

# CONFERENCE PROCEEDINGS



CP 357

## **AFRICAN REGIONAL CONFERENCE ON ENGINEERING EDUCATION AND SUB-REGIONAL WORKSHOP ON NEW ENGINEERING CURRICULUM**

CONFERENCE PAPER



*in partnership with UNESCO*



**University of Lagos, Yaba, Lagos, Nigeria**

**23rd - 25th September, 2002**

**Edited by:**

**DR. FUNSO FALADE**

# ACADEMIA-GOVERNMENT-INDUSTRY RELATIONS: A CASE FOR THE ENGINEERING DISCIPLINE IN NIGERIA.

Tolu Ajayi

Department of Chemical Engineering  
University of Lagos, Akoka,  
Lagos State, NIGERIA

## ABSTRACT

Nigeria has for long been a developing nation without much progress. An observation of some of the countries of the world reveals a strong interplay between the quality of engineering education and the technological advancement of such country.

This paper succinctly examines the practice of engineering education in Nigeria and shows that not much attention is given to the various components that make for quality engineering education. There is the need for academia - the trainer of the manpower for technological advancement, and industry - the user of such manpower, to come together in an interactive partnership. It is the synergy achieved by such interaction that technologically advances a country. The government has been identified as the facilitator of such a partnership and the engineering professional body as the umbrella under which all three - academia, government and industry can meet and strategize.

## 1. INTRODUCTION

Engineering is the lifeblood of any nation. It is a social activity in that it exists to serve humanity. It is about maintaining or improving the quality of life and the environment in which we live. Roads, buildings, the different means of communication, plastics, fertilizers, materials, medicines, the different modes of energy and so much more are examples of services/products targeted at this. Engineering, at the same time is also an economic activity concerned with the optimal use of resources.

Training to be an engineer begins in the secondary school with education in scientific principles. This training progresses, through higher education in the university, by extending knowledge and understanding of these basic scientific principles to the solution of real world problems<sup>1</sup>.

Engineering education has well been said to be the tool for accommodating technological changes, which in turn makes way for technological advancement and the socio-economic wellbeing of the wider society. The university or academia as it is referred to in this paper, therefore plays a major role in the technological advancement of any country. According to

Biobaku<sup>ii</sup> the fundamental objective of universities in a developing country (like Nigeria) is “to teach, undertake research and inculcate the spirit of service – which has the obligation of contributing to development and modernisation”. These three goals he said are the tripod upon which university education should rest.

Universities have also been referred to as engines of growth<sup>iii</sup>. The more society invests in university education, the faster its economy will grow; the faster the economy grows, the more it would be able to invest in university education and the economy will continue to grow. Figure 1<sup>iv</sup> shows this interplay between quality of education and technological advancement for some countries of the world. From this figure it can be seen that Asian countries such as Japan, Malaysia, China, India and Singapore have achieved great strides in technological advancement through the promotion of education. This figure therefore buttresses the fact that the level of technological advancement achieved by any country is very much a function of the quality of its engineering education and not just the quantity of its natural resources. Japan is a country with minimal natural resources but whose wealth flows from the quality of its graduate<sup>v</sup>.

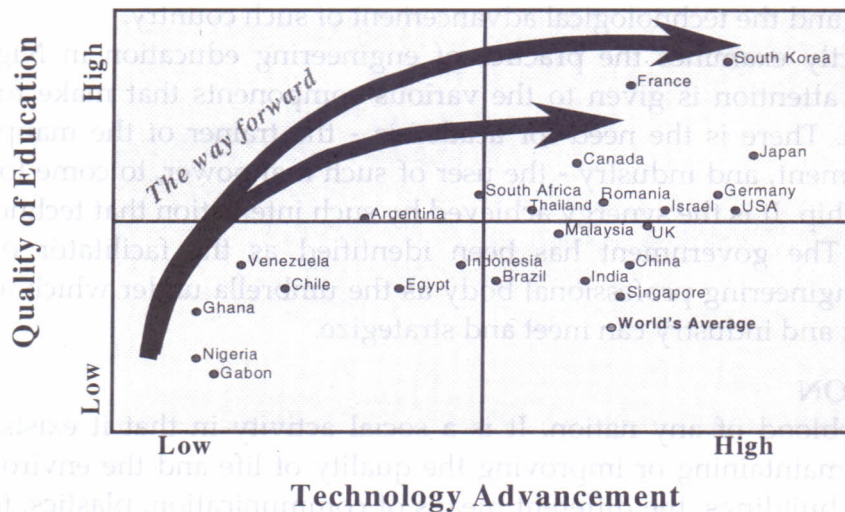


Figure 1: Quality of Education versus Technology Advancement for some countries of the world

## 2 THE ACADEMIA AND INDUSTRY

There are basically two types of engineers in society: the engineer-in-academia, and the engineer-in-industry. It is essential that both work together for the technological advancement of the society. The engineer-in-academia is the trainer or teacher. He\* is open

\* He and his are used in this paper as the general gender for both male and female engineer.

...with his researches and is therefore the forefront of new ideas, methods and techniques. He attempts to push technology forward. The engineer-in-industry is a much more conservative person. He is the end-user of the ideas that have been developed in academia; he it is who helps academia to reform their output so as to make them practical. He attempts to pull technology forward. Because both have the same goal, that of moving technology forward, there ought to be a co-operation, a working together between them. It is the synergistic effect of both engineers working together, informing and reforming, illustrated in figure 2, that moves technology forward and advances a country technologically.

Academics are theoreticians. They push technology forward by informing industry of their products that is the graduates and research results. Industries, on the other hand, are busy in pulling technology forward by reforming academia. Industries, are one of the main end-users of the university's product, they are the practitioners. They employ the graduates and are to put to test the findings/results of the various researches carried out by academics. They therefore are in the best position of making academia more relevant to the country's advancement by reforming them.

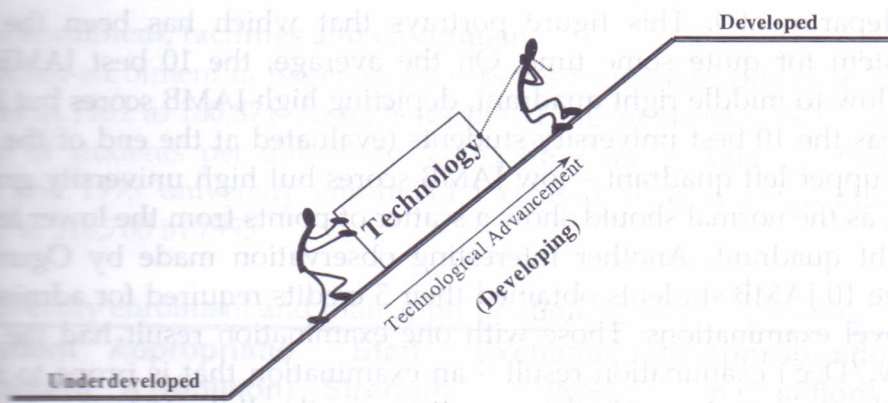


Figure 2: Synergistic effect of technology push and technology pull in technological advancement

## ENGINEERING EDUCATION IN NIGERIA – THE STATE-OF THE ART

Engineering education in Nigeria is being affected by such factors as poor secondary school education, faulty admission policies, large student enrolment versus poor facilities and the non-flexibility of the engineering curricula.

### 3.1 Poor secondary school foundation

Since engineering is all about the application of the principles of nature to designing tools machines, processes and plants, one who aspires to be an engineer must not only have a firm grasp of the natural sciences but must be taught to be imaginative, innovative and be a problem-solver. This is absent in most of our secondary schools.

### 3.2 Faulty admission policies

Entrance into any of the Nigerian universities is primarily through the Joint Admission and Matriculation Board (JAMB). JAMB is a body that was set up by the federal government in 1977 to prevent multiplicity of admission and to reflect the federal character by giving a fair chance to all and sundry via the quota system. By the quota system only 40-45% are admitted on merit, 30-35% are from the states around (catchment), 20% from educationally less disadvantaged states and the remaining 0-10% is left to the discretion of the university. Not only is this admission system faulty, as less than half of those admitted are merit students, but the JAMB examinations, known as University Matriculation Examination-UME, are fraught with a number of examination malpractices. The UME is no longer an effective and reliable tool in predicting the academic performance of students for the purpose of admission into an engineering programme. A number of research studies<sup>(vi, vii, viii)</sup> confirm this fact.

Figure 3 shows a summary of the results of one of the studies carried out in an engineering department<sup>(8)</sup>. This figure portrays that which has been the trend in the university system for quite some time. On the average, the 10 best JAMB students are located in the low to middle right quadrant, depicting high JAMB scores but low university grades. Whereas the 10 best university students (evaluated at the end of the first year) are located in the upper left quadrant – low JAMB scores but high university grades. This is a skewed result, as the normal should show a scatter of points from the lower left quadrant to the upper right quadrant. Another interesting observation made by Ogunleye<sup>(8)</sup> is that virtually all the 10 JAMB students obtained their 5 credits required for admission from two different O'Level examinations. Those with one examination result had the GCE O'Level (external –Nov./Dec.) examination result – an examination that is prone to impersonation and various other malpractices. On the converse virtually all the 10 best university students registered with results from one examination, the May/June (internal) WAEC examination, an examination normally conducted under strict supervision and less prone to examination malpractices.

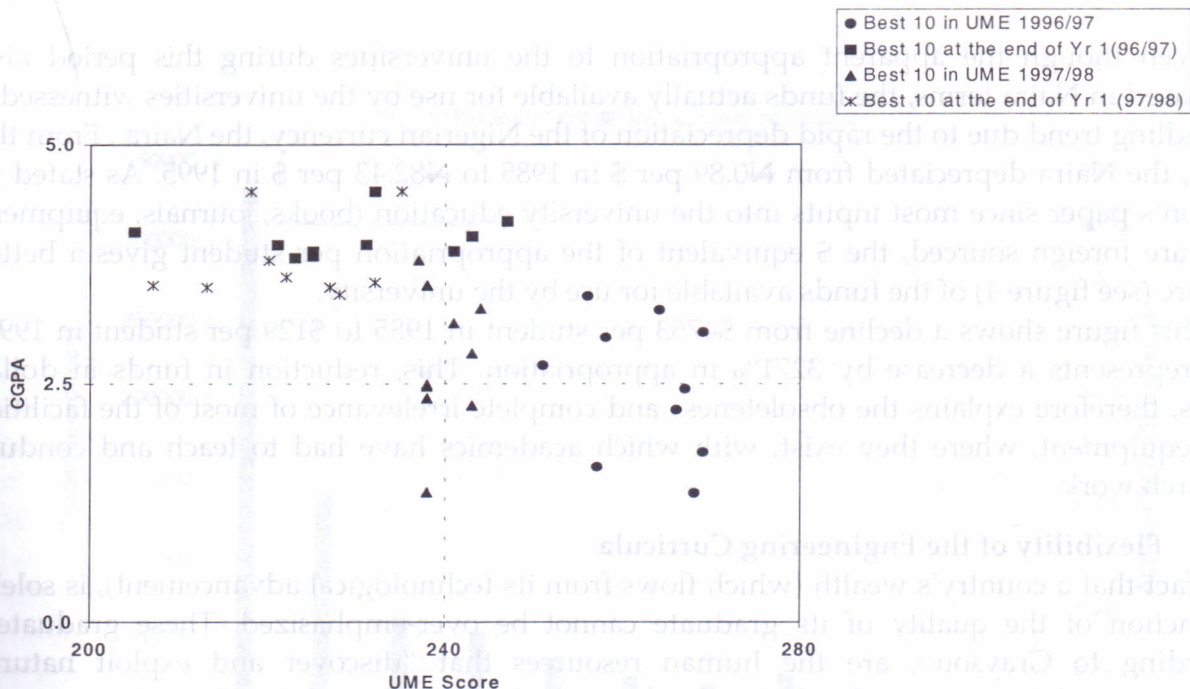


Figure 3: Comparison of UME (JAMB examination) scores with university grade.

### 3.3 Student enrolment, facilities and equipment

The rate of student enrolment in Nigerian universities increased from 3,646 students for the five universities in 1962 to 180,871 students for the 31 universities by 1990<sup>ix</sup>, a 700% increase in the number of students per university. Using the data of Agbon<sup>x</sup>, shown in Table 1, between 1985 and 1995 university enrolment increased at an average rate of 20% from 102,370 in 1985 to 310,700 in 1995.

Table 1. University enrolment and total appropriation for Nigerian Federal Universities

Year	Student enrolment	Appropriation (Nmillion)	Staff Strength	Exchange rate (N/\$)	Appropriation n (\$million)	\$/studer
1985	102370	433	11530	0.89	487	4753
1986	134000	470	11720	1.73	272	2027
1987	141635	500	11950	3.97	126	889
1988	174133	610	12118	4.54	134	772
1989	179488	730	12289	7.37	99	552
1990	200774	660	13645	8.35	79	394
1991	232482	744	12927	9.91	75	323
1992	240800	2150	12860	22.05	98	405
1993	270433	2600	12600	33.45	78	287
1994	279066	2970	12530	80.21	37	133
1995	310700	3310	12495	82.43	40	129

Even though the apparent appropriation to the universities during this period also increased in Naira terms, the funds actually available for use by the universities witnessed a dwindling trend due to the rapid depreciation of the Nigerian currency, the Naira. From the table, the Naira depreciated from ₦0.89 per \$ in 1985 to ₦82.43 per \$ in 1995. As stated in Agbon's paper since most inputs into the university education (books, journals, equipment etc.) are foreign sourced, the \$ equivalent of the appropriation per student gives a better picture (see figure 4) of the funds available for use by the university.

This figure shows a decline from \$4753 per student in 1985 to \$129 per student in 1995, this represents a decrease by 3271% in appropriation. This, reduction in funds in dollar terms, therefore explains the obsolescence and complete irrelevance of most of the facilities and equipment, where they exist, with which academics have had to teach and conduct research work.

### 3.4 Flexibility of the Engineering Curricula

The fact that a country's wealth (which flows from its technological advancement), is solely a function of the quality of its graduate cannot be over-emphasized. These graduates, according to Grayson<sup>xi</sup>, are the human resources that "discover and exploit natural resources, mobilise capital, develop technology, produce goods and distribute them among the people for the welfare of the nation". These qualities are not innate in a person but have to be imbibed. This process of imbibing knowledge is done via the university curricula (see figure 5). Academic curricula of the early nineties were shaped by the pressing needs of the industries of those days<sup>xiii</sup>. With industrialization came a lot of unforeseen phenomena, for example environmental pollution and process safety are key issues today that today's engineer must be taught to integrate protection of the environment and safety into the design, installation and operation of plants and components. This therefore calls for flexibility in the engineering curricula so that it can change as the need of technology changes.

Table 1: University enrolment and total appropriation for Nigerian Federal Universities

Year	Year enrolment n	Student Appropriation n (Million)	Staff Strength	Exchange rate (N/\$)	Appropriation n (Million)	Student
1985	102370	483	11530	0.89	487	4753
1986	134000	470	11720	1.73	575	5057
1987	141635	600	11950	2.97	158	889
1988	174133	610	12118	4.54	134	772
1989	179488	730	12588	7.37	99	555
1990	200774	680	13645	8.35	79	394
1991	232482	744	12927	9.81	75	353
1992	248000	2150	12860	22.05	98	405
1993	270403	2600	15800	32.25	78	287
1994	279086	2670	15230	80.51	37	133
1995	310700	3310	15495	82.43	40	159

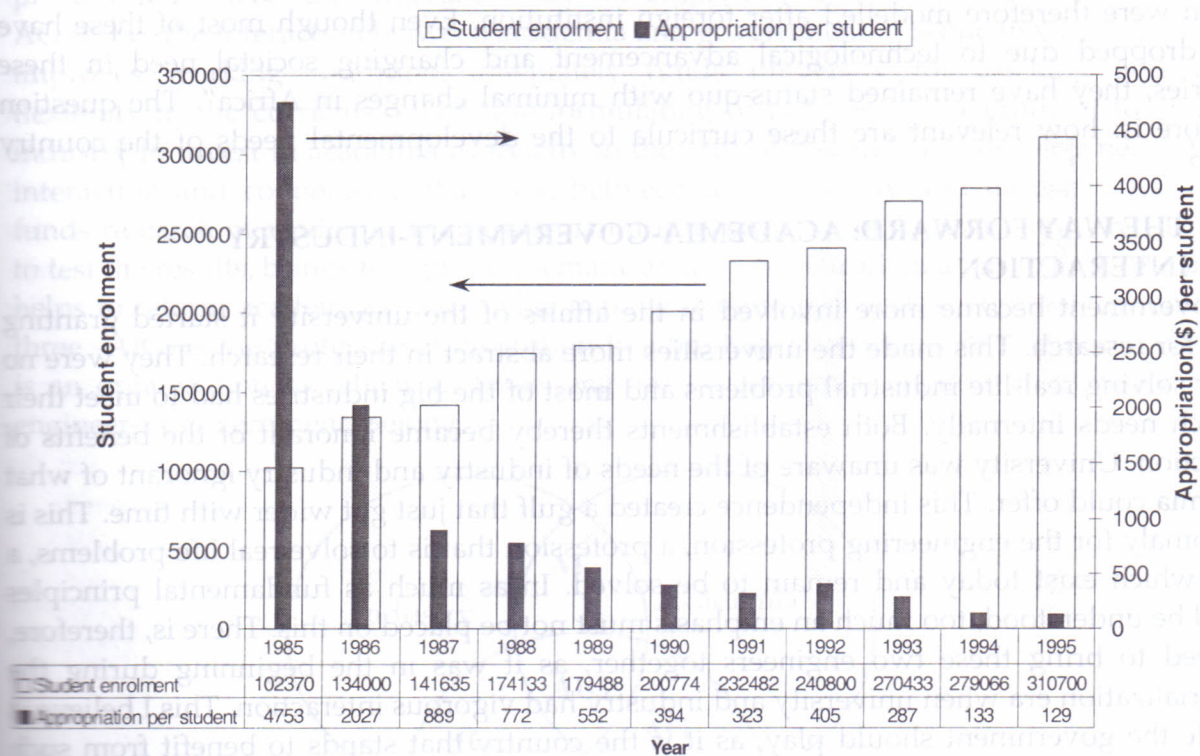


Figure 4. Student enrolment and Appropriation for Nigeria's federal universities

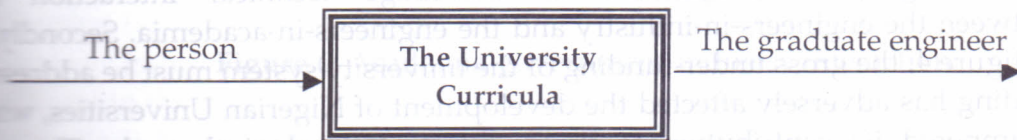


Figure 5: The making of an engineer

Over the years engineering academics have focussed on understanding and researching fundamental principles that there has been a growing concern the world over on the quality of their graduates and research results to industry. It is this change of focus, from 'industry's' problem to understanding fundamental principles, that has resulted in a widening with time, between the engineer-in-industry and the engineer-in-academia. There is therefore the need to re-orientate and re-adapt engineering curricula and teaching mode to meet the ever-changing technologies throughout the world while at the same time being relevant to ones own society. As noted in the report of the UNESCO expert



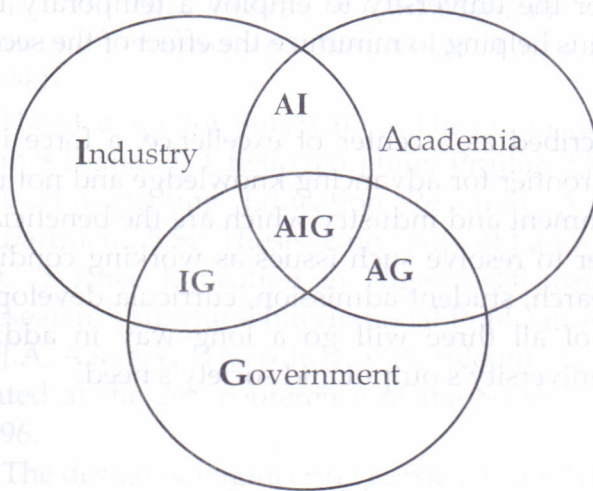
group<sup>xiii</sup> meeting on engineering education - "most of the engineering faculties in Africa were founded by former colonial governments. The curricula and engineering education system were therefore modelled after foreign institution. Even though most of these have been dropped due to technological advancement and changing societal need in these countries, they have remained status-quo with minimal changes in Africa". The question therefore is: how relevant are these curricula to the developmental needs of the country today?

#### 4. THE WAY FORWARD: ACADEMIA-GOVERNMENT-INDUSTRY INTERACTION

As Government became more involved in the affairs of the university it started granting funds for research. This made the universities more abstract in their research. They were no longer solving real-life industrial problems and most of the big industries had to meet their research needs internally. Both establishments thereby became ignorant of the benefits of interaction. University was unaware of the needs of industry and industry ignorant of what academia could offer. This independence created a gulf that just got wider with time. This is an anomaly for the engineering profession, a profession that is to solve real life problems, a lot of which exist today and remain to be solved. In as much as fundamental principles should be understood, too much an emphasis must not be placed on this. There is, therefore, the need to bring these two engineers together, as it was in the beginning during the industrialization era when university and industry had vigorous interaction. This I believe is the role the government should play, as it is the country that stands to benefit from such interaction – technological advancement.

The role of government is not to fund, on an extensive level, research in University. Experience of developed countries has shown that this only widens the gap between academia and industry. The role of government is to enforce, monitor and see to it that the relationship between academia and industry is healthy. This it must do by first and foremost, formulating policies/legislation to encourage technical interaction and cooperation between the engineers-in-industry and the engineers-in-academia. Secondly, as was seen from figure 4, the gross under-funding of the university system must be addressed. This under-funding has adversely affected the development of Nigerian Universities, which in turn has hampered its contribution to the country's technological needs. The poor conditions of service, the unconducive environment for teaching and research has led to brain drain - an exodus of seasoned academics to greener pastures, both in and outside the country. In the United Kingdom, in order to curb brain drain, where the best brains are leaving for America, the government under the auspices of the Royal Society instituted a program to award grants to selected researchers annually. The aim of this scheme, according to the UK science minister is "to attract the world's top scientist to work in the UK, to promote a UK 'brain gain' boosting the increasingly knowledge-driven economy". Thirdly the government should ensure that the curricula adopted by Nigerian Universities are relevant to the developmental needs of the country and not just tailored after those from developed countries. Our universities are to prepare engineers first and foremost for the benefit of the Nigerian public and market and not the international market.

A very good platform for all three; academia, government and industry is the professional body – the Nigerian Society of Engineers, NSE. This is illustrated in figure 6. AG shows the interaction between academia and government, it is one in which government improves working condition, adequately funds university for teaching and ensures flexibility in the curricula. IG is the formulating of policies by government to encourage industry to invest in academia especially in the area of research and development. AI is the interaction and cooperation that exist between the university and industry. As industry funds research in academia and academia informs industry of its result, industry in putting to test the results, brings to light problematic areas, which academia has to look into and this helps to reform academia's knowledge making it more practical. A common ground for all three –AIG, is the professional institution like the Nigerian Society of Engineers, NSE. NSE is an organisation to which all three; engineer-in-academia, engineer-in-industry and the engineer-in-government, belong.



**Figure 6.** Academia-government-industry interaction.

The NSE must bring all three bodies together. It must ensure that the appropriate government agency in association with the university and industry work on and develop an appropriate curricula, it must ensure that the government funds teaching and that industry funds and participates in research. It must also monitor academia, via accreditation, to ensure that the technological needs of the country are being met. Because technology changes everyday, this process is a continuous closed loop system of developing, implementing, monitoring, improving and back to developing.

Another key area where professional bodies can promote academia-industry relation is the area of industrial secondment, where lecturers have time out in industry so as to give a little bit of reality to their lectures. Horwitz and Nault<sup>xv</sup> noted that a medical student doing a course in thoracic surgery would be taught by a lecturer (M.D.) who has been in the operating room and performed that type of surgery. A law student will also most likely, be

taught by a lecturer (lawyer) who has been in a courtroom. But, one who has never really practiced engineering usually teaches the engineering student. This undermines the need to relate industrial practices to students.

The Royal Academy of Engineering (RAEng) of United Kingdom, is an academy that "exists to pursue, encourage and maintain excellence in the whole field of engineering in order to promote the advancement of the science, art and practice of engineering for the benefit of the public"<sup>(1)</sup>. This academy has an industrial secondment scheme in which it seeks to bring industry and academia together in a partnership. The main objective of this scheme is to improve the quality and relevance of the teaching of engineering. This not only has the advantage of making theoretical learning 'come alive' and have relevance to the world of industry and commerce, but also exposes the engineering academic to current practices and also creates, develops and strengthens links between industry and academia. In order to make it easy for the university to release members of staff for this scheme, the academy provides funding for the university to employ a temporary replacement for the one who has been seconded thus helping to minimize the effect of the secondee's absence.

## 5 CONCLUSION

Academia has well been described as a center of excellence, a force in the technological advancement of a country, a frontier for advancing knowledge and not recycling ignorance. If this be the case, then government and industry which are the beneficiaries of university's output must all come together to resolve such issues as working conditions for academia, funding for teaching and research, student admission, curricula development and so much more. The coming together of all three will go a long way in addressing the current mismatch that exist between university's output and society's need.

## REFERENCES

1. Engineering Links <http://www.raeng.org.uk/Engineering/Eng.html>
2. Biobaku, S. "University Education in Nigeria – Trends and Prospects for a Qualitative University Education" being the text of a lecture delivered at the 1<sup>st</sup> annual distinguished alumni lecture of the University of Lagos alumni association (December 1996)
3. "Universities: Towers of babble" *The Economist*, p. 38 (Dec. 25 1993 – Jan 7 1994)
4. Anubi, J.D. Adapted from the presentation of "Management of the Nigerian Petroleum Industry in the 21<sup>st</sup> century through a memorandum of understanding (M.O.U.)" a paper presented at the 27<sup>th</sup> Annual conference of the Nigerian Society of Chemical Engineers, NSChE, 13<sup>th</sup> – 15<sup>th</sup> Nov. 1997, Kaduna
5. Tom Ryan "Learning and the method of Science in Engineering Education" Proceedings on The National Seminar on Engineering Education in South Africa p. 253 (11 – 12 September 1997)
6. Ukwunife, R.P.I. " The effectiveness of Joint Matriculation Examination in Predicting University Academic Performance" *The Journal of Educational Research & Development*. Vol. 1, No. 1. (1990).
7. Nwana O.C., "The struggle for Survival" in History of the Science Teachers Association of Nigeria, Bajah S.T. and O.O. Bello (ed.) Intec Printers Ltd., Ibadan (1996)
8. Ogunyele, A.O. "Engineering Education Research: A case study of the Chemical Engineering Department, B.Sc. Thesis, University of Lagos. (1999)
9. Ogunleye, A.O. "Science Education in Nigeria (Historical Development, Curriculum Reforms and Research)" Sunshine International Publications (Nig.) Ltd. (1999)
10. Agbon I.S. and J.A. Ajiienka, "The future of Petroleum Engineering education in Nigeria" A paper presented at the 20<sup>th</sup> conference of the Society of Petroleum Engineers, Warri Sept. 25 – 27, 1996.
11. Grayson, P.L. " The design of engineering curricula" a UNESCO publication, pp 9 (1977)
12. Landau, R. "Education: Moving from chemistry to chemical engineering and Beyond" *Chemical Engineering Progress* p. 52 – 65 (Jan. 1997)
13. Strategic Issues in Engineering Education in Africa, UNESCO , Kenya (Nov. 1995)
14. "Plugging the brain drain" *The Chemical Engineer* pp 2 (Jan. 2001)
15. Horwitz B.A. and L.G. Nault "Rethinking academia: Relate to the real world" *Chemical Engineering Progress* pp 84 (Oct. 1996)