensive studies will simultaneously be carried out to understand the basis requirements in theory and practice for generating energy from solar, petroleum, fossils, hydro, wind and other sources. Existing relevant energy-generating equipment and machinery will also be studied, in terms of nomenclature, uncoupling and coupling, component replacement and repairs, understanding of inter-relations within the system and understanding consequences of changes. This would be done for all infrastructural support systems.

Estimates indicate that ₦250 (two Hundred and fifty) billion Naira would be devoted to carrying out the training Programme in this phase.

Phase III, Five Years:

Efforts in this phase of the plan would be devoted to duplicating and modifying automobile, energy generating and industrial engines. With the availability of the capabilities for manipulating materials, duplicating and modifying components of units and systems, automobile parts would readily be made and be available in Nigeria. Under such situations, there will be spontaneous efforts towards assembling the components. Various combinations will be attempted,

and one combination will produce the ideal Nigeria car - an innovation.

This phase is estimated to cost N300 (three hundred billion Naira). The total estimated for the 20-year development plan would then be about N750 (seven hundred and fifty billion Naria). This amount should not be seen as an evidence in support of the usual undue emphasis on capital as the only basis of technological development. This plan will be self-sustaining, because it is based on developing human resource as a basis of development; the plan would perpetually develop increasing production force that would sustain it. As such, even when loans are secured to embark upon it, it would pay off the loans and bring about irreversible growth- the development of the capabilities to make high-technology products, including affordable cars in Nigeria.

SUMMARY AND CONCLUSIONS

The automobile technology is an important one that should be acquired by any developing nation that wishes to become truly industrialized. This is because the automobile engine is very versatile; beside transportation, it has many other adaptations in industry.

Nigeria seems to have realised this and she has made attempts towards acquiring the technology. But no significants progress has so far been made. That has largely been due to a wrong conceptualisation of the technological development process.

The assumption has been that technological development is a passive process in which any society may begin in any manner. And that it could be acquired by establishing complex physical structures like automobile, iron-and-steel and petrochemical plants, telecommunication and road networks, etc. But technology is not a hay hazard affair. It is now sufficiently understood hot to be a matter of gambling.

Erection of physical structures, per se, does not constitute technological development. Technological development comes with learning and acquiring new skills. It is new skills which bestow the capability to do what was not possible hitherto, on a society. Rapid development comes with conscious and aggressive approach to acquiring new and relevant skills, not by erecting structures with loans.

All the skills acquired by the individuals of a society, figuratively, from an invisible technological framework which attacks the problems which confront the society, once various skills have been developed in depth and breadth. It is after a society has sufficiently developed skills to form this valuable framework that the society can embark upon developing specific or more specialised technologies like automobile and those associated with efficient sourcing and utilisation of raw materials. In the absence of this desirable invisible framework, common complaints are those of absence of raw materials, capital, and infrastructure.

The invisible framework, evidently, has not been developed in Nigeria. This is because Nigeria has not developed the people with adequate theoretical and practical skills and who also are able to blend the skills. Nigeria could therefore not successfully embark on making cheap automobiles at her present level of development.

However, Nigeria can make an affordable car through a three-phase development Programme. First, many people with appreciable theoretical and practical skills must be produced. This can be achieved, readily, by placing high and equal emphasis on on-the-job training of university/polytechnic graduates in science and engineering as it is already placed on acquiring theory. Indeed, a national framework for on-the-job training should be established. The emphasis should be graduates of science/engineering programmes who have acquired adequate advanced theoretical skills and who need the on-the-job practical skills as complementary skills to acquire the capability to assess problems from both theoretical and practical skills prospectives. This training would take a minimum of three years, in craft/artisan workshops and factory floor work settings. Participants should be well paid to keep interest high and maintain discipline.

The next phase would ensure that those who have acquired fundamental theoretical and practical skills become engaged in acquiring more specific skills such as developing the knowledge and capabilities for manipulating metals and other materials, identifying components, understanding interactions, determining the consequences of changes in interrelationships in automobile engines, industrial machines, energy generating plants, etc. These capabilities would best be acquired in maintenance and lowly-mechanized

production settings in which the use of hands and mental works exist.

In the third phase, with the foregoing capabilities developed, copying or duplicating or 'stealing' technologies becomes possible. Because parts of high-tech products, including automobiles would be produced at affordable cost, assembling parts to make affordable Nigerian-adapted automobile will follow spontaneously.

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