Restricted
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Terminal Report

GUYANA

Research and Development Support for the Institute of Applied Science and Technology

Project Findings and Recommendations

Serial No. FMR/SC/OPS/82/214 (UNDP)

United Nations Educational, Scientific and Cultural Organization

United Nations Development Programme

Paris, 1982

G U Y A N A

Research and Development Support for the Institute of Applied Science and Technology

Project Findings and Recommendations

Report prepared for the Government of Guyana by the United Nations Educational, Scientific and Cultural Organization (Unesco) acting as Executing Agency for the United Nations Development Programme (UNDP)

United Nations Educational, Scientific and Cultural Organization

United Nations Development Programme

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GUY/79/002 - Research and Development Support for the Institute of Applied Science and Technology (IAST)

TERMINAL REPORT

I. INTRODUCTION

1. The Government of Guyana has consistently given special priority to the development of skills and expertise in the fields of science and technology. In order to assist in the formulation of a national science policy a Cabinet decision of the Guyana Government in 1972 recommended the formation of a National Science Research Council (NSRC). The NSRC was incorporated by an Act of Parliament in 1974 and it was given the additional tasks of promoting research and determining priorities for spending in the diverse fields of science and technology.

2. Research facilities in Guyana at this time were restricted to the University of Guyana and a few of the larger corporations operating in the country. The facilities at the University were very limited, while equipment in the producing sector tended to be highly specialized and orientated to daily quality control rather than longer-term development.

3. Research and training at a local or regional level has generally been considered more desirable so long as the available facilities are of a sufficiently high standard.

4. There was little original research or development work being undertaken in Guyana and any interesting or serious scientific or technical problems that required long-term work were invariably referred to outside agencies or institutions, usually in Europe or North America. As a result of this situation, local skills were not being developed, trained personnel were becoming disillusioned and man-power was being wasted.

5. The Government of Guyana realized that this situation was developing and, through the NSRC, it acted to alleviate the problem. A recommendation was made that an independent research institute should be built. This institute would become the National Centre for Research in specific areas of high priority to the Government's development thrust. It was envisaged that this institute might also become a 'regional' centre for research in specialized areas unique, or especially significant to Guyana.

6. Formal plans for the Institute of Applied Science and Technology were laid during 1975 and, under an agreement with the Canadian International Development Agency (CIDA), work on the building started in 1978. The Government of Guyana accepted

responsibility for construction of the building, while the CIDA provided technical and planning assistance in a total aid package of US$ ½million.

7. The building was completed during 1979. A Director was appointed and four priority areas were identified as being significant to the National Development Programme of Guyana. These areas were:

(i) Alternative sources of energy

(ii) Mineral resource development

(iii) Natural products development

(iv) Wood research

8. The Government of Guyana, realizing that the mineral resources of the country, other than bauxite, were so far virtually untapped, and being aware that development work sent to overseas agencies would be of little long-term benefit to the country, recommended the installation of a mineral-processing pilot plant that would be capable of full commercial assessments of local minerals and rocks to the IAST.

9. In addition, the Government of Guyana felt that in order to establish a nucleus of high calibre professional scientists and technologists at the IAST, it would initially be necessary to appoint one or two senior overseas experts.

10. In January of 1980, the Government of Guyana made a formal approach to Unesco, through the UNDP, for the provision of two experts. In addition, equipment has to be provided for both programmes.

11. The Unesco project, offering research and development support to the IAST, was formally initiated on 16 March 1980.

II. OBJECTIVES OF THE PROJECT

12. The long-term development objectives of the project are:

(i) to apply science and technology to the exploration, exploitation and conservation of natural resources in Guyana;

(ii) to promote the application of science and technology to the economic and social development of Guyana;

(iii) to promote the development and utilization of local technological systems in Guyana; and

(iv) to reduce thereby the dependency of Guyana on foreign technology and imports and to provide the technological basis for improved export earnings.

13. Within the framework of the long-term objectives, the immediate objectives of the project were:

(i) to establish an Alternative Energy Programme at the IAST: This programme would develop prototype equipment and installations for such activities as solar crop drying, biogas generation, wind generation of electricity and bicycle-powered agricultural machines. It would also concentrate on the specific area of charcoal production, using kilns instead of the traditional pits, and would disseminate information on the utilization of charcoal kilns and train potential users in production and quality control.

(ii) to establish a Mineral Sciences Programme at the Institute: This programme would install and develop a pilot plant facility at the IAST capable of beneficiating potentially commercial mineral ores that might be found in Guyana. It would aim to produce saleable quantities of commercial grade feldspar and kaolin, while assessing other ores, and would establish laboratories and preparation facilities for undertaking mineral assessments and train local staff to operate the pilot plant and carry out feasibility work.

(iii) to establish a Ceramics Programme at the IAST: This programme would analyse and catalogue the most important raw materials for the ceramics industry. Research work would be undertaken to establish the suitability of these raw materials for use in a local ceramic wares industry. Body formulations for tiles and domestic ware would be prepared and tested and a matched glaze would then also be developed.

III. TERMS OF REFERENCE

14. The IAST is seen as an instrument for the development of indigenous scientific and technological capacity in Guyana as well as a means by which to attract to Guyana national and expatriate scientists to work on problems of relevance to the country's needs. In order to attract competent professionals, it was decided that a reputation for excellence and high standards should be set at an early stage and subsequently maintained.

15. Such a standard would not be possible in all fields of science and technology and so certain key areas, with specific importance to Guyana, were selected for special development. In addition to the three programmes detailed in the UNDP/Unesco Project, natural products and wood research complete these key areas.

16. Being aware of the importance of science and technology to developing countries, and being familiar with the special circumstances of the Caribbean basin, it was decided that the IAST should seek and offer technical co-operation within the region and should work towards establishing itself as a regional centre for work in its selected special areas.

IV. ACTIVITIES AND OUTPUTS

Alternative Energy Programme

(a) Staff:

17. A Unesco Expert in Alternative Energy was appointed to the Project and took up his post in the programme on 16 March 1980. Although a Senior Scientific Officer (and Research Director Designate) for the programme had been identified, the candidate was never appointed and the post remained vacant throughout the period of the programme. A Scientific Officer working with the Science and Industry Committee of the National Science Research Council was seconded to the programme in March 1980. In January 1981, he was joined in the programme by a second graduate who assumed responsibilities for the biogas work. When the Unesco Expert in Alternative Energy left the programme in March 1981, the scientific officers continued in their own programmes reporting directly to the Director of the IAST.

(b) Solar Energy and Dryers

18. Under the direction of the Unesco Expert in Alternative Energy, and subsequently under the Director of the IAST, various types of passive solar dryers were built and tested.

(i) During 1980, the Director of the IAST supplied the Unesco Expert with plans for a cabinet dryer. The Expert supervised the construction of these dryers which were then field tested on a variety of crops with great success; these crops included ginger, tumeric and plantains. In September 1981, the IAST supplied three cabinet dryers to the Mahaica/Mahaicony/Abary Development Scheme (MMA) for use in that project. The units at the IAST have been demonstrated to both farmers and manufacturers.

(ii) In August 1980, the Caribbean Development Bank (CDB) agreed to fund work on the cultivation, drying and utilization of chilli peppers in Guyana, and solar dryers made at the IAST were chosen for the drying. The work has continued throughout 1981 with excellent results and the dried chillies have been used successfully in the preparation of a locally-marketed curry powder.

(iii) A greenhouse-type passive solar dryer had been designed and developed by the Unesco Expert during a previous assignment and work was started on the construction of such a dryer at the Belbaag Co-operative Scheme towards the end of 1980. Shortage of materials, together with lack of consultation about the siting of the dryer, resulted in lengthy delays. The original building was subsequently dismantled in May 1981 and, working on a modified design, the dryer was re-sited in a more suitable location. This second Belbaag dryer was finally completed in October 1981 and will be used for the drying of local chilli peppers, sorrel, fruits, pigeon peas, black-eye peas, local seasonings and field testedfor copra drying. The modified design of the greenhouse passive solar dryer was also used for an installation at the McDoom processing plant of the Guyana Fisheries Limited. Construction was again severely delayed because of shortage of essential materials, but the work was completed in August 1981 and is now being fully utilized for the preparation of dried fish.

(iv) A solar hot water system for the IAST was considered early in 1980 but the plans were never formalized. However, in July 1981 the design for the system was modified with the aim of producing distilled water

which is vitally important to the day-to-day functioning of the Institute. A small solar distillation unit was subsequently constructed and the distilled water produced from it is being used in the research laboratories.

(v) The Scientific Officer introduced to the Institute the designs of solar dryers investigated by the University of Guyana, Faculty of Technology (box type) and NSRC ('V' roof design). These were also constructed and field-tested.

(c) Biogas:

19. At the beginning of 1980, there was already a well-established programme for assessing the designs and performance of biogas generation plants in Guyana. The programme was under the direction of the Energy Authority of the Ministry of Energy and Mines, with technical and financial assistance provided by the Latin American Energy Organization (OLADE). In March 1980, it was agreed that the project would be co-managed by the IAST. Throughout 1980 and the early part of 1981, the IAST took a rather passive role, simply observing and monitoring the work of OLADE and the Energy Authority. However, in June 1981, it was decided that the IAST would build an Indian design biogas plant, as opposed to the Latin American and Chinese design plants of the OLADE programme. A small farm holding at the nearby community of Liliendaal was chosen for the site and by September the plant was complete and operational. Tha IAST maintained constant surveillance of the plant operation and was thereby able to identify, and solve, initial problems. The plant is now running smoothly and the farmer is well pleased with the results.

(d) Wind Energy:

20. Throughout 1980, the Unesco Expert in Alternative Energy examined various wind-powered generators for electricity, and compared their design with the water pumping wind-mills already operational in Guyana. The desirability of having a functional wind generator operating at the IAST site was realized, but there was no provision for the purchase of such equipment in the 1980 Project Document. The Unesco Expert proceeded to fabricate a number of units based on his own prototype designs, but none was successful, and the work was put into abeyance in April 1981.

(e) Bicycle Power:

21. During a previous assignment, the Unesco Expert in Alternative Energy had modified and developed his original standard

design of a 'bicycle power unit' to suit the Guyana environment. The concept of a 'take-off unit', into which could be fitted a conventional bicycle, with slight modifications to the rear hub, was most successful and was well received throughout the country. The prototype chicken plucker, also developed by the Unesco Expert from conventional designs, was also very favourably received and the Expert demonstrated these designs to farmers all along the coastal strip. The Unesco Expert presented three papers on his work and was also interviewed by the Canadian Broadcasting Corporation in August 1980. However, problems in obtaining suitable centrifugal fans for a winnower-grader, based on the bicycle take-off unit, effectively stopped further development of the work and, after some initial attempts on a cassava grater, the programme was discontinued in June 1981.

(f) Charcoal:

22. The Unesco Expert in Alternative Energy was never directly involved in charcoal work, although it was part of the overall Alternative Energy Programme, and the activities listed here are given purely for the sake of completeness. The Director of the IAST took full responsibility for this work and under his direction:

(i) twenty-four Mark V kilns, based on a modified Uganda design, have been produced and supplied to rural communities. The IAST assisted with installing and commissioning the kilns and offered technical assistance when needed.

(ii) eight training programmes have been organized, demonstrating the operation of the Mark V kiln to prospective users and emphasizing the importance of quality control if an expanded overseas market for the charcoal product is to be realized.

(iii) the carbonization characteristics of numerous species of Guyana woods have been determined and catalogued and the IAST has been able to advise prospective buyers of charcoal on the type most suited to their needs.

(iv) activated charcoal has been produced. Both the sugar and alcoholic liquor industries in the country have expressed an interest in this work and are keen to see further development.

(v) by-products from the wood distillation have been collected and catalogued.

(vi) A pilot plant for producing charcoal briquettes from saw-dust and wood chips has been assessed, with a view to the possible introduction of this technology in Guyana.

(g) Training:

23. Early in 1981, one Scientific Officer attended a training programme in alternative energy technologies organized by the Solar Energy laboratory of the University of Florida and sponsored by the USAID. During October, he subsequently attended the Second Latin American Workshop in Bio-energy Technologies that was sponsored by OLADE. During June 1981, another Scientific Officer attended a training programme on the Biogas digester construction, operation, and utilization in India. This was sponsored by the Commonwealth Science Council.

Mineral Sciences Programme

(a) Staff:

24. A Unesco Expert in Mineral Sciences was appointed to the project and took up his post in the programme on 14 May 1980, after a period of briefing in Paris. A Research Officer was already working in the programme, having been appointed in April 1980 and a Senior Research Officer (and Research Director Designate for the programme) was appointed during May. A second Research Officer joined the programme in November. By mid-1981 the programme was also supervising four laboratory technicians, although three were specifically for analytical services.

(b) Pilot Plant and Ore Preparation:

25. The installation of a minerals beneficiation pilot plant was a key factor to the whole support project. The work involved not only supervising the installation of equipment, but also designing lay-outs for unit operations, equipping the ore preparation room, organizing an ore-storage shed and obtaining stocks of raw materials.

(i) After some initial problems with foundations, the storage shed was completed early in 1981. Stocks of kaolin, ball clay, feldspar, talc, ilmenite, laterites and bauxite had already been collected and these stocks were maintained throughout 1981.

(ii) The ore preparation room, designed to supply the laboratories with rock in a suitable form for feasibility tests, was completed before the end

of 1980 but the lack of an electrical power supply because of delays in the completion of the IAST sub-station, prevented the facilities being used. A temporary line was connected in February 1981 pending the connection of the permanent supply to the entire pilot plant building, which was commissioned in June 1981. Equipment in the ore preparation room includes a crusher/grinder, a jar mill and a pug mill, sieves and a sieve shaker rock-saw and lapping wheels.

(iii) All of the equipment for the pilot plant was ordered from a firm in the United Kingdom. It was despatched in three consignments and the last of these was received on site at the IAST at the beginning of June 1981. It was then necessary to assemble the equipment and prepare foundations for its installation in the pilot plant building. It was possible to install certain units - the jaw crusher, filter press and thickener - immediately, while others, such as the hydrocyclone and comminution circuit, required ancillary structural steel work. This work was contracted out to a local engineering company, which fell far behind on its completion date because of difficulties in obtaining steel and, it was claimed, due to pressure from other work. By October 1981, most of the units were, however, in place and commissioning work is now under way. Shortage of pipe and electrical switches is still causing delays. Work in the pilot plant was simplified and assisted by two overhead travelling cranes that had been installed early in 1981.

(c) Laboratory and feasibility work:

26. The laboratory work of the programme fulfilled three functions: (i) facilitated the training of local staff; (ii) facilitated the supply of beneficiated material to the ceramics programme; and (iii) offered a research and development service to industry and interested persons in the country.

(i) It was necessary to teach a few basic skills. These included the operation of flotation machines and test hydrocyclones, particle size analysis using the Andraesen pipette and liberation analysis. This was quickly achieved and the Research Officers, under the immediate direction of the Senior Research Officer, settled down to individual research projects.

(ii) The ceramics programme required kaolin of the correct particle size and feldspar containing as little iron as possible. Using the facilities in the ore preparation room in conjunction with a small hydrocyclone unit and flotation machines, raw materials were crushed and beneficiated to the stipulated specification - kaolin minus 2 microns in size, feldspar to contain less than 0.1% iron. A continuous supply was maintained to the ceramics programme.

(iii) During the life of the project, the mineral sciences programme was asked to assess numerous locally-available raw materials as possible substitutes for imported products. The work was handled entirely by the Research Officers and problems were discussed at weekly project meetings with the Unesco Expert in Mineral Sciences. This work has included:

Pozzolanic Materials: There is keen international interest in cements based on rice husk ash and lime, and early in 1980 the Guyana Rice Board approached the IAST to undertake research in this field. A kiln was designed to provide a suitably burnt rice husk and the ash was then mixed with cement to make mortar blocks. The work concentrated on parameters such as age of the ash, particle size, method of grinding and mix proportions with the cement. The finished blocks were compression tested and compared with British and American standards. It was found that although the mortar produced by mixing rice husk ash with cement was not as strong as portland cement, its strength was quite adequate for normal building practice and a considerable saving in foreign exchange was possible.

Pigments: Pigments, used in the colouring of paints, plastics and wood stains, are all imported and yet many of the rocks and minerals of Guyana have pigment potential. By crushing, grinding and carefully sizing a selection of laterites it was possible to produce yellow, brown and red pigments which were supplied to the Guyana Pharmaceutical Corporation for paint formulation. Various possible white pigments were also prepared and tested. The results were most encouraging and it was evident that locally prepared pigments would be quite acceptable in replacing the imported material. As soon as the pilot plant is fully commissioned, five tonnes of each colour will be prepared.

Chalk substitute: Blackboard chalk, shoe whitener and putty are all based on limestone or chalk of one form or another. The use of these materials is purely traditional in that chalk was the most commonly found white material in Western Europe. In Guyana, which completely lacks chalk or limestone deposits, the use of some other material must be sought. It was found that by incorporating kaolin with a binding agent and extruding it through a die, a quite acceptable blackboard chalk could be produced. Similarly, a whitener was possible and if the kaolin was calcined to improve its oil adsorption characteristics and durability, a good putty could be made.

Salt: After discussions with the Ministry of Economic Development and the Guyana Pharmaceutical Corporation, the IAST undertook a pre-feasibility study of the coastal sea waters of Guyana. Samples of sea water were collected at distances of 1.5, 4 and 8 km. from the shore at various points along the coast. It was found that salinity values were low and it would be necessary to remove silt from the water prior to any solar evaporation.

Coloured bricks: The Guyana National Engineering Corporation produces clay building bricks which are structurally very sound but aesthetically uninteresting. In July 1980, the IAST was asked if it could assess the possibility of producing a good quality facing and/or coloured brick. The experimental work, which continued throughout 1981, investigated surface coatings of sand and body colouring using manganese dioxide and a range or iron oxides. The bricks, displayed at the National Exhibition in August 1981, elicited much interest and were acclaimed.

Testing: The mineral science laboratories have undertaken numerous small 'testing' jobs. These are generally in the nature of particle-size analysis, moisture determination or mineralogical analysis. The laboratories are now offering a wide range of services including bulk density and air permeability testing, together with an assessment of any local gem materials.

(d) Analytical Services:

27. The ability to perform an accurate chemical analysis of rock or mineral samples was essential to the programme. Hence, shortly after his arrival, the Unesco Expert in Mineral Sciences gave special emphasis to installing and calibrating certain analytical instruments. An analytical instrument room was identified and equipped with an air conditioning unit, fume extraction ducting and safety cage to house gas cylinders. An atomic absorption spectrophotometer was installed, together with an ion activity meter and, under the supervision of the Expert, the laboratory technicians gained experience in the use of these instruments and techniques of analysis. The instruments have been in continuous use throughout 1981.

Although the Unesco Expert still maintains a supervisory role over the inorganic section of the analytical laboratories, it was recently decided to make the Analytical Services an autonomous centre within the IAST. Analyses have been undertaken for a wide cross section of the Guyana community, the most notable contracts being for the analysis of cow's blood serum for the Livestock Development Company (LIDCO) and the geochemical analysis of soil samples for the United Nations Revolving Fund for Natural Resources Exploration (UNRF).

(e) Overseas training:

28. On 1 October 1981, one Scientific Officer from the programme took up a Unesco Research/Study fellowship with Robertson Research International Limited in Llandudno, North Wales (United Kingdom). There he will gain experience in project evaluation and feasibility studies at an international level. It is hoped to extend his stay in order to include exposure to clay brick technology.

Ceramics Programme

(a) Staff:

29. On his arrival in May 1980, the Unesco Expert in Mineral Sciences also assumed immediate responsibility for the ceramics programme. A Research Officer was appointed in June 1980. A laboratory technician was appointed in January 1981 and four pottery assistants have since joined the programme. The pottery assistants work in clay and produce a range of items that are sold through commercial outlets in Georgetown. The income from these sales goes into the IAST general account and the team is almost self-funding.

(b) Characterisation of Clays:

30. In order to lay a solid foundation for the formulation of the programme it was decided to undertake a complete analysis of the clays found in Guyana and to catalogue the results for future reference. The work, which started in June 1980, included thermal expansion, differential thermal analysis, workability, particle size and colour analysis. Over twenty clays, from different locations, have been tested and a full report has been prepared. The report is held on file at the IAST and additions or modifications are made, as necessary, whenever a new clay is received.

(c) Projects:

31. The project work of the ceramics programme has been directed towards producing ceramic bodies based on local raw materials and glazes to match these bodies.

(i) Tiles: Most houses in Guyana use ceramics tiles in the bathroom and these are imported. The raw materials to make tiles - kaolin, ball clay, feldspar and talc - are all available in Guyana and the work of the ceramics programme has been orientated to formulating a suitable 'body' mix from these materials. The work, which has continued throughout 1981, involves mixing the raw materials in fixed proportions, pressing the resultant clay body into a flat tile and firing this to a pre-determined temperature. The resultant 'biscuit' is then tested for warping, strength and colour. As can readily be appreciated, a large number of test firings have been necessary, but an acceptable body has now been identified. The work has been followed with great interest by the Guyana National Engineering Corporation and also a smaller private company. Both organizations are keen to enter into commercial production as soon as the development work has been completed.

(ii) Tableware: Everybody uses cups, saucers, and plates and if these could be produced in Guyana there would be a saving of foreign exchange, together with additional employment prospects created by the new industry. It was relatively simple to modify the tile body formulation work to incorporate tableware and a 'slip body' has now been prepared that gives a good strong ware of acceptable colour. Work is currently under way to prepare a glaze for this ware, and it is hoped that a selection of items will be available for sale early in 1982.

(iii) Porcelain: The possibility of producing a porcelain body from local raw materials was well known and, towards the end of 1980, the IAST was approached by an important building project seeking assistance in obtaining porcelain electrical insulators which were then in short supply. The Programme Research Officer designed a mould for the insulators, formulated a suitable porcelain body, prepared a glaze to match this body and, subsequently, supplied the building project with the fifty insulators that they required. This represented a major piece of work, which will be followed up in future projects.

(iv) Early in 1981, work was also started on building a wood-burning kiln for firing the finished ware. The kiln was completed in September and after successful test firings a second, larger, unit was proposed. This kiln is presently under construction. It was found that one 'load' of timber 'scraps', costing G$ 12 (US$ 4), would fire a fully loaded kiln to 1020°C. This represents a considerable saving over the conventional electrically-fired kiln. The wood-burning kilns are open for inspection by local potters who are being encouraged to build their own. The IAST is offering technical assistance.

(d) Inter-Agency Co-operation:

32. Contact was made in May 1981 with the UNIDO-Czechoslovakia "Joint Programme for International Co-operation in the field of Ceramics, Building Materials and Non-metallic Mineral-based Industries" with the aim of establishing a formal link between this programme and the IAST. The IAST would act as a Caribbean Regional Centre for the programme, undertaking training programmes and certain research projects. Technical assistance and training literature would be provided from Vienna. At the request of the Government of Guyana, Unesco undertook the necessary steps to formalize this agreement.

(e) Seminar:

33. On 19 November 1981, the Research Officer attended a seminar in Dominica, sponsored jointly by the Government of Dominica and the Commonwealth Youth Programme. The theme of the seminar was "A Youth Policy as it relates to strategies for employment creation in Dominica". The Research Officer presented a paper entitled "Appropriate technology for self-employment in Ceramics".

V. ACHIEVEMENT OF OBJECTIVES

34. Within the framework of the terms of reference for the UNDP/Unesco project, two important objectives have been achieved:

(i) fully functioning programmes in Alternative Energy, Mineral Science and Ceramic research and development work have been established.

(ii) The IAST has been given impetus in its developmental drive and this impetus has enabled it to achieve a degree of excellence far sooner than would otherwise have been possible.

35. Within the Alternative Energy Programme, the following objectives have been achieved:

(i) the effectiveness of solar drying has been proved and the real benefits that can accrue from its use have been demonstrated. Operational solar dryers are now functioning in a number of commercial applications and the IAST has orders to supply additional units.

(ii) a biogas plant has been erected in a rural community that would have been unable to fund such development by itself. Thus, a new technology has been introduced into the community, its effectiveness has been demonstrated and underlying doubts about operation, maintenance and usefulness have been removed.

(iii) a bicycle-powered chicken plucker has been fully developed and demonstrated to a large section of the farming community.

(iv) twenty-four charcoal kilns have been installed in rural communities and eight training programmes have been successfully completed. The operation of the kilns has been explained and the importance of quality control has been emphasized. Links with a research centre in Brazil are being developed.

36. Within the Mineral Sciences Programme, the following objectives have been achieved:

(i) an operational pilot plant fully capable of beneficiating kaolin, feldspar, talc rock and ilmenite has been installed at the IAST.

(ii) a small team of local scientists is now offering a consultancy research and development service to industry in Guyana within the field of mineral sciences. The team has already solved a wide variety of problems.

(iii) kaolin and feldspar have been processed and supplied to the Ceramics Programme.

(iv) an analytical laboratory has been equipped and commissioned and an analytical service is now offered to industry in Guyana. The laboratory technicians operating the instruments have all been trained within the Programme.

37. Within the Ceramics Programme, the following objectives have been achieved:

(i) a catalogue, listing the properties and characteristics of the main clays found in Guyana, has been prepared.

(ii) a ceramic body that produces a tile of good strength and acceptable colour has been developed.

(iii) a ceramic body that produces tableware of good strength and acceptable colour has been developed.

(iv) electrical insulators made from a locally developed porcelain body have been produced and supplied to a building project.

(v) a small team of pottery technicians is producing pottery-ware for sale in Georgetown.

(vi) two kilns, burning wood, have been built and pottery-ware has been fired in them. The kilns are on display to demonstrate how they can be used to save on fuel costs.

VI. OBSERVATIONS

38. While much has been achieved, there have also been problems and delays in each of the individual programmes.

Alternative Energy:

39. Although the initial project document contained provisions for both fibre-glass and a comprehensive wind-recording system, requisitions were never made to Unesco. This equipment, together with the much needed black paint, was ordered through the IAST foreign exchange allocation and, as a result, excessive delays were incurred.

40. Being aware of these problems, the IAST has taken steps to ensure that full stocks of paint and fibre-glass are held for future development work.

41. The IAST is still without equipment and instruments capable of producing a complete and comprehensive record of the wind characteristics in selected sites. Such information is not available from any other institution and without this information it is impossible to run a realistic wind energy programme.

42. Neither the wind energy and bicycle power programmes nor the solar dryer programme were ever put on a solid scientific basis. Equipment was produced and demonstrated most effectively, but no scientific investigations were ever carried out into, for example, ambient temperature and drying rates, horse-power input and Kw/hr output. It must be recorded that this was a weakness in the programme.

43. Throughout 1980, the IAST was uncertain of its role in the biogas programme. After the positive moves taken in the summer of 1981, this uncertainty was removed.

44. There has been a reluctance to accept scientists and technologists into more senior research posts unless they possess Masters or Doctorate degrees. In many instances, this reluctance has persisted even when the persons involved have proved their ability. The IAST is endeavouring to promote staff on the basis of proved ability and not paper qualifications alone.

Mineral Sciences

45. There was a severe error in preparing the budget for the mineral sciences pilot plant and as a result the total cost involved was under-estimated by a factor of 3. Because of this error, there were delays in ordering, but the invaluable help and assistance of the UNDP in modifying the budget must be recorded.

46. During the summer of 1981, the Unesco Expert in Mineral Sciences took annual leave in the United Kingdom. His absence from the programme exacerbated the delays that had already developed. Because of them, it has not been possible to bring the pilot plant into full production.

47. The IAST authorities feel that the procedure of international bidding based on requisitions to the Agency caused delays in the completion of the mineral processing pilot plant.

48. It is felt that many very competent Guyanese scientists and technologists would be only too willing to remain in Guyana, or to return home from abroad, if they could be confident of receiving a salary that reflects their skill and expertise at an international level.

49. Most of the development thrust at the IAST has been directed towards equipping laboratories and establishing programmes. Most training has been 'on-the-job' without much emphasis on overseas courses. During the next two years this emphasis will change and it will be important for scientists from the IAST to gain overseas experience. But this experience will not be limited to academic training exercises and the IAST will be seeking assistance for its officers to be seconded to industry and research establishments overseas.

VII. CONCLUSIONS AND RECOMMENDATIONS

50. The UNDP/Unesco Project of Research and Development Support to the Institute of Applied Science and Technology has been a great success.

51. A programme of continued international support to the IAST is highly desirable in order to allow it to maintain its present position and to consolidate the work that has already been completed. In this respect the following recommendations are made:

(i) the alternative energy programme should be put on a firm scientific basis allowing detailed monitoring of all equipment installed by the IAST.

(ii) the mineral sciences and ceramics programmes should adopt a realistic commercial attitude to their programmes, selling services and products whenever possible.

(iii) special emphasis should be given to the ceramics programme and the analytical services section, as both are key areas in the developmental thrust of the country.

52. It is recommended that some form of local contract be offered to local professionals in the project field which will afford them a salary that reflects their skill at an international level.

53. It is recommended that greater emphasis be given to industrial secondments, e.g. short industrial apprenticeships and in-plant training.

APPENDIX 1

Unesco Experts

Name	Country of Origin	Field of Specialization	Duration of Contract
B. N. Ghosh	India	Alternative Energy	3/80 - 3/81
R. J. Lee	United Kingdom	Mineral Sciences	5/80 - 4/82

APPENDIX 2

National Staff

Post Description	Name of Incumbent	Assumed Duty
National Project Director	Dr. U. O'D. Trotz	3/80
Alternative Energy Programme		
Research Director Designate	Mr. U. Bhimsen	3/80
Scientific Officer	Mr. J. Jairam	1/81
Laboratory Technician	Mr. A. Cunje	3/80
Mineral Sciences Programme		
Research Director Designate	Mr. A. Ramwa	3/80
Research Officer	Miss Y. Lochan	3/80
Research Officer	Mrs. L. Locke	3/80
Research Officer	Mr. B. Christiani	11/80
Laboratory Technician	Mr. G. Tobarran	1/81
Laboratory Technician	Mr. H. Nandkumar	3/81
Laboratory Technician	Miss Y. Andrews	3/81

APPENDIX 3

Fellowships

Christiani, Brian - Mineral Processing Research and Development Work	Robertson Research International Ltd. North Wales, United Kingdom	1/10/81 - 31/1/82

APPENDIX 4

Unesco Equipment Input

Supplier	Item	Order No.	Cost	
1. Luna AB	Tools	472075	US$ 840	
2. Green Equipment	Moisture Tester	807935	400	
3. McMaster Carr	Miscellaneous	807571	1,032	
4. Andrews Mail Order	Camera & Calculator	472074	350	
5. Richard Kwan Ltd.	Audio Visual	807572	2,042	
6. TI Raleigh	Bicycles	807631	680	*
7. Broodhead Garbett	Tools	472079	603	
8. Belford Instrument Co.	Thermohygrograph	472080	590	
9. Toyota	Car	472025	4,986	
10. William Boulton	Pilot Plant Equip.	472458	202,940	
11. Pye Unicam	Integrator	807841	10,985	*
TOTAL RECEIVED NOVEMBER 1981:			US$213,783	

* not received 10/81

APPENDIX 5

Selection of the CIDA/IAT Equipment

		US$
1.	Rotary Pre-Grinder, blades, wheels, etc;	2,170
2.	Vibro-screen unit	4,000
3.	Mixer	1,050
4.	Spray booth, gun and accessories	880
5.	Filter press - small for ceramics	12,000
6.	Box kiln	5,590
7.	Avery Weighing Scale	2,910
8.	Crusher/Grinder - bench unit	3,000
9.	Jar mill, jars and media	5,040
10.	Titrimeter	3,490
11.	Laboratory Oven	1,700
12.	Thermal Gradient Furnace	6,030
13.	Thermal expansion apparatus	8,000
14.	Viscometer and flow tube	4,650
15.	AAS, recorders, lamps, etc.	40,660
16.	Ion activity meter	3,000
17.	2 Denver Flotation cells	4,720
18.	Electronic Servicing Equipment	8,620
19.	IR Spec.	14,700
20.	Machine Shop Lathe	15,270
	TOTAL	US$ 147,480

APPENDIX 6

IAST Administration Expenditure

	1979 G$	1980 G$	1981 G$
Salaries	78,440	241,680	285,650
Vehicles maintenance and operation		16,140	22,495
Outside contracts and general services		60,300	169,740
Overseas travel and training		59,930	46,610
Supplies (general)		42,630	67,320
Stationery and photocopying		19,140	20,970

APPENDIX 7

IAST Expenditure on Programmes

	1979 G$	1980 G$	1981 (2) G$
Alternative Energy	3,000	31,300	63,610
Charcoal Unit	55,780	35,865	14,180
Pilot Plant and Mineral Laboratories	--	49,450	70,280
Ceramics Unit	520	2,180	11,965
Natural Products	49,000	26,485	32,230
Technical Services	--	(1)	52,925

(1) Technical services such as electronics servicing, photographic services, machine workshop, wood workshop, glass blowing workshop were being established during 1980 and were not separately accountable until 1 January 1981.

(2) for nine months to 30 September 1981