

**Women and Engineering in Nigeria:
Towards Improved Policy Initiatives and
Increased Female Participation**

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LIST OF ABBREVIATIONS AND ACRONYMS

APWEN	Association of Professional Women Engineers in Nigeria
DOI	Department of Industry
EITB	Engineering Industry Training Board
GATE	Girls and Technology Education
GIST	Girls into Science and Technology
NAWSTEM	National Association of Women in Science, Technology and Mathematics
NS/E	Natural Sciences and Engineering
NTH	Norwegian Institute of Technology
NUC	National University Commission
S&E	Scientific and Engineering
STM	Science, Technology and Mathematics
SWE	Science and Women Engineering
WES	Women's Engineering Society
WISE	Women into Science and Engineering
WISEST	Women in Scholarship, Engineering, Science and Technology

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The African Technology Policy Studies Network (ATPS) is a multi-disciplinary network of researchers, policymakers, actors in the private sector and other end users interested in generating, promoting and strengthening innovative science and technology policies in Africa. With a regional secretariate in Nairobi, the network operates through national chapters in 17 countries, with an expansion plan to cover the entire sub-Saharan Africa.

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Chapter One

Introduction and Background

Introduction

In Nigeria, the Government and individuals are increasingly realizing that technological development is mandatory for the country's overall development. However, criticism is being leveled against the way the objective is to be achieved.

Since independence in 1960 focus has been on mobilization of resources. All national development plans have since reiterated the need to strengthen technical education in a bid to galvanize the nation for development. While such attention is being focused on technological development, a shortage of skilled manpower has been on the rise. A cursory examination of any of the National Plans shows the predominant roles that the engineering profession is expected to play in the nation's technological development (Oladapo: 1983).

Regardless of the effort made to increase the number of engineers in the past, shortages as Ukaegbu (1985) found still tend to be as high as 50 percent. The shortages, remarkably, persist even in universities and polytechnics charged with manpower production. Deficits also exist in intermediate technical manpower needed to support engineers. In fact, as found by Oladapo (1983), constraints to technological development lie more with the intermediate category of technicians and craftsmen than with the professional engineers. The graduate output of middle-level technicians from technical colleges in Nigeria has been found to be the same as that of engineers from universities and polytechnics. Women constitute a small part of the total output from these institutions (Badekale, 1992; Agbeyisi, 1985). The total output provides a ratio of one engineer to one technician in the job market. This economic manpower ratio is inadequate. In the developed countries, the economic ratio is eight or ten technicians to one engineer. Such odd ratios for the specialized workforce need to compare favourably with those in the advanced nations. For example, women make up six percent of all US scientists with college degrees in natural sciences and engineering. Policies to correct this situation in Nigeria need to be instituted after a thorough examination of the circumstances that produce this misfits, particularly with respect to participation of women. Such policy may indeed be applicable across the African region as similar scenarios are found in sub-Saharan Africa.

Background

During introduction of formal education in Nigeria, efforts were made to ensure women did not attend formal school. This was for several reasons: It was considered wasteful, as girls would eventually be married off to become housewives. Thus, women's education was not favoured by parents. However, traditional forms of education were available to prepare women for future roles. Educational

opportunities were not equally available to boys and girls. Most often, girls' education was terminated at the primary level. Thus very few girls proceeded to secondary school (see Table 1).

Table 1: Distribution of Pupils in Nigerian Secondary Schools, 1959, 1963 and 1970

Year	Male	Female	Total	% Girls
1959	92,480	23,106	115,586	19.99
1965	151,807	60,072	211,879	28.35
1970	205,959	104,095	310,054	33.57

Source: Alele-Williams (1988)

Table 2 further reflects the dismal picture: girls formed as low as 3.45 percent of the secondary school population in the 1975/76 school year.

Table 2: Statistics of Secondary Education in Nigeria by Sex

Year	Male	Female	Total	% Girls
1975/76	580,889	20,763	601,652	3.45
1976/77	650,131	80,768	730,899	11.05
1977/78	852,558	61,090	913,648	6.69
1978/79	796,577	397,902	1,194,479	35.31
1979/80	1,009,781	543,564	1,553,345	34.99

Source: *Statistics of Education in Nigeria (1985)* by Federal Ministry of Education.

A constant problem to the continued attendance of girls in school at this early period was withdrawal for early marriages. This was common in the northern part of the country. However, various efforts were geared towards ensuring active attendance of girls in school, even at higher levels of education. In a Science Teachers Association of Nigeria's publication (1992), it was reported that as far back as the 1950s, the colonial government began to seek ways of increasing the population of girls in secondary school. These came in form of scholarships and laws forbidding early marriages. Later, the Federal Government introduced bursary allocations to assist both male and female students in higher institutions.

With increasing attention being paid to the low participation of girls in education, more and more women began to enroll in higher institutions. As reported by Stan (1992), while the ratio was about 1:40 in 1949 at the University College, Ibadan, the under-representation had reduced to 1:3 by the 1970s. Despite this, the problem of gender bias remained in science, technology, and mathematics courses.

It would be seen however that with various efforts made by appropriate authorities and professional bodies, coupled with advancing economic development, remarkable, albeit slow, increases began

to be recorded in female participation in science-related courses. Table 3 shows that technology recorded the lowest number of women, with just 7.2 percent of the total entrants.

Table 3: Entrants by Sex in Science and Science-Based Courses 1984/85, University of Ibadan

Faculty	Male	Female	Total	% Female
Science	282	124	406	30.5
Medicine	310	145	455	31.9
Agric. Forestry	234	41	475	14.9
Vet. Medicine	54	8	62	12.9
Technology	180	14	194	7.2

Source: University of Ibadan, Digest of Statistics.

Chapter Two

Current State of Discussion

Overview of Factors Serving as Barriers to Women's Participation in Science and Technology Education

It is adequate to argue that the under-representation of women in education generally, and in the wide field of science and technology in particular, has been given deserved attention. As a result of this worldwide attention, varied efforts, been made to find solutions to the inadequate number of women in the field.

Giving impetus to these efforts was the placing of increased importance on science and technology for national economic development. Also important was the influence of the growing commitment to equality of men and women.

Several causes had been identified for women's low participation in science and technology education. Harding (1987) classified some of the factors into three:

- i) The assumptions that society makes about males and females (their abilities, behaviours, roles, and aspirations);
- ii) The objectives and organization of education;
- iii) The practice of science, technology and mathematics.

These factors, she highlighted, are embedded in the political and cultural context of society.

Harding highlighted the study by Maccoby and Jacklin (1975), which concluded that males display superior spatial skills (with the sex differential increasing with age of sample) and females show greater verbal skills (with the sex differential increasing with age).

Further analysis of the studies earlier reviewed by Maccoby and Jacklin showed, however, that in none did the sex of the person contribute more than four percent to the total variance within the sample (Harding, 1987; Hyde, 1981). As Harding puts it, there is much more variation in spatial abilities within one sex than between the sexes. Despite these findings, however, there persists schools of thoughts that are still firmly based on "perceived" biological sex differences, genetically pre-programmed, that promote boys' effectiveness in mathematics and linguistics than girls and which consequently precipitate the subject specialisms.

Strategies for Recruiting Females into Engineering – The Case of other Countries

In a study of 42 schools of engineering in the US, Sproule and Mathis (1976) found that successful recruiting techniques employed by the schools made a difference. Such techniques included the appointment of a person or committee that is committed to and responsible for recruiting women, the

use of brochures, written appeal to women students, publicity through television announcements, films and use of female engineering students. Such female engineering students serve as role models to attract other female students still in high school.

Other techniques included outreach devices aimed particularly at high school counsellors who, in turn, were expected to counsel their high school students on the suitability of engineering, orientation programmes, and use of individual advisors (preferably women) for all female students enrolling in engineering. Successful techniques further included participation in the society of women engineers to provide increased contact with other women engineers in the field, employment of female faculty members, and involvement of women professionals as guest speakers to serve as role models. As Gappa and Uehling (1979) affirmed, these techniques as well as the appropriation of recognition to outstanding women students, were successfully adopted in the United States to bring about increased participation of women in engineering.

In Canada's University of Alberta, a task force on Women in Scholarship, Engineering, Science and Technology (WISEST) was established to take action aimed at increasing the representation of women in science, engineering and technology. WISEST in turn formed the UAYs (pronounced UA-WISE) to foster mutual support among women students and staff, while also assisting them to set and achieve goals. The UAYs was expected to provide a forum for role models to dispel the ingrained and subconscious feeling among women that they do not belong in the fields.

Armour (1985) reported that the UAYs had been effective in providing a forum for communication between female staff, graduate students and undergraduates. It was also able to organize successful participation of high school female students in research groups located in faculties of science and engineering. This and other programmes gave high school students opportunities to interact with engineering, thereby forming positive feelings towards the profession. Other activities conducted by WISEST's UAYs included a conference and series of mini symposia in which female scientists and engineers presented summaries of their work in intelligible terms. Armour reported that the programmes received enthusiastic responses.

Oost (1988) reported the Project Technika-10, which was started in the Netherlands in 1985 to stimulate girls' interest and knowledge in technology before the age of adolescence. Research had ascertained that young girls aged between 10 and 12 have the same affinity and interest in technical features as boys, but girls on the other hand have less experience and knowledge. Their limited experience stems from the fact that girls are provided with games and items which do not stimulate technological insights. Technika-10 organized technical courses in 10 different towns in the field of informatics, electronics, chemistry, etc. for young girls. These were done with co-operation from technical colleges and technical universities. The courses were for girls only and the supervisors who were women served as role models. It was expected that girls who attended the course would probably choose to study in natural science and technology.

The United Kingdom also pays special attention to girls and technology and has set up several bodies like the Engineering Council and the Equal Opportunities Commission which in turn initiated the Women Into Science and Engineering (WISE) campaign. Various types of activities were organized including the WISE-bus that toured the country and held a national conference. Since the 1970s, the Engineering Industry Training Board has recruited 16-year

old girls into technical training courses and began to woo the interest of girls to careers in engineering (Harding, 1986; Newton, 1981).

In 1979, the United Kingdom introduced the Insight Courses during which students are invited to visit technical colleges and universities in order to practice engineering for themselves. Oost (1988) noted that such courses had been attended by 400 - 600 girls selected from thousands of applicants. For the duration of the one week course, the female participants were supervised by female engineers, and they were also taken on visits to industries. Similar mini-courses as Oost reported had been organized in Norway and Sweden.

In Norway, a quota system whereby girls are given extra points because of their sex is implemented to encourage more girls to opt for the course. Whyte (1984) reported that in Sweden and the United Kingdom, special schemes which brought women engineers into the classroom were introduced. These were the Dutch apprenticeship project and the Engineering Industries Training Board programmes, respectively.

In most developed countries like Norway, Finland and the United Kingdom, national councils of engineering have been very active in making available information materials to relevant target groups. The target of such information is the change of existing attitude towards participation of women in engineering.

Other measures have been taken to create a conducive atmosphere for the entry of women into science and technology-related professions. Sjøberg and Imsen (1991) reported the scene in Norway, and the advanced stage to which equality between the sexes had reached. He however reported that the impact in science and engineering is still extremely low. In the country, a considerable fraction of the adult labour force (40-45 percent) is female. This is remarkable. To remove obstacles to female participation, legislation against sex discrimination was enacted, while textbooks have to pass the sex discrimination test before being approved officially. Within the educational system, equality between the sexes was also considered a central issue.

Educational Impediments to Female Participation in Science and Engineering

Blackstone and Weinreich-Haste (1980) briefly reviewed the topic. They found that girls tend to set their sights lower, take easier courses in further education, take fewer A-levels for higher education and thus are less likely to go on to higher education.

They also found that girls attribute their success to luck and external factors and attribute their failure to lack of ability. Boys on the other hand, tend to be opposite, and attribute successes to themselves.

Newton (1981) reported that girls were found considerably behind boys in having experience in physics and crafts and technical subjects (two background areas important for entry into engineering). The reasons found for girls under-participation in physics, wood work, metal work and technical drawing included their being prevented from taking the courses, lack of or shortage of facilities and staff, social pressure and absence of traditional career guidance. Newton also found that girls reported that they were not exposed to engineering careers until it was too late for them to choose the appropriate subjects necessary for engineering studies.

Stan (1992) noted that in the United States, research indicated that girls have poor attitude towards science, thereby enrolling less often in it while also demonstrating lower achievement levels in the

subject. Stan thus highlighted the view of Skolnick et al. (1982) that since poor attitudes relate directly to lower achievement levels and to lower enrolment in science courses, negative attitudes must be ameliorated in girls and women in science and technology.

Masculinity and Feminization of Engineering

A cursory glance at the different engineering fields all over the world and in Nigeria particularly reveal that the fields are dominated by men and the profession regarded as a male domain. As Walton (1986) reported, societies do not expect women to become scientists and those that do are seen to step "out of line". As a response to this restriction, women are under-represented in the fields and over-represented in what can be termed the service-sector. The jobs include teaching, nursing, sales and advertising.

The explanations given for this dominance by men have been speculative. As Breakwell (1980) explained, there are undoubtedly overt institutional and organizational barriers which function to restrain access or involvement of women.

Nieva and Gutek (1981) presented four models explaining women's lower status in organizations. Among the four, the structural-institutional model highlighted the positive impact of role models and company policies on careers of women. Another school of thought proposes that there are biological sex differences, genetically pre-programmed which promote boys' effectiveness in mathematics and linguistics and consequently precipitate the subject specialisms. The subject specialisms favour the presence and entry of men into engineering and other science fields.

Newton (1981) wrote on the traditional image of engineering as being heavy, dirty and masculine, while a woman who would succeed in the field had to be tough, aggressive and masculine. If she does not possess these characteristics, then she must work in menial jobs requiring manual dexterity and "nimble fingers". Nieva and Gutek (1981) identified this as the sex role model.

The masculinity surrounding the image of engineering over the years remained very powerful and in turn reinforced the belief that the field is unsuitable for none other than men. Thus, women until recently formed a small percentage of total enrolments in university engineering departments all over the world. Linden et al (1985) and Sheridan (1984) affirmed that in the United States, the number of women who matriculate into and graduate from engineering faculties have increased over the past decade, while women form about 20 percent of beginning engineering students. They opined that there had also been changes in attitudes towards the roles of women and the probable changes in women's own perception of their capabilities. It must be observed rather enthusiastically that though there are increases in women enrolment, much is still needed to improve the lot of women.

Several developments have brought about this shift in the traditional view of science and engineering as perceived by men and women. As highlighted by Newton (1986), less emphasis is now placed on the "older heavy type of engineering", while talk is more and more about computers, printed circuit boards and electronics. Furthermore, the roles of women and men have been changing, with women's liberation and empowerment, movements and changes in economic conditions altering the division of labour and raising questions otherwise left unasked in the past. Particularly, concern has been intense about increases in the number of women in technology and how their access to the fields will be made easier.

Distribution of Women over Different Engineering Fields in Other Countries

Van Oost (1988) presented data on the distribution of women in engineering fields in European countries. Her work confirmed that women engineering students do not participate equally in the different fields of engineering. Data was compiled for Norway, Portugal, The Netherlands, and Hungary.

From the study, there was a “striking similarity in the pattern of distribution over the fields of engineering”. The participation of women was found to be at equal level with that of men in chemical engineering, and architecture. There was about an equal number of women as men in these two fields while in some countries, women formed the majority. Oost (1988) found that mechanical and electrical engineering did not seem to attract girls in any of the countries. She thus recommended special activities in order to recruit girls into mechanical and electrical engineering courses.

Writing earlier, Everts and Van Oost (1986) presented the 1982 figures for the Netherlands (Table 4).

Table 4: Female Students in Different Engineering Fields in The Netherlands, 1982

Field	N	%
Applied Mathematics	115	10.8
Civil Engineering	47	2.6
Architecture	489	14.8
Electronic Engineering	21	0.7
Mechanical Engineering	26	1.1
Chemical Engineering	121	7.5
Physical Engineering	36	2.5

Source: Everts and Van Oost (1986) p. 306 (from Statistical Year Book of Education, 1984)

The analysis revealed that three fields, applied mathematics, architecture and chemical engineering attracted the highest percentage of women. Other fields like electronic engineering, mechanical engineering and civil engineering were not attractive to women at all, with only one or two percent of the students being female. Explaining the trend for Netherlands, Everts and Oost referred to the statistical study on higher education in Europe (1970 – 1995), which rated the Dutch percentage of women in technological sciences as the second lowest of all European and North American percentages. This was in spite of widely held belief by the Dutch that Holland was a liberal and emancipated country.

Development Plan Projections for Engineering Manpower in Nigeria

The Federal Government in various National Development Plans placed emphasis on engineering manpower training, albeit without specific emphasis on gender. The various National Development Plans were for the following periods: First (1962-1968), Second (1970-1974), Third (1975-1980), and Fourth (1980-1985), and were released by the Federal Ministry of Information. As highlighted by the National University Commission (NUC, 1992), the First Plan (1962-1968) did not contain any

projections for the number of engineers required by the economy. Neither was there any proclamation on the number of other engineering cadres like technologists and technicians, craftsman and artisans. However, as adduced by the NUC (1992), it was obvious from a recommendation of the Ashby Commission Report on Higher Education that the government was committed to achieving a higher rate of production of engineering manpower for accelerated development of the country. However, during this period, of the number of graduating students, which was put at 356, an attrition rate of 44 percent was observed. Similarly, during the 1968/69 period, only 481 out of 1,011 students graduated, representing an attrition rate of 52 percent.

The Second National Development Plan (1970-1974) focused on the projected increases in the production of supportive personnel. Along with this development came the recommendation for the correction of the lopsidedness of the admission process which favoured the arts and humanities. This was a ratio of 50:50 recommended by the National Manpower Board for admission into the science-based and the arts and humanities-based disciplines. In addition, the plan prescribed an additional 7,000 places to be allocated to the various disciplines.

The Third National Development Plan (1975-1980) made more specific arrangements for additional universities as well as the number of engineering personnel required by the economy. It specified a massive increase in total student enrolment from 23,000 in 1975 to 53,000 by 1980 on a ratio of 60:40 for science-arts based courses (NUC, 1992). This plan thus brought about the establishment of the "Second Generation Universities". The number of civil and structural engineers was placed at 3,800.

The universities, as planned, were expected to increase the total student enrolment from 57,000 to 109,000 by the end of 1985. For engineering, enrolment figures were to be increased from 3,981 by the end of the 3rd Plan to 9,800 in the 4th Plan. However, 1985 witnessed a student population explosion, which increased actual enrolment to 11,272.

Figures for the Fifth National Development Plan (1986-1991) were in turn realistic, although as explained by the NUC (1992), the figures available were mechanical engineers at 1,400 and electrical engineers at 1,300, representing a total of 6,500. In addition, the Plan envisaged that by the end of the Plan period in 1980, there would be a total estimate of 12,250 engineers. As highlighted by NUC (1992), these figures excluded other engineering fields like agriculture, chemical, petroleum, mining and marine engineering and possibly surveying. A major highlight of this period is the deficit observed in the actual production of engineers. The actual output of engineers for the period was 3,008. This represented a deficit in the projection by 9,242 engineers.

The Fourth National Development Plan (1980-1985), however, still called for an increase in the production of engineering manpower. Thus several policy instruments and institutions emerged during this period, such as the establishment of universities of technology, and state universities, among others. The Plan projected additional requirements to boost existing stock of engineers for the economy. This is as replicated in Table 5 (culled from NUC, 1992 p. 156).

It is safe to agree with the conclusion of NUC (1992 p. 152) that the Plans were initially unrealistic in their projections of enrolment figures, until the third Plan.

Table 5: Professional and Intermediate Level Manpower in the Fourth National Development Plan

Category of Manpower	Estimated Current Stock 1980	Requirement for Meeting Existing Shortage	Requirement for Meeting 1985 Employment/ Population target	Requirement for Meeting Wastage 1980-1985	Additional Requirements 1980-1985
Civil and structural engineers*	4,000	4,700	6,000	310	7,010
Electrical and electronics engineers	3,500	2,070	5,000	270	3,840
Agricultural engineers	350	260	600	30	540
Total	7,850	7,030	11,600	610	11,390
Civil engineering technicians	9,800	5,950	12,300	760	9,210
Electrical/ electronics engineering technicians	10,600	8,060	13,400	825	11,785
Total	20,400	14,010	25,800	1,585	20,995

* Professional (engineering) level manpower

** Intermediate level manpower

Source: Culled from NUC (1992)

The Fifth Plan in turn witnessed a kind of catastrophe in the country's attempt to increase the population of its technical manpower with the adverse effect of the "brain drain" syndrome. Many professionals, including engineers, left the country in search of better lucrative jobs in other countries. Moreover, those that couldn't leave the country moved from the academic to the business world. Thus the lecturers left in universities were too few to produce the urgently needed technical manpower.

Science and Technology Policy Initiatives in Nigeria

The National Policy of Education introduced in 1979 and revised in 1981 initiated, among other changes, the 6-3-3-4 system of education in the country. Three of the policy's appropriate goals for technological education are:

- Diversify its curriculum to cater for the differences in talents, opportunities and roles possessed by or open to students after their secondary school course;
- Equip students to live effectively in our modern age of science and technology; and

- Raise a generation of people who can think for themselves, respect the views and feelings of others, respect the dignity of labour and appreciate those values and live as good citizens.

The policy tried to improve aspects related to the theme of this study. Section 5, Sub-section 38(ix) states: "In the present state of our development and in view of the rapidly expanding manpower requirements for qualified professionals, the Federal Government will look into the restrictive practices prevailing in some professions with a view to removing or relaxing such restrictions provided standards are not lowered".

In order to attract more people to the science-based courses, the policy further fixed the ratio of science to liberal arts students at 60:40 in order to attract students into the faculties of science and technology. It is, however, difficult to get enough students (both male and female) to meet this ratio as both the primary and secondary schools' curricula have not equipped students for higher studies in science and technology.

Section 10, Sub-section (ii) of the National Policy on Education (1981) is explicit on the Government's efforts to rectify apparent ignorance of many young people about career prospects. It states:

In view of the apparent ignorance of many young people about career prospects, and in view of personality mal-adjustment among school children, career officers, and counsellors will be appointed in post primary institutions...

As Oladapo (1988) states, the National Policy on Science and Technology was an attempt taken by the Federal Government at evolving a co-ordinated science and technology policy for the country. Organs such as the National Council for Science and Technology, its research councils, the National Science and Technology Development Agency, and the Ministry of Science and Technology, were established.

The objectives of the National Policy on Science and Technology (1986) are to ensure that the stated national objectives are met through the application of science and technology. To achieve this, it aims at:

- i) increasing public awareness in science and technology and their vital role in national development and well being;
- ii) directing science and technology efforts along identified national goals;
- iii) promoting the translation of science and technology results into actual goods and services;
- iv) creating, increasing and maintaining an endogenous science and technology base through research and development;
- v) motivating creative output in science and technology;
- vi) increasing and strengthening theoretical and practical scientific base in the society; and
- vii) increasing and strengthening the technological base of the nation.

Proposed Strategies for Implementation

Proposed strategies for assured manpower, among others, included the following:

- Enforcing strictly the 60:40 ratio of science-based disciplines to the humanities in student enrolment at universities, with a target ratio of 70:30 by the year 1988.

- Initiating and supporting continuing education programmes aimed at specific training for top-level scientists, practising science teachers, engineers and technologists.
- Initiating and encouraging programmes for the training of scientific and technical personnel on a scale adequate for the fulfilment of the country's needs in education, agriculture, medicine, engineering, industry, defense, etc.

To achieve this, the policy has another objective of increasing public awareness in science and technology.

It is noteworthy that none of these provisions stressed any activity to ensure the participation of women in the fields. The urge to involve women in national development was actually given the impetus by the declaration of the United Nations, which dedicated 1975-85 as the Decade for Women. This focused debate during the 1986 conference held in the country. At the conference, women's issues were discussed. The result of the conference was the Blueprint on Women Education in Nigeria. Thus for sure, in that year, the country was dedicated to women education.

Realising the enormity of the problems in the educational system, the National Council on Education directed both Federal and State ministries of education to comply with the recommendations of the Task Force on Guidance and Counselling, which it had ratified. According to Onanuga (1991), some aspects of the emphasis are that:

- Pre-vocational subjects should be introduced at the secondary school level as elective.
- Career guidance and counselling should be continuously carried out at both secondary and tertiary levels to prepare students for the world of work.
- Girls should be encouraged to pursue courses in science and technology by granting good candidates scholarships from their junior secondary through tertiary education.
- Girls should be protected from sexual harassment at all levels of development.
- Education for all (boys, girls, illiterate or partially literate adults, the nomads, etc.) is to be accomplished by the year 2000.
- Federal scholarship be more generously given to candidates interested in pursuing courses in guidance and counselling in order to train such greatly needed personnel.

The Federal Ministry of Education has since developed tests, which were made available for school counsellors' use. Some of these included Technical and Vocational Interest Scale for Junior Secondary School; Students' Attitude to School and Parental Expectations; and Social Adjustment Guide.

In 1986, the Federal Ministry of Education created the Women Education Branch with the objectives of promoting public awareness of the need to educate women, providing more adequate opportunities for women and encouraging female participation in social and economic activities in the country. The unit has since launched a massive campaign, which in turn had "reflected glaringly on enrolment". Thus Kano State, which had a 29 percent female enrolment, accorded 45 percent female enrolment in 1988, while that of Kaduna, which was previously 35 percent, also rose to 50 percent. The awareness campaign is launched periodically in all states of the country. A blueprint on Women Education in Nigeria was also printed to guide the ministry in its activities.

In the country, national and professional bodies, consisting of women only, began to be organized. An important achievement was the establishment of the National Association of Women in Science, Technology and Mathematics (NAWSTEM).

Vocational programmes under the auspices of the "Better Life for Rural Women" were introduced. The Ministry of Education also established a Women Education Model Centre and Women Education Units in each state. Working in collaboration with the Nigerian Educational Research and Development Council, the Women Education Branch effected the development of a curriculum for Women Education in the country. Other activities include the publication of articles and posters targeted towards attracting women to education, and re-orientating the attitude of the general society towards education of women. A major aim of the ministry thus was the promotion of the education of girls in the field of science, technology, and mathematics. Stringent measures were also taken by State governments with the enactment of policies to discourage the withdrawal of girls from school.

In 1987, a national workshop on promoting science, technology and mathematics (STM) among girls and women in Nigeria was organized. In order to motivate girls further to study STM oriented subjects, scholarships were awarded by the Federal Ministry of Education to senior secondary school girls who excelled in STM subjects in the JSS examination. Sixty-six girls benefited from the scheme which was for one year, but which could be renewed if the recipient took the best position the following year.

In addition to this, five female students from Nigeria participated in the STM clinic which took place at Achimota School in Accra, Ghana, from 26th August to 9th September, 1989. The five girls were the recipients of the Women Education (NAWSTEM) Scholarships for STM Scholars. A follow-up of this workshop was organized in Nigeria. This was the one-day STM road show clinic organized by the Women Education Branch for 200 secondary school girls in every state of the federation, including Abuja, from October to December, 1989. This included a series of activities geared towards motivating girls to take up STM-oriented professions. Female professionals in the STM-oriented fields gave career talks to participants.

Feminization Rate of Engineering Education in Developed Countries

Reliable sources of evidence was extremely difficult. So also was the literature to review even when visits were paid to some of the countries.

Van Oost (1988) turned out to be a very useful source of information on some developed European countries. The picture painted by the statistics confirmed the under-representation of women in engineering in the countries. However, it also revealed a growth in the 15 years preceding the report. The United Kingdom was reported to have achieved an approximate increase of about 10 percent in 1986. The increases in UK and The Netherlands were modest compared to those of other countries.

Explaining these increases, Van Oost took into cognizance the stimulating activities and programmes undertaken in the countries, particularly in the United Kingdom. In Norway, a positive discrimination policy of universities like the Norwegian Institute of Technology (NTH) in Trondheim made tremendous impact on enrolment of women.

However, Van Oost (1986) reported a rapid growth followed by a decline in women participation rate in Denmark and the United States. For the United States, Oost found that most of the industrial

resources for attracting girls to engineering were cut down for the greater part of the years under review. This was as a result of the shift of attention to the case of minorities in the country.

Feminization Rate Among Engineering Lecturers and Availability of Role Models

The rate of feminization among engineering lecturers pose a lot of concern. It has been highlighted that this rate is even lower than the rate of feminization among students (Van Oost, 1988). In essence, this means that there are very few or no role models for female engineering students. Consequently, female students are confronted with only men. Usually, men, in one way or the other, "scare" girls away from the field.

The importance of female role models to women's participation in their respective professions has been stressed by many. The availability of a large number of female professionals in society paves the way for new entrants into the field as they stimulate girls and give them attention in times of difficulty. It is difficult for girls to receive sympathetic attention from male lecturers. However, there are differing views.

Armour (1985) reported that although women are under-represented on the academic staff of the faculties of science and engineering at the University of Alberta, female undergraduates in the facilities do as well as or better than their male counterparts. The grade point average of females in the faculty of engineering was consistently higher than that of males. She however reported that the Task Force on Women in Scholarship, Engineering, Science and Technology (WISEST) established at the university had through another body UAYs provided role models, among other incentives to help students.

In the country, the Association of Professional Women Engineers in Nigeria (APWEN) is presently laying much importance to the provision of role models in schools through extension of student membership to female students.

Attrition and Wastage among Female Engineering Students

Everts and Oost (1986) pointed out that efforts to encourage women into engineering should not be considered as over with the women's enrolment in technical universities. Investigations of various studies have revealed wastage and educational inefficiency through high dropout rates among women who do not complete their courses. Several reasons were posited for this.

For Netherlands, Everts and Oost (1986) reported that the differences in men's and women's attrition rates decreased to two or three percent in 1981. However, for the same year, for technology, the difference was still up to 11 percent.

In their longitudinal study on women and men undergraduates who persisted successfully in their engineering programmes (Persisters) and others who left engineering (Non-Persisters), Linden et al (1985) found that men and women differ in their persistence rates. They found that the factors that best predicted persistence were "somewhat different". Women had slightly higher SAT scores and GPAs and reported lower self-perceived abilities than men. They found also that women (67 percent) are almost as likely as men (73 percent) to persist in engineering studies.

Oost (1991) reported that researches among engineering students indicated similar factors for dropping out of school as found in science education at secondary level. In her study, different

reasons were found to explain the attrition rates between male and female engineering students. The attrition rate for male students caused by academic performance was five times higher than that of female students. However, females stopped their engineering course more often because of the restrictive curriculum and unfriendly atmosphere of the university. She also found that to ensure females retention at school, it was important that items like social aspects, engineers' social responsibility, and environmental subjects are a substantive part of engineering education.

Experiences of Female Students in Male-Dominated Classes

Whyte (1986:25) with others paid several visits to eight schools and found, among other things, that "the sexes constantly divide and are divided at school; boys dominate classroom discussion, boys insist on more of the teachers' attention; boys and teachers 'masculinize' the lesson content in science and crafts; boys 'hog' resources; girls 'fetch and carry for the boys'... (p.25)".

Alting et al (1985) in their study of girls and women in science and technology found that on the first day of STE school, some girls were extremely nervous, shivered, felt very tense, were anxious or had headaches. The girls studied attributed these reactions to their conspicuous position as "the only girl in a boys' group". They, however, found that the presence of other girls and reassurance from boys they had previously known, and who also were attending the STE, reduced their anxiety.

Alting et al (1985) also found that some of the teachers in the male-dominated classes do not know how to react towards girls in their classes. They, however, found teachers' reaction inconsistent towards both boys and girls. While some teachers were found to be antagonistic and biased towards girls and their work, others were indifferent to them. Some teachers also thought that the presence of girls has positive effects on the behaviour of boys while some thought intimate relations between boys and girls could negatively affect the school atmosphere. Girls in the study also reported that teachers had authoritarian style which they did not like.

The study by Parker, Rennie and Hutchinson (1985) emphasized that teachers' attitudes and behaviours have a critical influence on the attitude of their pupils. In-service programmes conducted on ten teachers (five males and five females) and questions asked through pre and post treatment questionnaires revealed that the experimental teachers became more conscious of their attempt to "be fair to both sexes" in time and attention given. The study thus revealed the necessity for teachers to change their attitudes and behaviour towards females in their classes.

Staberg (1985) observed science lessons in grades 3, 7, and 9, and found that girls generally participate in fewer interactions than boys. Girls who made up about one half of the class got only one third of the attention. She also observed that girls seemed content with this as they made very little effort to participate nor adopted attention seeking strategies. Boys dominated the pupil-initiated interactions. They talked more and also dominated physically by being more active than girls.

Interviews have also revealed that girls complain about unpleasant behaviour of teachers. However, some of the girls thought that in most cases teachers' behaviour was unintentional, but was due to male teachers' limited knowledge on how to handle girls.

Others revealed the following as characteristics of mixed classes where girls are a minority:

- boys dominate classroom discussions;
- boys insist on more of teachers' attention than girls;

- boys and male teachers “masculinize” lesson content in science and crafts; and
- boys “hog” resources.

Female Engineers and Engineering Jobs

Generally, the employment of women workers is unstable as a result of various factors which can be attributed to the organizational stereotypes or to the women themselves. It is still stated statistically that women employment in industries is only 10 or 15 percent. The absence of these would-be “leaders” could discourage young girls from being attracted to male-dominated professions.

Newton (1986) highlighted that engineering as a profession was changing with less emphasis placed on the older heavy type of engineering. In its place are computers and chips, printed circuit boards and electronics. However, it was revealed that women in engineering are not dramatically different from women in the more traditionally feminine fields, or from their male engineer counterparts.

Kanter (1976) reported research on female workers which showed that women did not seek or find career success for several factors. One was that women learnt that high achievement meant a loss of their traditional femininity. Femininity, which was preferred, was thus preserved while achievement was sacrificed. The study conducted by Kanter however revealed that there were no serious sex-related individual differences between women and men’s behaviour at work. She found, along other things, that lack of opportunity to succeed and not a personality style that shuns success, is what separates the women from men.

Other research revealed that the corporate world requires its participants to be willing to relocate, to surpass rivals without hesitation and even use other people to advance in status. Highly mobile groups quickly become more involved with their task, avoid irrelevant chatter, and get on.

As reported by Kanter (1976), studies point out that people who have worked for a woman boss are much likely to be favourably disposed towards female leaders.

Chapter Three

Research Problem

In Nigeria, there is a shortage of skilled manpower at all levels. Aggravating this problem is the low rate of participation of women in engineering and technology. As a result, the Nigerian society is deprived of almost half of its human resources, greatly needed to solve its problems. For unknown or rather unempirically tested reasons, women are disadvantaged in many areas of life and particularly in engineering and technology. Some studies have revealed that engineering training remains the higher education sector with the lowest female participation rate despite efforts to attract them. (Michel, UNESCO 1988). These studies also show that there are contradictions which remain intolerable, thereby making engineering profession "a male quasi-monopoly".

Experts who met in Paris in 1986 for the Consultative Meeting on Women in Engineering and Technological Education and Training concluded, among other things, that for most countries, Nigeria included, there is only a small percentage of women in engineering and technological occupations. They identified, among many other problems, lack of statistics and research work on women in engineering. They thus recommended among others that more studies should be carried out at the national level on the participation of women in engineering, on the role of engineering educators and on reasons for the differences between male and female participation in the field.

In the recent past, efforts towards rectification of this imbalance have been preliminary and limited mostly to establishing the correct state or index of female participation in the field. It is thus imperative that action be set in motion for in-depth assessment of strategies for increasing female participation in specific fields of engineering and towards generalised initiation of policy to achieve the growth. Thus, the present study aims to present solid empirical evidence on factors for and the status quo of female participation in engineering in Nigeria.

Research Objectives

The general objective of this study is to present an accurate picture of female participation in engineering in Nigeria, showing important constraints that discourage women's participation, and to propose appropriate recommendations. In order to achieve this, the following specific objectives were focused upon:

- (a) generate information and statistics on the rate of feminization of engineering in Nigeria, and on the feminization rate in engineering disciplines;
- (b) identify factors in education and training which act as obstacles to the attraction of girls and women to engineering;

- (c) identify, through examination of the experience of women and men in engineering, employment conditions which discourage women from taking up or continuing with careers in engineering;
- (d) investigate the role of engineering educators in the under-representation of women in the field;
- (e) investigate, if there exist, the reasons for differences in female participation in the various engineering fields.

Research Questions

Answers were sought empirically to the following questions in the study:

- (a) Has there been an increase in the participation rate of females in engineering between 1983 and 1993?
- (b) What positive steps are being taken by professional engineering institutions towards ensuring increased participation of women in the field?
- (c) What is the dropout rate of the women in engineering education or do all female students enrolled in engineering persist successfully till they graduate?
- (d) How do these female engineering students experience their studies?
- (e) What steps are being taken by large organizations with regard to attracting women into engineering?
- (f) What are the experiences of the female engineers on the job?
- (g) Is there a strong career progression for women in engineering?
- (h) How do girls and women perceive remuneration or direct benefits of the different engineering specialists compared with those of other professions?
- (i) How will this perception influence their choice of engineering profession or careers?
- (j) Is there available in Nigeria any continuing and re-entry education programme for women in engineering?
- (k) What is the percentage of women in engineering compared with the general participation of women in the labour market?
- (l) Is there a similarity in the pattern of distribution of females in engineering in Nigeria and those in developed and developing countries?
- (m) What is the rate of feminization among engineering educators who serve as role models to students?
- (n) What factors (e.g. remuneration, work qualities, etc.) serve as correlates of women's choice of engineering as their career or profession?
- (o) Can technology policy initiatives in Nigeria be regarded as gender neutral or female friendly?
- (p) What suggestions can females in engineering contribute towards the initiation of better policies?

Methodology

Sample Selection

In order to achieve as much validity as feasible, the samples for the study were selected from females and males in Nigeria. The samples were stratified into four groups and comprised:

- (a) 120 female and 120 male engineering students in nine universities with engineering facilities. These were representative of different areas of specialization in Nigerian institutions.
- (b) 40 female and 40 male engineers already employed on the job. The male engineers were expected to give a comparable viewpoint.
- (c) 40 lecturers (including females) in university departments of engineering.
- (d) 20 technical and project managers in 10 industries.

The study was an indepth field survey. The country was zoned into three sections, South, Middle and North in order to obtain geographical representation. The selection of samples from the areas was by stratified random sampling. Nine universities were selected from those with engineering faculties in such a way as to include State universities, Federal universities and the three-generation universities. These were representatives of the almost 20 engineering faculties in Nigeria.

The definition of the sample size was not ambitious in the face of a dearth in data on female engineers available in Nigeria. To provide answers to some questions, the technical and project managers in 10 work organizations were involved, and were asked to participate in the interview or the completion of the questionnaire.

It was expected that the five sources of information and samples would eliminate the placement of limitation on results to be obtained from the study. The size of the sample would not also preclude wide generalizations. To ensure this, several other characteristics determined male and female engineers sampled. These were:

- (a) Graduate engineer samples should have been on the job for at least three years to be able to proffer intelligent comments about their career prospects. Earlier studies had affirmed that people would establish patterns for a career in their first two years of employment.
- (b) Student samples must have spent at least one full academic session studying engineering courses.
- (c) Technical managers must have supervised female engineers for more than a year.
- (d) Engineering lecturers must have had interactions with female engineering students.

Instruments for the study

Since the study adopted the quantitative and qualitative approaches, a combination of two means of gathering data was involved. In-depth interviews were conducted with the selected samples. This was necessary to avoid restricting responses of samples. The second method of data generation was the use of questionnaires for executives who had no time for, nor granted oral interviews with the researcher.

Questions asked revolved around the following factors: Emotional, cultural, risk taking, desire for gender equality, remuneration, experience, self concepts, coping strategies, government policies as it affects engineering, female preference of the different engineering fields, role of engineering teachers, influence of role models.

The study further drew its data from reliable statistics generated by the National Universities Commission (NUC). These were supplemented with statistics obtained, where possible, from few universities. NUC is the only body in charge of university education in Nigeria and the data it generates are considered reliable.

The principal researcher and the field assistants also visited the universities in order to seek additional information on individual university policy on attracting females to engineering.

Chapter Four

Results and Findings

To say that the Nigerian educational system lacks data is understating the problem. Despite the fact that there are statistics units in the universities and other bodies related to education at the tertiary level, the data-collection method leaves a lot of room for improvement and updating. As a result of these methodological shortcomings, useful data, particularly those highlighting gender differences were not available. The way data are maintained at the universities made it impossible to get any useful information. The National Universities Commission's annual reports were also severely limiting in the information contained. This resulted in the utility of the data in the reports and bulletins was limited, which in turn greatly limited how far some gender equity questions could be answered.

Statistics Generated

In order to achieve the objectives of this study, data were drawn from "reliable" statistics already generated from the universities by the National Universities Commission (NUC). However, these were supplemented by those provided by the university officials during the field and site visits, and literature.

Table 6: Number of Candidates by Sex in Science Subjects at the Secondary School Certificate Examinations In 1980, 1981, 1983 and 1984

Subjects	1980		1981		1983		1984	
	M	F	M	F	M	F	M	F
Physics	23,608	4,265	30,792	5,668	49,470	11,074	53,290	12,191
% increase	N/A	N/A	30.43	32.90	60.66	95.38	7.72	10.09
Chemistry	49,648	18,522	61,638	24,336	75,413	38,051	77,835	39,374
% increase	N/A	N/A	24.15	31.39	22.35	56.36	3.21	3.48
Biology	90,997	43,671	106,645	54,251	165,360	111,541	180,106	30,396
% increase	N/A	N/A	17.20	24.23	55.06	105.60	8.92	16.90

Source: *Adeyegbe and Olamusi (1987)*

Table 7: Entry by Sex for Science Subjects and Percentage Passes from Grades 1-6 (1980 - 1984)

Subject	Sex	1980 Entry	% Pass at Gd. 1-6	1981 Entry	% Pass at Gd. 1-6	1983 Entry	% Pass at Gd. 1-6	1984 Entry	% Pass at Gd. 1-6
Chemistry	M	49,648	42.23	61,638	24.26	75,413	14.68	77,835	29.70
	F	18,522	32.50	24,336	15.37	38,051	7.61	39,374	17.18
Biology	M	90,997	33.35	106,645	15.31	165,360	10.76	180,106	13.30
	F	43,671	24.91	54,251	9.88	6.23	130,396	6.81	
Physics	M	23,608	46.86	30,792	25.27	49,470	14.88	53,290	23.88
	F	4,265	44.10	5,668	20.94	11,074	13.18	12,191	20.58

Source: WAEC Reports (1980 - 1984)

Table 6 displays the number of students enrolled in chemistry, physics and biology in the Secondary School Certificate Examinations between 1980 and 1984. Though the pattern of gender difference in the enrolment for the subjects existed, there were definite increases in the number of female candidates from year to year. However, male enrolment was also favoured with steady increases.

Table 7 displays the number and percentage of passes at credit and distinction level. It is observed that there was no marked difference in the percentage of male and female scoring credit and above in the three science subjects.

Table 8, however, shows a marked difference between male and female students who obtained degrees in the faculties of engineering or technology between 1983 and 1988. Consistently during the period, female graduands formed less than 12 percent of the total graduands. However, this picture was a great improvement on the situation depicted in Table 9. Prior to 1983, very few female students were enrolled in the faculties of engineering and technology.

In 1968/69, the percentage of female students dropped to 0.8 percent due to the civil war. However, it picked up from 1971.

Table 8: Total Students by Sex Obtaining Degrees from Faculties of Engineering And Technology in all Nigerian Universities 1983 - 1990

Session	Male	Female	Total	% Female
1983/84	840	85	925	9.2
1984/85	280	37	317	11.7
1985/86	1,528	75	1,603	4.7
1986/87	1,635	111	1,746	6.4
1987/88	1,529	99	1,628	6.1
1988/89	N/A	N/A	N/A	N/A

N/A = Not Available Source: NUC Annual Reports

Trends in Enrolment in Selected University Faculties of Engineering

Table 9: Pre 1983 Total Enrolment in Faculties of Engineering and Technology

Year	Enrolled				Attrition Rate for both sexes
	Male	Female	Total	% Female	
1967/68	1,406	4	1,410	0.2	44%
1968/69	604	5	609*	0.8	52%
1971	3,354	101	3,455	3.0	N/A
1974/75	1,983	104	3,087	3.3	N/A

* Decrease could have been affected adversely by the civil war, which resulted in the closure of the University of Nsukka.

N/A = Not Available.

Table 10: Student Enrolment by Sex in Engineering and Technology, 1979 - 1986

Year	University	M	F	Total	% F
1979/80	ABU, Zaria	431	6	437	1.4
1980/81	All Universities	234	64	2,405	2.7
1981/82	All Universities	3,580	156	3,736	4.2
1985/86	UNN, Nsukka	1,078	22	1,110	1.98

Source: Compiled from STAN (1992) and University Digest of Statistics for the years.

Table 11: Enrolment by Sex in Engineering, University of Ife, 1983/84

Sex	Agric. Eng.	Chemical Eng.	Civil Eng.	Electrical & Electron Eng.	Mechanical Eng.	Metal Eng.
Male	63	102	123	177	118	67
Female	1	15	15	10	1	3
Total	64	117	124	187	119	70
% Female	1.6%	12.8%	0.8%	5.3%	0.8%	4.3%

Source: Adapted from Osibodu (1985)

Table 12: Enrolment in Engineering Graduating Classes, University of Ife, 1984

Sex	Agric. Eng.	Chemical Eng.	Civil Eng.	Electrical & Electron. Eng.	Mechanical Eng.	Metal Eng.
Male	10	29	27	67	26	14
Female	-	-	-	1	-	-
Total	10	29	27	68	26	14
% Female	0%	0%	0%	1.5%	0%	0%

Source: Adapted from Osibodu (1985)

Table 13: Performance of Graduating Class in Engineering, University of Ife, 1983/84

Sex	Status	Chemical Eng.	Civil Eng.	Electrical & Electron. Eng.	Mechanical Eng.	Metal Eng.	Total
M	Graduating	9	19	13	5	21	67
	Non-grad.	1	10	-	5	5	21
F	Graduating	-	-	-	-	-	-
	Non-grad.	-	-	3	7	-	10

Source: Adopted from Osibodu (1985)

Tables 10 and 11 show also the poor enrolment of female students in engineering. As depicted in Table 11, chemical engineering was the most attractive of the disciplines to female students with 12.8 percent enrolment of females.

Tables 12 and 13 presented an even more dismal picture. There was no female enrolled in the graduating class in chemical, civil and metal engineering departments. There were three in electrical and electronic and seven in mechanical engineering. These 10 female students were however non-graduating. This was due to the fact that they had not achieved well enough to graduate. As Osibodu categorised, "non-graduating students are failing, but not necessarily outright failure to warrant dropping out in all cases".

Thus the students have failed a course or more and need other opportunities to resit the examination. This is a provision available under the course system operated by the universities.

Table 14: Total New Entrants in Engineering Education Between 1983 and 1993 in Nigeria

Year	Sex		Total	% F
	M	F		
1983/84	2,518	130	1,648	7.9
1984/85	2,957	225	3,182	7.1
1985/86	2,754	186	2,940	6.3
1986/87	3,659	397	4,056	9.8
1987/88	1,181	202	1,383	14.6
1988/89	3,868	272	4,140	6.57
1989/90	3,677	342	4,019	8.5
1990/91	N/A	N/A	N/A	N/A
1991/92	N/A	N/A	N/A	N/A
1992/93	N/A	N/A	N/A	N/A

N/A = Not Available

Source: NUC Reports (1983 - 1993)

Table 15: Total Enrolment by Sex in Engineering Education Between 1983 and 1993 in Nigeria

Year	Sex		Total	% F	% F Increase
	M	F			
1983/84	8,541	452	8,993	5.0	-
1984/85	9,525	501	10,026	5.0	-
1985/86	10,668	604	11,272	5.7	-
1986/87	11,708	847	12,555	7.2	-
1987/88	12,982	982	13,964	7.6	7.6
1988/89	13,039	973	14,012	7.5	-
1989/90	13,372	871	14,243	6.1	-
1990/91	N/A	N/A	N/A	N/A	-
1991/92	N/A	N/A	N/A	N/A	-
1992/93	N/A	N/A	N/A	N/A	-

N/A = Not Available

Source: NUC Statistical Digest (1980-1986)

In its analysis of student enrolment for the year 1988, NUC found that the overall female enrolment was 26.0 percent of the total population in Nigerian universities for that year. In the same 1987/88 period, females accounted for only 7.6 percent of the engineering students enrolled. Both Tables 14 and 15 confirm this.

WOMEN AND ENGINEERING IN NIGERIA: TOWARDS IMPROVED POLICY INITIATIVES AND INCREASED FEMALE PARTICIPATION

Table 16: Total Enrolment and Graduation by Level of Course in Engineering and Technology, 1983 - 1990

Year	Enrolled						Graduated					
	First Degree		PG Dip/Cert.		Higher Degree		First Degree		PG Dip/Cert.		Higher Degree	
	M	F	M	F	M	F	M	F	M	F	M	F
1983/1984	1,889	100	41	3	188	7	725	73	30	5	85	7
1984/1985	8,758	457	35	3	438	39	92	1	54	35	134	1
1985/1986	9,146	569	27	9	521	47	1,380	55	26	10	122	10
1986/1987	10,830	778	68	14	508	34	1,490	79	15	8	211	17
1987/1988	11,043	871	N/A	N/A	N/A	N/A	1,529	99	N/A	N/A	N/A	N/A
1988/1989	12,299	906	81	7	576	55	N/A	N/A	N/A	N/A	N/A	N/A
1989/1990	13,372	871	40	9	632	39	N/A	N/A	N/A	N/A	N/A	N/A

N/A = Figures not available.

Source: NUC Annual Report (1983 - 1990)

Table 17: Total Enrolment by Sex in Nine Selected Faculties of Engineering and Technology - First Degree 1983-1990

University	1983/84		1984/85		1985/86		1986/87		1987/88		1988/89		1989/90	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Ibadan	637	59	829	52	897	54	1,260	78	858	63	704	44	703	61
Nsukka	1,090	37	1,149	28	1,138	32	1,080	29	1,055	31	1,000	29	944	30
Zaria	452	05	586	10	660	13	548	14	699	15	590	12	590	12
Benin	1,217	53	1,104	49	1,160	50	1,126	128	1,104	27	1,011	53	1,011	53
Lagos	1,089	58	1,197	72	1,276	73	1,260	78	1,495	89	1,309	92	1,290	76
Ife	1,071	151	1,201	168	1,576	221	1,490	208	1,602	213	1,651	216	1,772	48
Anambra State Univ. of Agric & Tech	847	16	548	12	889	18	680	25	715	38	738	42	773	62
Federal Univ. of Tech. Akure	-	-	-	-	-	-	-	-	-	-	266	16	321	18
Port Har.	222	07	327	10	349	19	377	17	546	22	631	21	631	26

Source: NUC Annual Reports and Statistical Digest (1983 - 1993).

Participation of Women in Different Engineering Fields

Various writers in developing economies have found that there are different and striking participation rates between engineering fields. Consequently, Everts and Oost (1986) argue that technology cannot be treated as one homogenous field. When the participation rate was examined for University of Lagos, it was discovered that chemical engineering had for the periods examined, the highest number of females among the four fields. Mechanical engineering consistently had the lowest rate of female participation. This is reflected in Tables 20, 21 and 22.

In their study in Netherlands, chemical engineering, along with applied mathematics, and architecture attracted the highest percentage of women. Other fields like electronic engineering, mechanical engineering and civil engineering were not attractive to women in Netherlands at all, as only 1 or 2 percent of the students enrolled were female.

Remarkably, as shown in Tables 20, 21 and 22, mechanical engineering in Nigeria attracted the lowest number of females as only 2.6 percent and 2.0 percent of the students that enrolled in the 1992/93 and 1994/95 sessions, respectively, were female.

Everts and Oost (1986) found it difficult to explain this development in their country but suggested that the reason could be related to a general perception of unfavoured fields as a male domain; mechanical engineering has to do with instruments, machines and tools, while on the other hand, the society portrays the woman as soft, gentle and fragile. Thus, the incompatibility between the purported comfort of women as against the ruggedness attributed to men is obvious. Evert and Oost suggested that other arguments can be found in the interest of women. Women relatively are more interested in fields that have different aspects combined. Such suggested fields include aesthetic, humanistic, political and technological aspects. Thus, as Everts and Oost argue, women favour technical studies with an interdisciplinary character.

Table 18: Student Enrolment by Sex in University of Lagos, 1984-91

Year	Male	Female	Total	% F
1984/85	10,815	3,051	13,866	22.0
1985/86	11,654	3,451	15,105	29.6
1986/87	8,821	3,494	12,315	28.3
1987/88	11,644	4,962	16,606	29.8
1988/89	11,230	4,025	15,255	26.3
1989/90	8,029	4,000	12,020	33.2
1990/91	7,647	5,000	12,647	39.5

Source: Academic Planning Unit, University of Lagos (1996)

WOMEN AND ENGINEERING IN NIGERIA: TOWARDS IMPROVED POLICY INITIATIVES AND INCREASED FEMALE PARTICIPATION

Table 19: Student Enrolment in Different Engineering Fields, University of Lagos, 1989 - 1995

Field	1989/90	1990/91	1991/92	1992/93	1994/95
Chemical Engineering	255	304	333	343	343
Civil Engineering	400	280	280	344	245
Electrical Engineering	308	390	412	396	359
Mechanical Engineering	337	381	431	457	299
Surveying	193	151	144	220	159
Engineering Analysis	-	-	2	-	-
Total	1,493	1,506	1,600	1,760	1,405

Source: Academic Planning Unit, University of Lagos (1996)

Table 20: Total Student Enrolment by Sex in Different Engineering Fields in University of Lagos, 1992/93

Department	M	F	Total	% F
*Electrical Engineering	268	38	306	12.4
Chemical Engineering	192	34	226	15.0
Mechanical Engineering	367	10	337	2.6
Civil Engineering	201	23	224	10.2

* Includes post-graduate students.

Source: Academic Planning Unit, University of Lagos (1996)

Table 21: Participation Rate by Sex in Different Engineering Fields (University of Lagos - 1994/95)

Department	M	F	Total	% F
Electrical Engineering	319	39	358	12.2
*Chemical Engineering	219	49	268	22.4
Mechanical Engineering	192	4	196	2.0
*Civil Engineering	154	16	170	9.4

* Figure excludes for year 1 students in asterisked departments.

Source: Academic Planning Unit, University of Lagos (1996)

Table 22: Student Enrolment in Different Engineering Fields, 1992/93 Year I, University of Lagos

Field	Male	Female	Total	% F
Electrical Engineering	43	17	60	28.3
Civil Engineering	35	4	39	10.3
Chemical Engineering	34	6	40	17.6
Mechanical Engineering	59	1	61	1.6
Electronics Engineering	CNA	CNA	CNA	CNA

CNA - Course not available in university

Source: Academic Planning Unit, University of Lagos (1996)

Table 23: Student Enrolment By Sex in Surveying, University of Lagos, 1995/96

Year	M	F	Total	% F
I	32	1	33	3.0
II	40	5	45	11.1
III	13	3	16	18.7
IV	23	3	26	11.5
V	31	0	31	0.0

Source: Academic Planning Unit, University of Lagos (1996)

Table 24: Student Enrolment in Mechanical Engineering, University of Lagos, 1995/96

Year	M	F	Total	% F
I	85	5	90	6.0
II	46	3	49	6.1
III	N/A	N/A	N/A	N/A
IV	65	5	70	7.1
V	84	1	85	1.2

N/A = Data not available

Source: Academic Planning Unit, University of Lagos (1996)

Table 25: Engineering Enrolment by Sex at University of Lagos, 1995/96

Department	Year 1		Year 2		Year 3		Year 4		Year 5		Year 6 (N/A)	
	M	F	M	F	M	F	M	F	M	F	M	F
Mechanical	67	5	67	2	55	1	66	3	75	3		
Electrical	68	7	71	9	50	5	61	10	121	7		
Civil	48	7	42	6	30	3	50	5	51	8		
Chemical	56	14	78	19	44	9	48	17	66	11		
Metalling & Materials	31	3	23	3	8	0	11	1	17	0		
Surveying	37	1	41	4	14	3	32	4	37	0		

Source: Faculty of Engineering, Unilag, (1996)

N/A = Not Available.

With the emerging picture that mechanical engineering was the least favoured by female students, an investigation was conducted into the enrolment for the discipline at the University of Lagos, (Table 20 and 21). Table 22 confirmed that for 1992/93 sessions, only one female student registered for chemical engineering. This was despite the fact that chemical engineering had for that year, the largest number of students, compared to other departments. By the 1995/96 sessions, the situation improved slightly, with less than 10 percent of students in all the levels being women.

A great source of concern is the disparity in the figures obtained from the faculty and the Academic Planning Unit. However, the main point that clearly stands out is that female enrolment did not significantly increase.

Courses and Fields Most Preferred by Female Lecturers and Feminization Rate in Engineering and Technology

The impact of women while being felt in other areas of education, has not been marked with increases of female lecturer participation in engineering. Tables 26 to 36 show the number of female lecturers in engineering for the period 1983-1988 in the selected universities. On the grounds of the data gathered from these tables, the following findings were derived:

Majority of faculties of engineering had no female lecturer. Out of the selected universities, for the period 1983-1988, Nsukka had no female lecturer, while Ibadan had only one in 1988. However, Lagos and Benin fared just better with its low but consistent number of female lecturers.

From the data, the field favoured by the few female lecturers is chemical engineering. At the University of Lagos, this department had the only two lecturers. However, in the 1995/96 session, the distribution pattern changed, with just a female lecturer retained in chemical engineering and another one in Engineering Analysis. This confirmed earlier assertions that the chemical branch is the most attractive of the different fields.

Tables 26 to 36 present the figures for the other universities in this study. For the generality of the universities, women were conspicuously less than ten in number and thus did not make up to 10 percent of academic staff in Engineering in any of the universities. In the pooled figure for the period 1983/84 to 1987/88, there were less than 6 percent females among academic staff in Engineering and Technology Faculties.

Table 26: Academic Staff in Engineering and Technology in all Nigerian Universities, 1980/81 - 1989/90

Year	Male/Female	Female	% Female
1980/81	572	17	2.9
1981/82	745	8	1.1
1982/83	761	29	3.7
1983/84	772	22	2.8
1984/85	837	27	3.2
1985/86	869	50	5.75
1986/87	529	20	3.8
1987/88	941	32	3.4
1988/89	*	*	*
1989/90	*	*	*

* Nil

Source: *National Universities Commission (1991)*

Table 27: Academic Staff by Sex in Engineering and Technology in Nigerian Universities, 1983 - 1988

Session	Male	Female	Total	% Female
1983/84	850	22	872	2.5
1984/85	810	27	837	3.2
1985/86	819	50	869	5.8
1986/87	909	20	929	2.2
1987/88	909	32	941	3.4

Source: *NUC Reports (1983 - 1988)*

Table 28: Academic Staff in Different Engineering Fields, University of Lagos, 1994 - 1996

Field/Department	1994/95		1995/96	
	M	F	M	F
Chemical Engineering	16	2*	15	1*
Civil Engineering	14	0	12	0
Electrical Engineering	13	0	10	0
Mechanical Engineering	15	0	14	0
Surveying	9	0	11	0
Engineering Analysis	5	0	9	1
Hydraulic Research	1	0	-	-

* Reduction in number of women probably through attrition.

Source: *Academic Planning Unit, University of Lagos (1996)*

WOMEN AND ENGINEERING IN NIGERIA: TOWARDS IMPROVED POLICY INITIATIVES AND INCREASED FEMALE PARTICIPATION

Table 29: Academic Staff by Sex in Engineering and Technology, University of Ife, 1983 - 1990

Year	M	F	Total	% F
1983/84	92	4	96	4.2
1984/85	107	4	111	3.6
1985/86	108	2	110	1.8
1986/87	101	2	103	2.0
1987/88	97	3	100	3.0
1988/89	N/A	N/A	N/A	N/A
1989/90	N/A	N/A	N/A	N/A

N/A = Not Available

Source: NUC (1983 - 1990)

Table 30: Academic Staff by Sex in Engineering and Technology, University of Ibadan, 1983 - 1990

Year	M	F	Total	% F
1983/84	84	0	84	0
1984/85	75	0	75	0
1985/86	79	0	79	0
1986/87	79	0	79	0
1987/88	83	1	84	1.1
1988/89	N/A	N/A		
1989/90	N/A	N/A		

N/A = Not Available

Source: NUC Annual Reports (1983 - 1990)

Table 31: Academic Staff by Sex in Engineering and Technology, Ahmadu Bello University, Zaria, 1983 - 1990

Year	M	F	Total	% F
1983/84	87	4	91	4.4
1984/85	93	4	97	4.1
1985/86	97	0	97	0
1986/87	97	0	97	0
1987/88	87	6	93	6.5
1988/89	N/A	N/A	N/A	N/A
1989/90	N/A	N/A	N/A	N/A

N/A = Not Available

Source: NUC (1983 - 1990)

Table 32: Academic Staff by Sex in Engineering and Technology, Anambra State University of Science and Technology, 1983 - 1990

Year	M	F	Total	% F
1983/84	47	5	52	10.0
1984/85	N/A	N/A	N/A	N/A
1985/86	41	0	41	0
1986/87	41	0	41	0
1987/88	53	1	54	2.0
1988/89	N/A	N/A	N/A	N/A
1989/90	N/A	N/A	N/A	N/A

N/A = Not Available

Source: NUC (1983 - 1990)

Table 33: Academic Staff by Sex in Engineering and Technology, University of Nigeria, Nsukka, 1983 - 1990

Year	M	F	Total	% F
1983/84	66	0	66	0
1984/85	65	0	65	0
1985/86	62	0	62	0
1986/87	51	0	51	0
1987/88	50	0	50	0
1988/89	N/A	N/A	N/A	N/A
1989/90	N/A	N/A	N/A	N/A

N/A = Not Available

Source: NUC (1983 - 1990)

Table 34: Academic Staff by Sex in Engineering and Technology, University of Benin, 1983 - 1990

Year	M	F	Total	% F
1983/84	71	1	72	1.4
1984/85	70	1	71	1.4
1985/86	65	2	67	3.0
1986/87	68	2	70	3.0
1987/88	69	2	71	2.8
1988/89	N/A	N/A	N/A	N/A
1989/90	N/A	N/A	N/A	N/A

N/A = Not Available

Source: NUC (1983 - 1990)

WOMEN AND ENGINEERING IN NIGERIA: TOWARDS IMPROVED POLICY INITIATIVES AND INCREASED FEMALE PARTICIPATION

Table 35: Academic Staff by Sex in Engineering and Technology, University of Port-Harcourt, 1983 - 1990

Year	M	F	Total	% F
1983/84	N/A	N/A	N/A	N/A
1984/85	N/A	N/A	N/A	N/A
1985/86	41	1	42	2.4
1986/87	41	1	42	2.4
1987/88	39	1	40	2.5
1988/89	N/A	N/A	N/A	N/A
1989/90	N/A	N/A	N/A	N/A

N/A = Not Available

Source: NUC (1983 - 1990)

Table 36: Academic Staff by Sex in Engineering and Technology, University of Lagos, 1983 - 1990

Year	M	F	Total	% F
1983/84	81	2	83	2.4
1984/85	89	3	92	3.3
1985/86	90	2	92	2.1
1986/87	99	3	102	3.0
1987/88	78	2	80	2.5
1988/89	N/A	N/A	N/A	N/A
1989/90	N/A	N/A	N/A	N/A

N/A = Not Available

Source: NUC (1983 - 1990)

Table 37: Mean Academic Staff-Student Ratio for Federal Universities Faculty of Engineering in 1993/94

NUC Recommended Guideline	1:9
Actual Staff and Student Ratio	1:21

Source: NUC Annual Report (1994), p. 53

Table 38: Student-Staff Ratios in Engineering Faculties in Nigeria*

Year	No. of Students	No. of Teachers	Student-Teacher Ratio
1962/63	278	20	14.1
1963/64	351	25	14.1
1964/65	505	24	21.1
1965/66	660	104	6.1
1966/67	777	89	8.1
1967/68	451	62	7.1
1968/69	588	66	9.1
1969/70	667	69	10.1
1970/71	1,299	161	8.1
1971/72	1,565	161	10.1
1972/73	2,211	225	10.1
1973/74	2,684	263	10.1
1974/75	3,027	348	9.1
1975/76	3,141	357	9.1
1976/77	2,899	304	10.1
1977/78	2,690	357	8.1
1978/79	3,357	398	8.1
1979/80	3,944	406	10.1
1980/81	4,855	572	8.1
1981/82	6,449	752	9.1
1982/83	7,240	768	9.1
1983/84	8,628	788	11.1
1984/85	8,527	837	10.1
1985/86	10,668	866**	12.1
1986/87	11,798	909	13.1
1987/88	12,381	937	13.1
1988/89	14,063	901	16.1
1989/90	14,787	772	19.1
1990/91	9,884	650	15.1

*These figures exclude post-graduate students enrolled in engineering courses.

** Including 46 female lecturers.

Source: *Culled from NUC (1992)*

Academic Staff-Student Ratio in Engineering

Table 37 presents the guideline on academic staff-student ratio for Federal universities' faculties of engineering in 1993/94. This is to be 1:9. However, the actual ratio in practice was 1:21. It is thus obvious that teachers are overstretched or stressed. Tables 24 and 25 show that in a class, the figure was even higher. Thus, it is appropriate to assume that such lecturers would have no time to devote specially to the few females in their classes.

Table 38 presents the student-staff ratios in engineering faculties for the whole of Nigeria. It could be observed that from the years following the implementation of the 60:40 Science: Arts admission

policy, there was an increase in enrolment in engineering. It, however, seems that there was adequately corresponding increase in the recruitment of teachers, either male or female.

How Female Engineering Students Experience their Study

Female engineering students were asked to discuss their experiences in the course. Their responses included the following positive remarks:

- All engineering requires is a lot of hard work. There are no pleasant experiences. It's been interesting and enlightening. Now I know the meaning of major stress — when a guy offers you his seat and helps you get something when there's a rush. Very superficial with little or no practical experience. It is an interesting course, but involves a lot of studying.
- The males try to help out the girls when it comes to some heavy machine experiment. I don't feel inferior to male students because I know that I am better off than some of them academically.
- Engineering has been a great challenge to me being a female. It has made me aware of my abilities, challenging and interesting.
- A little trying, but interesting and worthwhile. The favour I have over the males in terms of decisions.
- It's an interesting course because it sharpens one's intellect.
- Lack of adequate number of female students bothers me a lot.
- The course is okay, but the faculty lacks practical facilities relevant to present day developments.
- Tedious and time consuming.
- We have almost no practical training. I cannot thus say that I'll be a good engineer.
- The male students treat ladies with respect.

They however had negative experiences. These include:

- Lousy remarks made by male students, acts of indecency towards them, portraying of the male ego.
- Attempts to reduce the female students to mere play things.

Though majority of the female found the course stressful, challenging and "time consuming", they indicated a free choice of engineering and a determination based on interest to pass. Many also indicated the desire to see their course through.

Though some females (and some few males too) thought of dropping out during their first year, they had a change of mind and persisted and had settled down to enjoy the course.

Attrition and Wastage among Female Engineering Students

It was impossible to obtain addresses of students who had dropped out of engineering schools (irrespective of sex) for this study. This was because the institutions did not maintain adequate and retrievable data on such matters and thus had none to give to the researchers.

As a result of this, the limited evidence on attrition and dropout causes were derived from the questionnaires completed by current engineering students and from yearly cumulative enrolment data. The study confirmed the findings reported by Everts and Van Oost (1986) which did not find a

clear-cut difference between the graduated group and the dropout group. They concluded that there seemed to be few, if any, factors that would clearly and generally lead to failure. Interestingly, most of the factors which were given for causes of dropout (e.g. decreasing motivation, or difficulty of course) were also given as part of the experiences of graduated students. Everts and Oost concluded that for the dropout students, the factors highlighted interacted in such a way as to cause the students to drop out.

Table 39: Female Attrition at the University of Lagos

	1992/93	1994/95	1995/96
Civil Engineering	Year I (4) Year II (5) Year IV (9)	Year III (5) Year IV (8) Year V (0)*	Year IV N/A N/A
Mechanical Engineering	Year I (1) Year II (6) Year IV (0)	Year III (1) Year IV (0)* Year V (1)	Year IV (5) Year N/A (1) N/A
Chemical Engineering	Year I (6) Year II (12) Year III (7)	Year III (20) Year IV (10)* Year V (5)*	N/A N/A N/A
Electrical Engineering	Year I (17) Year II (N/A)	Year III (17) Year IV (4)	

* Drop in female enrolment
N/A = Figures not available

At the University of Lagos which was used as a case study for the test of this factor, the study shows that the nine female students who were in Year III during the 1992/93 session had dropped out and could not be accounted for in the figure of year V students for the 1994/95 session. For the year V, 1994/95 session, the presence of the single female student could be explained with factors like inter-university or inter-faculty transfer which could have taken place at the end of the third year or during the fourth year.

Just as Davis (1996) opines, this is a crude measure of retention, as it does not give adequate information about the movement of the students. Explanations for unexplained figures could not be given by the institutions. Davis further reiterated that actual retention rates in any field are difficult to find, as it is difficult to tell those who move on to other majors, change school or even drop out altogether.

From indepth interviews conducted, it was found that the few girls reported to have dropped out of engineering did so because of unplanned pregnancy or the need to get married.

The disadvantages faced by girls as indicated by both male and female respondents were inability to handle complex jobs, and lack of patience to perfect tasks that need accuracy and concentration.

Factors that Triggered off Thoughts of Dropping out of Engineering Course Among Female Students

The study sought to know why some female students stopped their studies or changed courses from engineering as a way to solve the problem of low representation of women in the field. Thus, a qualitative approach was adopted to seek the reasons why female respondents had thought of changing from or dropping out of the engineering school at one point or the other during their study. When asked to indicate their reasons, the following factors were given as having triggered off thoughts of dropping out of engineering school at one point or the other:

- Overloading of course work and inadequate time given by lecturers.
- Engineering course had been stressful.
- Intimidation of girls by male students (e.g. struggle to take lecture places or seats).
- Overcrowded classes with little individual attention.
- Poor teaching in certain courses which caused an inability to cope with the challenges such courses presented.
- Females were sometimes left out of class discussions or tutorials by the male students.
- Religious factor - "being a Muslim and a conscious one, it is against the Islamic ideals that opposite sex mix freely. Majority of students in engineering are male, so I don't find it easy to observe unless you don't want to talk to anyone".
- Thought that other courses (e.g. architecture) were better for a woman.
- Poor performance in subjects that had not been "well taught" by lecturers. This was particularly during the first year in the university and in courses that required mathematical skill.
- Lack of adequate numbers of fellow female students.
- Workload in engineering had been heavy, so many students thought of changing to arts.
- Constant closure of school.
- "Lecturers coming and starting lectures a few weeks or days to examinations and ending up failing everyone".
- School-related stress.

There were however "persisters" who had a different response to these issues.

"If I drop out of engineering, I would probably be doing another course which I won't be interested in. The thing about engineering is that you are studying something you can see and which is not abstract".

The female whose response is presented above never felt like dropping out of engineering school despite the stress she experienced ("All engineering requires a lot of hard work"). Dropping out of engineering would not be the end of schooling or studying, but this could mean a change to a more "simpler" course, which is of no interest to this female engineering respondent. She regarded herself as a persistent student.

Proportion of Female Students in Engineering Classes

All graduate engineer respondents indicated that female students were in the minority throughout the course of their study. In an average class, there were 48 male and between 2 to 6 females. 52.3 percent agreed that this complicates the problems of the female student. As a male respondent puts

it, "nasty experiences will make her serious and at the same time be able to do some serious projects".

However, respondents also agreed that not all female experiences in a male dominated class are nasty. Instances cited included friendliness and assistance from both sides. In fact, 60 percent indicated that even their predominantly male teachers were quite friendly and encouraging to the girls.

Choice of and Support for Engineering Courses

Respondents were asked to indicate how they decided on their choice of course. Nearly all the respondents (including males) indicated that the choice of engineering was theirs. Further analysis revealed that for some of the female students, they had no senior brothers and one of their parents (mostly the father) had a technical job. Only 2 percent attributed their choice to either their father, friends or other family members.

This finding supports some of the literature on this issue. Granstam (1985) found that female technology students were more often than not daughters of engineers or those with technical background.

For the female engineering students that participated in the study, their parents were supportive of their choice. The support was manifested in the payment of their fees, and other expenses for their course. A further analysis revealed that the support was given even when neither of the parents were not engineers. Parents' occupations were varied from farmers to engineers. None of the female respondents indicated that there was at any point in the course of their study, a period when parents or the family exerted pressures to dissuade them from choosing or continuing with their engineering course.

Some of the respondents did not have any brothers with whom to compete for parental love. This seemed to partially support LeBold's (n.d) view that women who choose engineering as a career are likely to have no brothers.

When the respondents were asked to indicate the toys played with as a child, the toys indicated were found to be mechanical.

Student Interaction

The female engineering students reported the following as some of their unpleasant experiences:

- Male students pretend to be friendly in order to find a way to date fellow female students. Assistance from male students has strings attached.
- Male students are rough, jump queues and displace girls' access to equipment. Most times, female students are intimidated by boys into taking back seats. This is mostly made possible because of the few numbers of females in the class.

Others, however, realized that in such male dominated classes, there usually exists friendly and co-operative males. Some boys were considered nice and were very helpful to the girls. Assistance included offer of seats to the girls in sparsely furnished classes or in overcrowded classes and offer to obtain services or equipment when there was a rush. Others were more often willing to share their ideas with the girls.

Talking further on their experiences in engineering classes, respondents reported the following:

- Loneliness and frustration in a largely male-dominated class.
- Victimization by male lecturers if offer of sexual advances is rebuffed.
- Where physical strength is required, we have to cope with stress.
- Disturbing approaches during and outside class by fellow male classmates for friendship.
- Group work was mostly difficult to achieve considering the fact that there is a limit to male-female interaction.
- Male students sometimes made life difficult by making fun of the females in engineering classes.

Male Student Perception of Females' Experience in Engineering Classes

Male engineering students were requested to discuss their perception of how their female colleagues experienced their courses and classes. Some of the views are summarized:

- Inability of girls to carry out "rugged" assignments which their male counter-parts do.
- Lack of respect from fieldworkers during practicals.
- They are always victims of male lecturers.
- Inability to discuss feminine issues in class.
- Inability to freely ask questions and participate in lessons.
- In practical classes, there are occasions when physical exertion is required and female students may want to avoid them especially in the presence of male students.
- Inability to discuss academic problems with others when out of class.

Engineering Subjects Found Difficult by Female Students

From responses given, the list of subjects female students have had difficulty with included technical drawing, highway engineering, classical mechanics, numerical analysis, engineering applied mathematics, and physics, particularly during the first year.

When asked to affirm whether the difficulty they had with any engineering subjects or courses could be linked to their teachers' attitude towards female students, majority (75 percent) responded positively. They attributed this to the incessant strikes at the universities, to poor attitude of lecturers to duty, to lecturers coming late for classes or sometimes missing classes altogether, which leads to a concentration of the workload over a short period of time.

The remaining 25 percent did not think their problem in the subjects could be attributed to their lecturers' fault. Some of the girls indicated that through interaction with their other classmates, they discovered that difficulty in some engineering subjects was not isolated to girls alone, but was a general problem.

Childhood Toys and Play Materials

Respondents were asked to indicate the type of toys and materials they played with in their childhood. This was analysed by sex. The finding was very interesting. Only 27 percent females indicated playing with toys which fit stereotypes created socially for females. These females indicated playing with dolls, indulging in plays which were strictly feminine. One of the games is Ten-Ten, played by

two girls who clap simultaneously and shoot out their legs before the other. It is usually won by the quickest girl to shoot out her leg continuously. Boys do not indulge in Ten-Ten.

All the boys and 75 percent of the girls indicated having had the following equipment for play: Jig-saw puzzles, cars and bicycles, ball, aeroplane toys, leggo, alphabet blocks, trains, wind-up record players.

It has been widely argued that early from childhood, and during the early school years, girls are made to believe that mathematical and mechanical talent are sex linked and that girls have less of this talent than boys (Davis, et al. 1996). Thus, girls are made to play with dolls and teddy bears and are ultimately conditioned for "feminine" roles.

This finding supports the fact that girls who ended up in engineering were those that had been positively sensitized to the field. Their parents had given them adequate preparation and sensitization, coupled with elementary training in the use of tools, arrangements of parts and interaction with mechanical parts (bicycles and cars, etc) which are activities and experiences typical of engineering.

On the other hand, the male students gave the following responses:

- "My earlier thought of dropping out was due to the fact that it took me much time in convincing myself about my capability in handling the course".
- "I wanted to change as I didn't like the course at first. I am now a year 4 student and I have developed keen interest in my mechanical course".

A larger proportion of the respondents who indicated having the thought of dropping out of engineering courses faced the problem during their first year at university.

Testing of Propositions

General Proposition

Since it has been widely highlighted that women find engineering studies and the work environment inhospitable, it was proposed generally that the responses of females on all factors within the focus of this study will not be the same as those of the male. Means, standard deviation and finally the t-test were calculated. The value of alpha was set at .05, making the critical t-values associated with the df above 30 equal to ± 1.960 .

As shown in Table 41, the calculated t-value was lower than the critical value for the following factors, as the t-test found no significant difference between male and female sample on the following factors: Annual salary, choice of engineering as a profession, support for engineering course and profession, factor for changing jobs, unpleasant experiences, and disadvantages on the job.

However, significant differences were found between female and male respondents on the following:

- Thought of abandoning engineering course while at school.
- Rank of female and male engineers.
- Disadvantages faced in engineering schools.
- Interaction with fellow students in engineering school.

The finding from the propositions tested corroborated that from the interviews conducted with the same group of samples. There is no stated or proven difference in the salary given to female and male engineers employed in industry. This is despite the fact that there is no legislation in the country

which compels employers to pay men and women at the same rate. It seems, however, that this is different from the practice in developed countries. In the US studies reported by the National Research Council (1994) showed that regardless of racial group, women scientists and engineers reported mean annual salaries lower than those of men of the same race.

It seems that both male and female engineers had the same favourable reasons for opting for engineering, changing jobs within engineering, and possibly had similar disadvantages and unpleasant experiences on the job.

However, the empirical test indicated that the male and female engineers differed in their persistence on the course. Male engineers faced different disadvantages in the school and perhaps had more interaction with fellow male students who were clearly more in number than the females.

Table 40: Demographic Characteristics of Professional Engineer Sample

Variable	(%)
<u>Sex</u>	
Male	24
Female	76
<u>Marital Status</u>	
Single	12
Married	88
<u>Nationality</u>	
Nigerians	96
Foreigners	4
<u>Age</u>	
25 - 35	51
36 - 45	35
above 45	14

Source: *Field work*

Fifty-one percent of the respondents were between the ages of 25 and 35, with thirty five percent between ages 36 and 45. Fourteen percent were above 45.

The majority (88 percent) were married. It is to be noted that this is the time when most women are also busy nursing children and starting families. Thus, they are adequately qualified to respond to issues on the stress involved in coping with family life and engineering duties.

Table 41: Differences Between Male and Female Respondents

Variables in abridged form	Female		Male		
	Mean	SD	Mean	SD	t
Annual Salary	1.20	.41	1.13	.49	.68
Choice	3.05	1.26	3.47	1.45	-1.14
Support	1.79	.41	1.81	.38	-.30
Thought of Abandoning Course	1.52	.90	3.07	2.13	-3.07
Rank	1.83	.38	1.33	.47	4.68
Factor for changing jobs	1.62	.49	1.44	.50	1.42
If Admission Policy was Discriminatory	1.00	.00	1.20	.40	Not calculated
Nasty Experience	3.45	1.21	2.98	1.13	1.73
Disadvantage in School	3.29	1.12	2.74	1.05	2.16
Disadvantage on the job	2.83	1.00	2.72	1.12	.52
Interaction	3.79	.41	2.37	1.29	5.26

Critical 1.960 P<0.05

Source: Field Work

Table 42: Perceptions of Female and Male Engineers

Item	Female		Male		
	Mean	SD	Mean	SD	t
Female engineering students lack information about situation of real life work. 4.20	.41	2.81	1.19	5.63	
There is a lot of prejudice and mistrust against female engineers in work places.	3.62	1.05	4.05	.90	-1.94
There isn't much contact between female and male engineers at work.	2.83	1.20	4.05	.77	-5.80
There is no teamwork between male and female.	2.79	1.21	3.32	1.20	-1.88
Job Security					
There is more job security for male engineers than for females.	1.41	.83	1.71	1.09	-1.23
Promotion					
The people who get promoted are the male engineers.	2.16	1.20	2.09	.87	.32
Opportunity for Professional Growth					
Male engineers get all the exciting jobs around here.	3.50	1.31	3.81	1.30	-1.01
There is no opportunity for personal and professional growth for women in this job.	2.00	.65	3.06	1.22	-4.09
Only male engineers are sent to sites/oil rigs, etc., while females are retained in the offices.	4.20	.77	2.05	.905	10.41

Critical 1.960 P<0.05

Source: Field Work

Table 43: Perception of Female and Male Engineers

Variables in abridged form	Female		Male		
	Mean	SD	Mean	SD	t
Disadvantages on the job	1.73	.45	1.91	.49	-2.37
Interactions with others	1.97	1.0	2.61	.69	-4.52
Girls were encouraged	1.62	.87	2.08	1.0	-2.79
Promotion	3.09	1.47	3.15	1.55	-.24
Annual Salary*	1.36	.48	1.40	.56	-.38
Girls had nasty experiences	1.59	.49	1.32	.55	3.08
Support of Parents	1.95	.84	2.14	.80	-1.40
Years spent studying	3.54	1.44	3.88	1.58	-1.35

Critical 1.960 P<0.05

Source: Field Work

No significant differences were found between male and female engineers in the following:

- Promotion
- Years spent studying
- Parent's support of course
- Annual salary (* reconfirmed).

Thus, respondents confirmed that there was no discrimination in the salary paid to female or male engineers. Similarly, there was no difference in the number of years spent on the job before engineers irrespective of sex, were promoted. Equal number of years was also mandatory for the study of engineering by either male or female students. In addition, parents of both category of engineers support their choice of course.

However, there were significant differences between female and male engineers on the following:

- Disadvantages suffered on the job
- Interactions with others
- Encouragement of girls
- Nasty experiences suffered by female students.

Remuneration

When asked to comment on remuneration paid to engineers generally in Nigeria, 69 percent responded that the remuneration was poor and unattractive. Sixty-three percent had an annual salary which was less than Naira 40,000.00 (less than \$500 at \$1:Naira 80) while 34 percent earned between Naira 40,000.00 and Naira 79,999. Only two percent indicated earning higher than 80,000.00 per annum.

During the interviews, it was noted that more women than men found the remuneration poor. One woman engineer said: "My husband complains about the poor pay I bring home for all the training I have. He is encouraging me to leave the job and go into some type of business. I'm yet to make up my mind".

Another female engineer remarked: "My husband has asked me to stay at home as he will take up the payment of my meagre salary".

What emerges strongly from these comments is that engineers are poorly remunerated in Nigeria. Also, since some women had spouses, they had a choice to change professions, go into other businesses or become full-time housewives.

Work Experience

Majority of respondents (96 percent) felt that engineering students had enough information about real life engineering work. This is because of the internship included in their five-year programme. Some of the students (particularly the females) indicated the problems they have in getting a place to serve their internship. The main factor for this problem is the economic depression in the country and the intensified unemployment.

However, the null hypothesis of no difference between the male and the female was rejected here. The difference observed was significant ($P < 0.05$). Female engineers believed that female students lack information about real life work situation.

Attitude of Female Engineers

Female engineers interviewed reported being discriminated against at work by the following factors:

- (a) Official discriminatory practices which include slow rate of promotion, barriers to specific and challenging jobs. They felt they were prevented from challenging jobs.
- (b) Unfriendly attitude of male colleagues. On the other hand, some female engineers reported the overprotective attitudes of male colleagues. They wished that male engineers would benefit from training courses on how to relate to female colleagues.

Career Experiences of Female Engineers in Nigerian Industry

A major barrier the researchers met on field visits to some industries was the reluctance of managers to disclose to the investigators how many female engineers they employ and their percentage among their workforce.

From the responses to inquiries, the following was observed:

- Most industries have double standards for their male and female engineers. Women usually were not sent to oil rigs or to carry out field work, while the men were involved in all aspects of the job. Inevitably, this was reflected in the differentials in the pay between male and female engineers.
- Most engineering companies had discriminatory recruitment policies. Eighty-five percent of those involved in the study reported that they had stayed unemployed for many years due to hostility from employers as a result of their sex.
- In the oil sector (here the respondents pleaded strict anonymity and confidentiality in order to preserve their jobs), women, particularly civil engineers, were retained in offices to carry out administrative duties. Thus their job experience was limited, as the opportunities they have are also limited. Of the three female civil engineers interviewed in that organization, two felt comfortable with the arrangement as it affords them time to combine office duties with their household responsibilities. However, the remaining female engineer was dissatisfied with

the arrangement. She perceived this to have arisen because she is a woman. She craved for an opportunity to work on sites.

A general complaint was the discrimination, though subtle, against women during recruitment. Questions asked prospective female engineers included whether they were married and how many children they had. This is because the presence of children is interpreted to cause instability and lack of dedication to the job. One female engineer reported: "I find it difficult to take time away from work to take my child to hospital. My boss shows his displeasure anytime I have to go off".

Retention and Exit of Female Engineers from Industries

There was no adequate source of data to present on the rate of retention and exit of female engineers from their job. However, items of the questionnaire and interview schedule sought responses to this issue. From responses, the following was deduced:

- The exit rate for women was higher than that of male engineers. This was made more visible because of the few numbers of women employed.
- Most often, women leave for family reasons. These include: desire to remain with family if transferred to sites outside the home vicinity, a desire to raise children, and maternity leave.
- Some leave because of unfriendly work environment. This was the most important factor for the exit of a 36-year-old female respondent who left a construction company. She reported stereotype behaviour of her manager who made her uncomfortable because of his criticisms even when she did perfectly well.
- Others reported the general poor salary paid to engineers employed in the private sector of Nigeria's economy. She was dissatisfied with the low pay, which she felt was not commensurate with the investment made.

Work-Family Issues

As had been found in developed countries, a work-family issue was a critical issue in the experience of female engineers. The women experienced difficulty and great stress in juggling work and family issues. As one puts it: "It was very uncomfortable carrying my pregnancy while at work. I was prevented from the site once my pregnancy became visible and I have been kept off site work ever since... Yes, even years after I had my baby".

Some expressed concern about the nature of their job which mostly took them away from their homes and children. They agreed that in the Nigerian context, it is mostly the duty of the mother to spend more time with the children. They thus had problems as it was impossible to be at both the distant site and home simultaneously.

For the single engineers who had not experienced motherhood, other family issues brought about stress in their duties. The need for the single girl or woman to be protected by parents or the family weighed strongly. In the African context, single women had to stay at the home in order to have respect and dignity from prospective suitors. Thus, the need to comply with this made such female engineers look as if they were unreliable for critical work movements. This in turn affected their suitability for advancement and brought about stagnation and frustration on the job.

An issue was the reluctance of spouse to permit their wives long travel. Thus, respondents all agreed that strictly, their employment was not truly free from stereotype, as questions ascertaining marital status were usually asked.

Unlike in some developed economies, Nigeria lacks laws and regulations protecting women from questions which probe their privacy and which could be used against their promotion and participation in development.

In the US, Federal legislation exists to prohibit the use of illegal questions to ascertain whether applicants are married, plan to marry or plan to have children.

The mean and standard deviations for some of the variables are presented in Tables 44 and 45. When the t-test was computed, a number of statistically significant ($P < 0.05$) sex differences in perception of the variables were found. It was hypothesized that for all categories of variables, there will be no difference between the female and male engineers.

Entry into Engineering Professions

Five items sought responses on accessibility of engineering posts.

Table 44: Entry and Re-Entry into Engineering

Item	Female		Male		
	Mean	SD	Mean	SD	t
Absence of re-entry programmes for female engineers. 1.79	.77	2.05	1.00	-1.16	
Few female engineers are able to practice as engineers, but obtain employment in training and administrative posts.	4.00	1.14	2.54	1.11	5.55
Most female engineers take up office, teaching or research jobs that are less exposed to risk.	3.04	.908	3.86	1.11	-3.28
Organizations generally prefer dealing with or hiring male engineers.	2.62	1.21	2.72	.88	-.45
Most organizations have no policy that enables female engineers to take career breaks and later re-enter the service.	4.79	.41	3.97	1.18	3.32
Remuneration					
Generally, for both male and female engineers, remuneration is poor.	3.20	1.21	2.13	1.01	4.30

Critical 1.960 $P < 0.05$

Source: Field Work

Entry and Re-Entry into Engineering Professions

The interview data indicated that women usually found it relatively difficult to get engineering jobs. The females in particular stressed that while entry was difficult, most organizations also lacked re-entry programmes for female workers. There was a significant difference between the male and female (see Table 44).

When asked for the gender of engineers preferred by organizations, there was a unanimous response that it was male. Most organizations had a silent recruitment policy which favoured men. Qualitative data from the interview with technical managers from the participating firms revealed that none had any policy structured to promote the recruitment of female engineers. In particular, none of the technical managers interviewed were ready to work with female engineers.

Pressure of Family Life

Four items sought responses of engineers on the effect of family life on the career performance of female engineers.

Table 45: Pressure of Family Life

Item	Female		Male		
	Mean	SD	Mean	SD	t
Difficulty in combining career and family commitment. 2.62	.82	1.94	.84	3.45	
Domestic reasons contribute to make women engineers give up profession.	3.58	.50	3.14	1.38	1.52
Young ages of children inhibit women engineers effective participation.	3.58	1.06	3.28	1.11	1.14
Engineering work as it involves lots of travel cannot be combined with family responsibilities.	3.62	.82	4.05	.77	-2.32

Source: *Field Work*

In-depth interview with some of the female engineers revealed that often, they had to change jobs because their husband moved to a different part of the country. The destabilizing effect of this was tremendous as it meant another beginning, and broken professional networks and contacts.

Other problems included the heavy load of domestic activities and care of young children. The various family constraints have resulted in non-utilization of the previous engineering education. For most part, the women practised other professions.

These included teaching, trading, doing contract work (supply of goods, materials and equipment to companies), and consultancies.

In the industry, female engineers revealed that they face a lot of prejudice and mistrust. Seventy-eight percent of respondents agreed to this. When the difference between female and male engineers was tested, the null hypothesis of no difference was rejected. It was also found that there was a lot of contact between female and male engineers on the job.

Job Security and Opportunity for Professional Growth

For job security, it was found that there is a significant difference in job security for female and male engineers. Female respondents indicated that their job was at risk for the following reasons: Leave of absence to join spouse, maternity leave, days-off to visit clinics or time off to attend to sick children or nurse other members of the family.

The study revealed that only the male engineers get all the exciting assignments, and are preferably sent to sites, oil rigs, etc. while female engineers are prevented from executing tasks, which are "strenuous". This in essence meant that the females have little or no opportunity for professional growth.

Discrimination Against Female Engineers

Attitudes prevalent in the construction industry towards women led to the following: Few women were usually recruited as employers thought that the management of their homes would prevent their effective performance on the job, and discrimination on promotion.

Perceptions of Engineers on Strategies to Attract Females to the Profession

Respondents were asked to give suggestions on possible means of attracting more women into engineering. Seminars, symposia, career talks and counselling were recommended. This, as argued, should be geared towards making women realize that engineering does not necessarily involve their being away from their home and family all the time.

Others suggested that special attention should be paid to improving performance of women in science and mathematics at secondary school. Teaching standards should be improved in order to attract girls to the basic subjects needed to specialize in engineering. Also suggested were:

- Introduction of catch-them-young programmes at both the primary and secondary schools. This would arrest the setting of stereotypes before "minds are set".
- Female engineers, particularly APWEN members, must be more visible by serving as role models to female students.
- Proper orientation of people in the society through radio jingles, newspaper highlights, etc., in order to discourage further stereotyping about engineering as a male profession.
- Make further mathematics compulsory for female students.
- Publicize the fact that engineering does not involve strenuous physical tasks as it has been purported to be.

Perception of Technical Managers

(a) Description of managers' sample

Sixty percent of managers were aged between 31 and 40 years while 20 percent were aged between 41 and 50 years. There were no data for the missing 20 percent. There were equal numbers of female and male managers. Seventy percent were married while 30 percent were single (including divorced managers). All managers were Nigerians. Seventy percent were engineers while 30 percent had positions with administrative duties.

(b) Recruitment and retrenchment policies of firms involved in the study

Majority (80 percent) of the firms as indicated by the technical managers revealed that their firms do not employ female engineers. Only 20 percent answered in the affirmative. Out of those that employ female engineers, 60 percent and above had just a single female, while 40 percent had more than one female engineer.

Only 30 percent of the firms indicated that they encourage women into engineering by sponsoring female students in engineering schools. Seventy percent indicated that they had no particular programme as such.

In times of personnel cuts, technical managers were asked to indicate their first target group. The result obtained was surprising. Sixty percent indicated that the male engineers would be the first to go, while 40 percent indicated that the female engineers would be the first target to be retrenched.

(c) Differences in salaries

Fifty percent of the respondents indicated that male engineers were not paid higher salaries than their female counterparts, while the remaining 50 percent had a different opinion. The group that did not perceive a difference in salary of female and male engineers also did not believe that male engineers had better negotiating power than females. Asked differently, only 20 percent disagreed that the firms paid lower salaries to female engineers.

(d) Exit of Female Engineers from Industry

An equal number of male and female respondents had differing views that female engineers often withdraw their services from the firm's employment. The 50 percent that indicated this also stated family reasons as the most important factor for their withdrawal. One said: "They usually leave after getting married. They usually find it difficult to combine the rigorous engineering job with their domestic obligations."

Job Quality

Eighty percent of technical managers considered the job output of male engineers to be of higher quality than that of females. To confirm this view, 70 percent disagreed with the proposition that female engineers were generally more effective than their male counterparts.

However, another 70 percent agreed that female engineers were mostly absent from sites because of family commitments.

Job Placement

We explored the issue of wrong placement of female engineers. The study revealed that while 50 percent were undecided, 50 percent strongly disagreed that female engineers are mostly used as technicians in organizations.

Affiliations with Professional Engineering Bodies

We sought to confirm in the survey whether many females as compared to males have been able to register in adequate numbers with COREN and NSE. Seventy percent agreed that only very few women had registered.

Suitability of Women in Engineering Jobs

Responses obtained to this item were interesting. Sixty percent of the respondents were undecided while the remaining 40 percent were equally divided in the position they took. Twenty percent agreed that women were unsuitable while an equal number (20 percent) disagreed that women were unsuited

to engineering jobs. Fifty percent were adamant that women's peculiar nature do not prevent them for being sent to the field, while only 20 percent felt that women engineers cannot work in the field due to their "peculiar" nature.

Flexibility of Work and Re-Entry Programmes for Women

All the technical managers agreed that their organizations did not have policies that enable female engineers to take career breaks and later re-enter the service. There was a 100 percent consensus on this. However, 50 percent of them were of the opinion that men were not expected to work equal hours with women. Fifty percent also stated that the industry does not have flexible working hours for women.

Employer Policies to Attract Female Engineers

None of the firms involved in the study had any policy aimed specifically at recruiting female engineers. Recruitment policies also did not specifically emphasize that open positions were available to both male and female engineers. In most cases, advertisements used the word "he" or the terms "prospective candidates". This sometimes sensitizes prospective female engineers negatively.

All the managers interviewed affirmed that their firm had no positive attempt to recruit any specific proportion of female engineers. Three managers categorically asserted that their company had no place for female engineers.

Differentials in Pay

The quest for equality in status and opportunity for women in developed countries has been matched with the adoption of equal opportunity policy by most countries. Consequently, much attention is being put on the salary offered to women compared to that offered men as incentives to attract them to specific jobs. In Nigeria, there is no distinct or special salary scale for women.

MacDonald (1985) found in her study that women working in science and engineering jobs earn 77 percent of men's salaries. This was not applicable in Nigeria. For the industries involved in the study the same salary scale was adopted for all engineers.

Efforts of other Types of Organizations to Promote Women's Participation in Engineering

The Zonta International Club of Lagos initiated the Amelia Earhart Memorial Lecture in January, 1977 with the aim of encouraging young women to take up careers in aeronautic engineering and aviation. The lectures were to girls to always see their male counter-parts as partners in progress. They were also attracted to go into all fields of engineering. Amelia Hart is remembered in January every year by the Zonta International Club for promoting the interests of women.

The Association of Professional Women Engineers of Nigeria (APWEN) declared its intention to promote female participation in engineering with the introduction of student membership. A Standing Committee has been constituted to see how the association can help enhance the learning capabilities of female engineering students. The members are also examining ways of bridging the "yearning information gap between school and the working environment". In addition, there are plans to open state chapters. More effort is also to be put into attracting membership in order to enable them benefit

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from networking. APWEN also intends to combat discrimination against female engineers in employment through awareness educational programmes. This will portray women as more dedicated and painstaking in decision-making.

Chapter Five

Case Study of Developed Countries

The United Kingdom

The United Kingdom as Chivers (in Michel, 1988) points out, has had its own poor record of women's participation in technological positions, at all levels. This was despite efforts made by the Women's Engineering Society (WES) formed in the 1920s to support women interested in the profession.

Despite its achievement, the United Kingdom is still having its own fair share of under-representation of women in engineering. However, the late 1970s saw increasing attention paid to amelioration of the problem. Steps taken so far (though not exhaustive), include the activities of the Engineering Industry Training Board (EITB).

The EITB was set up as a statutory body to take care of training needs of the engineering industry. In the 1970s the EITB found that girls with interest in mathematics seemed to be a major source of untapped potential for technical training. It thus developed a pilot programme for 15-16 year old girls to take up technician trainee posts in industry. This was known as the Girl Technician Scheme. As reported by Chivers (1988), the scheme was not as successful as expected. It however revealed that the education system was hostile to girls. Other programmes implemented by the EITB included the one-week pilot course for girls aged 17 years, who are interested in engineering. Costs were borne by EITB, and a national publicity campaign was launched. Its success led to the introduction of the programme in nine other universities across the country.

Other approaches adopted to attract girls to engineering included:

- Organization of information days.
- Mounting of school visits programmes by women engineers.
- Provision of incentives like the Engineering Award Scheme for women with the provision of a scholarship of £500 a year to women who wished to study engineering.
- Introduction of degree courses which combine technical studies with management studies. These courses produced graduates who could become industrial managers. The courses include environment engineering and materials engineering.
- Formation of more student branches of the Womens' Engineering Society.

Webster (1989) reviewed some of the schemes developed in Britain over the decade prior to 1989 to redress the problem. The schemes were concerned with addressing gender relations at work and women's marginalization in the work place, and how to address women's exclusion from technologies and processes of technological change.

The measures include:

- Designing crèches and career break schemes to overcome women's general disadvantages arising from their domestic responsibilities.
- Adoption of women's training officers.
- Establishing of assertive training programmes.
- Development of strong female "role models".

Others include "education-based" and "industry-based" schemes designed to address women's exclusion from technological change as well as equip them with technological skills. Such schemes include the Girls into Science and Technology (GIST) and Girls and Technology Education (GATE). The GIST project tried to effect changes in the science curriculum, to offer teaching materials and career advice. It also introduced school visits by women in non-traditional careers. Other interventions include:

- The Open University, along with other higher educational institutions, to run flexible distance learning programme to enable women with industrial skills to return to work after a break.
- Companies and industrial training boards developed scholarships and grant schemes along with open learning centres.
- Trade unions like BIFU and NALCO collaborated with employers to raise women's career awareness and make technology accessible to them.
- The Engineering Council and the Equal Opportunities Commission at the end of 1983 joined together and designated 1984 as WISE (Women in Science and Engineering) year in the United Kingdom. This brought about increased effort by institutions of learning and the local industries to organize local activities to attract women into engineering.

Efforts to Combat the Problem of Female Retention

Several studies as reported by Swarbrick (1984), particularly the career survey by the Department of Industry (DOI) and the Women's Engineering Society (WES) had suggested that female engineers in the United Kingdom found it difficult to combine engineering careers with family commitments. They also found that experienced women engineers who wish to return after several years off work would need retraining. Thus, the Funiston Committee recommended distance-learning methods as a ready means for courses to be brought to the student at their place of work.

The Case of the United States of America

Engineering Undergraduate Education in the United States of America

A review of the situation in the United States also showed that things were not too favourable there. Davis, et al (1996) highlighted Vetter's (1994) report that the number of bachelor's degrees awarded in the natural sciences and engineering (NS/E) have been dropping for both men and women, from a high of 214,000 in 1986 to 160,600 in 1991. This was a 25 percent drop in five years.

The National Research Council (1994) reported that although women comprised 16 percent of the U.S. scientific and engineering (S&E) labour force in 1988, they only represented 12.3 percent (roughly 400,000) of the scientists and engineers employed in industry that year.

For the female graduating class, the proportion of NS/E bachelor's degree fell from 12.3 percent in 1986 to 9.1 percent in 1991, although the percentage in social and behavioural sciences saw a steady rise. Tables 46 to 49 reflect this.

Table 46: Associate Degrees Conferred By US Institutions (1990-91)

Discipline	Men	Women	Total	% Women	5-year change
Engineering	2,192	268	2,460	10.8	-53
Engineering Technologies	44,948	4,689	49,637	9.4	-15

Source: U.S. Department of Education cited in *The Chronicle of Higher Education* (1993), p. A25

Table 47: Bachelor's Degrees Conferred by US Institutions (1990-91)

Discipline	Men	Women	Total	% Women	5-year change
Engineering	52,124	9,508	61,632	15.4	-19
Engineering Technologies	15,783	1,449	17,232	4.4	-12

Source: U.S. Department of Education cited in *The Chronicle of Higher Education* (1993), p.A25

Table 48: Masters Degrees Conferred by US Institutions (1990-91)

Discipline	Men	Women	Total	% Women	5-year change
Engineering	20,635	3,349	23,984	14.0	+14
Engineering Technologies	795	180	975	18.4	+62

Source: U.S. Department of Education cited in *The Chronicle of Higher Education* (1993), p.A25

Table 49: Doctoral Degrees Conferred by US Institutions (1990-91)

Discipline	Men	Women	Total	% Women	5-year change
Engineering	4,778	484	5,262	9.2	+55
Engineering Technologies	9	1	10	10.0	0

Source: U.S. Department of Education cited in *The Chronicle of Higher Education* (1993), p. A25

Attitude of Industry and Employers

The National Research Council (*New York Times*, 1994) reported that women working as scientists and engineers were making little progress in breaking into industry, and that the companies were to blame. As at 1994, women made up 45 percent of the work force, but only 12 percent of the scientists and engineers working in industry. However, the research council committee in 1994 stated in its report that women must contend with sexist attitudes and unequal pay as companies were doing little to help them juggle career and family.

However, some major companies in the US embarked on the following programmes among others:

- Sponsorship and mentorship to recruit women
- Publicized job openings
- Equal salaries
- Developed maternal leave policies
- Frequently held meetings to gather feedback from female scientists

In terms of wages paid, female engineers had a lot of complaints (*Business Week*, 1989). As reported, studies show that although men and women begin at comparable levels, women earn 25 percent less than men with similar experience after being out of school for 10 years.

The National Research Council (an arm of the National Academy of Sciences) found that other factors served to discourage women from the field. The report stated that: "The median salary of female scientists with bachelor's degrees and up to two years' experience was 73 percent that of their male colleagues in 1990, \$21,000 vs \$29,500. Those with doctorates made 88 percent of the median male salary, \$35,500 vs \$40,400..." (*New York Times*, 1994)

The following problems were also highlighted:

- Companies make it difficult for women to learn about job openings because scientific jobs are often filled through "good old boy" networks.
- Paternalism to women by older male members of the profession.
- Unwillingness of corporation to accommodate women with children. They fail to provide quality day care and flexible work schedules.
- Absence of regular re-entry provisions.
- Lack of interest in promoting women's participation through the provision of scholarships, mentorships, publicized job openings, equal salaries, etc.

Experience of Female Engineers in the United States of America

Teachers' Negative Sensitization

Iva M. Wilson (*Business Week*, 1989) an electrical engineer teacher suggested that she would be better off learning to cook.

Obstacles Hindering Women in High Technological or Male Dominated Arenas

These include:

- Lack of role models, mentors and contacts
- Conflict with family responsibilities
- "Glass ceilings"
- Societal myths which are still strong about what girls can do.

Betty M. Vetter (*Business Week*, 1989) highlighted that "Women who try to get into fields considered macho such as engineering, still face real discrimination".

Patricia McGrath (*Business Week*, 1989) said "females aren't considered as seriously as men."

Wage Gap

Bette Woody (reported in *Business Week*, 1989; 87) found that female engineers complained that they were often shunted to less desirable assignments because male counterparts resist working with them on teams. This ultimately affected their wage and promotion potentials since "engineering and design teams are proving grounds for technical managers."

Suzanne Jennisches, acting President of the Society of Women Engineers was reported as stating that as time goes on, the disparity in earnings between men and women with similar experience grow.

Coping and Survival Strategies of Female Engineers

Many found that sexism and lack of advancement were the major problems that they had to cope with. Female engineers said that they circumvented some of the barriers by launching companies of their own. Of those reported by *Business Week*, some like Balaz started her company after reaching a dead end in the semi-conductor industry. She found that since then, men put her under a different scrutiny and recognized the move as daring. This as reported helped to reduce discrimination put in their way. Others were determined not to allow prejudice to get them down. Others were of the opinion that choices have to be made.

Such choices may mean under achievement professionally if a female engineer decided to have a family. However, as others found it, such choices do not have to impose final limits on a woman's career (*Science*, 1993: 401). This is because the woman's career can progress as the children grow up.

Other women are benefiting from "family-friendly policies". Such policies include:

- A day off for mothers with sick children.
- Optional unpaid leave of up to a year.
- Generous maternity leave.
- Job-sharing options.
- Part-time work.
- Flex time.

However, the value of whatever policy is made available depends on the implementing supervisor.

Alternative but personal strategies adopted by some women engineers include the cooperation of their spouses who share "fifty-fifty". Others stay up late or employ baby-sitters who stay late. Others with predictable hours make use of day-care centres.

Women and College Academe

The American Association of University Women (1989) in their release gave the following statistics:

- In the 1964-65 academic year, 38 percent of college students were female with only 10.8 percent of doctorates awarded to women.
- In 1986 more than half (52 percent) of college students were female with 35.4 percent of doctorates awarded to women.
- In 1967-72, 16.7 percent of new faculty members were female.
- In 1975-80, the figure increased to 24.5 percent.

- In 1988-89, only 49 percent of female faculty held tenure compared to 71 percent of male faculty. Also, by this time, women's average salaries were still lower than men's at every rank and in all fields. Women with tenure were also concentrated in the lower ranks. In addition, in 1991, engineering had the lowest women share of Ph.D (Davis et al, 1996).

Women Engineering at the Ohio State University*

The Ohio State University, Columbus, Ohio

The women in engineering programme at the Ohio State University was established in 1979 in order to increase the participation of women in the engineering profession. The programme concentrates on recruiting, retaining, and counselling women as well as establishing close relationships with industry. The women in engineering programme actively recruit women students in a variety of ways. "Day on Campus" and "Weekend for Women" provide junior and senior high school women the opportunity to visit campus and spend a day attending classes with a woman engineering student as well as staying overnight in a living-cum-learning residence.

Each April, enrolled women engineering students call those prospective women students who have been accepted to Ohio State and have expressed an interest in studying engineering to answer any questions the prospective students might have. During the summer, luncheons are held for women attending engineering programmes such as Summer Engineering Experience for Women, Computers in Engineering, and Summer Academy. In addition, first-year merit scholarships sponsored by companies and engineering departments are awarded to qualified women. The programme maintains an "open door" policy so that students' problems can be addressed as they arise. A mentor programme assigns an upper-class student to each first-quarter student. A special letter is sent to the parents of first-quarter students enlisting their help in their daughter's initial adjustment to life as an engineering student. Quarterly newsletters are sent to all enrolled women students informing them of special events and opportunities. A course in which women engineers share their collegiate and professional experiences and offer their insights into the profession is offered annually. Outstanding students are recognized for their academic and extra-curricular achievements at an annual recognition dinner attended by corporate representatives and faculty.

* Culled from the Internet Explorer, courtesy The Ohio State University, Columbus, Ohio.

How Cornell University Helps Undergraduate Women in Engineering

Academic Assistance

- (a) Tutoring: Free tutoring is offered to help students keep up and get ahead in key freshman and sophomore courses.
- (b) Workshops: These are academic excellence workshops that include supplementary workshops for introductory calculus or physics. A cooperative approach to learning that has proved successful on campuses across the country is adopted.
- (c) Counseling: Assistance offered includes academic advising, encouragement, availability of someone to talk to, or personal counseling on any issue.

Networking

- (a) Society of Women Engineers (SWE): Students are encouraged to join SWE, which provides opportunities for social and academic networking. This provides the avenue for the dissemination of information about engineering, recruitment of students and professional assistance to students.
- (b) Dinners with Women Students and Faculty Members: Under the sponsorship of women's programmes, dinners are given by the engineering departments. These give students an opportunity to interact with women undergraduate and graduate students and faculty members who in turn can help students to navigate academic environments as well as explore career opportunities.
- (c) Career Planning Seminars: A one-credit seminar for junior and senior women is organized. Corporate professionals and faculty and staff members participate in class discussion, on aspects of the transition from student to practising engineer and other issues of interest to women.

Facilitating Communication

- (a) Newsletter: In particular, the newsletter, *Women in Engineering News* is published by the Women's Program several times a year.
- (b) Student Advisory Board: Students are encouraged to become members. Membership allows such students to advise the college on how to tailor programmes so that they will better serve the needs of women in engineering.
- (c) Faculty Education: Women's programmes promote various activities to assist the faculty become more sensitive to women students and to better meet their needs.

In particular, a workshop developed in conjunction with the Cornell Interactive Theatre Ensemble is helping faculty understand sexism, both in and outside classrooms.

Steps To Promote Engineering Among Women

- (a) Use of Audio-Visual Materials: *She's the Engineer*, a video which shows young women in high school how they can use their talents in math and science to pursue a career in engineering was recorded. This is made available on order from the Office of Engineering Admissions for a \$7.00 shipping-and-handling fee.
- (b) Summer Program: In this programme, the participants, who essentially are high school girls are given a chance to experience engineering. They are allowed to work on practical projects under the guidance of Cornell faculty members.
- (c) Expanding your Horizons in Math, Science and Engineering: Under this programme, graduate students from across the university present a one-day programme for girls in junior high school. A companion workshop helps parents learn how to support their daughters' interest in math and science.

Chapter Six

Discussion, Recommendations and Conclusions

Discussion

The results of this study have averred that female participation in engineering, particularly civil and mechanical engineering, has been very poor in Nigeria and in the United States of America and Britain. While universities and other bodies in the developed countries make special efforts to attract, recruit and retrain women, only sporadic effort is taken by the Association for Professional Women Engineers in Nigeria. Universities and the National Universities Commission have not issued any special releases on admission policy to attract the female gender to engineering.

At universities generally, students with poor academic standing and who have demonstrated inability to master the content of their studies are put on probation and later asked to withdraw if there is no improvement. Most often, cohort advisers recommend a change of course to such students.

More and more, the under-representation of females in engineering has come to be seen as needing drastic solutions. Women now see it as injustice towards them generally, and are now clamouring through special programmes under the Family Support Programmes to ensure that women are given the opportunity and support to get into technical jobs as well as high-powered positions.

It seems, however, that women's role as wives and mothers cannot be changed. These have been recognized everywhere and even by feminists. Thus, feminists themselves argue that "women can because of their different upbringing, and as long as this upbringing remains different, make specific contributions to technology, from which all of society could benefit" (Everts & Oost, 1986). Thus, there has to be introduced certain arrangements to facilitate more active and increased participation of women in engineering. Processes at the Nigerian National level should specifically attract women to this field.

Recommendations

It is evident that intervening measures have to be taken. It is hoped that the following will serve as guidelines for the actions to be implemented.

1. As has been found in developed countries, and in this study, teachers' attitudes to girls in science and technology can be crucial to determining whether they will continue their studies in the area. Teachers should be trained to relate to all their students. They should be made to realise the importance and urgency of dispelling of sexism from their teaching attitudes.

2. The role of guidance counsellors in Nigeria should be reviewed. These counsellors should be encouraged to pay particular attention to the problems of girls in science and technology classes. Guidance and counselling units should be introduced in each faculty of engineering or technology in the Nigerian universities to take care of problems of students in general and female engineering students in particular.
3. More and more women engineering lecturers should be invited and attracted to teach engineering at university. This would eliminate some problems faced by girls.
4. The idea of a women's university already proposed in Nigeria should be brought to fruition quickly. The university should lay emphasis on the production of female engineers and technologists.
5. There is still a lot of room for promotion of awareness in the society. Nation-wide campaigns should be made now for the training of female engineers. There has in the past, been campaigns for general education of women. Presently, the campaign should channel the female training in engineering fields. Such campaigns will also be targeted towards disabusing the minds of people from labeling engineering "masculine."
6. The government, through the Family Support Programme, and women's professional bodies should launch systematic campaigns to enlighten families on the importance of preparing their daughters for the engineering profession. Such campaigns would reduce the sexist stereotyping of children at a very young age, and thus create a stable background for positive socialization of females. With positive socialization, more and more girls would naturally be attracted to the science subjects needed to enter the engineering profession.
7. Textbook writers should be penalized whenever they present engineering as a masculine profession.
8. As follow-up, legislation should be used to prevent discrimination in staff hiring practices. This supports the view of Rathgeber (1995) that "...governments have emphasized the importance of S&T policy without recognizing the inherent gender biases in their own systems." Employers should be encouraged to hire women engineers and make special provisions for their existence in their establishments. There should be crèches for young children of female engineers. (As Davis (1996) argues, some of these barriers would be relatively simple to remove if those concerned want them removed.

Suggestions to Female Engineers

- It will be necessary to time pregnancies so that one does not miss out on family life.
- Female Engineers can team up and start their own businesses, which can, in turn, introduce policies that are favourable to them.
- The balance between family life and career is always a knotty issue, particularly for female engineers who have to be on site.

Summary and Conclusions

This study has attempted to generate data on institutions that are representative of others in order to reveal the rate of participation of women in engineering. The data presented are more than adequate to enable the researcher to reach conclusions. The study showed and confirmed the low rate of

enrolment and graduation of women in engineering. It also revealed practices in institutions and in industry that discourage women from staying in engineering. Though societal beliefs and practices seem entrenched, concrete efforts should be made to alleviate the barriers.

The investigation of the various questions posed in the study led to the following conclusions:

- There are definite differences in the attitude of male engineering lecturers to male and female students.
- Universities in Nigeria still maintain data in ways that severely limit the usefulness of the data. This in turn makes it almost impossible for the universities and even the National Universities Commission to note and in turn make changes in policies affecting students, and in particular their gender.
- Female engineering students lack role models in form of female university lecturers.
- Girls do not like the long periods of training that engineering requires.
- Women in engineering often experience prejudices and antagonisms from their male bosses, colleagues and subordinates.
- Generally, female engineers are not favourably considered when it comes to employment.
- Nigerian universities and the National Universities Commission do not have any programme for the attraction of either female students or female lecturers to the faculties of engineering.

It is worthwhile concluding that more girls should be attracted, retained through positive interventions, and encouraged to practice the profession at the end of the day through the cooperative effort of all members of society. Examples of developed countries and their universities would have to be followed. Generally, the society should see it as extremely important to recognize that there is a need for women's participation in engineering. It is then that the stage can be set for positive policy making geared towards full participation of both men and women in all fields of engineering.

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