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REPORT OF THE PANEL OF EXPERTS ON ADVANCED INSTITUTES FOR APPLIED SCIENCE AND TECHNOLOGY IN AFRICA

(University of Manchester, 10-14 August 1970)

M71-2655

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FIRST REPORT OF THE PANEL OF EXPERTS ON ADVANCED INSTITUTES FOR APPLIED SCIENCE AND TECHNOLOGY IN AFRICA

1. INTRODUCTION

The provision of high-level manpower in science and technology and of the institutions which will function as repositories of imported technology and generators of new technology has been identified as one of the key priorities for the development of African countries. Programmes for development at national and regional levels have therefore given recognition to this priority need by providing for the reinforcement of national networks of technological institutions through the establishment of a limited number of institutions for training high level technological manpower and for research. These institutions, sometimes referred to as "centres of excellence", could develop as national or multinational in status, depending on the fields of specialization estimated needs and the extent of concidence of the interests of a number of Governments.

During the past five years, the need for the creation of these institutions has been considered at various regional expert meetings attended by representatives of the African countries, the OAU 1/, ECA 2/, and other international organizations. These discussions have resulted in the identification of priority fields in which the establishment of such institutes appears to be urgently needed in the African region. One of these fields is applied science and technology. The ECA has selected this field for action and has initiated preliminary consultations and studies on the general structure and form which these institutes should have. It is hoped that these preliminary enquiries will produce general guidelines and principles which will facilitate the establishment of advanced institutes for applied science and technology within the African region. The establishment of a panel of experts to look into this subject is a direct outcome of these earlier considerations. Details of the panel membership, its terms of reference and a summary of its deliberations are given in the following paragraphs of this report.

2. TERMS OF REFERENCE

At the request of the Science and Technology Section of the United Nations Economic Commission for Africa, a panel of experts was invited to study the problems of establishing advanced institutes for applied science and technology in Africa with the following terms of reference:

(i) To study, at close hand, the experience and the structure of selected advanced institutes for applied science and technology in the developing countries whose mission is the generation of new technology and the training of corresponding manpower for industrial development.

1/ Organization of African Unity.

2/ Economic Commission for Africa.

(ii) To pool together the different ideas as to objectives and functions of advanced institutes for applied science and technology which have led to the emergence of demands for their creation in different African countries.

(iii) To derive, if considered appropriate, a limited set of models for such institutes in terms of objectives, functions and structure which would answer to varying sets of economic and technological needs and priorities of countries within the African region.

(iv) To study and recommend alternative strategies for the implementation of a programme for the establishment of such institutes in Africa.

(v) To advise the ECA secretariat in the preparation of plans for technological assistance to promote the establishment of such institutes in Africa.

3. COMPOSITION OF THE PANEL

The Panel of Experts invited to deal with the above assignment consisted of six members whose names are given below. They all participated in the discussions with the exception of Dr. Audu and Professor Erdmann, Jesnitzer who did not arrive for the meeting.

Professor F. Koenigsberger, Chairman
Chairman of the Department
of Mechanical Engineering
University of Manchester Institute
of Science and Technology
Manchester, England

Dr. I.S. Audu
Vice-Chancellor
Ahmadu Bello University
Zaria, Nigeria

Dr. A. Panjo
Head
Science & Technology Section
United Nations Economic Commission
for Africa
Addis Ababa, Ethiopia

Professor Dr. Ing. Habil Friedrich Erdmann-Jesnitzer
Director
Institut fur Werkstoffkunde
Hannover, Federal Republic of Germany

Professor F.A. Kufuor
Pro-Vice-Chancellor
University of Science and Technology
Kumasi, Ghana

Professor T.A. Lambo
Vice-Chancellor
University of Ibadan
Ibadan, Nigeria

A number of eminent academicians, development economists and the Assistant Secretary-General of the OAU responsible for science and culture were also invited to take part in the discussions, viz.

The Rt. Hon. the Lord Bowden
of Chesterfield
Principal,
University of Manchester Institute
of Science & Technology,
Manchester, England

Mr. J.D. Buliro
Assistant Secretary-General,
Organization of African Unity
Addis Ababa, Ethiopia

Professor T.A.I. Grillo
Head,
Department of Anatomy
University of Ibadan,
Ibadan, Nigeria

Mr. G. McRobie
Chief Executive
Intermediate Technology
Development Group,
9 King Street
London W.C.2., England

Professor V.A. Oyenuga,
Head,
Department of Animal Science,
Faculty of Agriculture,
Forestry & Veterinary Science
University of Ibadan,
Ibadan, Nigeria

Mr. J. Pickett,
Senior Lecturer,
Department of Economics,
University of Strathclyde
Glasgow C.1., Scotland

Professor S. Sey,
Dean,
Faculty of Agriculture
University of Science and Technology,
Kumasi, Ghana

Professor T.A. Taylor,
Dean,
Faculty of Agriculture,
Forestry and Veterinary Science,
University of Ibadan,
Ibadan Nigeria

The Secretary to the Panel was Mr. T.S. Karumuna, Associate Economic Affairs Officer, Science & Technology Section, United Nations Economic Commission for Africa, Addis Ababa, Ethiopia.

4. ORGANIZATION AND DURATION OF THE MEETING

The first meeting of the Panel of Experts on Advanced Institutes for Applied Science and Technology in Africa was held under the chairmanship of Professor Koenigsberger at the University of Manchester Institute of science and Technology (UMIST) from 10 to 14 August 1970. The host university is one of the leading advanced institutes for applied science and technology in the United Kingdom and the panel took advantage of this by welcoming its Principal to address the meeting on the Institute's orgin, structure and experience. Later on in the programme, members were taken on a conducted tour of the Institute's laboratories to see the activities being undertaken.

After Lord Bowden's address and the discussions which followed, the meeting considered two papers presented by Dr. Banjo. This was then followed by consideration of the proposals for setting up an advanced institute for applied science and technology at the University of Ibadan presented by professor Lambo, and for creating a Technology Advisory Service at the University of Science and Technology, Kumasi, presented by Professor Sey. As the discussion proceeded, various contributions were made some of which are specifically referred to in this report. The detailed programme of the meeting forms one of the appendices to this report.

The members of the Panel wish to record their gratitude to the University of Manchester Institute of Science and Technology for all the facilities placed at their disposal in connection with this meeting and for the assistance and generous hospitality accorded to them throughout their stay in Manchester.

5. STRUCTURE, FUNCTION AND EXPERIENCE OF AN ADVANCED INSTITUTE FOR APPLIED SCIENCE AND TECHNOLOGY

During its first session, the Panel dealt with item (i) of its Terms of Reference by inviting Lord Bowden, the Principal of the University of Manchester Institute of Science and Technology, to give a talk and lead the discussion on the structure, function and experience of UMIST within the U.K.

In his talk, Lord Bowden explained that the Institute originated from a Mechanics Institute which was established in Manchester in 1824. The Mechanics Institute was established in order to enable a mechanics and artisans to become acquainted with and to further their knowledge of the scientific principles relevant to their trades. This was expected to lead ultimately to the acquisition of higher skills and to increased proficiency in the performance of their tasks. The growth, expansion and transformation of the Mechanics Institute derived its impetus largely from the leading men in the City of Manchester and the surrounding industrial centres who considered that the establishment of an institution offering high-level technical education was essential for the economic development of the area. The Institute later became a College of Technology and in 1902 joined with Owen's College to form the Victoria University of Manchester. Owen's College, also situated in Manchester, was then offering higher education in various fields of science and humanities. The Institute of Science and Technology though part of the University of Manchester, has its own independent administration and funds.

From its inception the Institute of Technology has had more in common with the German Technische Hochschule than with the typical British University engineering departments. Essentially, its work is industry-oriented and its programmes and research activities have always been complementary to the work of the local industry. Its close relationship with industry is demonstrated by the numbers of leading industrial personnel who take up part-time appointments with the Institute, the consultancy services undertaken for industry by its professors and the participation of leading industrialists on its governing council.

In matters of academic work, the Institute has pioneered the establishment of many new departments of technology in Britain. It has strong orientation towards research and a good proportion of its activities is dominated by post-graduate research. The composition of the student population reflects this: post-graduate students are about one quarter of the total.

In 1956, the Institute, together with two other universities, was selected for special development as a centre of excellence for technological education and research. This programme placed additional funds at the disposal of the Institute and made it possible to further its goals succesfully.

A fuller record of the talk by Lord Bowden is contained in appendix I.

Discussion

Lord Bowden's talk was followed by a very lively discussion which covered three main areas of interest to the Panel members. These were the position of the Institute within the University of Manchester and its staffing; the orientation of the Institute's research work and the teaching of undergraduates; the services offered by the Institute to industries surrounding it.

The position of the Institute within the university and its staffing

The discussion on this topic related to whether it was necessary for an Institute like UMIST to be part of a large university or whether it would have been a better arrangement to be a separate institution.

This was a question that had in fact been debated at UMIST for many years, but eventually the policymakers had decided to remain as part of the University of Manchester. It should be noted, however, that the Institute has its own funds directly from the University Grants Committee 1/ and a separate governing council. It would have been just as easy to have adopted the solution of becoming an independent institution. The same question had

1/ This is a Committee of the U.K. Government which advises the Government as to the distribution to different universities of any financial grants that may be made by Parliament towards meeting the recurrent and capital needs of the U.K. universities. A number of English-speaking African contries have set up similar arrangements.

been raised in the case of the other two institutes for advanced technology in the U.K. In the case of the Imperial College, they had chosen to remain a part of the University of London. At Strathclyde, however, they had made an opposite choice and have become an independent technological university. Either solution can be made to work successfully.

As already mentioned in the talk, the Institute employed an appreciable number of part-time staff. Part-time staff made up about 15 per cent of faculty teaching and research staff. These were not just men needing extra earnings but leading men in their fields within industry who were invited to join the faculty on a part-time basis so that the Institute, particularly the students, could benefit from their knowlege and experience as active professionals in industry.

With respect to its permanent teaching staff, the Institute also tries as much as possible, particularly in engineering, to recruit professional men from industry. If for any reason they had lecturers who had not come in from industry, arrangements were made for such staff to go out to work in industry for some time to get real life experience before returning to the Institute. The practice of staffing engineering departments with research graduates who had never practised professionally as engineers which was prevalent in U.K. universities in the past had been avoided by the Institute. As with other professional fields of study, it was unrealistic to expect a lecturer or professor who had never practiced the profession to train students to become professional men.

Professional staff at the Institute could be roughly classified into teaching and research. However, even those staff who were primarily engaged on research, such as Research Fellows, were requested to do some teaching. For a research worker, it was often beneficial to teach students as the response and questions of students often threw a light on the research work in progress. All teaching staff also participated in or supervised some research project. Proper teaching at a university needs to be backed up by research activity.

In regard to non-professional technical staff, there were no laid down ratios. The Institute, however, tended to have a large number of technical staff in relation to academic staff than typical engineering departments in U.K. universities because of the nature of its work.

Content and orientation of teaching and research

An institute for applied science and technology such as UMIST needs to take special care in the selection of the content of its teaching and research and the orientation of its courses. At UMIST, the general philosophy is that the courses and the research carried out should be oriented towards the needs of the society it serves. This philosophy often means that the Institute has to pioneer new courses which may sometimes not fit into the traditional list of academic courses.

When Building Technology was introduced as a new subject at UMIST, many university people scoffed that the Institute was simply teaching a "superior form of bricklaying". However, the subject had been developed into teaching and research in building processes so as to obtain better utilization of the raw materials available for building including improved methods of design and construction to obtain buildings better adapted to the climate and to the requirements of human habitation. It is now a well-recognized course in the U.K.

In this example lies a lesson for universities in African countries. Often many of these countries interpret the need for excellence in their courses with a faithful copying of the courses available in European or American universities. The results were often ludicrous as could be seen in the example of the early medical courses in African countries. Practically all these medical schools copied their courses and the course contents from European medical schools. The result was that they graduated doctors qualified to practise temperate medicine in London and Paris but not in Accra or Senegal. To properly qualify to practise in their own countries, the African-trained doctor had to travel to Liverpool or other centres in Europe to take specialized courses in tropical medicine. It is only recently that medical educators in Africa had come to the realization that their medical courses should essentially be oriented to tropical medicine. Their graduates should qualify as a matter of course to practise tropical medicine rather than treat it as a postgraduate specialization.

This lesson is even more important for an institution devoted to applied science and technology. Its courses should prepare engineers and technologists to solve the problems of their societies and research should be directed to looking for solutions to outstanding problems. For example, building technology would be a very appropriate field of research in a tropical country like Ghana. The climate is different, the raw materials are different and the demands on a building arising from the patterns of living are also different. Unfortunately one is more apt to see examples of building in Accra which would be more suitably located in London or Copenhagen. Such buildings which were designed by imported architects make no provision for the heat or for the heavy rainfall. To make them habitable one has to import air conditioners!

In any African country, there will always exist a set of peculiar problems whether in building, in industry or in the environment which have not been solved elsewhere because they do not exist elsewhere. It is an opportunity and a challenge to a technological university in Africa to undertake the investigation and solution of such problems. In Ghana, some sort of research in nuclear physics was being done in Accra. This was a tragic mis-orientation of university resources because whatever work is done in this field in Accra will not create any new nuclear physics. That will occur somewhere else where the more ample and expensive facilities for nuclear research exist. On the other hand, if the university there oriented its research towards physical problems of Ghana, it will have no rival as no one else will be doing such research. The university will be more likely to make a reputation in such physical research than in nuclear physics.

Perhaps the most useful model for orienting the new institutes for science and technology which might be created under the programme envisaged by the ECA are the land grant universities of the USA. These universities which were set up under the Morril Act of 1875 were enjoined to study the problems of the local people and to help solve the problems of their society. The contribution of the land grant universities to the development of the USA has been enormous and the record of history testifies to this.

The teaching of design

Specific questions were raised on the teaching of design and manufacturing technologies. The teaching of design was a very serious problem in African engineering faculties. In U.K. universities it was possible to leave real training in design to industry which could fill in the gap as industry did not require new engineering graduates to produce designs for manufacturing straight after graduation. On the other hand, this was what industry often required from the newly qualified engineer in African countries.

The teaching of designs was a problem that had attracted much attention and debate at UMIST. The current approach was to teach the fundamental subjects for design such as Strength of Materials Mechanics of Structures, Mechanics of Fluids, Theory of Machines, etc. The students are then gradually introduced into the concepts of design through graduated design problems. These start primarily with simple components involving strength of materials calculations, sketching and preparation of specifications and drawings for making the component. At this stage other design considerations based on the operating conditions under which the component will perform (e.g. fatigue, creep, corrosion) and the method and economics of producing it are introduced. The teacher of engineering design must himself have been a designer in industry for the sucessful and realistic teaching of design.

At more advanced stages of the design course, the students are given longer exercises in the form of a design study or project. At this stage they have to establish the specification for the design and also prepare a feasibility study for the project before proceeding with the actual designers from industry to evaluate the design exercises and to discuss each design project with the student concerned. Each student has to explain and defend his design solutions before these outside designers.

One of the problems discussed was teaching of the relevant technology in different branches of engineering practice. In civil engineering this could be achieved by taking students out for field work in surveying and construction during their courses or in special vacation field camps. There were many opportunities in every African country for field experience of one type or the other in civil engineering. However this was not the case for the other branches of engineering, particularly those closely allied with manufacturing industry such as mechanical and chemical engineering.

One proposal which had been widely made in African countries was that universities should bring production facilities to their students in the form of larger and more elaborate workshops that would ordinarily be necessary in a traditionally designed engineering faculty. Such workshops would operate like small factories attached to the university and would offer engineering students practical experience in manufacturing processes such as metal casting, welding, sheet metal fabrication, metal machining, pressing and assembly procedures.

The criticism of this solution lies in the absence of the pressure of economic competition which is inseparable from the running of production factory. Goods and equipment not only have to be manufactured successfully in terms of technology but also within give cost tolerances. It will be unrealistic to expect to portray accurately the atmosphere of a factory in competitive manufacturing in a large university workshop for which costs are not a matter of success or failure. Although it was felt that the provision of manufacturing workshops would at least introduce undergradutes to manufacturing processes, for their full professional development they need to have direct practical experience in an actual factory either during their courses or afterwards.

Non-technical subjects in the Institute

In general the engineering courses at the Institute cover such a considerable range of topics in mathematics, applied science and engineering technology that there is not much time for non-professional subjects to be introduced. However, lectures on History of Technology and the Effect of Technology on the Modern World are provided as part of the curriculum. There are also courses in languages and in management. Lectures on music, art and a number of other subjects in the humanities are given from time to time, but these are not part of the examination curriculum.

Professional training of the graduate

The engineering graduate at the end of his studies requires a period of practical training in and introduction to professional practice in order to become a practising professional man. This is a common requirement in all professional occupations whether it be law, medicine, engineering or music. This is the part of the graduate's training which is usually referred to as "clinical experience" in the training of doctors.

In a similar manner, any graduate who hopes to become a professional engineer requires to undergo a period of clinical experience. The essence of clinical experience is that it introduces the graduate into those aspects of professional practice which cannot be taught in the lecture room or in the laboratory. The most important of these new aspects are:

(i) Many real life problems are unique in the sense that the engineer has to decide first on how he is going to tackle each problem in the environment in which it has to be solved before he can apply his knowledge; the quality of resourcefulness has to be developed.

(ii) In the solution of engineering problems decisions have to be taken which cannot be reached by calculations alone: the engineer has to make many decisions on the basis of judgement as to the best course of action.

(iii) In professional engineering practice, the engineer has to accept direct responsibility for his choices and decisions, and ultimately for the success or failure of the structure, machine or project he has designed or planned. The responsibility for his own decisions is perhaps more starkly present in engineering than in any other profession because of the wider range of the effects and consequences of engineering failures.

(iv) The inextricable and often larger involvement of economic considerations in engineering practice often means that the best engineering solutions are a compromise between technology and economics.

The only place to get this final conversion of the graduate into a professional engineering is in industry. After the period of academic training in the university, the new graduate should be given organized industrial experience in the form of engineering tasks of increasing complexity under conditions where he will be held fully responsible for his own work, but of course, under the supervision of a sound professional engineer. This part of the training depends just as much on the quality of the supervision as on the graduate himself. There is no experience quite so rewarding for a young engineering graduate as that of working with a creative professional engineer. The period of this professional training varies in different countries but is usually from 18 months to two years in the U.K.

Contract services provided for industry

Consultancy assignments involving research problems are accepted by the Institute. The Institute usually charges for these on a cost basis (salaries, equipment and materials) plus an overhead charge of about 15% of the salaries component of the cost to cover administrative costs. In general, the Institute tries to avoid undercutting professional consulting engineers in its charges so as not to be accused of unfair commercial practices. However, if the research project is one of especial interest to the Institute some reduction may be made in the charges.

As a rule, contract research is accepted where it is of medium or long term nature. This makes it possible for the Institute to engage a graduate student on the project with the prospect of completing sufficient work for a postgraduate degree. This meant that research projects of at least two years' duration are preferred. Occasionally, the Institute has accepted ad hoc projects of about three to six months duration where no academic motive of a degree was involved. In such a case, the Institute would simply pay the research worker for the period necessary to solve the particular problem.

Sometimes, small local firms without research facilities send their own personnel to the Institute's laboratories to carry out some ad hoc research or testing work with the equipment only available in the Institute. This was particularly the case in papermaking and textiles. In these two fields, the Institute had a special equipment which was perhaps unique in the district.

6. THE NEED FOR ADVANCED INSTITUTES FOR APPLIED SCIENCE AND TECHNOLOGY IN AFRICA

Dr. Banjo presented a paper entitled 'The Need for Advanced Institutes for Applied Science and Technology in Africa' (Appendix II). He stated that it has been a hard lesson for Africa to realise that, except for a few oil rich countries, no country can base a well-sustained development on the production and export of natural raw materials alone. These products continue to suffer from the price fluctuations in the world market and declining unit price. The developing countries are importers of finished products from developed countries, a situation which imposes a continuous strain on their foreign reserves. To improve on this situation calls for measures to ensure that prior to their export from the developing countries raw materials should be processed to semifinished or finished form to stand a chance of commanding a standard price in the world market. At the same time each country should build up its internal capacity to produce manufactured goods based on the available local resources.

Any positive steps in this direction will require the adoption and utilization of some of the existing technologies as well as the development of new technologies for the processing of raw materials and production of import substitution goods. There is therefore a need for the establishment in Africa of special institutes which will direct their attention to this very important activity. This will include:

- the development of new technologies for the processing of raw materials;
- the development of industrial processes to support and improve production in the small scale industries;
- the development of machinery and equipment particularly suited for local needs in the sectors such as agriculture, mineral processing and food processing;

- design and manufacture of domestic utensils suited to the local pattern of life;

- training manpower for the utilization of new technologies.

Discussion

At the end of the presentation, the Chairman observed that the primary need, if the situation in the developing countries described in the paper was to improve, was for technology and trained manpower in the widest sense of the word. The essence of the discussion should therefore be how to provide the means for developing technologies and the technologists to apply them.

An important point which came up during discussion was the orientation of the proposed advanced institutes. It was the general view that these new institutes should place emphasis on technology for industrialization and hence should give primary attention to industrial research and development. This was not to play down the importance of agricultural production which still had to meet increasing demands, particularly internal demands for food and fibre, but it should be appreciated that considerable provision was already being made for research to improve agriculture whereas little R. & D. capacity was available to support the growing industries. For example, in Ghana, out of seven government research institutions, only one dealt with industrial research: the rest were engaged in agricultural research. In Nigeria, the situation was similar. There was only one government industrial research establishment out of a total of 23 government research institutions; on the other hand there were 14 establishments for agricultural research. Of a total national research budget of US$ 35.6 million in 1967, US$ 20.3 million was spent on agricultural research. Only US$ 1.44 million went to industrial research. The time had come to ensure that industrial R. & D. also received necessary attention.

The paper had already suggested the main areas of concentration for industrial R. & D. However, the panel laid particular emphasis on the importance of R. & D. in food technology. Apart from the economic importance of food technology, it was also a major factor in the improvement of nutrition and hence in the health of the population.

In answering to the needs for technology and the training of technologies, it was the general view that a technological university or institute with the full emphasis on promoting technological R. & D. would be more effective than an all-purpose university which had technology as one of its departments. The institutions envisaged in the programme should take an example in their terms of reference from the land grant universities of the U.S.A. Their mission should be clearly utility to the community: this in no way conflicted with excellence.

The urgent tasks awaiting the advanced technological institutes envisaged were numerous. The experience of the Kumasi University of Science and Technology confirmed this point.

7. FORMS AND FUNCTIONS OF ADVANCED INSTITUTES FOR APPLIED SCIENCE AND TECHNOLOGY

Dr. Banjo presented a second paper entitled "Ideas as to the possible forms and Functions for Advanced Institutes for Applied Science and Technology in Africa". He elaborated on the purposes envisaged for these institutes which had been outlined in his first paper. The different types of approaches for creating these institutes were also considered, with particular reference to their relationships with already existing universities and research-type institutions.

These concepts of organization were proposed for consideration:

(a) An institution created to carry out R & D, having a completely independent organization of its own, or having its own administration, but attached to an existing university.

(b) An organization created to carry out R & D on behalf of Government and industry as an extension department of a technical university.

(c) A service provided by the strengthening of the science and engineering departments of an all-purpose university to enable them to carry out R & D on behalf of Government and industry.

The probable operating characteristics of each type of organization and the kinds of tasks that each type could be expected to carry out were examined in the paper.

In general, an institution of the first type is necessary if large scale R. & D. is envisaged, or if the production of entire new technology leading to the establishment of new industries is to be undertaken. An institution of this type is very well placed for mission-oriented research to be carried out to definite time-tables.

The second type of organization was easier to start off, but was limited in the kind of assignments it could effectively handle. It was particularly suitable for dealing with assignments involving looking for solutions to problems arising from the practice of existing technologies. Its main advantages lay in the possibility of dealing with a wider range of industries corresponding to the wider stretch of disciplines encompassed by the departments of a technological university as compared with a specialized research institute.

The third organization concept is really more to the nature of a service than an institution. The science and engineering departments of a normal all-purpose university could not really handle technological R. & D. as such. What they could provide is the possibility, on a very limited basis, of carrying out investigations of a more or less fundamental nature into narrowly defined aspects of industrial problems which involve either the basic or engineering sciences. Where a university exists, its science and engineering departments should relate their research as much as possible to problems arising out of their environment and should normally be expected to look for such "relevant" research topics in industry amongst other fields. Such a service cannot fulfil the requirements for technological R. & D. support to local industry. This can only be provided by one of the other of the first two types of institutions described.

Dr. Banjo explained that it was important for the Panel to give consideration to the possible forms and functions for the type of institutions envisaged in the study project. The second meeting of the Panel would also include a tour of a number of selected African countries and universities which were interested in the programme for institutional development. It would be necessary for the panel to arrive at some guide criteria which would enable the ECA to analyse and compare the different proposals that are expected to come in from several countries in the African region.

Discussion

The question as to the relation of the proposed institutions to existing universities came under close discussion. It was felt that whether they were developed as independent institutions or not, the advanced institutions should maintain the closest co-operation with existing universities. The panel also considered it desirable that existing research institutes should maintain close contacts with universities.

This latter view point seemed to run counter to the actual trend observed in some parts of Africa. In West Africa, for example, research institutes have indicated a preference to move away from the influence of universities. The main reason appears to be the conservative orientation of existing universities towards research. The universities in Africa still held to the "classical traditions" of university work they had inherited from their founders and were mainly oriented towards manpower production and discipline oriented research. Furthermore, their traditions of selecting research topics left much to be desired. Many African university science departments for example prefer to select research topics which were extensions of ingoing research in Europe or America. Such topics easily and early led to research papers for publication, but often did not contribute much towards the solution of local problems. Furthermore, the university traditions of leisurely research which they still maintained were not suitable for the pace of mission-oriented research with deadlines. This explained the general feeling prevalent among many policy-makers that the existing universities as constituted and administered, could not be depended upon as the most suitable institutions to generate new technology.

The Association of African Universities had discussed this subject at one of its meetings and had recommended that the research and other activities of its member universities should be directed towards the needs of the countries which they served. This should not be considered as incompatible with the pure science research activities that was often the central interest of university scientists.

It was suggested that a more effective way of influencing university research in the new directions would be to earmark the funds provided for research for different categories of research in accordance with the policies of Government. In the United Kingdom, for example, the University Grants Committee the Science Research Council and the Ministry of Technology provided funds for research in distinctly different fields such as pure science, applied science and industrial science.

Purposes and functions

The meeting accepted in principle the proposals put forward in the paper for the purposes to guide the creation of the proposed advanced institutes and classified them in three groups:

Group I - Research and development

(a) To produce new technology through applied research and development (R & D).

(b) To adapt imported technology to local conditions, including the use of local raw materials.

(c) To develop new products more suited to local requirements.

(d) To develop new or improved processes for the production of existing local products.

(e) To develop plant and equipment necessary for industrial utilization of the technologies and processes developed in the institute.

Group II - Technical assistance to industry

(a) To provide technical support and consulting services to local industries using new or imported technologies.

(b) To introduce and promote improved quality standards in local products.

Group III - Teaching and training

(a) To train manpower necessary for the utilization of the new technologies developed in the institute.

(b) To train teachers, produce literature and teaching materials to support teaching and training in the new technologies at other institutions.

Forms of organization

The subject of organizational form received considerable attention. The Panel considered it more useful to expand the three forms introduced in the paper to four categories for purposes of clearer consideration of the type characteristics of each form. The four organizational types were identified as follows:

Category A - An institute created primarily for research and development either as a completely independent organization or as an industry-sponsored organization.

Category B - A specialized research institute with independent administration but attached to an existing university under special relations.

Category C - Expansion of the activities of technological university to provide capacity for carrying out research and development on behalf of industry or Government.

Category D - Strenthening of existing departments of science and engineering in the usual "all-purpose" university to enable them to carry out research on behalf of Government and industry.

Each of these four approaches to providing R. & D. services were discussed at some length. Functionally, categories A and B could be considered the same. These types of organization offered the possibility of designing an institution more closely fitted to the kind of research and development required: the institute is free from any restrictive traditional observances and procedures of a university which might hamper its activities. Other advantages that could be derived from this form of organization include its adaptability for project-oriented research by teams, more accurate programming and the advantages of specialization.

This type of research institute is particularly suitable for research and development which is programmed as part of a timetable for implementation of development plans. The emphasis of the institute will be on the production of technology rather than on the production of manpower. However, the institute will make a valuable contribution to manpower production through the training of teachers for the technologies in which it specializes.

The main distinction that the Panel made between types A and B was that, in the case of a completely independent research institute, it might be difficult to obtain close co-operation between it and a local university where there is one, as would have been obtained if it was attached in some relation to the university. A research institute also has the advantage of being staffed by more permanent research workers. This feature has considerable advantages although there are also limitations arising from such staffing.

The case for an independent research institute of type A would usually arise under the following conditions:

(i) Where there is no university or equivalent institution available.

(ii) Where a university exists which is not equipped for or interested in technology.

(iii) Where there is well developed industrial co-operation within a particular industry and the member companies wish to tackle jointly some of their own technological problems.

(iv) Where entirely new industries require to be created based on a country's natural resources.

(v) Where there are large national projects which involve technological research on a scale that would swamp a university.

(vi) Where peculiar problems of human, political, military or climatic conditions exist.

Similar situational factors as for (iv) - (vi) would indicate a choice of type B when a suitable university already exists. However, one must bear in mind the growing trend in university thinking that universities should not undertake military research.

The type C solution, as already indicated, involves the expansion of the activities of an essentially technological university to provide the capacity for carrying out research and development on behalf of industry or Government. The most successful way of organizing such R. & D. services for outside clients is to create within the framework of the university a separate department charged with the responsibility of establishing and maintaining contacts with industry and other clients and with the negotiating and acceptance of R. & D. assignments from clients.

This solution is an easy and effective way of starting to assist industry where a technological university exists. It also has the special feature that a wider range of industries can be served than in the case of a specialized research institution. It is best suited to assignments which fall within one or the other of the following categories:

(i) Development of solutions to problems arising from the practice of existing technologies.

(ii) Advice on operating problems of industrial concerns.

(iii) General consultancy services of a limited scope.

This type of organization cannot deal properly with large scale R. & D. where an entirely new technology is being developed, or where extensive production techniques require to be created. The only way that a technological, or other university can tackle R. & D. assignments of greater magnitude than indicated in the categories listed would be to create a special task group researchers devoted entirely to a particular R. & D. assignment. However, this is really an embryo organization of type B already discussed.

A technological university which is offering R. & D. services to industry will need to pay great attention to the composition of its professional staff. In particular, a substantial proportion of its faculty members should be engineers and technologists recruited from industry and who have already achieved some reputation in their own fields. If this not the case, industry will not recognize the university teachers as experts in their R. & D. problems: the university may offer its services but nobody will come.

The type D solution covers the case where a classical university desires to strengthen existing departments of science and engineering so as to be able to carry out R. & D. on behalf of industry. One has to bear in mind that there are factors which limit the ability of a classical type university with essentially "academic" traditions to deploy its resources and modify its organization so as to carry out work for industry in the way that a technological university can do.

One of these factors is that research in the classical type of university is normally subject-oriented. This tradition makes it difficult for the university to undertake mission-oriented research of a multi-disciplinary nature. The research services which a university of this type can offer to industry will be more in the nature of research into fundamental scientific or applied science problems which might arise in connection with production activities.

The conclusion is that, if a classical type university wishes to assist industry by providing R. & D. services, it is better for it to create a separate unit for this purpose which will operate like an institute for technological research (type B solution).

8. LIAISON BETWEEN INDUSTRY AND INSTITUTES FOR APPLIED SCIENCE AND TECHNOLOGY

One subject which aroused considerable interest and discussion by the Panel was the question of lisison between industry and institutes for applied science and technology. It was emphasized that experience in the U.K. has shown that an institute or technological university wishing to enter into the field of R. & D. services for industry needs to take the initiative for creating and maintaining liaison with the industries in its proposed area of service. The provision for such liaison should be formalized in the Organization structure of the university through the creation of an organizational unit charged with the responsibilities of liaison.

The subject of liaison with industry was particularly relevant to the proposals of the University of Science and Technology, Kumasi and, at the request of the Panel, the Head of the Department of Industrial Liaison at UMIST was invited to join the discussions on the subject. During the discussion, a number of models of arrangements adopted by different U.K. universities including UMIST were considered.

Department of industrial liaison, UMIST

In order to provide for the functions of industrial liaison at UMIST, the Institute had set up a Department of Industrial Liaison with a Head of Department of the same status as other Heads of Departments in the Institute.

The Department was responsible for day to day contacts with industries in the Greater Manchester area. This was done through visits to industrial firms and by means of a periodical devoted to technology in industry and in the economy generally. Occasionally, one-day seminars were held at the Institute on technological advances or problems in selected industries to which high-level staff of firms in the industry concerned were invited.

In addition to general liaison and the dissemination of information of interest to industries, the Department was responsible for the reception of enquiries from industry related to any research services which might be requested. The Department would then arrange the consultations between the prospective clients and the technological Departments in the Institute which will deal with the research problem. The Department would negotiate the research contract with the clients with the assistance of the other Departments involved in the project, and would generally administer the research contract during the project period.

Fees were usually charged for each research project, sufficient to cover the costs of additional staff time, any specially recruited personnel for the project, materials used for the project and a percentage for overheads. In general, UMIST operated the services it offered on a non-profit basis, but care was taken not to undercut the fees that would be charged for a similar assignment by commercial R. & D. laboratories and firms.

Centre for industrial Innovation, University of Strathclyde, Glasgow

At the University of Strathclyde which was a technological university, a different arrangement had been chosen. With the assistance of the Ministry of Technology, a Centre of Industrial Innovation was established as a part of the formal structure of the University and is subject on policy matters to a Steering Board of six faculy members appointed by the University. The Centre is under the management of a Director with six Project Engineers under him.

The Centre operates like a research consulting and contracting company and accepts both design and research assignments. It has its own laboratory and workshops and can carry out entirely within its own facilities assignments of a nature which do not require the collaboration of the other departments in the University.

Where a research contract requires it, other departments are brought in. The Centre distributes particular problems in the contract to the appropriate departments, but retains responsibility for the progress and management of the contract vis-a-vis the client. This is ensured by making a Project Engineer responsible for the progress and execution of each contract. The Centre is thus responsible for keeping time schedules agreed with the client. The departments working on any problems within the University are thereby saved the necessity of commercial negotiations with outside firms.

One interesting feature in the operation of the Centre of Innovation is the freedom it has to place sub-contracts on any project outside the University, if it considers that the competence to carry out part of a project is not available within the University's departments.

Industrial promotion and development service, University of Lancaster

The University of Lancaster in the North of England is one of the new technological universities founded within the last decade in the U.K. Its involvement with the promotion of industry is expressed in a joint industrial promotion and development service created and run in partnership with the City Council of Lancaster.

The object of the scheme is to attract industry into Lancaster which is a smallish town in a rural area. The city offers new industries economic incentives in the form of accommodation, factory sites and services at reasonable rates. The University acts as the technical branch of the industrial promotion service by offering the services of its technological and management departments for tackling the technical and organizational problems of new industries to be established in the city. The Director of the industrial development service is jointly financed by the City Council and by the University.

Industrial consulting company, University of Loughborough

At the University of Loughborough, another of the new technological universities, again a different approach has been taken. Their solution to the problem of liaison with industries has been to set up a limited liability consulting firm with a full time Managing Director. The other directors of the firm are the Vice-Chancellor and the members of the University Council.

The consulting company takes on R. & D. contracts for industrial clients just like any private firm and passes on the research assignments to the appropriate departments of the university for performance. There are two advantages obtained by this arrangement. One is the freedom from university scales in fixing the remuneration of the Managing Director and his technical officers who have to be paid at rates competitive with their counterparts

in private research firms. The second advantage is the legal protection provided by the limited liability status of the consulting firm.

Motivating the participation of university staff members

The motivation of a university developing or entering into a scheme to provide R. & D. services for industry is quite clear. It is primarily to contribute to the technological and industrial progress of the community which supports the university itself and which it was created to serve. A second factor is provision of research projects and financing for post-graduate work. Many universities, particularly in the U.S.A., have built great research schools exclusively on the basis of accepting contract research assignments.

However, the motivation of staff members cannot be taken for granted to the same extent. There will, of course, be some members who will wish to participate in such a service for reasons very similar to those of the university itself: but these are likely to be Heads of Departments or very senior faculty members with research schools to maintain. Other staff members will require more personal incentives.

In many universities, whether there is a contract research scheme or not, individual staff members are still free to accept consulting assignments directly from industry under terms provided for in their contracts of service. In some universities, a proportion of fees received for such consulting assignments has to be paid over to the university. It seems clear that for an industrial R. & D. service formally operated by the university to be successful, some arrangements should be made for a proportion of the fees received from consulting contracts to be paid to staff members participating in a project, in the form of additional emoluments. This will provide motivation for staff members to participate in research contracts where they are not obliged to do so by their general service agreements with the university itself.

9. EXAMINATION OF SPECIFIC PROPOSALS FROM AFRICAN UNIVERSITIES

The later sessions of the Panel of Experts were devoted to a consideration of proposals from the University of Science and Technology, Kumasi and the University of Ibadan, for the establishment of new organizations, depending on the existing universities, which would be concerned with R. & D. services for industry. A third proposal which had been expected from Ahmadu Bello University, Zaria, was not available as the representative from that university had not been able to attend the meeting of the Panel. However, Dr. Banjo gave the information that some exploratory discussions which he had had with the Professor of Mechanical Engineering, Ahmadu Bello University, indicated that the objective of that university was to extend the activities of their engineering departments so as to enable the university to offer advisory and research services to the local industry. As Ahmadu Bello University was a classical all-purpose university, its proposals could be classified as falling within a type D organization as discussed in the previous section.

As the representative of Ahmadu Bello University was not present, no discussion was undertaken about its proposed technological services for industry. The Panel decided that it could take up these proposals for consideration during its Study Tour of a number of African universities the following year which would include Ahmadu Bello University.

Proposals for a technology advisory centre, U.S.T., Kumasi

The proposals of the University of Science and Technology, Kumasi, were presented orally by Professor Sey (see Appendix IV). He said that two years before, a number of staff from the engineering and chemistry departments of the University had constituted themselves into a "Technology Group" with the objective of providing scientific and technological advisory services to small businessmen and farmers in and around Kumasi. Membership of the Group was purely voluntary and the enthusiasm of its members provided its main driving force. The University did not officially recognize the Group which meant that it did not have formal support, or finance from the university authorities. Participation in the work of the Group was treated by the University as purely extramural activity by its members.

In the course of time, however, a change took place in the thinking of the University authorities in favour of the activities of the Technology Group. This was also partly motivated by the fact that the statutes of the University formally charged it to undertake functions vis-a-vis the commnity, similar to those being taken up by the Technology Group. It was, therefore, considered that, for the University to fully fulfil its terms of reference, a formally constituted organization should be created, within the framework of the University, which would be capable of offering advisory and research services to local industry, using all the T. & D. facilities and the technological expertise available at U.S.T.

This change in thinking at the policy-making level of U.S.T. led to the proposals for the creation of a "Technology Advisory Centre" which would provide a technology advisory service for local industry. Through such a service, the university could undertake suitable programmes of research and extension directly related to the problems of the country, its industry and all aspects of its development. Preliminary proposals for the financing and management of the service had already been considered by the University Council. Wider consultations with interested organizations such as the E.C.A. were being made with a view to securing technical support and expert assistance in the formation of concrete proposals for the establishment and operation of the proposed services at U.S.T., Kumasi.

In the ensuing discussion, a number of critical points were made about the proposals put forward for the scheme:

(i) Participation was still left to the personal enthusiasm and the voluntary decisions of staff members. This was good, but additional incentive should be provided by including more definite policy on the sharing of fees with participating staff members in place of the idea of paying honoraria.

(ii) The extent to which departmental resources could be utilized in the scheme and the involvement of staff members was dependent on time left over after discharging their normal teaching responsibilities. This limitation would require to be looked into.

(iii) The proposed Board (or Directorate) was very large because it was felt that this would provide many points of contact with Government and with industry. However, the Panel was of the view that there might be more effective methods of providing the contacts required without having the disadvantage of such a large Board composed, in a large part, of individuals not connected with the actual R. & D. operations.

(iv) The limitations of a type C organization as described in Section 7 of this report will be applicable. The University should not expect the advisory service to provide a suitable framework for large scale R. & D., unless some members of the staff can be detached on a full-time basis to concentrate on the assignments accepted.

The University appeared to have recognized this latter point by making provision in their plans for the eventual appointment of full-time research fellows.

(v) The idea of a Management Committee as constituted in the proposals with an Executive Secretary of lecturer status to manage and operate the scheme may be difficult to implement, successfully because of its membership which consists of very busy people already likely to be fully loaded with their existing responsibilities.

An arrangement with a more senior level executive in charge of the service in the role of General Manager, Director of Chief Executive of the scheme would probably be more realistic. The Director should not be below the status of other Heads of Department and the Management Committee would be better conceived of as organized around the office of the Director rather than the office of the Vice-Chancellor.

Proposals for an institute of applied science and technology, University of Ibadan

The proposals of the University of Ibadan were contained in a paper prepared by the University for the Panel. The paper was distributed to Panel members and presented by Professor Lambo, the Vice-Chancellor. It is reproduced at Appendix V of this report.

In presenting the paper, Professor Lambo stated that the proposal to establish an institute of applied science and technology was made in response to his country's need to correct the imbalance in her institutions of higher education between the humanities and social sciences on one hand and science and technology on the other. This imbalance had already been pointed out by the National Universities Commission in Nigeria which had advocated a policy requiring a gradual move to 70 per cent enrolment in science and technological courses in the country's universities. The proposals were a part of Ibadan University's response to the new policy. The establishment of the proposed institute, in addition to offering greater scope of activity in technological fields, would also permit the University to relate its research and teaching activities to the social and economic needs of the country.

The institute would be interdisciplinary in the nature of its work and would work very closely with research institutes and other university-level institutions in and around Ibadan. It would train high-level manpower in a number of selected priority fields and emphasis would be on postgraduate rather than undergraduate training. Emphasis would also be placed on the development of research programmes to promote the application of science and technology to development. During the previous months, considerable discussion had gone into defining the objectives for the proposed institute and outlining a programme for its operations. The result of their thinking and discussion was embodied in the paper he was presenting to the Panel.

The proposals of Ibadan University, being available to members in written form were discussed in some detail. The main points commented upon are summarized in this report.

(a) Objectives

It was suggested that the objectives would be a better guide to implementation action if they were specified clearly in terms of the purposes to be achieved rather than in terms of instruments that might be employed towards achieving such purposes. This would leave desired flexibility in implementation and avoid possible debates at a later date when protagonists of the "means" might convert these to the "ends".

In the analysis of the needs and considerations which led to defining the necessity for an institute, many important priorities had, in fact, been identified. However, it would be impracticable to attempt to cater for such a wide spectrum of needs in one institute as some of the subjects proposed were of sufficiently wide scope in themselves to have one institute each devoted to them.

A consideration of the network of existing universities in Nigeria and the analysis of needs indicated that if primarily manpower production was envisaged, this could be more efficiently undertaken by the strengthening of the engineering faculties already existing in three out of Nigeria's five universities viz. Lagos, Ahmadu Bello and Nsukka.

However, the problem revealed by the analysis of needs was essentially the lack of technology for the processing and utilization of local agricultural and other raw materials. It seemed therefore that the primary role for the institute envisaged should be the development of new or the adaptation of existing technology from elsewhere for the utilization of local raw materials in production.

With these comments, a suggested reformulation of the objectives was as follows:

(i) To develop the technology required for the exploitation of the country's natural resources and the efficient utilization of the country's raw materials in production.

(ii) To link university research and teaching more closely with the needs of industry enterprises and thereby ensure that the scientists and technologists produced by the university are better prepared to fit into the demand patterns of industry.

(iii) To develop and intensify research programmes which will promote the application of science and technology to development in Nigeria.

(b) Structure

The list of needs and subject areas identified in the Ibadan paper make it quite clear that one institute cannot answer to all the purposes envisaged. Some other needs could be effectively catered for by appropriate specializations in existing university technological departments and did not at this stage require the expensive approach of creating a whole new institute.

Among the subjects which would require separate institutional development at this stage were:

Earth sciences; Petroleum technology; Food science and technology; Materials science and technology; Machinery design and development; Agricultural engineering; Forestry engineering.

These could be combined into three groups each of which could form the basis of a separate institute:

I - Food science and technology; Materials science and technology, Machinery design and development;

II - Earth sciences; Petroleum technology;

III - Agricultural engineering, Forestry engineering.

Other subjects listed in the paper such as environmental studies and health engineering would not justify the creation of separate institutes at this stage. They could be provided for within the framework of existing university departments. Health engineering(or Sanitary Engineering as commonly known) could be effectively provided for as a specialization in Civil Engineering Department. Environmental studies could be dealt with as a multidisciplinary programme by the collaboration of a number of appropriate departments of the university.

(c) Technician training

One of the questions which figured large in the paper was the need to train technicians for industries. The inadequate supply of technicians for industries in Nigeria is well documented in a number of Government and other industrial reports. On the basis of the example of the Laboratory Technician's Training Scheme which had been in operation at Ibadan University for some years, a proposal was included in the paper that the new institute should develop a scheme to train technicians for a number of industries including textiles, plastics, petroleum, food, metallurgical, nuclear power, chemicals and pharmaceuticals.

This proposal was obviously based on an insufficient familiarity with the role of the technician in industry. The functions which the industrial technician has to carry out in an industrial establishment require considerable direct familiarity with the technologies of the industry and the actual production operations. This means that an industrial technician needs to be trained within, or at least in close contact with the industry in which he is going to work. The failure to realise and to provide sufficiently for such contact with his industry had led to many of the technicians produced by existing technical colleges in Nigeria being rejected by the industrial employers.

The proposal contained in the Ibadan paper on technician training would merely multiply the errors in the training of technicians which had already been demonstrated by the experience of the existing technical colleges in the country. Future improvements in the training of technicians lie in the direction of organizing training schemes and institutions closer to the industries concerned rather than in the academic context of a traditonal university.

NOTE ON THE CONCEPT OF "INSTITUTE"

For future discussions with the University of Ibadan it is important to bear in mind the difference in connotation in the usage of the word "Institute" which is current among members of the academic staff at Ibadan and the usage by the Panel. This difference in connotation was discovered at an earlier meeting between ECA and Ibadan University's representatives and may have been responsible for some of the proposals in their paper which do not fit into the framework of the institutional development programme being examined by the Panel.

The University of Ibadan has, over a number of years, developed an organizational device by which to provide for a specialization within a subject field. This consists in the creation of an "Institute" as a sub-department of a major department, with a small number of research and teaching personnel. Sometimes the Professor of the main department also functions as the director or head of the "Institute". However, such an "Institute" is a part of a larger department or faculty and often has no separate physical identity. It is primarily an administrative entity set up to provide special attention to research or training in a specialized sub-division of a major discipline. Existing examples in Ibadan University are the "Institute of Education" within the Faculty of Education and the "Institute of Child Health" whose director is also the professor of Pediatrics in the Faculty of Medicine.

The concept of an "Institute" which the ECA and the Panel are concerned with in the programme for the creation of advanced institutes for applied science and technology relate to multi-disciplinary research and training institutes with fully developed departments in a number of disciplines relevant to the mission of each institute. A separate physical entity is envisaged in each case with its own governing body which may be related to the university of which the Institute is a part, or may be completely independent.

10. FUTURE WORK OF THE PANEL OF EXPERTS

At the end of the meeting of the Panel of Experts, it was clear that the Panel was not yet in a position to give a final report and recommendations to guide future development of the programme for creating advanced institutions for applied science and technology in the African region.

To begin with the diversity of conditions in different countries, illustrated so well by the differences in the proposals from the U.S.T., Kumasi, and from University of Ibadan, made it imperative that the Panel be given the opportunity to familiarize itself with the conditions in the region at first hand in so far as these were relevant to the programme. This could be achieved by a study tour to a number of African countries and universities which had expressed an interest in institutional expansion that fell within the programme on hand. Amongst such universities were the University of Dar-es-Salaam, the University of Zambia, Ahmadu Bello University, Zaria, the University of Ibadan and the University of Science and Technology, Kumasi.

The ECA had envisaged that such study visits could be arranged during the middle of 1971 and would precede the Second Meeting of the Panel of Experts. The Second Meeting would be planned to take place in Addis Ababa at the conclusion of the study visits.

The first meeting had been devoted to an examination of concepts, issues and problems and had resulted in a number of very valuable guidelines. The study visits to be arranged would enable the Panel to study at first hand the conditions and environments of a number of proposed institutions to be dealt with in the institutions in the different countries.

The second meeting would analyse all the additional data to be collected during the study visits and using this in conjunction with the results of the first meeting would direct its attention to preparing a final report of a normative character with recommendations and guidelines for programme implementation.

The second report should deal with the following matters:

Part I: Type of Institutes relevant to the range of needs and priorities in the African region.

This section of the report will be devoted to an analysis of different models and a value analysis methodology for making a type selection which will take into consideration:

(a) conditions and environments;

(b) optimum suitable solutions;

(c) optimum possible solutions;

(d) optimum economically possible solutions.

An attempt will be made to put the final conclusions in this section into a tabular form which will facilitate selection of type of institute against given parameters.

Part II. Establish procedure guidelines for the selection and implementation of individual projects under the programme. The procedure will cover the following items:

(a) Study of needs and environmental conditions.

(b) Selection of the optimum institute or organizational solution on the basis of the value analysis described in Part I.

(c) Action to be taken to attract the interest and co-operation of clients for the services of the institute in industry and commerce and to maintain liaison.

(d) The practical organization, financing and budgeting for the project.

(e) The survey of manpower available for the project and the attraction of basic staff.

(f) The preparation of working programmes.

(g) Study, at a very early stage, of communication and collaboration with Government, Industry and other Institutions.

Appendix I: THE MANCHESTER UNIVERSITY INSTITUTE OF SCIENCE AND TECHNOLOGY

Talk given by the Right Honourable The Lord Bowden of Chesterfield, Principal of Manchester University Institute of Science & Technology

Historical background

The College of Technology was started in 1824 as a Mechanics Institute with the object of acquainting local cra tsmen and artisans with scientific knowledge and principles relevant to the trades they were practi ing. It was considered that in this way these local craftsmen could gain greater skills in their trades and possibly contribute new ideas in their relevant fields. Through local benefaction the Institute was able in 1827 to establish a nucleus of the necessary accommodation for its activities. Additional buildings were erected in 1857 and the present site of the Institute was acquired through the active intervention of the City elders. The present main building was opended in 1902 and additional structures have come up to meet the needs of the institutes expanded activities.

In 1902 the College of Technology joined with Owen's College (the other half of Manchester University, offering courses in science and arts) to form the Victoria University of Manchester which was granted the Royal Charter in 1903. The Institute has remained part of the University as its Faculty of Technology, but it differs from the other faculties in that under its charter which was granted in 1956, it has its own governing council and it is financed directly by the University Grants Committee.

Nature of Courses and Teaching

For a long time until the early sixties, the College of Technology continued to run non-degree courses along with its degree programmes. These included courses leading to the Higher National Certificate and to the Associateship and Fellowship of the College, as well as a number of courses for craftsmen. The responsibility for running these courses has gradually been taken over by other institutions established in Manchester. The College however continues to run short courses lasting a week or a month for practising engineers and specialists from industry who are brought up-to-date on recent advances in their fields. In all its activities, the College is very much influenced by its traditions of service to industry and maintains close connections with industry.

The College has always been a pace-setter in the U.K. and has never limited itself to doing only what others expect to do. One way leading to failure is to copy other people's ideas. The College is an unconventional outfit in the U.K. with more in common with a German Technische Hochschule than with most Engineering Departments in English Universities. It is more like the Technische Hochschule in Delft, Aachen or Zurich than an ordinary English Department of Engineering.

The Manchester University Institute of Science and Technology has pioneered the establishment of many new departments of technology in England. It was the first to establish in England departments of Building Technology, Paper Technology, Textile Technology, Polymer Technology and Chemical Engineering. The Chemical Engineering Department is still the biggest in Europe. It is also appropriate to note that Professor Koenigsberger's was the first Division of Machine Tool Engineering in England. There are now four others, but his is still the biggest and the only one which specializes in machine tool design. It is however worth noting that in the conservative climate of university thinking in U.K., it is often hard to establish an entirely new discipline of a new Professor; one has often to persevere in the face of opposition and the derision of the rest of the academic world.

Developments since 1956

In 1956, the British Government decided that it needed more engineers and in order to educate them it required a number of specialist institutions. Three were selected: the Imperial College of London, Strathclyde University and the Manchester University Institute of Science and Technology. As a result of this decision, extra resources and finance were put at the disposal of the Institute. Since then the student numbers and the balance of work changed. Some non-degree programmes were phased out and taken over by other institutions. However, because of its excellent laboratory facilities it was necessary and desirable to continue some of the non-degree programmes which could not be immediately carried out as well elsewhere.

There are now 700 post-graduate students and 2,500 undergraduates, a ratio of about 4:1. It is intended that the proportion of post-graduate students should rise still further till there is a balance between post-graduate and under-graduate numbers. This ratio has already been achieved in the Mechanical Engineering Department which at present has 150 post-graduate students.

Participation of industry in teaching and research

Its very close connection with local industry is one of the important features of the Institute and can be traced back to the early days of the Institute's existence. The professors are consulted by industry on a variety of research problems and generally all staff have had industrial experience. A number of prominent specialists from industry serve as part-time academic staff and offer part of their time either to give lectures or to supervise research programmes at the Institute. There are more part-time members of staff here than at any other University in Britain. To quote a few examples, the Head of the I.D.I.'s Pharmaceutical Division and a Director of the same firm come in one day a week. The Chief Personnel Officer of the British Railway Corporation had recently been appointed a part-time professor in the Department of Management Sciences. People like this help to bring the students in direct contact with the realities of life in industry.

There is, within the Institute's Structure, a Bureau of Industrial Liaison whose duty it is to promote close collaboration between industry and the Institute.

Non-academic technical staff

In order to run the various specialist laboratories in this Institute, it is necessary to have dedicated technicians; special attention has been paid to the selection and remuneration of these technicians. These men are experienced craftsmen in their own trades and have a great deal of professional pride. The research work of an institute like UMIST is different from a production programme in industry, but once these technicians grasp this point, they become dedicated, enthusiastic and competent men. The Institute depends more on them than perhaps any other university. They have enormous loyalty and affection for the place.

The Governing Council

As mentioned earlier, the Institute has its own Governing Council. The current President of the Council is the Chairman of I.C.I. and an ex-President was the Chairman of the Metropolitan-Vickers. The Chairman of the Council was an ex-Board member of I.C.I. The Council generally includes a great many businessmen from large local firms who are capable of offering good advice and guidance on a variety of issues affecting the Institute. If the Institute wants to divert a street, there is someone on the Council who has done it before. The assistance of the industrialists and businessmen on the Council has been enormously important.

Contacts with developing countries

The Institute has maintained very close contacts with many developing countries. Fox example, as some members of the Panel are aware, the Institute has established good links with the University of Science and Technology, Kumasi. It follows with interest and concern the vast number of engineering problems being tackled in the developing countries. For example the Institute has long been studying the problems of transmitting electric power. Countries such as Egypt, Iran, Pakistan, India, Siam and Turkey are some of the other fourteen countries where there are centres at which local engineers are studying the designs of the appropriate power transmitting networks for distributing electricity in their countries. Its particularly gratifying for the Institute that the Chief Engineers and their Deputies at twelve of these centres graduated from UMIST. The Institute continues to enrol many foreign students who come here for graduate or postgraduate studies. Its links with countries all over the world are thus maintained and particularly with developing countries. It is the belief of UMIST that one of the functions of the Institute is to make it possible for more people to lead better lives.

In conclusion, Lord Bowden added that people had wanted to do the things he and his colleagues had done at UMIST forty years or more ago but the money was not available. The present success is in a large measure due to the fact that the ideas that they had realized at UMIST came at the right moment of time.

Appendix II: THE NEED FOR ADVANCED INSTITUTES FOR APPLIED SCIENCE AND TECHNOLOGY IN AFRICA

Introduction

The standard of living and the well-being of any country depends in the first place on the quality and quantity and the value of the goods and services it produces. A common characteristic of the production of underdeveloped countries is that most of it is in the form of agricultural or mineral raw materials. The typical underdeveloped country leaves the industrial processing of its agricultural or mineral raw materials to other countries and imports the manufactured products it needs to sustain any modern patterns of living.

In the world of today, a country whose production remains in this pattern has few if any chances of becoming a developing let alone a developed country. Its income through trade depends entirely on decisions and conditions outside its control and the value of its national production depends on constantly detriorating terms of trade. This is so because a country exporting untreated raw materials has to accept the conditons and prices imposed by its overseas customers: on the other hand, the same country is entirely subject to the conditions and prices dictated by its suppliers when purchasing the manufactured goods it requires for modernizing its way of life.

Except for the special case of an oil-rich, small country, a country cannot, therefore, base any self-sustaining development on the production and export of natural raw materials alone. The first steps towards economic growth can only take place when such an underdeveloped country begins to put a growing proportion of the labour of its own people into the raw materials it exports, and at the same time begins to meet a growing proportion of its own requirements for manufactured articles through the growth of local industry.

This means that, as a first step, the developing country must try to increase the value added by labour to its raw material production either by processing them to a high quality corresponding to an internationally competitive form, or to more valuable semi-finished or even finished products. In a parallel development, the country should endeavour to stimulate local industry to manufacture some of the simpler imported manufactured products, particularly those based on the raw materials it produces.

Need to acquire and utilize technology

To achieve even this limited step forward in the expansion of its productive capacity, the country involved must acquire and utilize new technology. Here the word "new" is used only in the sense that the country concerned is not using it already.

The acquisition of technology for production can take many forms and generally varies at different levels of the organization of production. At the operating level, craftsmen can be taught new skills and processes, where the production process necessary for the transformation of the raw materials are available (already determined) and are directly applicable. The process of acquisition is primarily a training process. For such openly available, directly applicable technology, a similar process of training is sufficient at technician and professional levels.

Sometimes the technology is not openly avilable but is the property of a foreign company. In such a case two courses are open; either to purchase such technology through licenses and royalty agreements, or to carry out independent research and development to derive suitable but independent technology. Another alternative would be to invite the company owning the technology to open a plant to manufacture the product; this approach is only likely to be successful when attractive market conditions exist for the product to be manufactured.

Very often, although manufacturing processes exist for a product, either the product itself may need some alteration in design to adapt it more closely to its function in the developing country, or the process itself may need some modification to enable locally occuring raw materials to be utilized. In this case, some redesign and developmental research has to be carried out on the product or process, or on both.

A fourth type of case is where a new product needs to be designed, to satisfy requirements that are peculiar to the developing country, or entirely new processes have to be developed to suit unique features of locally occurring raw materials, or to manufacture products that are peculiar to the local demand. In such cases, new designs have to be undertaken and local research and development becomes essential.

When the technology to be acquired is already well developed and openly available, training of the manpower necessary can be carried out in trade schools, technical colleges and universities according to the level of manpower involved. Proprietary technology can also be acquired through training and practical experience in the plants of the company from which it is being bought. However, when adaptive design and development is involved, or applied research is necessary ab-initio, more specialized institutions are required. Such specialized institutions will be concerned in the first place with producing fresh technology through adaptive or original research and development, and seconday with training manpower in the skills necessary for the utilization of the resulting new technology.

Institutions of this type can take several forms, but essentially they will be advanced post-graduate institutions where qualified scientists and technologists will work on new problems arising from the needs of industry to produce finished materials from locally occurring raw materials, or to manufacture well-established products from local raw materials, or to develop new products and processes altogether to satisfy the peculiar needs of their community. Such institutions will also be required to underpin the utilization of an imported technology which requires a research base to sustain its industrial application.

Many tasks already await institutes of this type in many African countries. Some examples are:

(i) Processing of agricultural raw materials into higher grade, semi-finished or finished products for export.

(ii) Development of industrial scale processes for the production of local foods which are currently being produced by small-scale traditional manual methods which result in unstandardized and often lower quality processed foods.

(iii) Design and development of equipment and machinery more suited to local needs in a number of production sectors such as agricultural operations, food processing and mineral ore preparation.

(iv) Design and manufacture of domestic utensils and equipments suited to the pattern of life of the people. At the moment, the tendency is to import such utensils and equipments as are designed for foreign cultures and to alter the patterns of local domestic life to suit the imported articles.

Appendix III: IDEAS AS TO POSSIBLE FORMS AND FUNCTIONS FOR ADVANCED INSTITUTES FOR APPLIED SCIENCE AND TECHNOLOGY IN AFRICA

Introduction

The purposes envisaged for the type of institutes uder consideration include the following:

(i) To produce new technology through applied research and development (R.& D.).

(ii) To adapt imported technology to local conditions, including the use of local raw materials.

(iii) To provide technical support and consulting services to local industries using new or imported technologies.

(iv) To develop new products more suited to local requirements.

(v) To develop new or better processes for the production of existing local products.

(vi) To promote and introduce improved quality standards in local products.

(vii) To train manpower necessary for the utilization of the new technologies developed in the institute.

(viii) To develop plant and equipment necessary for industrial utilization of the technologies and processes developed in the institute.

(ix) To provide general R. & D. services to local industry in solving technical problems encountered in production.

Different approaches have been proposed for the creation of institutions with a mission including some or all of the purposes listed above. These fall into three main categories:

(a) The creation of an institution primarily for research and development either as a completely independent organization or as a specialized institute with independent administration but attached to an existing university under special relations.

(b) The expansion of the activities of an essentially technical university to provide the capacity for carrying out R. & D. on behalf of industry or Government.

(c) The strengthening of existing departments of science and engineering in the usual "all-purpose" university to enable them to carry out research on behalf of Government and industry.

The institutions resulting and their capacity to carroy out the purposes listed vary according to which approach is adopted.

Creation of a separate institution

The creation of a separate institution is usually advisable when the objectives of the R. & D. to be undertaken imply the production of new Technology such as could lead to the establishment of new industries. In this case, all aspects of the technology required for the new type of production will need to be developed including the product design, manufacturing processes and the equipment for the production.

By creating a separate institution, the organization can be fashioned to suit the scale and type of operations required for planned R. & D. programmes. The institution is not inhibited by academic traditions and procedures which would hinder its performance in the administration of its essentially research staff and in the management of its resources. This type of institution lends itself most readily to team-research of multi-disciplinary nature. The research work is project-oriented rather than subject oriented. Mission-oriented research programmes with time limits for expected results are best dealt with in this type of institution.

Usually, institutions of this type are created to deal with a narrow range of technologies. They tend to be specialized in objectives, but can deal with all the aspects of science and technology required for a particular field of industry, or type of production. In general, this is the most effective type of institution in terms of working to a programme for development of technology which is tied to the implementation of a development plan.

An institution of this type can train the manpower required for the new technologies developed in it. However, its resources are better employed in training those who are going to teach the new technologies in institutions that are more directly concerned with manpower production.

Expansion of the activities of an essentially technical university

A technical university is usually devoted to the training of manpower as a primary objective. The university also carries out research in applied science and technology, but manpower training is its most important purpose. This implies that the technical university teaches science and technology which is already researched and validated for application.

In its research activities, it is possible for the teaching staff of such a university to choose subjects for research depending entirely on their own individual interests. In this case, the research activity of the technical university will be similar in organization and tempo to the research work in the usual academic university. The situation changes only when such a university decides (as it probably ought to) that it should orient its research activities to solve problems arising from industry. Such problems can be selected on the initiative of the college, or undertaken at the request of industrial concerns.

In the latter case, the technical university usually starts by inviting to take advantage of its existing facilities. However, once the demand builds up, the university may soon find itself under pressure to cope with a large volume of R. & D. than its existing staff and plant can handle. At this stage, a technical university that wants to continue to carry out R.&D. in full partnership with industry has to organize such a relationship on a more formal basis, and must be prepared to expand its facilities to cope with a significant proportion of the demand.

This may imply increase in staffing both at professional (academic) and technician levels. It will certainly involve the acquisition of additional laboratory equipment and technical plant. If well organized, such co-operation can be very beneficial to the technical university itself in terms of increased resources and new knowledge if incorporate in the teaching materials.

The advantage of this approach is that it is easier to start off, since the R. & D. services offered are based on an existing institution. As large a range of industries can be served as there are technological departments in the university. However, the system has limitations in the type of R. & D. assignments it can cope with. The type of assignments that can be dealt with successfully will be more in the nature of looking for solutions to problems arising from the practice of existing technologies, advice on operating problems of industrial concerns, or general consultancy services of a limited nature.

The system cannot deal properly with large scale R. & D. where entirely new technology is being developed, or extensive production techniques require to be created. The only way the technical university can tackle assignments of greater magnitude would be to create a special task group devoted entirely to a research programme. This is, however, effectively the same as creating an embryo organization of the first type, separate but associated with the university.

The technical university offering advisory services to industry cannot orient its organization to the extent required to accept R. & D. programmes of large scope tied to a development programme. Its main forte is that, where existing industries already have sufficient technology to commence operations, the technical university can provide consultancy service over a wide range of industrial problems.

There is one caveat, however. The technical university will only attract a demand from industry for advisory services or for contract R. & D. if it has an appropriate staffing policy. By this is meant that a substantial proportion of its faculty members should be engineers and technologists drawn from industry who have already achieved some reputation in their own fields. Otherwise industry will not recognize the university teachers as experts in their R. & D. problems if they have no experience in the kinds of applied science and technology problems arising in production. All that might happen in that case is that isolated problems of a primarily pure science nature may be brought to the university by industry, but the chances are more that they will be offered to their own specialized industrial research laboratories where these exist.

Strengthening of existing departments of science and engineering in the usual "all-purpose" university

This approach is similar to the one dealt with in the preceding paragraph in that it is an attempt to make use of the facilities availabe in the science and engineering departments of the university to carry out R. & D. on behalf of industry. However, certain factors should be borne in mind which significantly affect the ability of a normal all-purpose university with essentially "academic" traditions to deploy its resources and modify its pattern of organization to carry out R. & D. for industry in the same way that a technical university can do.

The research in the ordinary type of university is usually subject-oriented rather than project-oriented, and tends to be carried out with the primary purpose of extending knowledge within a particular discipline rather than with solving a problem. This generally means that the tradition of research in such a university is for fundamental research and that the pace of work is not tied to deadlines for results. This approach to providing institutional facilities for applied science and technology is therefore but a compromise, and it is doubtful whether the ordinary "academic" university can provide really effective support to industry without radically changing the traditional patterns of organization and thinking which are characteristics of academic universities.

Nonetheless, the ordinary type of university can make some contribution even if it only does research on fundamental aspects of industrial problems. One should, however, not expect significant technology to be developed within the framework of such a university. This type of approach should only be looked upon as a stop gap measure. The most effective way for the usual all-purpose university to cater to the needs of industry for technological R. & D. is to create a separate unit for this purpose which will operate more or less as a small institute for technological research.

Appendix IV: PROPOSALS FOR A TECHNOLOGY ADVISORY CENTRE AT THE UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

(Presented by Professor S. Sey,
University of Science & Technology, Kumasi)

Historical background

The idea of a Technology Advisory Centre at the University of Science and Technology, Kumasi, originated from a number of staff members who decided to get together to form a group called the Kumasi Technology Group. Their aim was to constitute themselves into a new source of scientific and technological service for small businessmen and industrialists. The Group derived its inspiration from the University Act and the University Statutes which lay down that the University of Science and Technology, Kumasi, should concern itself directly with the problems of the country, of industry and of all aspects of the country's development.

The Group started from the initiative of a few individuals and slowly gained the support of a number of staff members and eventually some official support from the Academic Board of the University. However, its activities were based on the enthusiasm of individual members and were regarded as purely extramural activities on their part. Since the Group assembled together a wide range of technical expertise from the University staff, it was able to render valuable assistance on the solution of a number of problems which faced local industries. The Group did considerable work in advising small industries in textiles (weaving) and metal working.

Constitution into a University Technology Advisory Centre

As the activities of the Kumasi Technology Group expanded, it became quite obvious to the University authorities that the service they were offering was, in fact, one which it was the duty of the University to formally undertake in accordance with its Act, and that the fulfilment of this role could not be adequately discharged by depending on the inclinations and the enthusiasm of private individuals. It was therefore thought that something should be done to enhance the status of this type of service. Consideration was therefore given to making the University take over the activities of the Group as an integral part of its normal functions. This meant that the University would have to formulate a systematic programme of activities for such services and also would have to create a body responsible for organizing the use of the facilities of the University along the lines already being followed by the Kumasi Technology Group.

This led to the formulation of proposals for a Technology Advisory Service whose main purpose will be to promote applied research bearing directly on the needs of industry and the transfer of such research to the industries in the country. Once this decision to provide a formal Technology Advisory Service had been taken, the Academic Board laid down a number of principles to guide its implementation:

(a) that the University facilities should be made available to the Advisory Service;

(b) that the government research institutions associated with the University be fully involved in the work of the service;

(c) that the organization should serve as the official channel for advice going out to industries from the University and should also handle all the requests for advice from industries;

(d) that staff members involved in the Technology Advisory Service should receive equal treatment as for other staff members in matters of promotions;

(e) that participation of University staff in this service should be on a voluntary basis.

In order to operate this scheme, the University decided to set up an organization to be known as the Technology Advisory Centre within the University which would operate the technology advisory service. The proposals for the setting up of the Centre were incorporated in memorandum which had already been forwarded to the ECA and which is attached as part of this Appendix.

MEMORANDUM OF THE PROPOSED TECHNOLOGY ADVISORY SERVICE

1. Introduction

Nobody disputes the fact that by its very nature, this University can contribute immensely to economic development as well as accelerate the pace of social change in this country. Quite apart from its basic work of teaching and research, (of "laying" as a result, "golden eggs",) this University has in its senior members and supporting staff, in its laboratories and workshops, expertise and facilities for applied research in important areas of immediate interest to the country's economic development.

The University has indeed been assisting Ghanaian industry and contributing generally towards the pace of economic development through the consultancy service provided by its Faculties and staff. For various reasons, however, Ghanaian industry and public generally, are not sufficiently aware of the contribution this University can make, through applied research and advice, to development. It is possible that the University has not sufficiently advertised itself. Whatever be the reason, the time has come for the University to advertise its willingness and readiness to place its expertise and facilities at the disposal of Ghanaian industry. The University owes this contribution to the country because not only should it not stay unconcerned about the country's efforts to develop herself, but also, it must show some tangible returns for the sustenance it receives in full from the country. The University's role is not only and simply, to produce trained and qualified personnel. The country could buy these or train them abroad.

The University should therefore make a distinct impact on the community, and offer herself as a storehouse of infomration and an instrument for rapid social and economic change. The University itself, happily, recognizes and accepts that this is an important role it should not shirk. The University may discharge this role in the following ways:

A. Applied research in areas of direct bearing on Ghanian industry.

This may take the form of:

(i) Consultancy-- research and /or offer of advice instigated by direct requests from industry.

(ii) Research/advice on specific problems detected to be retarding any particular industrial organization, workshop of plant.

(iii) Feasibility studies, which may either be commissioned by prospective businessmen or conducted to show that a particular venture would pay if it were undertaken.

B. Extension Service - Through which the University may seek not only to disseminate knowledge of the community but also, and more especially, to improve upon the industrial/technical skill of the manager right down to the machine operator.

The organization of this service may be undetaken as part of the functions of the Technical Education Unit when this comes to be established. It may, to begin with, take the form of short courses - intra-mural courses run during term time but more especially, during the vacations for various categories of industrial personnel.

2. Technology Advisory Service

The time has come for the University to organize in a formal manner and in an institutional form its applied research and consultancy of potential. The Technology Group has been attempting this for the past two years, without much significant success, because not being an official University institution, it lacked material resources and facilities. Efforts put into the work of the group and successes achieved by individual members went unrecognized by the University. The results of private consultancy, as opposed to official Faculty consultancy, also tend to go unrecognized by the University! For the sake of its own image within the community which sustains it, the University ought to be aware of contributions its members make towards economic and social development. It should be aware of and recognise these contributions as useful and essential, also in order to encourage its members to continue to interest themselves in research/investigations into and offer of advice on problems which may not be immediately of academic interest but nonetheless is of vital importance to the economy of the country.

In view of the above, the Academic Board recommends that an official Advisory Service be established by the University.

(i) NAME:
The name for this organization shall be "Technology Advisory Service".

(ii) NATURE AND OPERATION

(a) Being an official organization it will place at the disposal of members of the University and of the Research Institutes on the campus facilities existing in the various departments, laboratories and workshops for research/investigation into practical and other problems in which it is interested.

(b) The Forest Products Research Institute and the Building and Road Research Institute have similarly indicated their willingness and preparedness to place their facilities at the disposal of the organization in whose work these Institutes will participate.

(c) The organization, that is to say, Technology Advisory Service will operate through "consultants" in the various Faculties and Departments of the University and in the Research Institutes. Any project too large to be handled by a single "expert" or "consultant" will be undertaken on behalf of the service as a Faculty or Departmental project, or by a group of experts brought together for that specific purpose.

(d) The Technology Advisory Service will act mainly as a clearing house.

(e) The organization will be profit-oriented and fees will be charged for the services it renders.

(f) While the organization will not discourage direct contacts between individual senior members (experts/consultants) and industry outside, it will be the body through which the University will officially accept requests/inquiries etc., and commission research/investigation as well as offer advice.

(g) In addition to the fact that work done for the organization will be officially recognized, for purposes of advancement, status-wise, honoraria at rates to be worked out, will be paid for service provided. For purposes of allocation of fees charged for consultancy by the organization, the Research Institutes will rank as Faculties. That is to say Faculties and the Institutes will be remunerated at the same rates for service provided on behalf of the organization.

(h) Although work for the organization will be voluntary, official cognizance will be taken of it, and senior members will be encouraged to work for the service.

(i) Care will be taken to ensure that work for the service does not minimize the effectiveness of any senior member as a teacher or research officer.

(iii) CONSULTATIVE BODY

(a) It is proposed that the Technology Advisory Service be assisted by a Consultative Board consisting of:

(i) The Vice-Chancellor
(ii) Deans of the Faculties of the University
(iii) The Directors of the Institutes of Building & Road Research and Forest Products Research
(iv) Four members elected by Convocation
(v) One member appointed by the Chamber of Commerce
(vi) One member appointed by the Chamber of Mines
(vii) One member appointed by the Ministry of Economic Affairs
(viii) One member appointed by the Ghana Manufactures Association
(ix) The Directors of the Soil Research and Crops Research Institutes
(x) The Chief Physical Planning Officer
(xi) Additional co-opted member(s).

(b) FUNCTION OF THE CONSULTATIVE BOARD

This Board may meet once a term to receive reports and review the activities of the Centre.

(c) A Management Committee consisting of:
(i) The Vice-Chancellor
(ii) The Deans
(iii) The Directors of the B.R.R.I., and F.P.R.I.
(iv) The Executive Secretary
(v) The Chief Accountant
(vi) Two members appointed by the University Council,

Which will meet to consider the allocation of the very large projects to Faculties/Departments/Institutes.

(d) An Executive Secretary (of not less than Assistant Registrar/Lecturer status) who will man the offices of the Centre and be in direct communication and contact with industry etc. He will be empowered to handle small enquiries leaving the bigger enquiries to the Management Committee.

(e) The status of the Executive Secretary may be upgraded when the Advisory Service expands or is well established. The Executive Secretary should have technical or scientific qualifications.

(iv) FINANCING THE SERVICE

IInitially, the University will have to meet the salaries and emoluments of the Service's Executive Secretary and his secretarial staff and other office expenses. It is hoped that as time goes on, the Organization will earn enough income to meet its operational costs and to be able itself to commission research etc. without being first prompted.

Appendix V: PROPOSALS FOR AN INSTITUTE OF APPLIED SCIENCE AND TECHNOLOGY AT THE UNIVERSITY OF IBADAN, NIGERIA

(Presented by Professor T.O. Lambo,
Vice-Chancellor, University of Ibadan)

There is a great need to redress the present imbalance in the University of Ibadan, and indeed throughout Nigeria's institutions of higher education, between the humanities and social sciences on the one hand and the scientific and technological courses on the other. The National Universities Commission has indicated that 70 per cent of total student enrolment in Nigerian universities should be in the sciences and technology. In accordance with this policy, the Commission has given approval to the establishment of an Institute of Applied Science and Technology at the University of Ibadan which Institute shall be an interdisciplinary, interfaculty enterprise, designed mainly to facilitate greater integration between academic studies and the industrial, social and economic needs of Nigeria.

Close liaison with government research institutes and industrial organizations is envisaged. This will facilitate the use of outside experts in the training programme and will assist students in obtaining first-hand and practical experience during their courses. It is proposed to offer post-graduate diploma and degree courses, as well as sub-degree programmes. The latter may include in-service training and several courses for government and commercial personnel as well as short courses in specialized areas.

This is a deliberate policy decision based on present socio-economic structures of Nigeria. In a rapidly developing country like Nigeria the industrial requirements in any specialized sector tend to change rapidly. It is therefore desirable to ensure that technologists intended to serve this society are rapidly adaptable to such changing requirements.

The need for technologists in Nigeria has been emphasized on many occasions by different people. From discussions with Canadian International Development Agency, it is clear that there is need for a wider variety of such trained personnel in technology than is at present available from Nigerian Engineering Faculties. There is, for instance, a demand for technologists and engineers to deal with agricultural products processing including textiles and fibres. There is a demand for drug technologists, wood technologists, mineral technologists, chemical (including plastics) technologists, and technologists in printing, to mention just a few examples.

Manpower needs

Manpower estimates prepared by the National Manpower Boards, understandably, do not specify requirements of qualified personnel in the kind of detail most needed for the planning of university expansion. The results of the Board's surveys, however, do give quite definite guidelines within which informed discussion can take place.

Thus, Manpower Study No.10 entitled "A Survey of Labour Requirements 1965" shows that establishments employing 10 or more persons provided employment for approximately half-a-million workers. Of this number 34,000 were recorded in the Senior Category, the larges occupational groups of which were Directors, Senior Administrative and Managerial Staff, Graduate Teachers, Engineers, Accountants, Doctors, and Scientists. The ratio of Nigerians to non-Nigerians in this category was 28:10. For particular sectors the ratios were: Manufacturing, 17:10, Mining, 6:10 Construction, 11:10; Electricity, 65:10.

In the Intermediate Category, there were 97,000 Nigerians but only 1,540 non-Nigerians. Junior Managers, non-Graduate Teachers, Nurses, Foremen and Supervisors, and Technical Assistants, formed the bulk of the occupational groups in this category.

In this context it should be noted that the Ashby Commission in 1960 set a target of 2,500 technicians to be produced yearly by 1970. But the National Development Plan doubled this figure and set the target of 5,000 technicians a year by 1968. In order to teach this target set by the Ashby Commission, Nigeria's institutions of higher education engaged in the training of technical personnel would have needed to increase their enrolments in senior courses up to 6,000 to 7,000 by 1970, and, according to the National Development Plan, up to 12,000 to 14,000 students by 1968. In fact, in 1966, in senior classes - there were only 1,524 full-time students and 922 part-time and evening students. The lack of provision for the training of senior technicians, therefore, must be regarded as perhaps the most significant shortfall in actual performances within Nigeria's educational system since 1960.

Again, there is considerable under-utilization of capacity within the productive establishments engaging 10 or more persons, a principal reason for which is lack of skilled personnel. Fuller utilisation of present idle capacity could generate additional employment within these industries for about 90,00 wokders. The largest manpower shortage in the Senior Category was for Engineers but there are opportunities also for Accountants, Doctors Scientists, and Graduate Teachers, all of whom are reported in short supply.

There are, therefore, three separate reasons for confidence that well-trained, highly-skilled technologists can be absorbed within the Nigerian economy of the 1970s. These reasons are as follows:

(1) That replacement of skilled Nigerians (with expereience) for non-Nigerians can still take place.

(2) That fuller utilization of capacity within existing establishments can occur if skilled personnel of the right training become available.

(3) That the anticipated annual growth of employment in the Senior and Intermediate categories within these establishments, together with numbers required for new units that will be set up, will be about five per cent.

The University of Ibadan of all the universities in Africa, is admirably placed for running a course in this area to serve the whole of the Federation of Nigeria and indeed the whole of Africa, since the University itself is the oldest and most vigorous Federal Institution in the country. The University has developed strong facilities in staff and equipment in the areas of pure sciences, social sciences, medicine, agriculture, forestry and veterinary medicine. The Nigerian Institute for Social and Economic Research, the population research unit, the Radio-Isotopes unit, the nutrition centre and the computing centre are located in the University of Ibadan. Many of these facilities also provide courses of possess physical training and equipments which are directly relevant to the requirements of the proposed Food Technology section of the Institute.

Besides, Ibadan, city with a population of well over one million people, is centrally and significantly placed as the most appropriate location for this type of development in Africa, in view of the diversity of agriculture in this area and the existing facilities in the city. It is on the main road, rail and air links between the coast and the capital city of Lagos, and the Northern, Mid-Western and Eastern States of the Federation. Marketing of various types of foodstuffs, including livestock markets for sheep, goats and cattle are carried on in the city. It therefore provides good facilities for field studies and research projects in the development of improved marketing and transportation of foodstuffs. Besides, a number of developments in areas related to food technology are growing in and around Ibadan. This includes canning factories, food industries, etc.; several milk industries (Fan Milk Limited), fruit juice industries, etc.; several departments of agricultural research belonging both to the Federal Government and the Western State Government, the laboratories of the Nigerian Store Products Research Institute of Nigeria, the newly established International Institute for Tropical Agriculture by Ford and Rockefeller Foundations of the United States of America, the proposed Horticultural Institute and a number of plantations around which Ibadan forms the urban centre.

In addition to the points already made above in support of Ibadan as the most suitable location, it is well to mention that a decision had already been taken that the Institute of Marketing, be sited in the Department of Agricultural Economic and Extension of the Faculty of Agriculture, Forestry and Veterinary Science at this University. The Marketing Institute is already included in our Quinquennial Programme, already eccepted by the National Universities Commission, and should have been in operation since June, 1968 had it not been for the war. Moreover, the Agricultural Technical Committee had alreay decided that that Horticultural Research and Production Centre should be sited in Ibadan.

The University of Ibadan, with its well established Agriculture and Science Faculties, and fully developed courses in the basic sciences (a necessary condition for the successful running of any such training programme), is ideally suited to develop along these lines.

At the present time the Faculty of Agriculture with its departments of Agronomy, Animal Science, Agricultural Economics, Agricultural Biology, Forestry and Veterinary Science, is the only Faculty with an Applied Science orientation. The diversified programme proposed here in will contribute greatly by providing further applied science enrichment to existing basic science and technology programmes and strengthening the Faculty of Agriculture.

Objectives

(a) To upgrade the academic activities by which more efficient and sophisticated use is made of woods, minerals, oils, foodstuffs and other natural resources with which Nigeria is endowed;

(b) To link academic life and industrial enterprise more closely through the training of men and women scientists, particularly at the postgraduate level, so that their knowledge might be broadened to include the design, adaptation, upkeep, and use of modern equipments and machines which are necessary for a fuller utilization of the raw materials which have hitherto been produced in Nigeria for export; and

(c) To develop and intensify research in the application of science and technology to development.

Organization and functions

In formulating the proposals for training such technologists, three important considerations have been taken into account. The first is the need for close liaison with Government Research Institutes and Industrial Organisations. Such liaison would allow for the utilisation of outside experts in the training programme. Through this liaison, other employees of Government and Industry would also have access to further education to work toward additional professional qualifications.

The second consideration relates to the continued usefulness of the person trained. All programmes will be under continual review to thereby provide the required changes of content and emphasis for tomorrow's needs. Emphasis will also be placed on in-service training and retraining.

The third consideration is to provide the much-needed technologists and technicians who will support engineers, chemists, physicists and other scientists.

Therefore, the Institute of Applied Science and Technology of the University of Ibadan:

1. is to be established on a parallel plane with the several faculties and the director will be on an equal basis with the deans of the faculties;

2. may have on its staff individuals or members listed in departments or faculties who are partially or wholly financed from the Institute budget- thus, these individuals could be listed by both a department and Institute;

3. will have some staff members responsible wholly to the Institute on either a full or part-time basis and for varying periods of tenure;

4. may either wholly or in co-operation with one or more departments sponsor curriculums or programmes for students on sub-professional, undergraduate, and graduate levels;

5. may individually, or in co-operation with one or more deaprtments, sponsor research activities and set up conferences, seminars, etc., on subjects within its purview.

Division within the Institute

Several programmes now operating on a small scale in different departments and faculties in the University but requiring expansion, will become units within the Institute. Other programmes, not now in operation, are also required for a well-rounded programme in applied science and technolongy.

Operating units:

1. Earth Science and Petroleum Technology
2. Chemical Industries Technology
3. Food Science and Technology
4. Electronics and Instrumentation Technology
5. Technician Training
6. Radiobiology and Radiotherapy

Proposed units

1. Agricultural and Forestry Engineering
2. Wood and Textile Technology
3. Health Engineering
4. Drug Technology
5. Environmental Studies.

Description of Programmes (Abbreviated)

Administrative Center

A central building will be constructed to house the Administration, Library, Lecture Theatres, Seminars Rooms, as well as a Common Service annexe for the Institute.

Food technology

Work is in progress in both Government and University departments of Agriculture to improve agricultural production and to make more food available to the community. Greater benefit of this work will result to the community through improved food production with less food wastage through development in the fields of storage, transportation, and marketing. Concurrent development of improved facilities for food processing and preservation is also needed.

To this end, it is hoped that undergraduate and postgraduate degree training programmes will be operated in the various aspects of food technology, including the technology of meat and dairy processing; the processing of vegetable crops including cereals, pulses, oil seed crops, roots and tubers; the processing of tree crop-products like oil-palm, cocoa, rubber, citrus, etc.; the processing and canning of various types of fruits; and the study of problems of food preservation and storage. The training programme will also include a one-year postgraduate training scheme for graduates in agriculture, engineering or science; one-year certificate course of in-service training for government and industry sponsored students and various other courses to meet the specific needs and requests of Government and Industry.

Petroleum Technology, Geophysics and Geochemistry

The main field for applied Geophysics is in the oil industry. Geologists are required for oil and mineral exploration, geophysicists, therefore, as well as petroleum geologists, are needed to cope with the rapid expansion of the petroleum industry and for gravity exploration, logging and log interpretation. A Postgraduate Degree, or Diploma course, is bound to thrive in the well-established Department of Geology at the University of Ibadan in which there is already a Professor of Petroleum Geology financed by several of the Oil Exploration Companies in Nigeria.

Existing training facilities in the University of Ibadan in Analytical Chemistry will be expanded. Research opportunities will be created in all of these areas of Technology in order to attract reputable faculty members. In addition to the Postgraduate training in Petroleum Technology, it is intended to set up a sub-degree programme similar to the Operator Training Programme operating in the University of Pittsburg, USA for the State of Kuwait. This is essential for the training of men skilled in the techniques of extracting oil and gas from the earth.

Wood Technology

As part of the Government's development programme an Institute of Applied Science and Technology has been established at the University of Ibadan. Within the Agricultural Division of this Institute it is proposed to establish suitable training facilities in the field of wood technology.

A department of Forestry has already been successfully established at the University. Profitable wood utilization is complementary to efficient timber cultivation, and there is a wide and rapidly expanding complex of wood-based industries and consequently an increasing need for specially trained personnel - wood technologists - at both the professional and sub-professional levels who can work in these industries.

It is proposed to develop the wood technology training in conjunction with the existing University Department of Forestry and with the Government Department of Forest Research in Ibadan.

The forestry degree course now successfully established at the University of Ibadan, was developed to meet the needs of the major employers in Nigeria (and also other African countries) concerned with the growing of timber.

Equally important to timber cultivation, however, is profitable timber utilization and the forests of the country now form the basis of a wide and rapidly expanding complex of wood and wood-based industries ranging from the extraction and primary conversion of logs to the production of wide variety of manufactured products. There is an increasing need for specially trained personnel at the professional and sub-professional level - wood technologists - who can work in these industries.

To meet this demand it is proposed to develop suitable training in wood technology at the Institute of Technology and Applied Science; there are no graduate training facilities in wood technology, elsewhere in tropical Africa to meet this need.

New buildings will be required and tentative plans are being prepared. It is proposed that the buildings should be of wood and should themselves demonstrate the architectural, economic and practical advantages of using local timbers for construction.

Wood technology cannot be taught effectively at the descriptive level and equipment and special facilities will be required. Very briefly the major items of equipment will consist of strength testing machines, seasoning kilns, pressure impregnation cylinders, presses for panel product production and equipment for mechanical and chemical processing of wood. Rooms maintained at controlled conditions of temperature and humidity will also be required.

For the laboratories it is not envisaged that any special form of construction will be required, but a good concrete floor about 6 inches thick will be required for mounting various machines.

A total floor area of about 9,000 - 10,000 square feet is suggested as being adequate.

Textile Technology

The textile industry is by far the largest domestic industry in Nigeria. In 1967 the domestic industrial production was as follows:

	No. of establishments	Number employed	Wages and Salaries £N'000	Gross output £N'000	Industrial cost £N'000	Value added £N'000
Manufacture of textiles	37	15,064	3,442	26,975	14,453	12,522
Wearing apparel	12	498	51	484	230	254
Made-up textile goods	7	1,605	267	1,928	1,162	766
TOTAL	56	17,167	3,760	29,387	15,845	13,542

Provisional data from the Federal Office of Statistics, Lagos.

In addition, £N16 million worth of textile were imported.

Cotton is the larges raw material used. In 1968 cotton production was 218,816,000 sq. yards and imports 127,908,000 sq. yards, excluding data from the three Eastern States. Since 1967 there has been a large increase in the number of textile industries, especially in factories producing wearing apparel and made-up goods.

There is a need to provide training facilities for Nigerians to fill management and development posts in this major industry. At present there are no such facilities. It is believed that the University of Ibadan with its strong science department (notably chemistry and physics) should develop this training facility.

The initial association of textile technology and wood technology is suggested because there are some areas of common interest; later on separate departments may be developed.

Nigeria does not have the necessary expertise and knowledge to plan a Department of Textile Technology and in the first instance a consultant Professor at Fibre/Textile Technology is required to carry out a feasibility study and to prepare detailed proposals for staff, equipment and buildings for the new department.

Agricultural Engineering

Technology in the area of food production and processing and of materials involves a considerable amount of engineering work. This include the subject fields of land planning and water control, machinery and power, electrical power and processing and housing and crop storage. At present a department of Agricultural Engineering is not available at the University of Ibadan: it is therefore proposed to establish training courses in Agricultural Engineering and to create facilities which would assist in the engineering aspects of agricultural production, food processing and technology and the processing and technology of forestry products.

Service programmes of agricultural mechanization and forestry engineering have been providing for several years, a rounding of education in these fields for majors of other honours programmes. However, a demand for individuals with honours in agricultural and forestry engineering has been expressed by students, government and industry spokesmen, and educators. In addition, applied research is required to adapt machinery and practices in use in other parts of the world to tropical African conditions.

Equipment for teaching and research is required for testing of agricultural and forestry equipment, such as diesel and petrol engines, field and forest equipment, electrical applications, heat driers, air movement, refrigeration, irrigation, land forming teaching of shop processes, etc.

It is hoped to develop a degree in Agricultural Engineering this quinquennium to provide the necessary basis for the mechanisation of ageiculture, storage and processing.

Electronics and Instrument Technology

This is intended to develop under the auspices of the Department of Physics but forming part and parcel of the Institute of Technology and Applied Sciences. Two year sub-degree Diploma and one-year postgraduate degree or diploma courses will be offered in applied Electronics including control system, and in Physical Measurements and Instrument Technology.

In the Physics department of the University of Ibadan, substantial facilities and experience in electronics and instrumentation exist, but a further development in electronics and instrumentation is proposed for the following reasons:

Sophisticated electronic and electro-mechanical equipment is used in many of the medical departments in the teaching hospitals in this country. The acquisition of such equipment is likely to grow. There is also growing introduction of isotope tracer methods with the associated equipment in agriculture and other departments of this University as well as outside. Furthermore, an increasing number of computers is coming into use in this country. Spectrophotometers, pH meters and other analytical instruments are in increasing use. There is therefore a need to establish a stable body of adequately trained technical staff to ensure the maintenance of such vital equipment. Many of the technical staff available in this country at the moment have mostly been trained through apprenticeships and correspondence courses. Although such staff are available in large numbers, they do not as a rule have the experience or abilities to deal with the very complex and difficult problems which often arise in specialized equipment. At the same time, physics graduates find few opportunities for suitable employment outside school teaching.

It is considered that a valuable purpose would be served by making available in the Institute post-graduate instruction in instrument technology with a strong bias for electronics, so as to provide technical personnel who would combine the broad knowledge of physical phenomena and the analytical outlook of the science graduate with a substantial basis of up-to-date technical knowledge.

The project is a new one. New buildings and installations will be required, but no contract has been signed.

Most of the students taking the various technological courses will require special training in Applied Mathematics. This would call for the enlargement of the teaching staff of the Mathematics Department. It is estimated that the cost of 2 teachers (five years) will be £50,000

Technician's Training Scheme

The Laboratory Technician's Training Scheme has been in operation for several years. The scheme, started around 1957, is intended to be a permanent one in view of the number of Universities and other higher institutions in West Africa. Because of the great need for technological and technical personnel all over Nigeria, this Scheme when expanded, will serve as a central training centre for most of our Universities, the Federal and State Governments, and industrial establishments all over West Africa.

At present the training is geared to the requirements of the City and Guilds of London Institute examinations. It will be necessary in the immediate future for the University to award its own Technician's Certificate in Science. A modified scheme has been prepared and is suited to West African needs for the award of Technician's Certificate in Science.

The course is intended to prepare the candidates for employment as technicians in a wide range of science based industries and occupations, e.g., Technician e and Laboratory Assistants engaged in experimental, analytical or quality control work in the textile, plastics, petroleum, food, metallurgical, nuclear power, chemical and pharmaceutical industries; in physical laboratories; and in agricultural science and paramedical occupations. The course is designed to provide a broadly based knowledge of biological, physical and chemical sciences follwed by a degree of specialisation in particular subjects from within the areas of these three sciences. This broadly based scientific education which includes some training for industrial occupations will enable technicians to apply their knowledge in the new industries or roles by acquiring additional specialist knowledge with a minimum of further training and education. This should contribute to that mobility of labour which is necessary for a rapid technological change and which is valuable in the developing countries.

A conscious effort was made in 1965 to provide permanent staff for the Training Scheme and expand this sub-professional Training Scheme. Definite proposals were presented in December 1965 to the National Universities Commission for approval. As stated above the modifications introduced into the training programme will enable the University to award its certificates.

The staff available now for the running of the Scheme numbers up to 44 drawn from the academic staff of the University of Ibadan as well as part-time staff from the nearby Technical College. With the appointment of permanent staff, to be assisted by part-time lecturers, the training programme will be given a new lease of life.

Financial Assistance and Training Programme

The University of Ibadan is seeking, and will gladly welcome any form of assistance, personnel, technical and financial, from all friendly countries, Foundations and other organisations, in the establishment of the Institute of Applied Science and Technology. Already, the Canadian International Development (CIDA) is co-operating actively with the university on the programme. The Economic Commission for Africa (ECA) has also taken an interest and has expressed its readiness to give every assistance to get the Institute off the ground.

The Institute is expected to start functioning in full swing from the 1971/72 session. Experts in the establishment of similar projects are being recruited from abroad, and a programme of training for Nigerian counterpart staff has begun. The University has invited applications from Nigerians at home and abroad in advanced stages of their academic programme in the relevent fields, for further training under this programme.

Appendix VI: PROGRAMME OF THE MEETING

Monday 10 August

12.00 noon - 1.45 p.m — Lunch with the Rt, Hon. The Lord Bowden of Chesterfield, Principal of University of Manchester Institute of Science and Technology

2.00 p.m. - 4.30 p.m. — First session - Talk

"Structure, function and experience of University of Manchester Institute of Science and Technology" -Lord Bowden

Tuesday 11 August

9.30 a.m. - 12.15 p.m — Second session - Paper

"The Need for Advanced Institute for Applied Science and Technology"
- Dr. A. Banjo

2.25 p.m. — Third session - Paper
"Ideas as to Possible Forms and Functions for Advanced Institutes for Applied Science and Technology in Africa"
- Dr. A. Banjo

Wednesday 12 August

9.30 a.m. - 12.15 p.m — Fourth session - Presentation of Proposals

"Creation of a Technology Advisory Group at the University of Science and Technology, Kumasi"
- Professor S. Sey

Wednesday 12 August

1.30 p.m. - 4.30 p.m. — Tour of the Laboratories, University of Manchester Institute of Science and Technology

Thursday 13 August

9.30 a.m. - 12.15 p.m. — Fifth session - Presentation of Proposals

"Proposals for an Institute of Applied Science and Technology"
- Professor T.O. Lambo