REPOSITIONING ENGINEERING AND TECHNOLOGY FOR WEALTH CREATION IN A DEVELOPING DEMOCRATIC ECONOMY

By

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Abstract

Since the return to democracy, there has been attempts by the Nigerian government to refocus national development using science and technology as vehicle for socio-economic development. Up to recent past the Federal Ministry of Science and Technology produced 13 policy documents (UNESCO Office Abuja, 2003), to guide the development of science and technology in the country. Notable amongst these are the policies on information technology, biotechnology, and space research and development. Nigerian science, technology and engineering sector is still affected by many factors among which are low human capacity, inadequate skills, poor funding, lack of interest among students to take science, technology. This paper therefore attempts to reawaken national efforts in Engineering and Technology and-redirect them towards a performing national economy where basically, every employable Nigerian is meaningfully engaged.

It is worthy of note to say that any country that is unable to put science to practical uses will not be able to finance fundamental research on a sustained level, however much they appreciate science for its own sake.

It is therefore necessary to rebuild the historic and increasingly important linkages between industry and engineering and emphasize the application of science for the purpose of wealth creation. Engineers and technologists must focus on research and methods for improving current product development activities in Nigeria. World economies are changing rapidly. New ideas and innovations are becoming increasingly the drivers of economic growth and societal progress. Industries are becoming knowledge-intensive. Even traditional industries are caught in the swing of the information revolution. Powerful new industries unimaginable a few years ago are now emerging. However, the most important phenomenon is the globalization of the economy and the net increase in international competition. It is in this tough and vibrant environment called the New Economy that Nigerian firms must grow and prosper.

The question is: how ready is Nigeria? How can we reposition from this present state of engineering? Some Small and Medium Scale Enterprises (SME5) are thriving on innovative products and services, but relatively very few of them in Nigeria even have an engineer in their employ. This is in strong contrast with SMEs in Germany, France, U.S., and several other countries. How can these SMEs hope to successfully break into world markets without having the basic requirements to deal with fast advancing technologies? How can they enter the world of total quality without having engineers in design, production and services to clients? How can they position themselves with regards to emerging technologies? How can they benefit from research carried out in our tertiary institutions with regard to emerging technologies transfers when they do not even have an "interpreter" of technology or of scientific advances? Unfortunately, due to the present recession, many competent engineers1 including many new graduates, cannot find employment in their field of competence.

Repositioning engineering and technology for wealth creation in Nigeria must of necessity address the following key issues of state like .poverty, corruption, energy, national health, education, security and food security.

All the stakeholders in the repositioning must be abreast of these national issues and must be prepared to focus our energies on putting the country in the forefront of economic relevance. God has blessed Nigeria and indeed, Sub-Saharan Africa with abundant human resources, solid mineral resources, crude oil and gas, bitumen, forest reserves, vast arable land for agricultural purposes, tourist attraction to mention but a few. Nigeria's geo-political position in Sub-Sahara is unquestionably advantageous. Unfortunately, however, the key players in the economy and the leadership of nations have not lived up to their expectation in positioning the region adequately to favourably compete in the world economy. This is as a result of the fact that they either do not know what to do or know what to do but do not know how to come about it.

Nigerian Engineers as Stakeholders

Importantly, engineers are the bridge between science and technology. Without engineers, technology has little meaning.

Nigerian Engineers constitute for the Federal Government a very important resource in all matters relating to the application of science and the full deployment of technology in the production of goods and services, which any federal strategy in Science and Technology must therefore take fully into account. Be that as it may, the relevance of engineers as instruments of technological transformation for wealth generation must be clear and practicable. In the midst of political opportunists who hijack and loot the national treasury we must be seen as crusaders of national ethics, marketing our national values, and core essence through technological competence.

The strength of a nation resides in its human capital, especially its engineering workforce. Engineers will develop the new processes and Products and will create and manage new systems for civil infrastructure, manufacturing, health care delivery,

information management, computer communications, and so on. In general, they will put knowledge to work for society and facilitate the private sector's potential to create wealth and jobs.

The Engineering Education

The linkage between education and work has been a subject of interest to many nations. In this era of globalisation, it becomes even more crucial to fit what is learnt in school not just to the world of work but in the development of competences for innovation in areas where the nation has strategic advantage.

A problem of Nigeria and indeed many nations in Sub-Saharan Africa is the utilization of its capacities in basic and engineering sciences in creating wealth creating wealth. By creating wealth, jobs will be created and this through the application of engineering and sciences innovatively to the production process. The importance of cross-disciplinary partnerships for solving these problems is priority and is given prime consideration.

We are in an age of "distributed intelligence"; an era in which knowledge is available to anyone, anywhere, at anytime; in which power, information, and responsibility are moving away from centralized control.

Within this context, engineers and scientists will play an increasingly significant role. Our system of education and training must therefore equip tomorrow's engineering and science professionals to shoulder growing responsibilities and pursue emerging opportunities.

As engineers we can be justly proud of the tremendous role that engineering played in enabling the Industrial Revolution and the information age should look forward now to enabling what is yet to come.

There is much evidence supporting the notion that technological innovation is central to wealth creation and economic growth. Many studies (National Science Board, 1996; Smith and Barfield, 1995; U.S. Council of Economic Advisors, 1995) indicate that, over the past 50 years, technological innovation has accounted for over one-third of U.S. economic growth.

Drucker, (1992) note that the source of wealth is knowledge creation, a human activity that can yield both productivity and innovation. Knowledge applied to tasks we already know how to do can boost productivity, while knowledge applied to tasks that are new and different is innovation, the process of creating new businesses and delivering new products and services.

The essence of engineering, on the other hand, is integrating all knowledge for some purpose. As society's "master integrators," engineers must provide leadership in the concurrent and interactive processes of innovation and wealth creation. The engineer

must be able to work across many different disciplines and fields--and make the connections that will lead to deeper insights, more creative solutions and getting things done.

Today's engineering students will spend most of their careers coping with challenges vastly different from those experienced by engineers of the last half-century. The intellectual skills of tomorrow's engineers will extend well beyond the traditional science-focused preparation. The factors contributing to this new thrust include global commercial competition (a major driver for industrial organization and engineering employment); opportunities offered by "intelligent" technology; an eclectic, constantly changing work environment calling for astute interpersonal skills and growing awareness of the need to place environment, health, and safety at the beginning of the design process.

Nigeria engineering graduates should provide added value in order to compete in today's global marketplace, not only added value resulting from state-of-the-art knowledge, but also that resulting from an understanding of risk and participation in the process of engineering throughout their educational experience.

Participating in the process of realizing a new product through the integration of seemingly disparate skills is an educational imperative. This is the ultimate added value that enables wealth creation. In this sense, the 21st-century engineer must have the capacity to:

- Design, in order to meet safety, reliability, environmental, cost, operational, and maintenance objectives;
- Realize products;
- Create, operate, and sustain complex systems;
- Understand the physical constructs and the economic, industrial, social, political, and international context within which engineering is practised;
- Understand and participate in the process of research and
- Gain the intellectual skills needed for lifelong learning.

Most curricula require students to learn in unconnected pieces. They take separate courses whose relationship to each other and to the engineering process is not explained until late in their undergraduate education, if ever. Further, engineering curricula usually present the set of topics engineers "need to know," leading to the feeling that an engineering education is simply a collection of courses. While the content of the courses may be valuable, this view of engineering education ignores the need for connections and integration.

Engineering education should shift emphasis from course content (and the consequent filtering out of students) to a more comprehensive view, a view that focuses on the development of human resources and the broader educational experience in which

individual courses and experiences are connected and integrated. This intent is made more facile in an era of knowledge and distributed intelligence.

Thus, a vision of engineering education for the 21st century can be based on developing, in as individualized a way as possible, the following capabilities in each student:

Integration: recognition of engineering as an integrative process in which analysis and synthesis are supported with sensitivity to societal need and environmental fragility.

Analysis: critical thinking that underlies problem definition (modeling, simulation, experiment, optimization)--derived from an in-depth understanding of the physical, life, and mathematical sciences, as well as the humanities and social sciences.

Innovation and synthesis: creating and implementing useful systems and products including their design and manufacture.

Contextual understanding: appreciating the economic, industrial, and international environment in which engineering is practiced and the ability to provide societal leadership effectively. (National Science Foundation. 1989)

Strategies for Wealth Creation

Some of the strategies for wealth creation using engineering as a vehicle are:

1. **Global Approach to Engineering Designs and Projects**

Except engineers and technologists have the global approach to solving national manufacturing /engineering sector problems, Nigeria will never be able to compete in the world economy which inevitably is controlled by the hard facts of globalisation.

The role of engineers would depend upon first his effectiveness in influencing the economy. Effectiveness of engineers influencing the economy has two aspects: The first is his competence. This will mean that an engineer, if he has to be effective, must be up-to-date in his technical knowledge and skills. We are living in an era of explosion of knowledge that is knowledge economy. For any engineer to be effective, he must keep himself up-to-date otherwise he will become a back number. This would also mean that apart from keeping up to date, an effective engineer must have a capacity to welcome changes. Either we make changes or we have changes happening to us. It is necessary in this modern age that the engineers are able to initiate changes and not react to them. It is said that some people make things happen, some have things happening to them. There are some who have no idea of what is happening. An effective engineer must be of the first type — he must make things happen.

Engineers should have an alert and open mind and capacity to judge facts.

2. **Focus on Productivity**

One common value where all engineers may agree and contribute is in productivity. Just as corruption is a negative factor for economic development, improving productivity is a positive factor for the economy.

Nigeria is perhaps one of the least productive nations. Part of the reason for our poverty and backwardness and the perennial "developing country" status is our low productivity in every sector. The tools of governance are the legislature, the executive and the judiciary. We see the waste of legislative time in recent times. Legislatures viewed, from the point of view productivity as instruments for legislation are very poor. Corruption, delay and waste of time of the characterise executive action. Nigeria being a large and democratic country seems to lack national focus on major issues facing the country. In 1973 when the first oil shock occurred, the Japanese realised that they were so vulnerable on the energy front. The whole nation focused on how to save energy. They took both technological as well as legal solutions to solve the energy problems in terms of reducing energy consumption. The net result was, they were able to save 30% of the energy without losing the growth in GNP. Nigeria has faced the energy shock for several years now but our response has been very lukewarm. Power is to the manufacturing sector as air is to life. The issue of PHCN requires urgent attention if national productivity must grow.

Unfortunately, Nigeria politics is very much dominated by sociology. Our entire politics today is only an exercise in caste arithmetic. Even development issues are viewed in terms of sociological empowerment of sectors be they women, weaker sections and so on. Why cannot we face the issue of productivity as it is without bringing in the emotional and the cultural baggage of sociology and for a change try to get results?

Given the right environment, Nigerian engineers can play an effective role in the national economy and build Nigeria into an economic superpower. If, to begin with, they observe the highest professional standards, keep themselves professionally competent and up-to-date and also focus on productivity, they will be able to create the wealth which will make our national economy buoyant.

3. **Poverty Reduction**

Poverty is not only about lack of wealth in monetary terms; it also implies the 'denial of various choices and opportunities basic to human development. These include the ability to lead a long, creative and healthy life, to acquire knowledge, to have freedom, dignity, self-respect and respect for others, and to have access to the resources needed for a decent standard of living.'

Community infrastructure is a key to alleviating poverty — and thus engineers have an essential role to play. Without ready access to clean water and sanitation, productivity is severely reduced through illness and time spent in water collection. Without roads, the poor are unable to get their goods to ready markets. Basic

infrastructure is not a luxury that can wait for better economic times, but a precondition for creating them and its provision is an urgent and ongoing requirement.

Poverty Alleviation Strategies

At one of recent Summits, both the United Nations and the World Bank called for alleviation strategies involving 'no more hardware', noting that major investments over the last 20-30 years in water infrastructure schemes had often failed to benefit the people at whom they were aimed. This is because most facilities involving technology are generally abandoned within two years, as revenue streams are insufficient to pay for repairs and maintenance and because of the lack of local skills to carry out repairs. The role of engineers in delivering infrastructure schemes needs to change significantly.

Engineering solutions are integral to mitigating poverty; however, engineering is not the sole contributor to successful poverty alleviation programmes, which also require attention to social, economic, and political influences. Sustainable engineering will be achieved when the engineering solutions adopted take into account their use of natural resources. Optimum solutions will have a positive or neutral impact on natural resource consumption. Unsound engineering solutions, by comparison, may leave the environment depleted and society poorer over time.

Life-cycle engineering takes into account the operational and maintenance cost of the engineering solutions proposed, such that the completed projects have effective and affordable operational and maintenance regimes.

Empowered engineering will take into account the capabilities of the local community, particularly its engineering and technical professions. Where possible, the solutions developed will involve local professional and technical staff and will establish an on-going engineering and operational resource. Appropriate engineering will consider various options that meet the engineering needs of the project and may adopt techniques of labour-based construction which differs significantly from labour-intensive construction. The latter basically substitutes men for machines, e.g. constructing a concrete-framed building where the concrete is mixed by hand without a mechanical mixer. Labour-based construction, by contrast, aims to change the technology involved to what is appropriate for manual labour, e.g. eliminating the concrete frame and building the structure of load-bearing masonry. Labour-based construction has been shown to compare favourably with plant-based construction.

In addition, it facilitates knowledge transfer, creates jobs, encourages private enterprise, creates ownership and may reduce cost.

Today the challenge for the engineering profession is to revisit our roots and develop a suite of solutions to the issues raised in this paper. These should include solutions not only to the alleviation of poverty when it occur but also to the development of sustainable urban infrastructure, solutions that recognize rather than resist the

inevitability of migration to urban centres and then make provision for these rapidly growing populations.

Engineers can work effectively with other professions and community leaders to develop sustainable solutions to poverty. And Engineers can take the lead in developing sustainable concepts for the urban areas of the future concepts in which:

- Access to and opportunities for employment are enhanced,
- Housing, sanitation, and water supply are provided at affordable price,
- Access to and opportunities for education are enhanced, and
- Affordable transport facilities are available.

4. **Use of Information Superhighway (ICT)**

Nigeria Engineers should consider the advent of the electronic information highway not only inevitable but also most desirable. All Nigerians will ultimately benefit from this development.

It is not only a matter of technology and telecommunications; it involves all segments of industry and a myriad of services. It encompasses not only science and technology but culture as well. It embraces practically all realms of human activity of the incoming information age.

The existence of this electronic highway will enhance considerably Nigeria's attractiveness as a good country to locate head offices, research laboratories, and production and marketing facilities for dynamic companies operating worldwide.

The existence of an advanced communications infrastructures at competitively priced services is becoming essential for many types of business activities. It is already critical in terms of Nigeria's competitive positioning with regard to the World Trade Organisation (WTO) Agreement. In addition to facilitating the creation and design of new products, new services and new information-based firms, as well as Research and Development (R&D) and other essential parts of the innovation process, the electronic highway will radically alter existing modes for instruction delivery.

Conclusion

It is important to note that engineering is not only a science but also a profession and a very demanding one. It requires the best of training and calls for permanent education in the face of the relentless evolution of technology, growing complexity of system and ever increasing international competition affecting manufacturing and service industries.

Nigeria and indeed all countries of Sub-Saharan Africa must strengthen their Science Technology effort by doing a better job in taking the results of our investments in science and translating them into wealth-creating goods and service. We as a nation,

have to improve our record in this regards to convert the investments we are making in fundamental research and to cultural activity, as opposed to one which is strategic in an innovation-driven society.

We need to improve our means of identifying and developing promising technologies into marketable products and services.

Engineering schools must now put more emphasis on a problem-solving approach, introducing new dynamics in the solution of problems affecting our well-being and economic growth.

Rather than putting emphasis on the traditional disciplinary divisions (viz, civil, mechanical, electrical, etc.), the focus must now be on the main problem areas falling within the purview of the engineer: such as infrastructures, environment, processes and systems. Each one has a particular set of parameters, including materials of various types, energy in various forms, etc. Mentalities must be transformed, attitudes changed. Engineering education must place greater emphasis on problem definition and formulation. Outreach approaches toward other disciplines must be entertained.

Engineering design must be rediscovered and given a central role in training engineers. Interdisciplinary projects should be encouraged and special courses to that effect introduced accordingly.

Recommendations

The federal government should take the necessary steps to ensure that tertiary institution as well as the national granting councils supporting tertiary institution researches sensitive to the special nature of engineering and that their program criteria reflect this through added emphasis on innovative problem-solving and interdisciplinary approaches.

Effective mechanism should be devised whereby. federal government support for longer-term applied research would be delivered increasingly through tertiary institutions in the country.

The federal government should be supportive of and provide enhanced support for research undertaken by engineering professors and their graduate students that are directed at real and relevant issues of significance to the present and future needs of society and its industrial and services sectors.

Engineering schools should have much more autonomy than they now have, being immersed in a sea of science faculties, and should focus more on problem-solving and interdisciplinary approaches in the curricula than they presently do. They should encourage business sabbaticals and value more the professional experience of their

recruits than just academic credentials. The 1tpublish or perish" policy should be replaced by "excellence through relevance".

The federal government should increase its financial commitment to Research Institutes, develop an open client-server attitude and consider transferring fundamental research to tertiary institutions and making them open their laboratories to industry.

As a way of creating durable new jobs for Nigerians in the global economy, the federal government should expand its collaboration with the private sector in the establishment of a coast-to-coast world class Information Superhighway and the effective use of that facility.

The federal government should help ensure that faculties and schools of engineering and applied sciences become actively involved in partnership with industry in the technological development and the applications deployment of the Information Superhighway, particularly with respect to broadband development of interactive multimedia and the delivery of education at a distance.

The federal government must move ahead with its intention to help finance the new economy. It must facilitate access to adequate capital for small business, particularly the emerging high-tech companies.

The federal government in collaboration with the other levels of government and the engineering community should establish the "Engineers and Scientists Program", to increase rapidly the employment of engineers in small and medium sized enterprises.

It is incumbent on theeder5overnment to provide leadership in public awareness programs relating to science, engineering and technology an jointly with the state and local governments and the business community, to launch educational initiatives to make Nigerians more aware of the spectacular advances of science and technology and the remarkable achievements of engineering in today's society as it affects wealth creation.

The modern engineer needs to be educated to thrive through change else, the engineer will become a commodity on the global market instead of society's enabler of wealth creation. The former is bought cheaply while the latter is more dearly valued.

Engineers must be enabled to grasp the opportunities for innovation rather than simply contribute to enhancing productivity. Innovation results when new knowledge is applied to tasks which are new and different, yielding brand-new enterprises and delivering new products and services and new jobs. Innovation, especially through engineering enterprise, is at the core of a healthy economy.

References

Drucker, P.F. (1992): *Managing for the Future: The 1990s and Beyond*. New York: Truman Talley Books/Plume.

Joseph A. 8. (1997): *Next-Generation Engineering: Innovation through Integration.* National Science Foundation (NSF)

Joseph B. (1997): *Making Connections: The Role of Engineers and Engineering Education* 27, 27(1) Spring

National Science Board (1996): *Science and Engineering lndicators-1996. (NSB 96- 21).* Washington, D.C.: Government Printing Office.

National Science Foundation (1989): *Imperatives in Undergraduate Engineering Education:*

Issues andActions; *Report of an NSF Ad Hoc Task Force, August. Washington,* D.C.: National Science Foundation.

Smith, B.L.R. & C.E. Barfield. Eds. (1995): *Technology, R&D, and the Economy.* Washington, D.C.: The Brookings Institution and The American Enterprise Institute.

UNESCO Office Abuja, (2003): *Workshop on application of best practices in mechanical Engineering for job creation* (Abuja, Nigeria; 09-07-2003 4:19 pm - 09-07-2003 4:19 pm)

U.S. Council of Economic Advisors. (1995): *Supporting research and development to promote economic growth:* The federal government's role. October Working paper available: http://www.whitehouse. gov/WH/EOP/CEA/econ/html/ econ-top.html. March 3, 1997.