

BRIDGING THE UNIVERSITY INDUSTRY GAP FOR EFFECTIVE RESEARCH AND DEVELOPMENT

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Abstract — *Research and development are essential for national development and industrialization. Development-oriented research calls for strong links between universities (as well as other research institutions) and industry. However, a gap has always existed between universities and industry. In developed and industrialised countries, universities have succeeded in forging necessary links with industry via sponsored research activities and continuing education. In developing countries, the gap is quite wide. The paper discusses the Nigerian university-industry gap syndrome and outlines strategies for narrowing the gap to engender development-oriented research aimed at achieving the goals of wealth creation (building industries, creating employment, increasing exports, etc.) and improvement of quality of life.*

Index Terms — *Research and development, Engineering education, university-industry links*

INTRODUCTION

In developed countries, universities preceded industry by several centuries. Consequently, the university-industry gap has always existed – essentially due to the fact that *ab initio* university programs were neither driven by nor based on actual industrial requirements. However, during the twentieth century, the developed and highly industrialised countries realised the need to bridge the gap [1]. The United States of America (USA) was the first country to realise the importance of and furiously worked towards establishing close links between industry and academia in the late 1960s. Europe and the United Kingdom (UK) followed suit in the 1980s.

Engineering curricula in Nigerian universities were generally modelled on those of the western world without any regard for local industry requirements. Liaison with any existing industries appears to have been completely ignored. In spite of the growth of industry, the universities have remained confined to their ivory towers and, unfortunately, little or no effort has been made to bridge the ever-widening university-industry gap.

The Nigerian university system has traditionally provided a steady stream of engineers to meet the needs of local industries – industries that operate in a small, tariff-protected domestic market, and influenced by a national

economy reliant on export earnings from oil, rural products and minerals, with little value-adding. Added to this is the poor infrastructure that is mostly developed and maintained by large government operated utilities. However, in recent years, this operating environment is gradually changing. Nigerian firms are faced with a globally competitive market. Government has set into motion the process of privatizing of public enterprises. Moreover, rather than exporting unprocessed rural products and minerals, there is a drive to embark on exporting processed or value-added products with a view of creating employment and wealth. This means that industry and universities have to evolve strategies of not only producing engineering manpower in the required quality and quantity, but also to find engineering innovations that ensure that Nigerian products compete favourably in the global market-place. This calls for urgent steps to be taken to bridge the present university-industry gap.

This paper examines the state of Nigerian university system and university-industry gap syndrome. Strategies for bridging the gap are proposed along lines that would ensure effective research and development for beneficial wealth creation in today's competitive global market.

STATE OF THE NIGERIAN UNIVERSITY SYSTEM

The Nigerian university system has witnessed phenomenal growth since its inception in 1948. The system currently comprises fifty-three universities under the proprietorship of Federal and State governments as well as private bodies. Twenty-six universities in the system offer engineering-related academic programmes. The first degree is the Bachelor of Engineering (or Bachelor of Science) in the relevant engineering disciplines. The postgraduate degrees are those of Master of Engineering (or Master of Science.) and Doctor of Philosophy in the relevant disciplines. The Nigerian Universities Commission (NUC) has the responsibility of monitoring and enforcing minimum academic standards in all the academic programmes. On the other hand the Council for Regulation of Engineering in Nigeria (COREN) is responsible for monitoring and enforcing appropriate professional content in the programmes. Both NUC and COREN carry out accreditation exercises of the programmes in all universities every five

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years. The current state of the university system (with particular reference to engineering education) is provided by the results of the 1999/2000 accreditation exercise carried out by NUC.

To achieve objectivity in the accreditation exercise, NUC used certain criteria to assess each programme. The criteria (or performance indicators) are:

- Academic content – philosophy and objectives of the programme, curriculum content, admission into the programme, academic regulations, evaluation of students’ work, practical/project work, standard of examinations, and staffing
- Physical facilities – laboratories, classrooms, offices, safety and environmental sanitation
- Funding of the programme by the university
- Library facilities
- Employers’ rating of the products of the programme

Scores are awarded based on the performance of the programme in the area of each indicator. The aggregate score is then used to determine the accreditation status as **Full**, **Interim**, or **Denied**. Table 1 was compiled based on the report of NUC’s 1999/2000 accreditation exercise [2]. Column 2 of the table gives the number of universities that offer a given engineering programme. The last three columns show the number of universities with a given accreditation status in respect of each programme. For example out of the thirteen universities offering agricultural engineering, one got full accreditation ten got interim accreditation while two were denied accreditation. It is alarming that very few programmes got full accreditation.

TABLE 1
ACCREDITATION STATUS OF
ENGINEERINGPROGRAMMES (1999/2000)

Programme	Number of Universities	Accreditation Status		
		Full	Interim	Denied
Agricultural	13	1	10	2
Chemical	12	3	7	2
Civil	22	2	14	6
Computer	6	Nil	1	5
Electrical	8	1	5	2
Electrical & Electronic	14	3	5	6
Electronic	1	Nil	1	Nil
Food Science Technology	13	2	7	4
Industrial	1	Nil	1	Nil
Marine	1	Nil	1	Nil
Mechanical	24	8	7	9
Metallurgical & Materials	6	Nil	6	Nil
Metallurgical	1	Nil	Nil	Denied
Production	1	Nil	Nil	1
Petroleum	4	1	2	1

Polymer & Textile	1	Nil	1	Nil
Water & Environmental	1	Nil	1	Nil

A common problem was that of gross inadequacy in infrastructures. Physical facilities like classrooms, laboratories, and workshops were either dilapidated or inadequate. The accreditation exercise also revealed the magnitude of the deficiency of teaching and research equipment in most of the programmes. Apart from being inadequate and overstretched (due to ever-increasing student population), most of the equipment are obsolete. There was also an observed dearth of current or up-to-date engineering books and journals. Matters are compounded by the current Federal Government attitude to funding of tertiary education, with increasing emphasis on autonomy and the *user pays* principle. Moreover the ever-widening university-industry gap does not help matters.

UNIVERSITY-INDUSTRY GAP SYNDROME

The genesis of the university-industry gap in Nigeria can be traced to two major sources. First of all, most engineering faculty staff in the older universities completed their college education, undergraduate or postgraduate or both, at universities in advanced countries. Moreover, in the colonial era most members of faculty staff were expatriates brought in from foreign universities. Consequently, curricula were modelled on those at such universities without any regard for local industrial requirements. On the other hand majority of staff in the younger universities were trained in the older universities so that they carried over the same ‘alien’ curricula to the new universities.

Secondly, the poor economic conditions in universities resulted in the so-called ‘brain-drain’. The few academics left in the ivory towers with no financial motivation ended up being overworked with very heavy teaching loads. Coupled with promotion-oriented research work, faculty staff found very little time for promoting any of the university-industry interaction which is necessary for broadening professional experience and exposure. To compound matters further, in the 1970s the Federal Government banned engineering academics from participating in ‘private practice’ while engaged in university service.

The contributory factors in the university-industry gap syndrome depend on whether one views the situation from within the university or from the side of industry. From the university viewpoint the principal factors include the following [3]:

- Academic institutions are ‘non-profit’ institutions which

exist primarily to teach and educate students and undertake pure and fundamental research.

- Academic research is an open activity where staffs are valued by publication record; their research is motivated by promotion and tenure and hence requires maximum publicity. The motto for survival is 'publish or perish'.
 - Research is mainly to look for and extend new knowledge in an absolute way. Acquisition of knowledge itself is valuable.
 - For faculty staff, research is a part-time activity
 - There is no emphasis on urgency; research workers are more relaxed and more scholarly.
 - The main objective of university education is to develop students' self confidence, mental capabilities and latent abilities, to produce creative individuals capable of independent thinking and mature judgement. It is not the function of universities to give professional training.

On the other hand from the industry's point of view the principal factors include the following [4].

- The almost sole objective of industry is to make a profit by producing a marketable product or rendering a useful service.
- To safeguard investment, research is a closed activity and new developments require protection, mainly through patents. Thus communication and publication are restricted. Industry publishes only when competitors learn little from the discovery.
- Knowledge is valuable only if it can be exploited in products. Likewise research is pointless unless investment in it can be justified by turning discoveries into products. R&D is a form of industrial investment leading to wealth creation.
- In an industrial research laboratory, research is a full-time activity
- Industry's goals are usually short-term. In technological development the overriding consideration is time
- University faculty lack industrial experience. There is thus a mismatch between industry's expectations and the type of education provided by the university

The point has to be stressed that there are good reasons why the university-industry gap needs to be narrowed and ultimately bridged. From the point of view of the universities the major reasons are the following:

- An urgent need for financial support, particularly now that government is driving for university autonomy with minimal financial support.
- Make use of sophisticated and expensive industrial equipment and facilities.
- Industry can provide valuable co-operation and guidance for courses and student projects which are relevant to industry, e.g. design and implementation

of technology.

- Liaison with industry provides an excellent opportunity for faculty to acquire some first-hand industrial experience.
- Attract graduates from industry and government by developing a strong continuing education program which is practically oriented (Diploma courses) and in which experts from industry and government can co-operate with faculty and staff in specific topics.

Industries ought to be interested in closing the gap due to the following reasons:

- Industry is the most direct beneficiary of engineering programmes. Over 90% of graduates are ultimately employed by industry and government or private utilities. This calls for the strengthening of ties with universities.
- Any company's most important asset is itself. Engineers and scientists must be kept abreast of the rapid advances in science and technology and the best way of doing this is through sponsoring its staff for continuing education or professional advancement courses.
- Industry will be in position to utilize university talent and facilities at a maximum benefit-to-cost ratio. Moreover consulting is an excellent way for faculty to have a close relationship with industry and generate money in the process.
- Universities are best suited to carry out long-term research on problems which require a high degree of sophisticated theoretical knowledge in specific fields.
- Interaction with universities provides industry with a window into leading-edge scientific research.

STRATEGIES FOR NARROWING THE UNIVERSITY-INDUSTRY GAP

To narrow the university-industry gap it is necessary that industry should:

- carry out needs analysis: where is it going and what are the human resources it needs to get there?
- provide support for students projects
- sponsor long-term research
- hold periodic seminars in collaboration with universities
- provide support for and participate in continuing education programmes in specific areas
- share equipment and facilities with universities.

In particular, industries with scarce cash resources will achieve a maximum benefit-to-cost ratio by investing primarily in continuing education. This will in turn be a good source of income for universities.

On the other hand universities should:

- Project the needs of industry and undertake to provide the quality of education that the industry requires. Today, knowledge of technology alone is not sufficient:

in addition to formal engineering skills, industry requires people with communication skills and with knowledge of how technology relates to economics and the commercial world.

- Encourage industry to participate in the planning and periodic review of curricula and course content at both undergraduate and postgraduate levels.

However, by far the most important single strategy for bridging the university-industry gap is to be found in the area of research and development.

RESEARCH AND DEVELOPMENT AS A LINK BETWEEN UNIVERSITIES AND INDUSTRY

As long as humanity inhabits the earth, so long will there be problems in all diverse areas of human endeavour. Research is aimed at providing solutions to such problems as well as for pre-empting others arising from human activities.

Traditionally, research used to be the 'monopoly' of universities, whilst development was the 'monopoly' of industries. Research implied 'pure' or 'disinterested' quest, almost totally dedicated towards finding out how nature works; the objective being to serve world science irrespective of economical and industrial considerations. Development on the other hand implied improvement of existing technologies.

However, as a consequence of the staggering rate of advances of both science and technology, research is nowadays very detailed, specialised and expensive. The tendency is now for researchers to know more and more about less and less. What is needed today are persons able to integrate scientific knowledge in practical applications.

When science is so used for practical purposes it normally becomes a technology and as such requires development. It therefore became imperative for scientific research and technological development to join forces for the purpose of achieving the goals of national development: *creation of wealth* (building industries, creating employment, increasing exports, etc.) and *improvement in the quality of life*.

Taking a broad view it is possible to define four categories of research [5]:

- *Undirected research*: This is the so-called pure or disinterested research. It is research pursuing exciting new and speculative ideas in which no immediate pay-off is perceived.
- *Fundamental research*: This is research directed towards identified gaps in knowledge. It is a major component of the type of research that industry looks to universities to perform.
- *Directed or strategic research*: This is research having a direct bearing on local conditions/needs and long-term aims connected with the economic and/or industrial potential of a country.

- *Applied or ad hoc research*: This is multidisciplinary research. It seeks solutions to identified industrial problems which use the already known facts of science. It is thus strongly associated with the development of technology and usually involves meeting timescales needed for product development.

What is the position of Nigeria vis-à-vis R&D as a linkage between industry and universities? It would appear that in general any link between the two hardly exists. Whereas in advanced countries universities have forsaken their ivory towers and are working with industry and government as partners in the research and development drive, in Nigeria most universities still exist in 'splendid isolation' as far as links with industry are concerned. Reasons for this include the following.

- Lack of funds.
- Lack of practical industrial experience, and hence awareness, amongst academics results in failure to direct engineering research towards industrial applications.
- Choice of research topics is made almost exclusively by the different supervisors, each according to own inclination.
- The sole objective and incentive for research is to obtain promotion via publications.
- Research laboratories and support facilities are virtually non-existent or have been allowed to age without renewal.
- Lack of equipment and facilities has forced academics to resort to 'virtual research' whereby research results are almost totally computer generated.

The low efficacy of R&D programmes in Nigeria might mainly be due to the lack of a consistent national R&D policy in either the public or private sectors of industry. A case in point is that of the Centre for Automotive Design and Development (CADD) in Ahmadu Bello University, Zaria. After working hard over the years and successfully producing a locally designed block engine for a 'Nigerian car', the centre was recently disbanded by the Federal Government.

Another factor is the absence of the all-important interface between industry and university. For universities to participate in and make positive contributions to research and development programmes there has to be an effective interface between industry and academia such as that provided by the USA federal agencies (NASA, DoD, etc.), the Universities Grant Commission and EPSRC (Engineering and Physical Sciences Research Council) in the UK, the CNRS in France, etc]. Also, in order to ensure a cross-flow between industrial and academic communities it is important that both industrialists and academics be equally represented in research council committees.

The establishment of specialised and national research

centres can also provide very valuable links between universities and industry. Most of the future growth will come from small- and medium-scale industries, and it is these industries that stand to gain the most from such research centres. Research centres are expected to:

- make available to industry (and thus avoid duplication of) expensive research equipment and test facilities
- have available highly qualified personnel with exceptional skills and a high degree of expertise in their fields of activity
- realise considerable savings in time and money by providing solutions to technological problems which may be common to several industries
- collaborate as partners with universities pursuing strategic research
- develop highly qualified human resources in their fields of activity
- act as centres for the transfer of technology.

In terms of natural resources, Nigeria is stupendously rich. For this reason the tendency is there to fail to realize the urgency or the necessity for wealth generation, hence the apparent low priority accorded to R&D. There is a need to realise that any R&D programme, however modest, can provide excellent returns if effectively oriented and efficiently administered. There is therefore the need to draw up research programmes that address Nigeria's problems while taking into account her needs and peculiarities.

CONCLUSION

The paper has examined the state of engineering education in the Nigerian university system as well as the university-industry gap syndrome. The point was made that the current wave of privatization of large public enterprises in the country and the emerging policy of producing value-added export products call for extensive research and development. There can be no doubt that science without industry (technology) will not lead to wealth creation or improvement in the quality of life, nor will industry without continuous research and development. Thus government, industry and universities must all be convinced that a close partnership between them is vital in today's world of ferocious competitiveness. It is industry and its investors (entrepreneurs) that must ultimately shoulder the burden of wealth creation. Without R&D the long-term effect would be wealth depletion.

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