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A FRAMEWORK FOR TECHNOLOGICAL CAPACITY BUILDING IN NIGERIA: LESSONS FROM DEVELOPED COUNTRIES

Bankole Oni

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Universität Bremen

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Preface

The advancement of the developed countries since the end of the second world war has been through an aggressive development of technological capacity both human and institutional. Indeed, the globalisation phenomenon of the present age could not have been possible without the development of technology and the institutional capacity to sustain it. An important condition for technological development is the collaboration among institutions involved in capacity building through networking. The examples of the United States of America and Germany, and of course, other developed countries reveal the critical role that universities, research centres, industries, foundations and government play in the institutionalisation of technological capacity building. Universities and research institutes in Europe and America demonstrate their social relevance not only through their esoteric research, but also through their contribution to meeting the needs of industry. An enabling environment for collaborative performance among the community of actors is important and the government in these countries recognise their important role in this.

If Nigeria is to develop technologically, it would need to look critically at some of the policies and institutional arrangements that have assisted the advanced countries to achieve technological progress. This critical investigation which is suggested will perhaps provide Nigerian policy makers with what can or cannot be adopted. Nigeria will however need to develop its own institutional framework which must be responsive to the social, cultural and above all the political situation in the country. The integration of these environmental variables into technological capacity building framework is considered necessary in a multi-ethnic society like Nigeria where many previous policies and institutions have failed because those who designed them assumed away the political and social realities. All levels of government and all stake holders must be seen as a "community of actors" in this enterprise.

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Bankole Oni

1 Introduction

The countries of Africa constitute most of the poorest societies in the world as evidenced by the fact that they show the lowest indicators of socio-economic development (World Bank, 1996). While the level of poverty in the continent has been attributed to many interrelated causes by different social science researchers and other scholars, the low level of science and technology indicators has in the last decade begun to emerge in research as a major cause of Africa‘s underdevelopment (World Bank, 1998). It is also argued that the recent rapid economic development of the countries of Southeast Asia in the latter part of the 20th century has been due largely to their deliberate policy on technological capacity building through investment in human capital and institutional building. Technological development in Southeast Asia has been facilitated by a number of systematic and deliberate policies directed at the building of a network of institutions for the promotion of technological innovation in production.

Institution capacity building and co-ordination have remained part of the strategies for tackling the questions of technological backwardness in many developed countries after the second world war. In contrast, most African countries have displayed a lack of attention to the relevance and development of institutional capacity building. This is not to suggest that African countries must follow the same development path to technological capacity building like

the S. E. Asian countries as suggested recently by the Malaysian Prime Minister (see Mansell and Wehn 1998). The important lesson is that the Asian experience has confirmed the general view that human and institutional capacity building are critical to technological development. In this context it is perhaps instructional and relevant to identify and analyse some of the critical constraints to technological capacity building (TCB) in Nigeria and also discover what lessons may be learnt from developed countries like the U. S. A. and Germany.

1.1 Problem of the study

There exists a structural relationship between a society's technological capabilities and the capacity to engineer social and economic development. A social system which places little emphasis on technology is less inclined to acquire technological capability and to achieve economic development. The link between building local technological capability and the ability to respond to challenges is usually brought about in the process of learning and co-operation between institutions. It is the absence of institutional co-operation and effective co-ordination and how these two major problems can be overcome in Nigeria that constitutes the problem of the present investigation. This is because without the co-operation among the "community of actors" and the necessary institutional framework for co-ordinating their activities it may be impossible for Nigeria to develop the technological capacity that the country would require for the global competition of the 21st century.

The research problem therefore is in two facets: the first is the identification and analysis of the environmental factors which serve as constraints to TCB in Nigeria. The second which is derived from the first is the development of an institutional framework for

building and sustaining technological capacity as a social process in the country.

1.2 Objectives and justification

The main objective of the present investigation is to provide through an investigation of the American and German experience an institutionally feasible and politically sustainable framework for TCB in Nigeria. Political sustainability is critical to the success and effective performance of any arrangement in Nigeria as history reveals that many institutions in the country have failed to achieve their mandate due to the dynamics of the political environment. The study will therefore be guided by the following specific objectives which are, to:

(a) identify and analyse the determinants of the weak technological capacity building institution in Nigeria
(b) examine through document search, direct observation and interview particularly in Germany the role of government, universities, research centres, industry and foundations in TCB; and
(c) suggest an institutionally feasible and politically sustainable framework for Nigeria

Even though the Nigerian government recognises the importance of the development of science and technology as a matter of national policy, the existing research centres and universities are faced with a number of problems which affect their performance. These problems are the products of the environment. Inspite of this there still exists within the country today a corps of internationally and locally recognised expertise and intellectual capacity that need to be harnessed to build the desired national capacity for technology policy design, implementation, co-ordination and evaluation. The justification for this research

therefore is that these existing technological potentials should not be allowed to rot away as Nigeria approaches the next century

1.3 Conceptual framework

The requirements for human and institutional capacity building generally exist within the social and political environment. It is salient therefore to assume that the success or failure of any attempt to build technological capacity especially within the African context of development must be interpreted as the product of the structural relationship between the environment and the various institutions involved. Thus, capacity building in a broad development context implies a dynamic process which enables individuals and agencies to develop the critical social/technical capabilities to identify and analyse problems and proffer solutions to them. A conducive policy environment is therefore a sine qua non for the process of TCB to thrive without hindrance.

The policy environment for TCB should be multisectoral, involving government, universities, research centres, the private sector and other stake holders. This is important in any political environment that is characterised by social and ideological heterogeneity.

Broadly defined technology is not necessarily hardware. It is the totality of knowledge and skills embodied in people and institutions which provide them with mastery over their natural environment. The role of capacity building in this context therefore is to harness the capabilities within the network of institutions and enhance organisational interactions to better manage the process of technology acquisition, diffusion, utilisation and skill development. A general policy environment that induces human and institutional interaction and collaboration is therefore necessary for effective technology policy management and capacity building.

Two critical social forces in the policy environment in Africa are the government and the bureaucracy. These two institutions are critical to the extent that well-intentioned policies may produce undesired outputs if the people charged with their implementation do not possess the necessary scientific background (Dahlman, 1989). Trained experts can only be productive within an appropriately designed institutional framework and not outside it. Such institutions can only exist in an appropriate policy environment where research institutes, university laboratories and the private sector are encouraged to build a network of information, knowledge and personnel exchanges.

Thus, the above suggests the intellectual relevance of a holistic theoretical approach that describes and also prescribes a structured and dynamic relationship between institutional networking for technological capacity building and the total environment. This view is that an appropriate policy environment would induce institutions to collaborate in building a network for the objective of strengthening national technological capacity.

Inherent in the present perspective is the possibility of lack of social cohesion within the community of actors (institutions), especially when resource allocators may not possess the critical minimum technical competence for prescribing standards to the experts within the relationship or when rewards or incentives generate conflict (Wohlmuth, 1998). However, if the machinery for decision making is democratised, it should be possible to reduce the areas of conflict and promote social cohesion within the system.

1.4 Definition of some terms

As a starting point in the present discussion, the definition of certain terms is important in order to avoid possible conceptual confusion. This is important because terms like technology,

knowledge, and social capability which are used in the present discourse must have their technical exactness within the context in which they are used.

Technology

The term technology as used in the text does not imply just machine. Dahlman's (1989) definition which is adopted refers to technology as the inherent or acquired capability (skills) possessed by people and/or institutions which enables them to convert available inputs into desired outputs at maximum efficiency level. Thus the term technological capacity building is a dynamic and progressive process in which human and institutional capability is developed and sustained by organisations, communities and nations in order to benefit from economic interconnections within the global system (Lisk, 1996).

Knowledge

Knowledge is a general term often used as the opposite of ignorance about science and technology and their application to the production and distribution of goods and services. Technological knowledge simply means know-how. Those countries which possess less of it are caught in the poverty bracket (World Bank, 1998, p.1) As the World Development Report (World Bank, 1998) indicates, poor countries and indeed poor people are not able to compete in the global system not because they do not have capital or other material resources, but because they have less knowledge much of which, because of its high cost is created in the rich countries. Knowledge is critical to progress and development. Lack of it means the lack of capacity to even access existing knowledge available.

There are however two types of knowledge: ideas and skill (Conceicao and Heitor, 1998). These authors also made use of the taxonomy often used in the economic analysis of knowledge (see Nelson and Romer, 1996). In this taxonomy, ideas are software while skills are described as wetware. The former, ideas are knowledge that is codified in books, disks, records etc. ; they are therefore public. Skills on the other hand are knowledge that is personalised. It continues to improve as the individual acquires more technological or social capabilities through learning.

Between ideas which are cheap because they are readily available and skills which are personal and can be monopolised and hence expensive to produce, it is possible to identify the ownership of property rights (Conceicao and Heitor, 1998). Both concepts are mutually influencing as the existence of an idea creates the need for human skill to translate the idea into technology for the production of human needs (Pavitt, 1987 ; Nelson, 1993; 1996).

Social Capability

Technological capacity building is only possible where and when the critical minimum social capability is present. By social capability is meant the levels of general education and technical competence of the people. This also must be complemented by the commercial, industrial, financial and managerial institutions that enable them to efficiently organise resources for economic growth and development.

Our definition of these three terms reveal that social capability which embraces technology and knowledge is an important facilitator within the environment in which technological capacity building can and must thrive. Technological capacity also strengthens social capability through their mutual interaction and dependence on knowledge.

1.5 Methodology

This study was carried out between October 1998 and May 1999 when the author was a visiting international scholar at the Institute of World Economics and International Management, (IWIM) University of Bremen, Germany. The methodology adopted in this investigation involved extensive literature search in the State and University library in Bremen and elsewhere. This search was complemented with interviews during visits to university departments, the Uni-Trasfer, (office of technology transfer) industries, and other agencies involved in either technology transfer and capacity building. These visits were arranged for me by the secretariat of IWIM. Staff and students involved in various on-going R&D projects for industries also provided information on their activities. A representative sample of industries in the technology park was also covered. These selected industries covered light engineering, information and communication, gold denture manufacturing, environmental management and paper conversion. The information from these different sources were subjected to content analysis. Where disagreements were observed in data from different sources on the same subject, visits were repeated for clarification and consistency.

Continuous discussions of findings with German colleagues at IWIM enriched the information as the Institute at the time of my visit was also engaged in a study on International Comparison of Technology Policies. This provided a lot of research material on the current situation in Europe and the USA. Because of this on-going study at IWIM it was possible to subject every stage of this study to peer review within the Institute.

Owing to lack of adequate resources the American component of the study could not be conducted empirically, nevertheless this aspect was covered through the reliance on available literature. One major problem of the investigation was that some of the materials collected during visits were written in the German language. This

was solved by members of the Institute all of whom could speak and write in the English language. They provided summary translations of German materials in English. By involving other colleagues in this work, it was possible to tap the experience and expertise of others who have lived and continue to work in the environment where this work was started and completed.

2 Review of Literature

2.1 Introduction

All over the world the development of science and technology have been recognised as a necessary condition for economic growth and social progress. (World Bank, 1998; Mansell and Wehn, 1998). In Africa however, all development including science and technology indicators show lower values than in other parts of the world (Wangwe, 1992). The relevance of coming to terms with the importance of science and technology at this stage of Africa's development cannot be overemphasised. Africa as a whole has the resources and market for industrialisation (Green and Siedman, 1967) but the poor knowledge of its managers and weak technological institutions constitute major constraints (Richman, 1977). In a country where the education and training systems are not geared to the needs of industry, Richman concludes that more productive technology cannot be employed.

The implication of this fact is that a science and technology policy framework should be designed to guide all research and development activities for the promotion and utilisation of technology. It should also incorporate a strategy for technological capacity building (TCB) as a continuous social process.

Technology policy in a developing country is a set of interrelated policies that structure the process of technology acquisition, diffusion, and utilisation (Dahlman, 1989). Adubifa (1990) also makes the same point when he defined technology policy as a framework consciously put in place for the purpose of acquiring and utilising scientific and technological knowledge in order to achieve national development objectives. The effective performance of this framework according to Dahlman requires enormous amounts of financial, human and strong organisational or institutional capability.

To develop this capability a nation therefore needs to have the appropriate policy, build the necessary institutions and structures which must be sustainable. But while many African countries are technologically backward they are still unable or unprepared to build the institutional/management structures for overcoming their problems. Hence Bell and Pavitt (1992) conclude that these countries are likely to remain without the necessary technological capability for entry into the global market as they do not possess those distinct resources which Bell and Pavitt describe as technological skills, knowledge, experience and institutional structures and linkages.

The environment within which technology must thrive is important because technological innovation and scientific discovery are often not the product of work by an individual scientist or research institution (Wangwe, 1997). Thus the change from atomistic theory of technological innovation to the collaborative model has implications for the critical role of networks in TCB (Nelson and Rosenberg, 1993). David (1992), also explains the rationale for institutional networking for TCB. In his own view co-operation ought to exist between esoteric research for the purpose of expanding the frontiers of knowledge and research directed toward the production of goods and services. Just as technology poses explanatory challenges to the scientist, the work of scientists also

pose technological problems the solutions which according to David may find applications in the production sector. The trend towards institutional networking for the pursuit of technological knowledge "has been furthered by the greater availability of standardised procedures embodied in new instruments for generating and analysing data, as well as by the availability of high-speed digital communication networks for linking spatially separated researchers" (Mansell and Wehn, 1998).

Of course, the financial capital required for the provision of physical and laboratory facilities maybe beyond the capability of a single institution. There is therefore need for co-operation among researchers and centres. But where research activities are fragmented and weak as in Nigeria, (Adubifa, 1990), research seldom leads to successful technological development. It was perhaps for this and other reasons that the United Nations Advisory Committee on Science and Technology organised five working panels of experts between 1982 and 1983 on the theme Science and Technology Policy Management in Developing Countries. In their report, the Committee suggested that during the 1980s and 1990s, new conceptual approaches will be needed to stimulate research and development that meets the needs of developing countries. The new approaches, in the view of the committee consist of research and development agencies, higher educational institutions, consulting engineering firms, public and private companies, all operating in a network. Each member of the network, according to the committee's framework will engage in research and development related activities in support of the others. This collective interaction is anticipated in Nelson and Rosenberg's (1993) "community of actors" within the system of national innovation. Again Soete and Weel, (1999) who very recently examined the trend in technology policy in Europe describe the existence of a complex and dynamic social process involving many social and economic interests and a wide range of specialist individuals, institutions and companies involved in information and

knowledge exchange through a network. The strength of the network is to be derived from co-operation among the members. In his own contribution, Wohlmuth (1998) identifies some of these members as consisting of education and training institutions, public and private research organisations, private enterprises investing in R&D, finance institutions, joint ventures among enterprises and research organisations, professional bodies that set standards of performance etc. all working together in concert to sustain the national technological innovation system. More on this later.

Since a given country is to derive benefits from the activities of the network, the UN Committee recommends that government should be involved in stimulating and sustaining the network. Government also has the additional responsibility of providing the necessary policy guidelines for the network. Government should be involved because institutions do not exist in a political vacuum. They operate within a policy and cultural environment in which competition for resources and power exists. Thus, any analysis of institutional capacity building must take account of the interrelationships of the structures within the larger environment.

The building of a network is seldom without management problems (Wohlmuth, 1998). Public policy intervention is an essential ingredient in networking because of the danger of market failure in policy design. This is because TCB through networking involves what Bell and Pavitt (1992) describe as the determinants of successful technological accumulation. These are (a) acquisition of foreign technology, (b) investment in education, training and research, (c) economic incentives for innovation and imitation, (d) continuous growth in demand, (e) linkages designed to encourage the accumulation of technology. The integration of these components must be a policy objective of government, argue these authors.

With respect to developing countries however, Dahlman (1989) calls for caution. Given the inherent policy instability and the nature of the bureaucracy in developing countries, it is important to consider the level of efficiency of government policy implementation machinery. Dahlman's point of view is that even well intentioned policies can produce bad results if not properly designed or if the implementers do not have the necessary technical competence. Again, policies may not work if efforts are uncoordinated or frittered away due to inter- institutional or inter-ministerial rivalries (Oni, 1996).

Capacity under-utilisation and low retention due to brain drain constitutes another problem area in capacity building in Africa and other developing countries, (Adubifa, 1990; Bossuyt, 1995). An evaluation of structural adjustment programmes in many African countries reflect a lack of capacity and management skills (Phillips and Ndekwu, 1987). Bad governance and instability can also decapacitate a potentially efficient administrative machinery. Hence, Bossuyt suggests that capacity building issues particularly through networking touch on many sensitivities which include governance, quality of leadership, management philosophy, resource allocation strategies etc.

Capacity building through institutional networking therefore should be grounded in an appraisal of the environment. Management weaknesses are usually not merely due to technical problems, they generally manifest more pervasive and fundamental problems which are generated through the structural relationships of these organisations with their environment.

2.2 Lessons from developed countries

What lessons can the poor countries learn from the role of various institutions in TCB? While Africa may be looking up to

Europe for models of TCB, the latter continent is concerned about its recent decline in TCB. In its recent report for the mid year 1998, the European Union (EU) is worried that it has not performed well in the field of science and technology. The EC attributes the continent's lower economic growth, lower employment and declining global competitiveness to its recent cutback policy on investment in R&D, science and technology, education and training. As a major technological and economic power in the world today, Europe feels that it must promote long term economic growth through aggressive investment in TCB if it must retain its leadership position in the world in the 21st century (EU; June/July, 1998).

The building of technological capacity through institutional collaboration is not a recent development (Rondinelli, 1998; Soete and Weel, 1999). Inter-institutional networking according to Rondinelli has witnessed three historical waves in the second half of the 20th century. The late 1950s witnessed the growth of science and technology parks in America, Asia and Europe. With these parks also grew technology co-ordinating centres; both of these were used as a matter of government policy to stimulate innovation, diffusion and commercialisation of technology. The second wave was in the 1970s ; this produced the growth of high technology industry clusters with very strong R&D capacity in internet services, data processing and computer networks in America, Europe and Japan.

The third wave (1980-1990s) produced policy response to the awareness that previous TCB policies in these developed countries would not be able to cope with the global challenges of the 21st century. Future success argues Rondinelli would "depend on creating stronger regional technological development capacity and a more complex and diverse institutional infrastructure to support technology based industries". The management of what Rondinelli recommends for effective TCB in any nation requires complex

interactions among stakeholders (Mansell and Wehn, 1998, p.49); that is, co-operation and co-ordination within the "community of actors" (Nelson and Rosenbeg, 1993).

These actors are the universities, research institutes, industry, foundations and government. The role of each of these institutions in the developed countries is reviewed very briefly in order to draw out lessons for the developing countries.

2.3 Universities

The role of universities in human capital development, research and technological innovation cannot be underestimated. All over the world investment in university education is a critical component of national development effort. Nations today depend increasingly on knowledge, ideas and skills which are produced in universities (World Bank, 1997; OECD, 1996). As a nation's knowledge industry, universities increase the productive capacity of the labour force. In the developed countries university scientists are able to monitor global technology trends, assess their relevance to national needs and assist in developing the national technological capacity for economic growth. For example, a World Bank study of about 1000 inventors in the Indian subcontinent revealed that almost 90% of them had a university first degree; those with some graduate training among them were more than half and almost 30% had their Ph. D. (World Bank, 1998, p. 43). Since industry and the public sector demand high level manpower the role of the university is to satisfy this demand.

The problem in Africa today is that the universities lack top quality professors, up to date facilities for teaching and research modern curricula particularly in science and technology (World Bank, 1998, p. 55). Yet the demand for highly competent personnel in Africa still continues to grow further increasing the inability of the

universities to produce high quality graduates (Oni, 1991; Oni, 1999; Yesufu, 1996).

2.4 Research Institutes

Knowledge production through R&D, that is, the process and mechanism for TCB is no more the exclusive preserve of universities. Today knowledge production and innovation have spread from academia to many different types of R&D institutions both public and private in Europe America, Japan and Southeast Asia. The increasing complexity of the network among many research institutes scattered all over Europe enables them to internalise knowledge and technology through the use of information –communication technology (ICT) (Soete and Weel, 1999). The frequency and speed of interaction among these institutes has risen in the last decade (Mansell and Wehn, 1998) especially within the framework of Technological globalisation (Rondinelli, 1998; Soete and Turner, 1984).

2.5 Industry

The transformation of the results of research into the production of goods and services to meet the demands of the market is the main role of industry. As a result of the competition from other producers and pressures from shareholders, many industries are unable to wait for the results of university research that may tend to have long gestation periods. Industries therefore tend to develop their own in-house technological capacity for market oriented R&D activities but making use of the research personnel already developed and produced by the university (Soete and Weel, 1999).

2.6 Government

The social benefits of TCB is higher than the private returns; a private organisation therefore does not always have the motivation to invest in it. There are two main alternatives either of which must involve the State (David and Dasgupta, 1994). The first is the direct involvement of government through the establishment of R&D laboratories as in the U. S. A. and Brazil. The second is through funding and subsidising university R&D programmes.

The role of the government must be seen as extending beyond funding. Solomon and Tornatzky (1986), argue that government (American) at every level should strengthen certain institutions and functions critical to TCB. As a matter of public policy, technological capacity building should be seen as the key to the transformation of scientific knowledge to the production of goods and services. In this perspective TCB is not a problem of financial investment alone but also the building of the capacity to manage institutions, resources and processes effectively and efficiently. An enabling political environment should also be created for the community of actors to interact and derive mutual benefits from their collective experience.

2.7 Foundations

Foundations are usually not-for-profit organisations with or without government support. They provide resources and opportunities for scientific research and training in specific areas of interest to them or in response to social need. For example, the Alexander von Humbolt Foundation in Germany contributes to TCB all over the world by providing qualified foreign academics with opportunities to carry out research of the grantees' choice in a German university. One of the biggest foundations in Europe is owned by the Volkswagen Company of Germany. This foundation

is famous for its very generous contributions to the development of science and technology in all facets of human need.

A major lesson for the developing countries is that these institutions in the developed countries (universities, research institutes, industry, government, foundations) are able to operate together in a systematic way through their contributions to common societal goals. Through the exchange of personnel and information, universities, industry and research institutes are able to strengthen one another and build needed capacity. Government is the major allocator of resources. The government in the developed countries provide the necessary infrastructures (electricity, water, road networks etc) and the legislative framework within which these agencies are able to operate effectively. More importantly is the stability that is already built into government policies ; this is important as it enables the various actors to have long planning perspectives which is important in networking.

3. Assessment of Nigeria's Effort in Technological Capacity Building

3.1 Introduction

With a total population of about 100 million people (Nigeria Census, 1991), abundant natural resources, 37 universities, over 50 polytechnics and 26 research and development centres, Nigeria has the potentials for building and sustaining technological capacity if the right policy framework and institutions exist. Since the attainment of political independence in 1960, successive governments have adopted economic growth policies designed to harness both the human and natural resources of the country. While many other sectors of the economy have continued to experience

decline, the human resources development subsector (education) has shown dramatic increases over time. Both the federal and state governments continue to see education as a central pivot of development planning.

3.2 University Education in Nigeria

The first university was established in Ibadan in 1948. Over a period of fifty years the number of universities rose to 37. Through their teaching and research programmes these universities have produced the personnel that has filled high level posts in the various professions both in the public and private sectors of the economy. Of all the resources – human, material/equipment and finance which universities require to perform their functions, human resources, that is, academic staff constitute the most critical. This is because the ability of a country's educational system, particularly that of its universities to contribute to technological and economic development is largely dependent on the number and quality of its teaching and research staff (Oni, 1985). No educational system can be better than the people who operate it.

The story of the Nigerian university today is different from that of its glorious past (Oni, 1999). The system has largely been affected by the impact of the economic down turn and general social disequilibrium (Bangura, 1994) which are manifested in strikes, burning of university property by students, violent confrontation with law enforcement agents resulting in deaths, cultism and all other social malaise of decadence. The loss of academic staff to the university is part of the response of some individual staff to this decadence and the frustration it engenders. Available statistics show that a total of 883 lecturers and professors left the universities between 1992 and 1995 (Federal Office of Statistics, 1996) out of a total number of 12, 977. This percentage loss of 6.8 within a period

of three years is significant for a developing country where the replacement rate is also very low (Oni, 1987).

Through the loss of academic staff, the quality of capacity building in the Nigerian university system is bound to be of a low quality. When this loss is compared with the demand for university admission, (see Table 1) the level of depreciation in the quality of the human capacity being built can be further appreciated.

Table 1: Applications and Admissions to Nigerian Universities, 1987/88-1991/92

Years	*Number*	*Applications Index*	*Number*	*Admissions Index*	*%*
(1)	(2)	(3)	(4)	(5)	(6)= (5)/(3)
87-88	210,252	100.0	32,839	100.0	15.6
88-89	189,552	90.0	41,065	125.0	21.7
89.90	249,164	118.4	36,616	111.5	14.7
90-91	n.a.	-	48,168	146.7	-
91-92	373,016	117.2	61,212	186.4	16.4

Source: Federal Office of Statistics, Annual Abstract of Statistics, 1994 edition, Tables 94-102.

Even with a total of 37 universities not all the candidates who desire university education can be admitted as less than a quarter of the total number of applicants are actually admitted. The implication of this is very serious for a country of over 100 million people blessed with abundant natural resources. While these universities continue to produce highly educated citizens and personnel that manage the nation's 37 federal and state bureaucracies, its over 700 local administrations, government parastatals and private sector organisations, the quality of the output from the universities has deteriorated. The technical and managerial capabilities of the products have also experienced a decline over time. The overall impact of this trend is manifested in the observed low level of economic development in the country.

3.3 Research and Development Institutes

In the advanced countries most R&D centres grew up gradually in response to the expressed scientific and technological needs of industry (Arnold, et. al., 1998) These centres developed their specialised contribution to solving the problems of industries that also provide personnel and financial resources to collaborative projects. Later government R&D centres also grew up in specialised areas like defence, aerospace engineering and telecommunications.

By contrast the less developed countries did not have the industries that could generate the need for the services of R&D centres. Consequently government is the major agency responsible for establishing and financing these centres. Because these centres in Nigeria did not emerge in response to felt local needs many of them are modelled on the most advanced R&D centres in the advanced countries. When the economic decline came most of them did not, and still do not have the funds to either replace obsolete equipment or to sponsor their staff for capacity building training programmes overseas as was the practice during the period of the oil boom. It is therefore not difficult to understand the lack of industrial or TCB relevance of many of these centres today

There is today a total of 26 Research and Technological Development (RTD) Institutes in Nigeria. These are shown in Table 2 below.

Table 2: Names and Functional Classification of RTD Institutes in Nigeria.

1. Industrial	Federal Institute of Industrial Research, Oshodi, (FIIRO)
	Project Development Institute, (PRODA), Enugu
	National Institute for Energy Research
	National Technology Development Centre, Abuja
	National Institute for Chemicals Research, Zaria
2. Fisheries and Marine	Nigerian Institute for Oceanography and Marine

	Research, Lagos
	Lake Chad Research Institute, Maiduguri
	Kainji Lake Research Institute, New Bussa
3. Food Crops	National Cereals Research Institute, Badeggi
	Institute for Agricultural Research, Zaria
	National Root Crops Research Institute, Umudike
	National Horticultural Research Institute, Ibadan
	Institute of Agricultural Research and Training, Ibadan
4. Tree Crops	Forestry Research Institute, Ibadan
	Cocoa Research Institute of Nigeria, Ibadan
	Nigerian Institute for Oil Palm Research, Benin
	Rubber Research Institute of Nigeria, Benin
5. Livestock	Nigerian Institute for Trypanosomiasis Research, Kaduna
	National Veterinary Research Institute, Vom
	National Animal Production Research Institute, Shika
6. Medical	National Institute for Medical Research, Lagos
7. Civil Engineering	Nigerian Building and Roads Research Institute, Lagos
8. General Agric. Services	Agricultural Extension & Research Liaison Services Zaria
	Nigerian Stored Products Research Institute, Ibadan
	National Centre for Agricultural Mechanisation, Ilorin
	Institute of Agric. Research and Training, (Obafemi Awolowo University) Ile-Ife

Source: Federal Ministry of Science and Technology, 1996.

These institutes cover eight different sectors: industry 5; fisheries and marine, 3; food crops, 5, tree crops, 3; livestock, 3; medical, 1; civil engineering, 1; general agricultural services, 5. The distribution shows that the agricultural sector is linked with 50% of the RTD facilities in Nigeria while the industrial sector has about 20%. The rest 30% is distributed among the remaining six sub-sectors. This distribution shows the importance which the government attaches to agriculture and industry.

The Nigerian government recognises as a matter of national development policy that RTD institutes, universities, and

polytechnics are necessary institutions for TCB. Both the Ministries of Education and Science and Technology have the statutory responsibility for the promotion of research and technology. Unfortunately, the lack of policy co-ordination between these two key ministries has left the government unable to rationalise or institutionalise co-operation among these institutes or between them on the one hand and the universities on the other.

Lack of knowledge and information exchange among the institutes within the same industrial subsector constitutes a major operational problem. This problem is perpetuated by human factors such as ethnic mistrust, power rivalry and jealousy, corruption and political patronage in appointments. There are also physical constraints like unreliable communication network, poor roads and other infrastructures, all of which hinder the smooth flow of ideas and information (Adubifa, 1990).

Like the universities, the technical capacity of these institutes is limited by their low quality of personnel and high turnover. This is traceable to the poor conditions of service and lack of social recognition of staff vis-à-vis their colleagues in the parent ministries. Even the few researchers that are left in these institutes hardly engage in collaborative research projects with their colleagues because of the absence of the necessary institutional mechanism for such productive collaboration.

3.4 Industry

The very important role which the industrial sector plays in TCB is not obvious in Nigeria. This is because the industrial sector is not only small relative to agriculture but also suffers from a number of constraints imposed on it by government macro-economic policies (Ariyo, ed., 1996) The agricultural sector that is meant to be served by 50% of national RTD capacity does not

benefit in terms TCB investments. Peasant farmers who constitute the majority of people in this sector are in the villages where they do not have access to any TCB programmes. The young energetic and educated youths whose capabilities could be developed are averse to farming because of its drudgery and lack of motivation.

The oil industry which provides almost 80% foreign exchange earnings relies largely on imported technology whose linkage to the domestic economy and the local technological condition is very limited. Again the informal sector characterised by small entrepreneurs lack the resources to link them with the potentials of the universities or research institutes.

4 Technology Capacity Building in USA and Germany

4.1 Introduction

In the review of literature we discovered that TCB as a development process involves the active participation of government, university, private firms research centres and foundations in the developed countries. Of very important significance in the development process are the character and effectiveness of a country's system of education and training especially at the post secondary level. The education and training system not only determine the supply of technical skills, it also influences the attitudes of workers towards technological innovation (Nelson and Rosenberg, 1993). Labour-management relations in industry or the relationship between the scientist and the technician in a laboratory setting are critical in the process of research, learning and discovery of new ideas.

The development and diffusion of technological innovation generally requires the co-operation of the men of ideas and the

translators of ideas into useable technology. But because those who generate ideas and those who use them operate in different attitudinal and normative value systems, the tendency is for the existence of lack of co-operation between the two groups. For example, the initial attempts to forge co-operation between university and industry in the USA met with opposition from industry. At first, entrepreneurs did not appreciate any commercial benefits derivable from basic research. There was also the suspicion that any outside interference with industrial R&D programmes would stifle industrial research initiative and affect economic returns to investment. The preoccupation of industry with short-term profits and development of new products rather than innovative processes therefore stonewalled the initial efforts aimed at university –industry collaboration in America.

This situation however was to change later even in other parts of the developed world (Keyworth, 1986; Solomon and Tornatzky, 1986; Gray, et. al. 1986). Today technological innovation and the process of capacity building which brings it about have become dependent on institutional and organisational partnerships particularly between the university and industry. According to Solomon and Tornatzky, no single agency can take the initiative without there being a national policy backed up by the provision of institutional resources. Government has an important role to play here. Through the provision of infrastructures, resources and strengthening of institutions, the governments in the developed countries have promoted collaboration between university, industry, and other social partners. How this has been done and the results in two countries (America and Germany) is the subject of the rest of this section.

4.2 USA

The major determinant of the aggressive American government political and financial investment in technological capacity building (TCB) after the second world war was the perceived ideological and security challenge posed to America by the then Soviet Union (Grey et al., 1986). Technological superiority was viewed by the Eisenhower's administration as a major asset of America in the east-west geopolitical, military and ideological competition with the Soviet Union. In 1961, the federal expenditure on TCB and R&D equalled $9.2 billion which was about 65% of total national investments. Increased technological competition in aerospace technology further intensified the American government effort in TCB in later years.

4.2.1 Strategies

A major strategy adopted by the United States of America was the promotion of university-industry collaboration as a matter of deliberate national policy through the National Science Foundation (NSF). All administrations through their legislation further promoted this collaborative effort. The assumptions of the American federal administration were that:

(i) collaboration between university and industry would lead to new technological breakthrough which would benefit industry and Americans ;

(ii) such collaboration would contribute to the production of highly skilled manpower;

(iii) such collaboration would sustain the status of America in global competition ; and

(iv) unless promoted deliberately by government, collaboration between university and industry would not occur voluntarily.

Assumption (iv) was legitimate and realistic to the extent that the values of the university scientist which is based on scholarship and extension of the frontiers of knowledge are antithetical to the profit motive of the industrial manager.

The American government policy on TCB lays emphasis on research in the universities with co-operation from the industrial sector. The specific policy objectives according to Keyworth (1986) are to (a) produce highly competent manpower that would maintain American technological leadership in a competitive world; (b) enable American scientists and engineers challenge intellectual frontiers in the most important fields of technology and engineering; (c) stimulate "productive partnerships between scientists and engineers in all sectors of society partnerships that are increasingly vital to the development of new technologies that will keep American industry competitive" within the framework of globalisation.

The establishment of university-industry co-operative research centres under the auspices of the NSF established in 1972 has improved collaboration and TCB through institution building and networking.

4.2.2 American Model of Industry/University Co-operative Research Centre (IUCRC)

Although university based, the American model of Industry/ University Co-operative Research Centre (IUCRC) is usually jointly supported by a number of enterprises (see figure 1). The centre relies on a multidisciplinary team of scientists from the university faculty and industrial R&D. Each centre has an organisational structure headed by a university departmental administrator. The academic interests are represented by an academic advisory committee while an industrial advisory board is

made up of representatives of each sponsoring enterprise. Both the academic advisory committee (AAC) and the industrial advisory board (IAB) make policies and jointly monitor the research projects of the centre. Usually, faculty members and students participate in the centre's research projects. The centre's policy making body pass laws and determine procedures that relate to patent ownership, royalties, and publications etc. Review meetings and seminars are held periodically so as to exchange knowledge and vital information among participating members.

By involving students and young professionals in the work and management of the centre, not only are skills developed, but institutions are built that can further strengthen the future work of these centres and improve the economy. The interdisciplinary nature of the activities of these centres enable them to build capacity not only in technology but also in organisational management and team building. These centres are so successful today that many American State governments have adopted and funded them. Some of the centres have also developed spin-off research centres on their own without additional funding from the NSF.

Fig. 1: Organisational Chart of the IUCRC

Adapted from Gray, D.O. et al. (eds.) 1986, p. 179

Apart from these centres, other research organisations (public and private) exist side by side with or without government funding.

These organisations are also engaged one way or the other in TCB through training conferences, exhibitions, public enlightenment programmes or tailor made capacity development programmes designed for workers in specific organisations. Other strategies adopted include the provision of research funds to specific academicians directly engaged in industrial R&D projects which also involve student participation. The development of industry-university technological extension services also helps to communicate existing capacity to potential consumers (Logsdon, 1986).

Torkomion (1998) describes the "industry-university extension service" as technology administration unit" (TAU) which has the function of coordinating technology R&D programmes between the two organisations. The TAU according to Torkomion will be effective if it is headed by a knowledgeable leader, a researcher-manager who is linked to the university but also understands the needs of the industrial environment and the potentials of the university to meet them.

4.3 Germany

The German approach to TCB is influenced first of all by its own domestic technological demands of the national economy and secondly by its place in the global context of the European Union (Bundesministerium für Bildung und Forschung, 1999). There is no doubt that both these conditions are important as they are mutually influencing. The European countries recognise the importance of collaboration between industry and the university and between the university and the larger society. For example, a United Kingdom government white paper states that cooperation between scientists, industry, financial sector and government is critical in order to improve national competitiveness and quality of life (see Downes, et. al. October, 1998). As a collaborative process technology policy

design and implementation are being brought into much wider social issues like unemployment, environment crisis, health, and housing in the developed countries. All these developments in Europe continue to impact on the German assumptions and strategies of TCB.

The European and ipso facto German assumption is that the university can only become relevant to society and industry if its researchers move away from esoteric intellectual pursuit towards industrial and market relevance (BmB&F, 1999). Another important socially relevant assumption in Europe is that the continent may not be able to maintain its technological leadership position in the 21st century unless it invests in building its human capital and institutions as aggressively as it did before the depression of the 1990s (EU, 1998).

Given the above conditions, Germany lays emphasis on the role which the country can and must play in European scientific and technological cooperation. European cooperation therefore is the key to the increasing international orientation in German approach to TCB. The cooperation in vital fields is being achieved through (a) the networking of European research and technological capacity building potentials, (b) intensification of cooperation between universities, research centres and industry, and (c) promotion of interdisciplinary and interindustry projects that lead to innovation. Another means of building capacity through the interational network is further reinforced by the policy of the German government which states that:

"We must give the younger generation the tools it needs to succeed in the internationalising world of work. We will therefore work to intensify student exchanges, not only in Europe but also with Asia and Latin America, and to improve possibilities for young scientists to obtain qualifications abroad. In addition, those undergoing

initial or continuing vocational training must be given an opportunity to gather experience abroad".(BmBxF, 1998).

Through its Ministry of Education, Science, Research and Technology, the German government encourages and actually promotes university-industry linkages. The governments of the Länder (States) also provide support for R&D activities in university-industry projects. There are also foundations that are either public funded or private that also provide resources for R&D work in university laboratories and industries. The exchange of information, and personnel between industry is a continuous process that is encouraged through collaboration. All these collaboration efforts provide training and exposure for students whose capacities are developed against the future.

In building technological capacity, German universities play a very important role. They are able to do this because they can access funds from a number of sources. For example, both the Federal Government (Bundesregierung) and the State (Länder) Government provide funds for university-industry collaborative R&D. Funds from the European Union are also available to universities to assist relevant industrial sectors. Apart from these funds, there are also resources from various foundations as well as private industrial establishments that universities can also utilise. All these provide opportunities for researchers to improve their skills and the knowledge of their students.

In Bremen for example, the university reported in its quarterly publication "Highlights" (no. 1, August, 1998), the donation of DM500,000 and DM 460,000 by the Volkswagen Foundation of Germany to two different research projects respectively. The Institute for German Press Research at the same university also received a grant of DM 300,000 from the German Research Association. The university is noted for its close collaboration with industry through joint research. Through this it seeks to improve

the education and training provided to the students and research assistants (Highlights, 1998, p.12) There are also two important institutions in Bremen that are involved in TCB through the promotion of university- industry cooperation. These are the Uni-Transfer at the University of Bremen and the Bremen Innovation Agency (BIA)

4.3.1. Uni-Transfer

Located within the campus of the University of Bremen is Uni-Transfer, which is the office for science and technology transfer, a connecting link between the university and the Bremen industrial environment. Uni-Transfer is a facilitator of cooperation between the scientists and institutes of the university and industries that are in search of cooperation partners for research and development projects, professionals for scientific consultation and new employees from the university for firms. The office collects on a regular basis information on the needs of industries and funnels it to the relevant institute or department of the university. It also markets the potentials of the university institutes to the outside world. An important advantage of the unit within the context of TCB is that its functions are similar to the technological administration unit (TAU) alluded to earlier.

4.3.2. Bremen Innovation Agency (BIA)

The Bremen Innovation Agency (BIA) is one of the three agencies under the government owned Bremen Investment Corporation. The other two are the Bremen Aufbau Bank (BAB) i.e. Bremen Development Bank and the Business Promotion Agency. As its name implies the role of BIA in Bremen State is two fold. The first is the development and promotion of technological innovation adoption in existing or new enterprises;

the second is the development of technological capacity in the enterprises.

Because of their size, small and medium enterprises are usually unable to access new innovations on their own. BIA's role therefore is to facilitate linkage between SMEs and the products of R&D from research centres, university institutes and bigger firms. For a new innovation from the university, BIA provides about 60% of the total cost for the enterprise to acquire the technology. Young graduates are assisted to the tune of DM 500,000 to start of a business that has high technological innovation and capacity building potential.

As a condition for the loan, a young graduate must undergo a period of training in a relevant university institute where he or she can acquire the necessary technological and business management capacity. Recent examples of training which have resulted in the establishment of businesses in the Bremen region are in information/ communication technology, environmental management, etc. For the effective monitoring of business enterprises BIA holds shares in the business for between 5 to 10 years after which the shares are sold to willing members of the public. Periodically BIA organises tailor made technological innovation/business management capacity building training seminars for entrepreneurs in similar areas of business.

In conclusion, the discussions so far on the American and German examples reveal the simple fact that TCB is a social process that involves the cooperation among different actors the university, private sector, financial sector, foundations etc. have critical roles to play. The most important actor of course is the government. To promote the necessary culture of cooperation among the community of actors requires appropriate legislation, initial financial investment for take-off and monitoring standards. At a period of financial cutback by government due to economic

depression, universities need to identify and exploit reliable alternative sources of financing their R&D activities. This is important for Nigerian universities today more than ever before. Industries and foundations as we have seen in the discussion present alternative sources of funding which universities and research institutes must exploit if they want to make their TCB activities relevant to the needs of the larger society.

5 Lessons for Nigeria

5.1 Introduction

In spite of its huge economic potentials Nigeria still remains one of the poorest countries in the world. With its arable land, flora, fauna, large population size (100 million 1997), and vast oil resources the country is unable to utilise its universities, research institutes, industry and local expertise and other institutions to pull itself up from its current level of underdevelopment This is so because of the country's low level of human and institutional capacity. Huge public/private bureaucracies and institutions and vast reservoirs of natural resources cannot provide, let alone develop institutional capabilities; there must be a deliberate collective effort directed towards capacity building (Oni and Akerele, 1997).

Collective effort also involves the role of the government in promoting and sustaining inter-agency cooperation in national policy on TCB. It is this that determines the context and behaviours of various structures (universities, research institutes, industry, government etc.) and the way they relate in a social network. Thus to be able to achieve the goal of TCB the Nigerian government must institutionalise and co-ordinate TCB as an important social

engineering process that can be sustained in order to produce the desired result. The challenges in doing this must however be appreciated. The opportunities for facing these challenges offer themselves within a democratic framework of governance that Nigeria now vigorously pursues to institutionalise.

5.2 Challenges

There are universities, polytechnics and research institutes all scattered in different parts of the country without any effective information technology network that can facilitate cooperation among them or between some of them in very remote areas of the country and industries that are located in the cities. There is also a serious spatial maldistribution of these institutions ; for example, out of the 36 States in Nigeria, Lagos State alone has 2 universities, two polytechnics, 2 advanced teachers colleges and 4 out of the 26 research institutes in the country. Yet new States like Ebonyi, and Zamfara have none of these facilities. This maldistribution of TCB facilities constitutes a serious problem of geo-political equality in Nigeria, a country already almost torn apart by the politics of ethnic and spatial competition for government patronage.

The poor state of infrastructures in the country is a formidable constraint to information and knowledge exchange between institutions. No single institution can solve the problem of erratic supply of electricity, water or poor road networks not to talk of telephones that do not work. If institutions must collaborate with one another these intractable infrastructure bottlenecks must be removed by government.

Inadequate funding due to government cutbacks in recent times are being experienced by all public institutions. The result is that many institutions are unable to pay the salaries of their staff ; this has developed into industrial disputes in many research institutes and

universities. Rather than engage in R&D activities, management in these institutions are engaged most of the time in industrial negotiations with their workers. The high staff turnover in these centres is a product of lack of motivation and irregular payment of staff entitlements. Productivity decline due to frustration is a common phenomenon in some of these centres today.

While government needs to fund these institutions adequately, industry-university collaboration must be encouraged through part financing of joint research projects by government. The example of America and BIA in Bremen can be copied. Tax relief to industry should be considered as a means of promoting university-research institute- industry collaboration.

The Nigerian industrial landscape is covered by SMEs. These firms lack the financial strength to access the products of R&D from the universities and similar organisations. Very often they cannot even afford to sponsor their staff for capacity development training programmes. As a result of their heterogeneity, different types of TCB programmes are required by them. These firms can be reached through consultancy, awareness schemes and targeted technology transfer projects. Special government support and multilateral donor support is required to assist these firms improve their technological and management capacity.

Organisational success and effectiveness is often attributed to the leadership and management of the organisation. The choice of who to head and manage an organisation must be seriously considered: this consideration is critical as political and ethnic considerations rather than merit have always been used in selecting the chief executives of most government parastatals in Nigeria. The use of non objective criteria in the appointment of heads of institutions and departments, to say the least, has remained a fundamental remote cause of the crisis that many of the organisations concerned have gone through. These challenges are formidable, but given the

philosophy, spirit and opportunities for collective participation which democratic governance will offer the country in the 21st century, these challenges are not insurmountable.

5.3 Proposal for a Framework

We have seen in the previous sections that technological innovation and the process involved in capacity building in the developed countries depend on the formation of effective organisational and institutional partnerships particularly between universities, research institutes and industry. Collaborative effort between these agencies are considered germane to TCB, but given the different values of these organisations, collaboration did not take place voluntarily even in the United States of America. It required the legislation, support and policy consistency on the part of the government to promote inter-agency cooperation. This is an important lesson for Nigerian policy makers.

Given the Nigerian situation it would require not only a federal government legislation to institutionalise university/ research and institute/ industry relationship, it would also require government funding and establishment of a sustainable management frame–work. This proposed framework which is here termed National Agency for University-Industry Collaboration (NAUIC) (see Figure 2) would have representatives from the following key institutions and bodies.

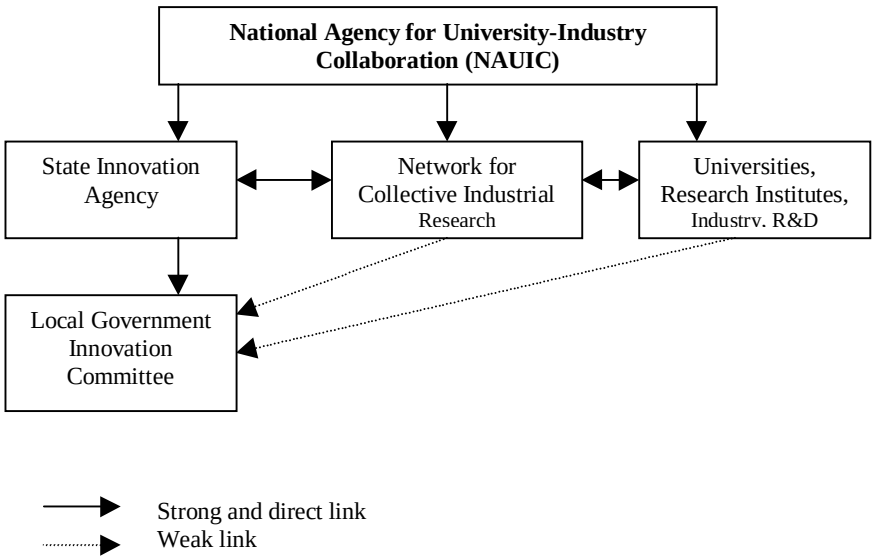
Membership of NAUIC :

- Universities, (federal and state)
- Polytechnics (federal and state)
- Research and Development Institutes

- National Association of Chambers of Commerce, Industry, Manufacturing and Agriculture (NACCIMA)
- Manufacturers Association of Nigeria (MAN)
- National Association of Small Scale Industrialists (NASSI)
- Federal Ministry of Education
- Federal Ministry of Science and Technology
- Federal Ministry of Industry
- National Planning Commission
- Other agencies
  (a) Nigerian Institute of Social and Economic Research (NISER)
  (b) National Manpower Board (NMB)
  (c) Industrial Training Fund (ITF)

As a national organisation, this agency should have autonomous administrative powers and resources to be able to perform effectively. The role of this agency would be similar to that of the National Science Foundation (NSF) in the United States of America, or the Deutsche Forschungsgemeinschaft (DFG) in Germany. That is it should play co-ordinating and facilitating roles in the functions of other lower structures within the national community of technological capacity building institutions.

Fig. 2: Proposed Organisational Framework for Technological Capacity Building in Nigeria



5.3.1 Functions

The functions of NAUIC would be to :

(a) promote effective collaboration between universities, research institutes and industry ;
(b) encourage the development of technology parks in the new industrial master plan for the country
(c) identify priority areas in TCB and national R&D projects;
(d) lobby government for TCB and industrial R&D funds
(e) set objective criteria for fund allocation to different research projects with high TCB content;
(f) on the basis of identified national needs and priorities influence curriculum engineering in the universities and polytechnics

(g) promote collective industrial research and development activities among trade associations

The role of other agencies (NISER; NMB; ITF) would be to provide the agency with technical support like information, data, research input etc. for the deliberations of the agency.

5.3.2 Network for Collective Industrial Research (NCIR)

A Network for Collective Industrial Research (NCIR) is a group of firms or trade associations that support research for capacity building in research centres with a view to strengthening both the capacity of individual firms and also the research centre in terms of equipment and development of new skills to further help the group of industries. A trade association according to the American Society of Association Executives is a non-profit organisation of business competitors in a single industry formed to provide mutually beneficial services in promoting total output, income and employment in the industry. Their collective efforts help to strengthen the technological base of the industry. Through their collaboration with the university, the latter is able to build and accumulate technological knowledge used in improving the quality of its graduates. In a situation of government cutback the university through this means has access to alternative sources of revenue. These and other advantages which will be discussed presently make this network a feasible proposal for a developing country like Nigeria.

Within the Manufacturers Association of Nigeria (MAN) can be found different industrial subgroups. If we assume a network consisting of the Food and Beverages Producers Group, then Table 3 below will represent its objectives and modus operandi of the NCIR.

Apart from the advantages of this type of networking which are already mentioned, there are other benefits which both the university and industry can derive. One of these is that the work of the university will have social and economic relevance. This is very important in a developing country like Nigeria at this time. The joint effort also will serve to increase the supply and quality of trained manpower in the economy because students will be exposed to current problems that require technological solutions. By concentrating scarce resources on critical problem areas industry will get results that are cost-efficient. The collective action also will reduce the cost of TCB per enterprise.

Table 3: Network for Collective Industrial Research for the Food and Beverages Subgroup of the Manufacturers Association of Nigeria (MAN).

Subgroup	*Food and Beverage Manufacturers*
Objective	To promote TCB through collaborative research and manpower development programmes with the university and research institutions in food and beverages science and technology
Membership	University faculty, graduate students, industrial scientists and big and SM enterprises in the food and beverage subsector
Funding	Membership dues, subvention for NAUIC, support from the relevant government ministries, support from MAN, NACCIMA and NASSI, foreign donations
Research Emphasis	Basic and applied research as may be determined by subgroup and national priority
Training	Capacity building through joint research activities, innovation, workshop, seminars, personnel exchange between industry and university

Adapted from Fusfeld and Haklish, 1986

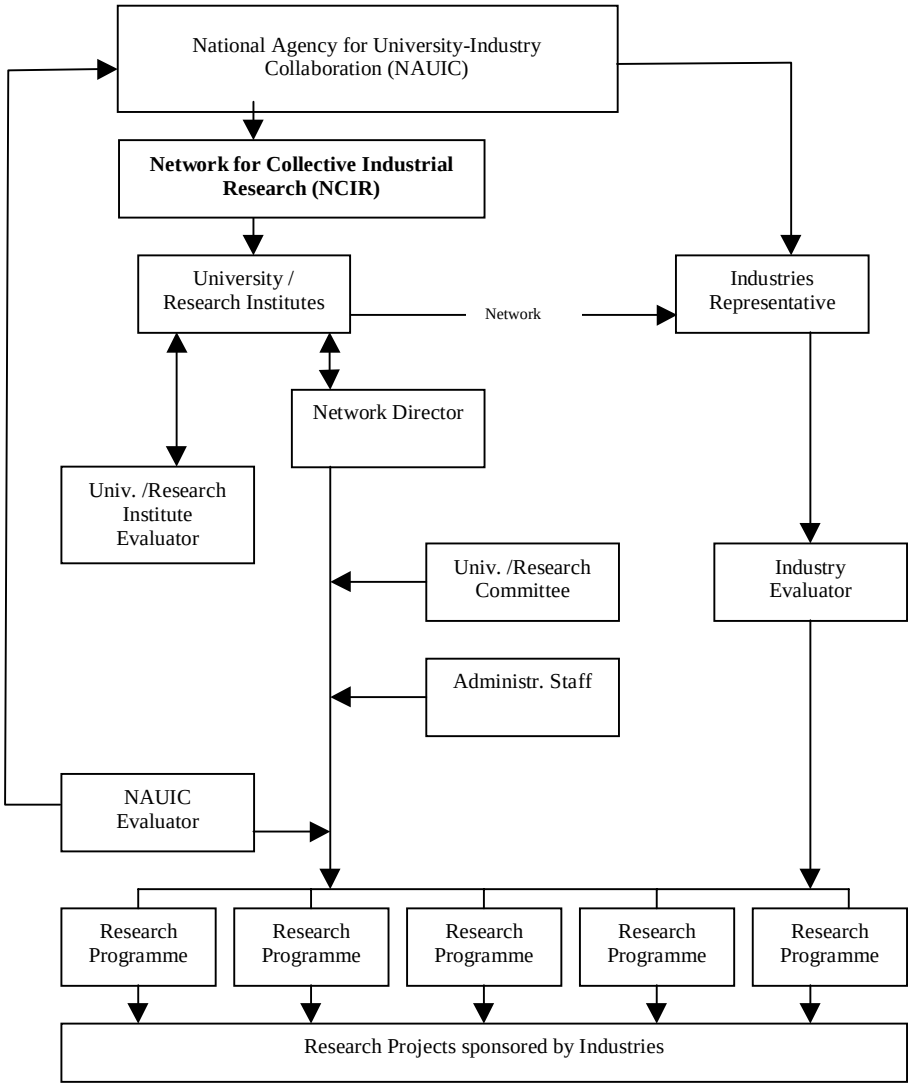
5.3.3 Organisation of the NCIR

Borrowing from the model of the NSF Industry/University Co-operative Research Centre (UICRC) in the United States of

America, the proposed Network for Collective Industrial Research (NCIR) would be based in a university or research institute depending on the spatial concentration of industries and their proximity to a R&D laboratory. The network will have the structures depicted in figure 3 for effective organisational performance. Figure 3 shows the structural relationship between the NAUIC, the policy making agency at the national level and the NCIR at the zonal level. The assumption is that the country will be zoned according the spatial distribution of research and technological development (RTD) institutions. With the possibility of 12 networks, a network would cover three contiguous states in the federation at the ratio of one network to three states.

The network Director would be a leader, a scientist/manager who is acceptable to all interested parties on the basis of demonstrated personal academic and managerial qualities. The representatives of industrial enterprises will be staff in R&D units of their various organisations. The academic and research committees would be responsible for determining the integration of projects into various disciplinary moulds so that the relevant faculty members and students can be selected. The three evaluators (NAUIC; University/Research Institutes, Industry) would carry out their project evaluation together, present their findings to the network before finally reporting to their individual sponsors.

Fig. 3: Proposed Organigram of the Network for Collective Industrial Research (NCIR)



5.4 Role of Individual Universities and Research Institutes

Universities and research institutes in the developed countries assist business organisations to solve their technological problems. Nigerian institutions can and must be seen to do the same. What is important is to make their findings relevant to the needs of SMEs that cover the industrial landscape in the country. Since this is the fact of the environment Nigerian universities and research institutes should not wait until there are giant industries that can afford their bill. Each university and research institute should establish a structure for technology transfer as found in the University of Bremen, Germany. A technology transfer unit (TTU) must play three basic functions (Torkomion, 1998). These are to:

- support the development of technological innovations that can be commercialised;
- introduce to industry new processes that can lead to cost reduction and employment creation
- offer capacity building training programmes to staff in new and old establishments.

The TTU by its functions will be a liaison office charged with marketing the technological potentials of the various faculties to the industrial world and chanelling the demand from industry to the appropriate department or institute.

5.5 State Innovation Agency

There are 36 states and a federal capital territory (FCT) in Nigeria. Some of the new states like Taraba, Yobe, Adamawa, have neither a university nor big industries. The few industries that may be found in many of the states are SMEs coupled with a growing informal sector. For these states to contribute to TCB would require

the establishment of State Innovation Agencies (SIA) The role of SIA should be broader than that of the Bremen Innovation Agency in Germany as the informal sector will also be covered in its activities. The membership of the State Innovation Agency will include the following stakeholders:

(i) State polytechnic or technical college
(ii) Industrial development centre (IDC)
(iii) Industrial Training Fund (ITF)
(iv) State Ministry of Commerce, Industry and Co-operatives
(v) State Ministry of Education
(vi) Manufacturers Association of Nigeria (MAN)
(vii) National Association of Small Scale Industrialists (NASSI)
(viii) National Directorate of Employment (NDE)

The role of the SIA would be to articulate policies and develop joint TCB programmes for polytechnics and technical college students and workers in SMEs and informal enterprises. Already the Industrial Development Centres, Industrial Training Fund, National Directorate of Employment and Polytechnics are individually engaged in uncoordinated TCB programmes. Even though these institutions of government are located in every state, there is no coordination of their activities. A more useful approach would be to integrate the programmes of these agencies so as to maximise the benefits derivable from cooperation. The polytechnics, technical colleges, IDC and ITF as well as consultants should be mobilised to design TCB packages for the approval of the State Innovation Agency before implementation.

The funding of the SIA activities should be through the following sources:

(i) Statutory allocation from the State government;
(ii) Revenue generated through projects and training packages by the SIA
(iii) Contribution from the SMEs and informal sector trade associations;

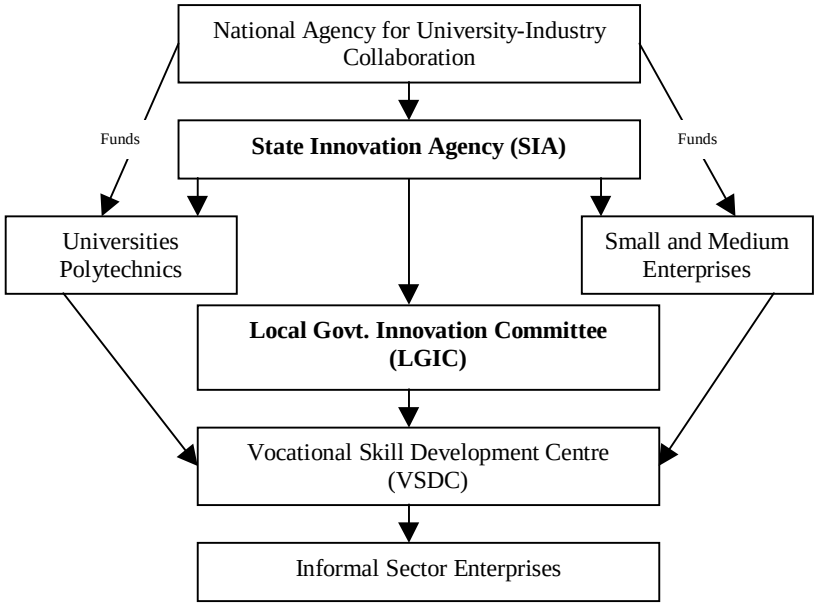
(iv) Federal Ministry of Science and Technology;
(v) Federal Ministry of Industry
(vi) Contribution from the Petroleum Trust Fund (PTF).

For effective coverage of the informal sector, each local government in every state should establish a Local Government Technology Innovation Committee (LGTIC) comprising of :

(i) Local Government Director of Works
(ii) Principal of the local Technical College (if any)
(iii) Representatives of key trade associations
(iv) Representatives of NASSI
(v) Any other relevant interests (e.g. retired civil servant or Professional).

Fig. 4 shows the proposed structural relationship between the National Agency for University-Industry Cooperation (NAUIC) at the national level, the State Innovation Agency (SIA) and the Local Government Technological Innovation Committee (LGTIC) at the grassroot. While the NAUIC provides the global policy framework and funds for the universities and SMEs, the SIA would be expected to contribute its own resources also to the universities, polytechnic and SMEs for R&D projects at the State level. By linking up with the LGIC, the SIA, universities, polytechnics and staff of the SMES will be able to develop and deliver TCB packages to informal sector operators through the Vocational Skill Development Centres (VSDC) at the local government level.

Fig 4. Organisational Structure of the State Innovation Agency (SIA) and the Local Government Technological Innovation Committee (LGTIC)



Finally, there is need for the monitoring of the performance of each of the structures proposed in this section. Objective performance standards should be set by the NAUIC; criteria for measuring performance at each level must also be set. The fact must be appreciated that while the building of structures for technological capacity building in Nigeria is important at this time, desired results can only be attained if there is stability in policy design programme implementation, and collective participation by all structures.

6 Conclusion and Policy Suggestions

The analytical focus in the present work indicated from the beginning that the requirements for technological capacity building generally coexist within the social and political environment. Hence, it was argued that the success or failure of any attempt to build technological capacity especially within the African context and development process must be seen as the product of the relationship between the policy environment and the various institutions involved. Our examination of the situation in the developed countries proved that this view is not only correct, but that it is realistic. Thus human and institutional capacity building is a dynamic process which enables organisations to develop knowledge and capabilities for the solution of the problems imposed on them by the environment.

Since we argued that technology is not simply hardware but the totality of the knowledge and skills embodied in people and organisations, it was suggested that TCB as a dynamic social process of development must involve a multi-sectoral participatory approach as in the developed countries that were used as examples. This multi-sectorality should involve the community of actors, viz. government as the major actor because of its power of resource allocation and organisational behavioural control through legislation, universities, research institutes, the private sector and other stakeholders. By other stake holders in the Nigerian context we mean the local government at the grassroot, small and medium enterprises and of course the ever expanding and heterogeneous informal sector. By also involving the masses at the grassroots through the Local Government Technology Innovation Committee (LGIC) and the local Vocational Skill Development Centre (VSDC), the creation of a development structure and process that will possess political sustainability over time would have been established. In other words, TCB structures and process will not

reflect the traditional strategy of urban bias in development planning any more.

Government has a big role to play. The general principle that institutions should act on their comparative strengths and capacities suggests that government should focus on those responsibilities that the private sector is most unlikely to shoulder. In the case of Nigeria these are road networks, telecommunication, energy and water supply, human resources development through university education and most importantly good governance. This implies that government should concentrate its energy on those activities whose spillover effects (externalities)are especially critical to the effective performance of the structures and institutions mentioned in this report.

In building technological capacity no nation can be an island to itself. Learning from other economies will remain a very important component of TCB and national development. This cannot be possible under a regime of sanctions imposed on Nigeria by the international community. This is, where good governance and democracy become critical social and political conditionalities for technological capacity building and its sustenance.

Universities and research institutes should focus their R&D activities on the needs of the environment. Industries must be induced to engage in collaborative endeavours with local institutions, this can be achieved through tax incentives for R&D.

In the fields of technological development and organisational management nation states depend on their universities for the production of the manpower required. These universities depend on society (government) for adequate resource inputs if they are to perform their functions as expected. Unfortunately the Nigerian university system today is constrained by the lack of resources, brain drain, poor teaching and research facilities. Persecution of

university staff by successive military governments is not only destructive to the university alone, it is a disservice to a nation that urgently needs to develop the capacity to compete in the global knowledge and technology market. Intellectual criticism of government policy from the ivory tower should be tolerated, as this helps to create a new perspective for development and policy review.

Given the past, present and future role of the universities, research institutes, industry and the large community of informal sector operators the structures proposed in this report should be examined against the background of national goals and aspirations for the integration of technological capacity building as a dynamic social process that need to be sustained regardless of the political changes in future Nigeria.

In the design of a TCB policy, the nature and quality of the bureaucrats and the efficiency with which they are able to provide policy advice to decision makers (politicians or military personnel) is very critical. If the people charged with policy design do not possess the critical technical background and expertise it would not be helpful. Lack of technical competence is a major problem in most government ministries especially in the new states in Nigeria today. The use of local consultants who are familiar with the environment and strategies for TCB may have to be considered.

All institutions or agencies concerned with TCB need supporting networks and other bodies for information supply and technical cooperation. It is important that the policy environment should motivate them to provide the mutual technical and communication lubricant (information) for one another.

In conclusion, The proposed National Agency for University-Industry Collaboration (NAUIC) should be a statutory body of the federal government that straddles the Ministries of Education,

Industry, and Science and Technology: It should be located in the Presidency because of its national importance. Its role will be the articulation and monitoring of TCB policy implementation at all the relevant levels. An effective institutional partnership through networking should be established so that ideas, information and personnel can be exchanged among collaborating institutions speedily and at least cost. (The assumption is that the communication infrastructures would be improved by the government as earlier suggested). Nigeria will need to review its legislation form time to time through a participatory mechanism to meet the needs of changing technological requirements.

The successful establishment of institutional structures, articulation of policies and monitoring of their implementation are the key to goal achievement. Many laudable policies and programmes and institutions in the past have been hampered or rendered counter productive at the national or state level by gross incompetence, lack of coordination, bureaucratic phlegmatism, politics and /or corruption. The structures recommended in this report will have to function within the environment characterised by these problems. For them to function as expected there must be the political and patriotic commitment on the part of all sections of the "community of actors" if Nigeria must develop the needed capacity to face the technological challenges of the 21st century.

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