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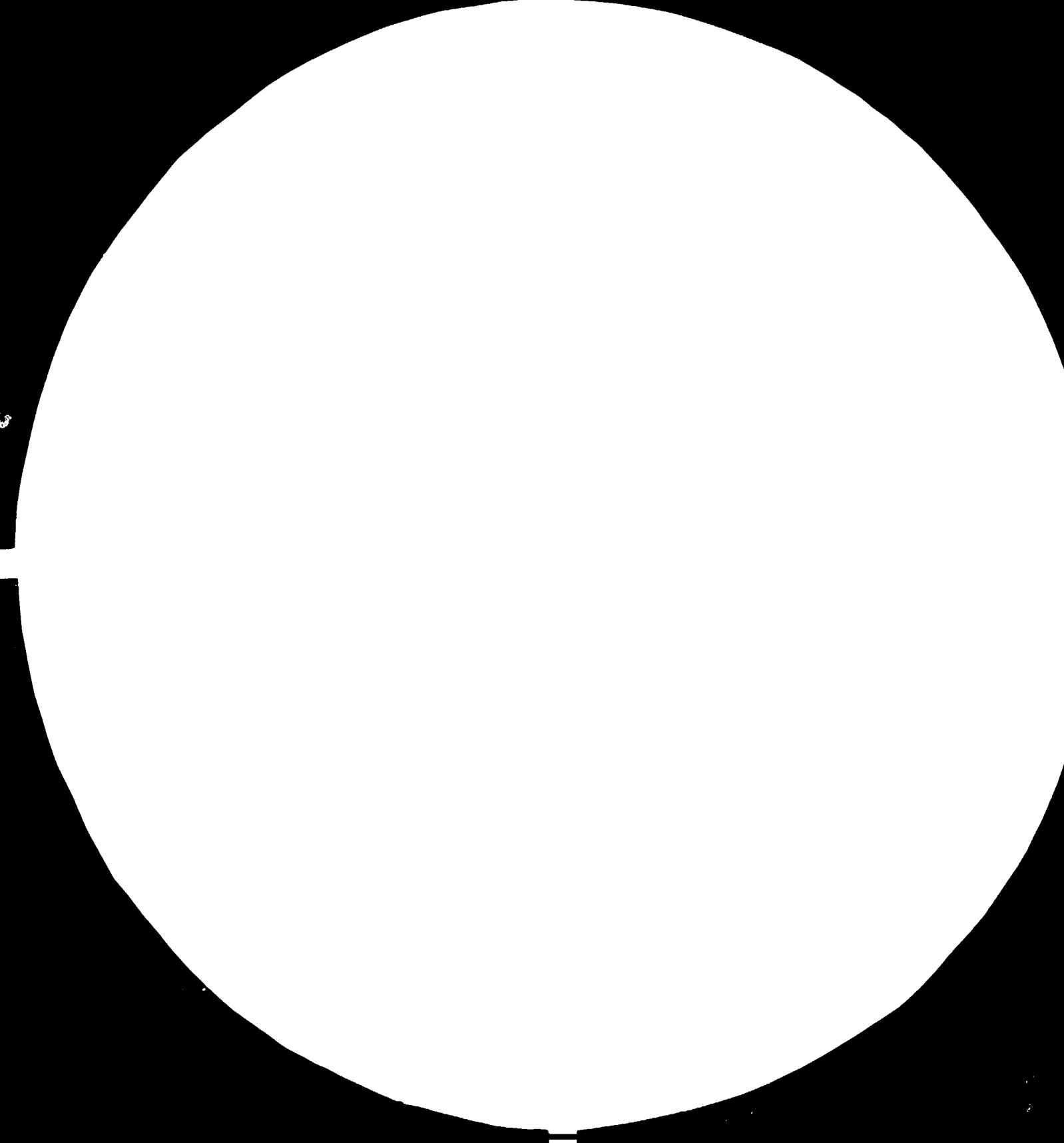

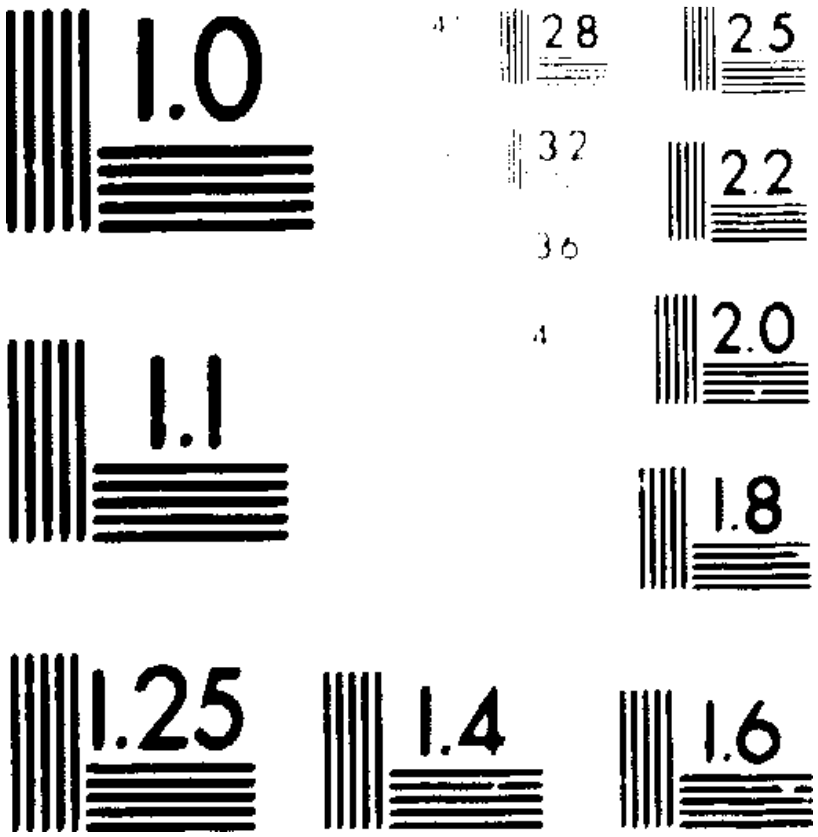

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GUYANA

Terminal Report: A Timber Research Laboratory for Guyana*

Prepared for the Government of Guyana by the
United Nations Industrial Development Organization

Based on the work of Robert H. Leicester**

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SUMMARY

This report describes the findings of a visit Guyana to develop a long range plan for the structural utilization of Guyana's timbers, and to develop a proposal for a Timber Research Laboratory to assist in fulfilling this plan.

The forests of Guyana are characterized by numerous mixed species of tropical hardwoods. Only a small percentage of the merchantable logs are utilized, and most of this comprises a single species, greenheart or Ocotea rodiaei. This species dominates both local useage and the export trade. The existing infrastructure for timber engineering is meagre, and what there is, has been developed largely for the quality control of timber exports.

The professional level of expertise that is available in Guyana is quite satisfactory. However, any attempt to develop a viable timber engineering infrastructure will be dominated by the fact that the population of the country is very small, less than a million. The only solution would appear to be that all professional organizations, including the proposed Timber Research Laboratory, interact closely within a common national strategy. The effectiveness of this solution can be enhanced considerably if the Laboratory develops close ties with larger technical organizations outside the country.

In Section 4 of this report a proposal is outlined for an overall strategy for timber utilization. The role of the proposed Timber Research Laboratory is given in Section 5, and a corresponding plan of action over a period of five years is suggested in Appendix D.

The proposal notes that the minimum staff for a viable Laboratory would comprise two research scientists and three assistants. A more realistic staffing to achieve the plan of action suggested would be twice this level. The associated costs of buildings and equipment for the proposal are roughly $US 200,000 and $US 150,000 respectively.

Acknowledgements

The writer is indebted to the numerous people of Guyana who were so generous with their assistance during the course of the mission. In particular, the writer would like to express his deep gratitude to Dr Kenneth Smith of IAST for arranging the numerous contacts, and to Messrs John Douglas, Clayton Hall, Gladstone Innes and Halford Simon of GFC, who assisted with logistics and who also supplied much of the information given in this report. Mention should also be made of the assistance by Dr David Klautky, of Klautky and Associates, Ms Lorna Lawrence of GNBS, William Wilson of UG, Berkley Wickham of GUYNEC and Dr C R Choo Kang of NDMA.

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1. MISSION BRIEF

The project was an UNIDO consultancy in timber engineering. The official document of the brief is given in Appendix A. In general terms, the project was aimed at developing a long range programme of research for the structural utilization of the timber of Guyana. In particular, the intention was to draw up plans for a Timber Research Laboratory to undertake this research. It was intended that part of the funding be arranged through Brazil.

The initial proposal to be considered was that the research Laboratory be located in IAST (the Institute of Applied Science and Technology, Georgetwon, Guyana) and that IPT (The Instituto do Pesquisas Technológicas, Sao Paulo, Brazil) would represent Brazilian interests in the project. Accordingly, the two key personnel related to the project were Dr Ulrich Trotz, director of IAST, and Dr Amantino Ramos de Freitas, Head of the Wood Division of IPT.

The project lasted approximately one month over September 1983, comprising roughly two and a half weeks in Guyana, followed by half a week in each of Brazil and Austria (the latter for debriefing purposes). A further one week was spent on travel.

Possibly the greatest weakness in executing the mission was that for various reasons the writer was unable to hold in-depth discussions on the development of a timber engineering research program with any potential personnel of the proposed laboratory. This situation was exacerbated by the fact that for logistical reasons the available contact time with Drs Trotz and de Freitas was limited to less than a day in each case.

2. BACKGROUND ON GUYANA

2.1 General

Because of the short duration of the project, and the difficulty of obtaining official statistics, much of the information to be given in the following was obtained largely from interviews and accordingly should be regarded as indicative only.

Useful background information on Guyana is given in the UNDP report on 'Living Conditions in Guyana' [1]. The country is located on the north east coast of South America and comprises an area of some 200,000 sq.km. It ranges in extent from 2^{0} to 8^{0} north of the equator and has a tropical climate. Along the coast the usual temperature is 24^{0} to 30^{0}C, the humidity 75 to 95 per cent and the rainfall is slightly over 2000 mm per year. Some further detail on temperature and humidity is given in Figures 1 and 2.

Most of the population, the capital city Georgetown, and the limited road system, is located within a narrow coastal belt, about 40 km wide, comprising 5% of the total land area. Much of the remainder of the country is difficult to access due to the multitude of large rivers and thick forests.

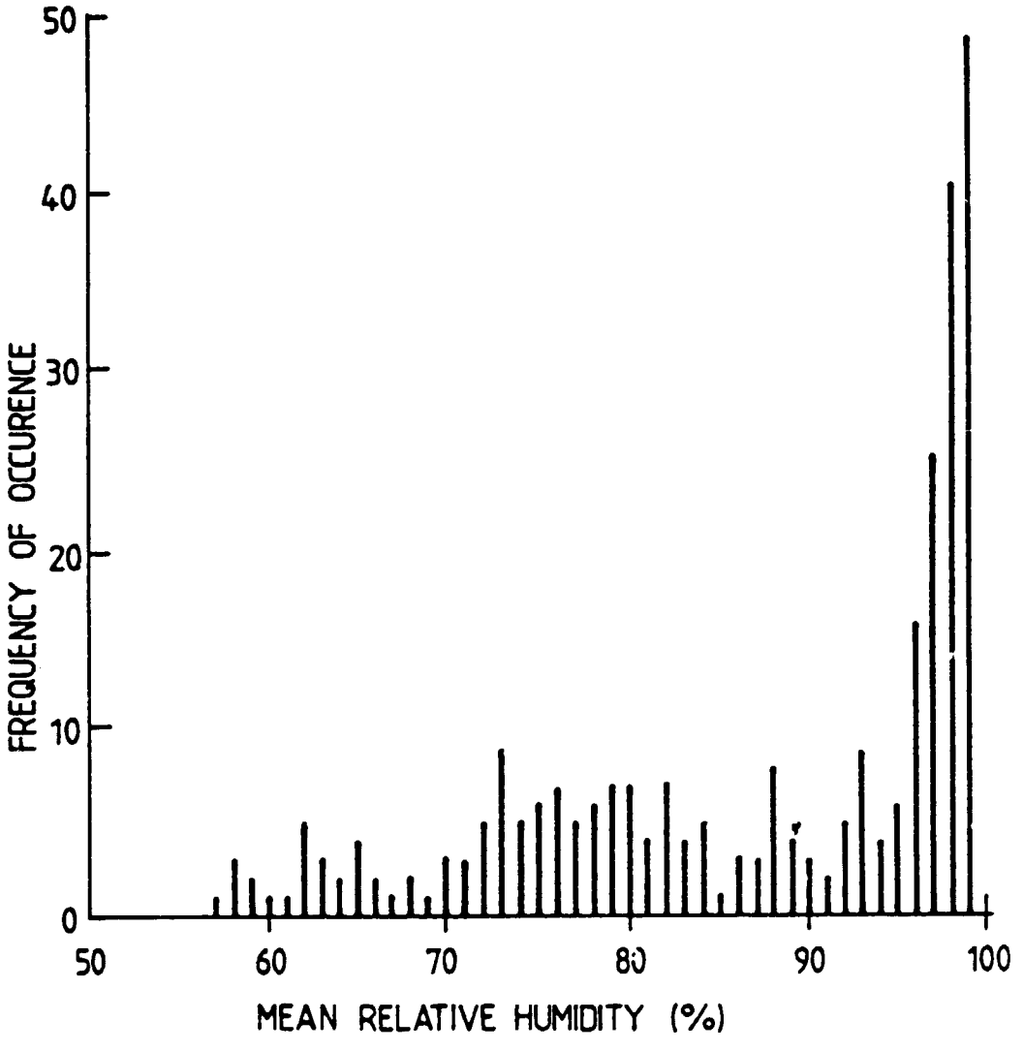

Figure 1 Relative humidity at Timehri airport in 1973, after Bonar [2]

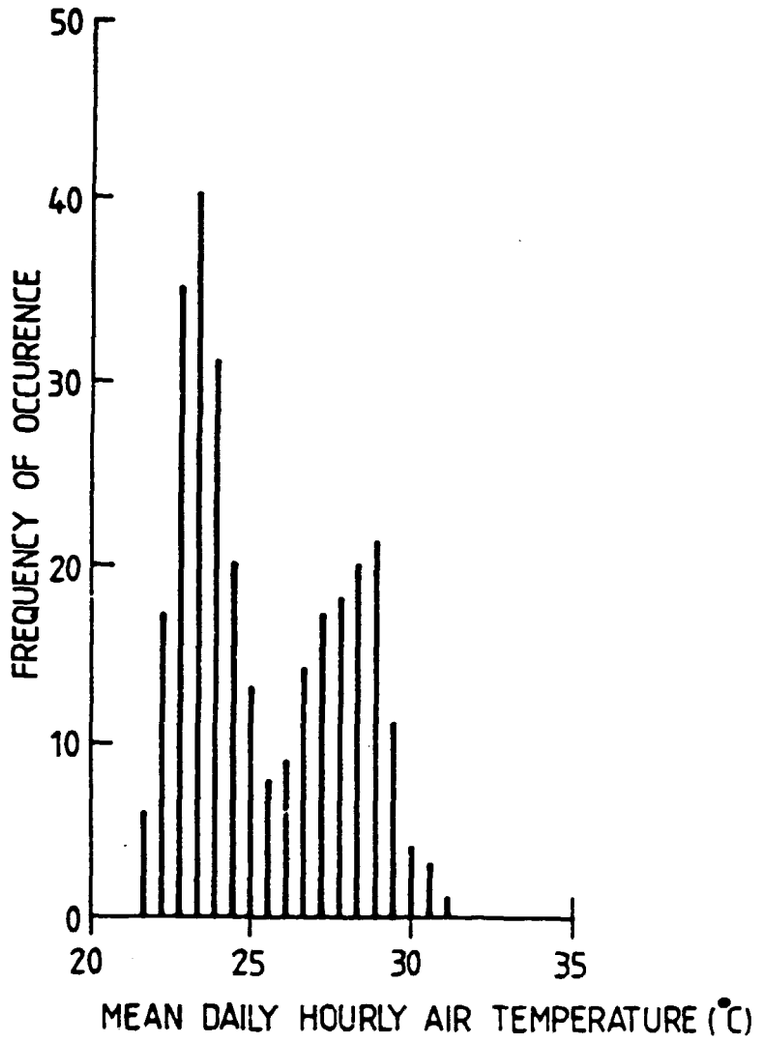

Figure 2 Air temperature at Timehri airport in 1973, after Bonar [2]

The country was colonized by the Dutch in about 1600, then by the British in 1800, and finally obtained its independence in 1966. The current population of 800,000 is largely descended from the indentured labour and the traders of those colonial eras. The make-up is roughly 50% of East Indian origin, 35% of African origin, and perhaps 5% Amerindians, the original indigenous inhabitants of Guyana.

The economy of the country is built around the export of sugar, rice and bauxite/alumina. For reasons which will not be discussed herein, the economy of the country is going through a difficult phase. Foreign exchange is scarce, and the available supply is tightly controlled by the government. In addition, and perhaps because of these factors, many of the qualified professionals (particularly those of East Indian origin) are leaving the country. Any plans for a Timber Research Laboratory must take all these factors into account.

2.2 Structural Timber Utilization

As noted earlier, hard statistics are difficult to obtain in Guyana. However, useful information on structural timber utilization can be obtained from References [2] to [8]. Of particular value are the overview of timber engineering in Guyana by Bonar [2], the statistics by Haspey [4], the properties of Guyana timbers collated by the Guyana Forestry Commission [8], and the Guyana Grading Rules for Hardwood Timber [7].

The history of Guyana is one of extensive timber usage for domestic dwellings. These dwellings comprise the major portion of the country's building construction. Statistics collated by Bonar [2] indicate that during the period 1964 to 1973 the rate of completion of domestic dwellings averaged almost 2000 units per year, about 85% of these being built with timber.

In earlier colonial times, many large structures were also built of timber in Georgetown. This included St George's Cathedral, one of the largest timber structures in the world at the time of its construction. However, the combination of restrictive legislation following disastrous fires in 1913 and 1945, together with the competitive prices of imported cement and steel, and the lack of any domestic timber engineering infrastructure such as design codes and quality control of structural products, have led to an almost complete absence of any timber engineering in Guyana. In recent times however, an enterprising local consultant, Dr D Klautky, has designed several large structures with spans up to 30 metres. These include structures for the National Park, Georgetown Cricket Club, and the Guyana Defence Force.

Further discussion on timber engineering will be given later. At this stage it should be mentioned that in Guyana, timber utilization is dominated by the use of greenheart (Octea rodiaei) a superb hardwood of extremely high strength and durability. This favoured usage for greenheart is due to the need to combat the high level of environmental hazards in Guyana. This applies not only to timber in ground contact. Timber above-ground is attacked by cryptotermes brevis, a drywood termite, and lyctus, a green sapwood borer.

2.3 Timber Exports

The export of timber is of considerable economic significance in view of the foreign exchange shortage in Guyana. Table 1 shows an estimate of the current value of timber exports relative to the principal exports of Guyana. As will be apparent from later discussions, there is a potential to increase the volume of timber exports by several hundred per cent.

TABLE 1
GUYANA EXPORTS, 1982
(Estimate by Guyana Forestry Commission)

Product	Export value 10^6 $US
Bauxite	94
Sugar	88
Rice	19
Timber	5

As with the domestic market, the timber exports are dominated by the species greenheart. The high durability, strength and availability of large sizes of this timber means that it is without peer for marine construction in temperate zones. The selling price of this timber in Europe is roughly twice that of the softwoods used in the building industry. Unfortunately, this advantage is to some extent offset by the high freight costs from Guyana. These costs effectively double the selling price of timber and arise largely from the fact that there are no large tonnage ships, say over 20,000 tonnes, involved in bringing imports to Guyana which could be used to ship the timber exports.

An estimate by the writer of the distribution of merchantable timber is shown in Table 2. From this it is seen that only a minor portion of the greenheart cut is exported. Tables 3, 4 and 5 show the distribution of timber exports according to species, products and country of destination. Some further detail is given in Tables B1 and B2 in Appendix B.

The botanical names for the timbers mentioned in Table 3, and for other timbers mentioned in the following sections of this report, are given in Appendix C.

TABLE 2
DISTRIBUTION OF MERCHANTABLE TIMBER

Timber	Percentage of timber cut
Greenheart	
- export	15
- domestic	45
Other species	
- export	5
- domestic	35
Total	100

TABLE 3
VALUE OF GUYANA TIMBER SPECIES EXPORTS, 1978
(After Haspey [4])

Species	Percentage value of exports
Greenheart	80
Wallaba	11
Purpleheart	6
Silverballi	1
Karkarelli	1

TABLE 4
VALUE OF GUYANA TIMBER PRODUCT EXPORTS, 1978
(After Haspey [4])

Product	Percentage value of exports
Sawn	24
Hewn	21
Piles	15
Poles	9
Dressed	8
Posts	1
Logs	1
Shingles	1

TABLE 5
VALUE OF GUYANA TIMBER EXPORTS TO COUNTRIES, 1978
(After Haspey [4])

Country	Percentage value of exports
USA	29
UK	29
Barbados	10
Trinidad	8
Grenada	5
Holland	4
Germany	4
St. Vincent	3
St. Lucia	2
Jamaica	1
Canada	1

3. RESOURCES

3.1 Timber

Guyana has a forest area of roughly 18 million hectares, of which some four million contain greenheart. The total volume of merchantable timber is about 100 million cubic metres and this is being cut at the rate of about 0.2 million cubic metres per year [2].

An estimate of the distribution of merchantable timber available is given in Table 6. The distribution of actual timber production is indicated in Table 7. A comparison of these two tables suggests that less than 10% of the available merchantable timber is being cut and used in the logged areas.

TABLE 6
INVENTORY OF MERCHANTABLE LOGS IN FOREST (1970)
(Data from Guyana Forestry Commission [9])

Species*	Per cent of timber
Black Karkaralli	9.7
Mora	8.2
Haiariballi	6.6
Morabukea	5.6
Wallaba	3.9
Greenheart	3.4
Wamara	1.2

* Only species contributing more than one per cent of the total merchantable timber have been included here.

TABLE 7
PRODUCTION ACCORDING TO SPECIES (1974)
(After Bonar [2])

Species*	Percentage of total production
Greenheart	51.3
Kabukalli	8.5
Mora	7.2
Wallaba	5.8
Purpleheart	3.9
Kereti	3.5
Gabwood	2.3
Dalli	2.2
Tauroniro	2.1

Because of the large trees available, the sizes cut can be up to 400 x 400 mm in cross-section, and 20 metres long. Standard thicknesses of sawn lumber are 25, 38 and 50 mm.

3.2 Human Resources

Because of the small size of Guyana's population, a key aspect in the development of structural timber research and engineering will be the availability and quality of the professional resources available. The following are brief comments on the most obvious organization that may be expected to interact with a Timber Research Laboratory. These organizations are presented roughly in order of their relevance.

IAST (Institute of Applied Science and Technology)
IAST has been operational only since about 1980; it contains about 40 people of which 16 are professionals. It has tended to be fairly flexible in management, and to look for quick solutions to the immediate problems of Guyana. Examples of topics examined include minerals (laterites, clay, bauxite, ceramics, paint pigments), natural products from local plants, food substitutes, and charcoal.

GFC (Guyana Forestry Commission)
GFC was depleted during the past decade, but is now being rebuilt. Currently, it contains about 8 professionals (only two are foresters); many GFC operatives are given on-the-spot training. The two significant sections of GFC are the Marketing Unit (mentioned earlier) and an as yet unnamed timber products unit.

The timber products unit is expected to be fully operational before the end of 1984. It will contain about 90 people; its equipment includes a sawmill and furniture manufacturing equipment, both pressure and dip diffusion plants and three drying kilns of different types. This unit will produce furniture and other timber products for commercial sale, and will also act as a demonstration unit for the correct methods of producing timber products.

UG (University of Guyana)
The Faculty of Technology of UG produces a total of roughly 40 graduates each year in Architecture, Civil Engineering, Mechanical Engineering and Electrical Engineering; the staff of the Civil Engineering Department would be about six, with about six additional part-time associates. Over the past few years one or two members of the Civil Engineering Department each year have investigated various topics related to structural timber engineering (such as the study of timber properties and the design of timber structures with local species).

The Civil Engineering Department contains a laboratory with a Denison Model T42 B4 universal testing machine with a minimum loading range of 10 kN and a maximum of 500 kN. It also has some floor space which could be used for testing prototype structures of the size of a single roof truss, but is really inadequate for this purpose.

GNBS (Guyana National Bureau of Standards)
Due to become operational before the end of 1984, the GNBS will have 8 professionals including two engineers. GNBS is also stated to be planning a 'mechanical and structural engineering laboratory', although not for at least another year. Initial work will primarily concern standards

and quality control studies for food products, but GNBS will eventually concern itself with drafting structural design standards, including timber engineering codes; in this work GNBS will act in a coordinating function, much the same as Standards Organizations of other countries. GNBS has already commenced collecting standards of other countries.

GAPE (Guyana Association of Professional Engineers)
GAPE has about 200 members, and there are probably an additional 100 professional engineers in Guyana. GAPE is closely associated with CCEO (the Council of Carribean Engineering Organisations). As indicated earlier, timber engineering by professional engineers in Guyana is very limited.

FPA (Forest Products Association)
FPA represents the mill owners of Guyana. Because of tight government control on the marketing of export timber, FPA members have little incentive to develop the structural application of timber. Additionally, because of the current economic climate, there appears to be little interest and/or ability to invest in the timber products industry, either in terms of equipment or promotional activity.

GUYNEC (Guyana National Engineering Corp. Ltd)
Guyana has some very effective commercial engineering organizations such as GUYNEC and IEL (Industrial Engineering Ltd).

GUYNEC currently employs some 1200 people. The Works Division which builds ships, steel building structures, etc., can in fact handle any entrepreneural enterprise. It has some 550 people, including 40 professionals of whom 15 are professional engineers, many with overseas training and/or degrees. These commercial engineering organizations appear to be one of the few types that are able to operate effectively in the current difficult economic conditions that exist in Guyana.

NDMA (National Data Management Authority)
The experiences of NDMA and that of other computer systems operations in Guyana have been discouraging. There are currently about half a dozen computer systems operating in Guyana. They are all IBM systems, and there is only one IBM engineer in the country; because of this, and because of the difficulties associated with obtaining currency for overseas purchases, it takes a long time (several years) to bring a system into effective operation and there is a long delay (several weeks) in restoring a system malfunction. There are some Guyanese professionals who have or are being trained in the software aspects of computer systems, but there is a negligible capability to handle the hardware side.

3.3 Infrastructure for Timber Engineering

The infrastructure required for effective timber engineering is almost non-existent in Guyana. The available design standards, building regulations, quality control systems, component fabricators and educational programs are extremely limited. Virtually all of the existing infrastructure is directed towards improving the efficiency of the export business.

There are two Guyanese documents available for engineering timber structures in Guyana. The first is a list of the structural properties of clear wood of some 90 species of Guyanese timber [8]. With the use of

any of the many timber engineering systems that have been developed overseas, these properties could be used to produce effective design recommendations. An example of a suitable system would be the Australian system contained in References [10], [11] and [12].

The second useful document is the Guyana Grading Rules for Hardwood Timber [7]. This document provides rules for grouping timber into four strength and four durability classes, and applies these rules to 30 species. The expected performances for the durability classes are given in Table 8. The document also provides rules for grading sawn timber into 'Select' and 'Merchantable' grades. Design stresses are given for select grade timber of each strength class. Special grading rules and design properties are given for greenheart.

TABLE 8
DURABILITY CLASSES FOR GUYANESE TIMBERS
(Guyana Forestry Commission [7])

Durability class	Expected performance
1	Heartwood is resistant to Cryptotermes brevis, and has a ground contact life of 10 years in the tropics, and 40 years in temperate zones
1A	Heartwood is resistant to Cryptotermes brevis, but not to subterranean termite attack or to ground contact
2	Heartwood is resistant to Cryptotermes brevis, but not to exposed exterior conditions
2A	Heartwood is not resistant to Cryptotermes brevis

Structural timber utilization tends to be dominated by durability considerations. Because of this, only very dense and strong timbers are utilized. As a result, strength considerations are not a significant concern. Guyana's building regulations specify neither design loads nor design strengths. Engineers make their own decisions on these matters. For timber design, they would normally make use of an overseas code such as CP 112 (the British Standard Institution's Code of Practice), usually in a highly conservative fashion. Examination of a draft of a proposed timber engineering code by the CCEO reveals no attempt to improve on this situation.

Most connections are nailed lapped-joints [2], which cannot be expected to develop the full structural capacity of the connected timber members. There are some bolted structures, based on 8 mm and 16 mm bolt sizes. Nailed plates are rarely used and toothed plate connectors have yet to be introduced.

The education and training aspects of timber enginering is minimal. There is little content in the civil engineering course at the University of Guyana; and there is virtually no technical literature distrib-

uted on timber engineering. The only formal training scheme is that associated with the grading of timber for export purposes.

In concluding this section, two general observations will be made on the timber engineering infrastructure. The first is that essentially all the existing infrastructure resides within the Guyana Forestry Commission. The Commission is currently the most useful source of technical information, and it is also responsible for the educational and operational aspects of the grading scheme for exported timber. The second point to note is that the intense preoccupation of builders with durability is probably the basic reason for the neglect of species other than greenheart, and for the neglect of timber engineering generally*.

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* It is of interest to note that in regions of Guyana that have no greenheart, other species apparently have been used successfully for buildings; for example in the Berbice region, Karaballi is used extensively; unfortunately time did not permit the writer to pursue this matter.

4. STRATEGY

4.1 General

Because of the small population of Guyana and the probable limited size of the proposed Laboratory, plans for the Laboratory must be coordinated with some overall strategy of the government of Guyana if it is to be effective. A detailed strategy of this type has yet to be developed. However, for discussion purposes, a feasible strategy will be assumed in the following.

In general terms, it will be assumed that the intent is to optimize the utilization of the available forest timber, and to maximize the earnings of foreign exchange obtained from the export of forest products, particularly that obtained from the export of structural timber.

In order to accomplish this, the two following goals must be achieved:

- utilization of the lesser-known species in order to maximize utilization of the available timber and to release the better known timber for export; and

- development of a sound timber engineering infrastructure in order to optimize domestic construction, and to build up confidence in Guyana timber exports.

Development of an effective timber engineering infrastructure will require the following:

- research and development of technology;
- production and quality control of structural products;
- development of new products and systems;
- education and product promotion; and
- production of design standards and building regulations.

The problems and strategies associated with developing the efficient utilization and market of structural timber have been discussed in detail elsewhere (e.g. [14], [15]) and will not be repeated herein. However, they should be studied carefully in developing a strategy for Guyana. In the following, only aspects relevant to the proposed Timber Research Laboratory will be mentioned.

4.2 Forest Products

The forests represent an immense natural resource to Guyana. This resource is characterized by a large number of species and a wide range of properties. It will be assumed that the intention is to utilize most of these species; and if possible to use the wide range available as a marketing advantage.

A dominant, possibly critical, aspect in the utilization of timber is the high cost of marketing a new species [14], [15]. This arises not only from the obvious promotional costs associated with market penetration, but also from costs for the build up of a related infrastructure specific to that species.

To do this would require the setting up of supply, production and quality control systems, the undertaking of research to produce a set of

acceptable design parameters, the obtaining of acceptance by appropriate building regulatory authorities, and possibly even engaging in the development of building systems. Obviously then, it is not feasible to consider the marketing of a new species unless there is not only an assured market for it, but also that there is an assured supply.

In view of this, the marketing of Guyana timbers by generic species, particularly timber for export, should be applied only to those species that have a special place in the market place. In particular, at least 90 per cent of the greenheart cut should be allocated to the export market. The other timbers should be classified into groups according to structural properties, durability, etc., and it is these groups or the whole grouping system that should be marketed. With timber for export, the ideal classification to choose would be that of the strength group system that is already established in the importing country. A similar but perhaps less satisfactory alternative would be to market species by attempting substitutions for accepted species.

Because the Guyana forests contain many species which are frequently difficult to identify positively, consideration sould be given to the application of grading and classification techniques that can be used with mixtures of unidentified species.

In the export of structural timber, it is important to inspire buyer confidence in the structural reliability of the product. This is best achieved by developing buyer confidence in the timber technology infrastructure of Guyana. Effective actions for this would include the publication of sound technical information, and the use of timber structures both for conventional dwellings and for prestige buildings.

4.3 Deployment of the Human Resource

The most relevant qualities of the human resource in Guyana are the following:

- the technical and academic competence of the technologists is excellent;
- the total population is small (less than one million); and
- there is a current difficulty associated with the rapid turnover of professional staff, often due to the fact that they are leaving the country.

The severe handicap of having a small population can be mitigated to some extent if a close interaction is achieved between the various professional organizations in Guyana. This interaction should be related to an overall strategy of structural timber utilization which typically would have the following components:

- research;
- development; and
- application.

In view of the current activities of the various professional organizations operating in Guyana, the following would appear to be a reasonable allocation of responsibilities:

- Proposed Timber Research Laboratory ... derivation of basic research information, development of grading schemes, development of prototype structures, and assistance in the development of standards for structural design and product quality control.

- Guyana Forestry Commission ... demonstration and application of seasoning, preservation and stress grading schemes.

- University of Guyana ... development of prototype structures and assistance in the development of design standards.

- Guyana Association of Professional Engineers ... production of of design standards and product quality control schemes.

- Guyana National Bureau of Standards ... coordination of the production of standards for design.

- Forest Products Association ... participation in development of product control systems, and in promotional activities for timber products.

Because the proposed Timber Research Laboratory is expected to play an important role in creating importer confidence in Guyana's structural timber exports, it is highly desirable that the operations of the Laboratory be relatively autonomous and of guaranteed long term stability, even if it is located within IAST as proposed. Furthermore, it would be beneficial if all research and development work related to timber utilization in Guyana be promoted through the publications of this laboratory; this includes work undertaken outside the laboratory; hopefully this will not present an unsoluble administrative problems.

The above describes a strategy for overcoming the handicap of the small size of Guyana's population. This strategy could be enhanced considerably if Guyana's Timber Research Laboratory were to develop effective technological interaction with groups outside its borders. This could include interaction with research and/or technical groups in neighbouring countries (e.g. IPT and CPPF of Brazil), with the technical organization of local regional groups (e.g. the Council of Carribean Engineering Organisations), with international organizations (e.g. International Standards Organisation, the International Union of Forestry Research Organisations) or with research organizations of countries who have developed a technology for the structural utilization of tropical timbers (e.g. CSIRO in Australia).

On the matter of countering the rapid turnover of professional staff, one approach could be to set up a rigorous system for the detailed documentation of progress achieved at each step of every research project. This would contrast with the more usual procedure of delaying documentation until the end of projects.

4.4 Equipment

The current economic climate is characterized by an extreme shortage of foreign exchange. As a result, it would be disasterous for the proposed Timber Research Laboratory to be critically dependent on purchasing overseas supplies for the maintenance and replacement of equipment. The solution would appear to be to use only equipment that is sufficiently simple that it can be maintained, or even possibly copied, by the

several excellent local commercial engineering organizations such as GUYNEC mentioned earlier.

The use of electronic and other sophisticated equipment, such as computers, represents a special problem. While it would appear desirable to recommend the use of such equipment as a means of upgrading the level of technology in Guyana, the poor quality of the infrastructure currently available to service this equipment is a deterrent in this regard. A reasonble compromise would be to use this equipment without being critically dependent on it, and to minimize the effect of breakdowns by having duplicates of all units.

5. THE TIMBER RESEARCH LABORATORY

5.1 General

The following is a summary of the goals for the Laboratory as discussed in the previous section:

- To obtain the data required for developing methods to utilize essentially all of the merchantable timber in Guyana's multi-species forests; this refers to timber for both local consumption and for export.

- To assist in the development of timber design standards for Guyana.

- To assist and/or coordinate the documentation of timber technology in Guyana, with a view to developing buyer confidence in the reliability of Guyana's structural timber exports.

In order for the Laboratory to interact effectively with the structural timber utilization strategy of Guyana, it is recommended that the management committee include representatives of IAST, GFC, UG, GAPE and IPT; ideally there should also be a representative of UNIDO and at least one major overseas research laboratory. The full committee should endeavour to meet at least once every two years in order to check the progress of the Laboratory with a view to deciding on the next increment of financial aid, and to discuss and decide targets for future laboratory activities.

Since a major role of the Laboratory is to present a favourable image of Guyanese technology to potential importers of Guyana's timber, it is important that the Laboratory have a fair degree of autonomy, and be assured of a long existence. Other tactics to achieve this aim would be to expend considerble efforts to enable the top scientists to keep in touch with international research and developments, and to provide every assistance in the design and construction of novel and/or spectacular timber structures with Guyana's timbers, either in Guyana itself or overseas. In fact, it would be very effective if the Laboratory itself were to be constructed with structures of this type.

Other important aspects of strategy, some discussed earlier, include the following:

- All critical equipment is to be sufficiently simple in design that they can be maintained and repaired by the local engineering infrastructure.

- The use of microcomputers is recommended as a method of automating the Laboratory's work, and as a method of upgrading the technology level of the Laboratory's operations; however, for reasons mentioned earlier, no research program should be critically dependent on the use of these microcomputers.

- The administration and day-to-day operation of the Laboratory must be arranged in such a way that a sudden change in staff does not have a crippling effect on any on-going research project.

- For various reasons, including the shortage of foreign currency, it would appear desirable that overseas aid money be directed largely

to matters related to international technological interaction; this could include travel for Guyanese scientists to overseas laboratories and conferences, the financing of overseas experts to visit Guyana, and the purchase of equipment and books.

- Where test conditions specified in international or other prestigious standards are expensive to attain, consideration should be given to the use of alternative cheaper but more conservation conditions. For example, the requirement of a standard test condition of 20°C at 65° RH will require expensive air conditioning of the Laboratory area. The ambient conditions of Guyana, which have a higher temperature and relative humidity, will reduce the strength and stiffness properties and hence form both a cheaper and conservative test condition.

5.2 First Projects

5.2.1 Forest inventory

If it is not being undertaken by another organization in Guyana, some attempt should be made to obtain a rough inventory of the merchantable logs in this forest, together with an estimate of probable logging rates. This will provide some idea of the potential distribution and quantity of the future supply of Guyana timber. This information will be used to formulate a utilization strategy which will then be reflected in the research of the Laboratory.

5.2.2 Testing of small clear timber

The existing data bank on 80 species should be extended at a steady rate. This will provide a sound basis for policy decisions on utilization.

5.2.3 Stress grading of structural size timber

Various methods of grading structural size timber should be attempted. Overseas practice in this area should only be taken as indicative. The focus should be on attaining simplicity and reliability in grading; this is in contrast with many grading procedures which tend to be directed towards obtaining a target percentage grade. In particular, an investigation should be made into the feasibility of using techniques for grading mixtures of unidentified species.

5.2.4 In-grade testing

In-grade testing to measure the structural properties of graded timber is of the utmost importance in developing user confidence. Because of the many species involved, the normal slow laboratory techniques used in North America and Europe cannot be used, except perhaps for a few important species. Instead, it would be more effective to use the rapid method involving the use of continuous proof testing machines such as the inexpensive ones developed in Australia.

5.2.5 Connectors

Design properties of various standard connectors should be assessed for application with a range of Guyanese timbers. A suitable procedure to do this is given in the Australian Standard AS 1649 [13].

5.2.6 Environmental effects

Climate has an influence on the creep and long term strength of timber and connector systems. Investigations on the long term effects of Guyana's climate on structural elements should be initiated.

5.2.7 Durability

If it is not undertaken elsewhere in Guyana, the Timber Research Laboratory should commence a project to systematically classify the natural durability characteristics of Guyana's timbers. If possible, separate classifications should be given for the various hazards such as fungi, termites, marine borers, etc. Classifications should be according to standard index methods so that they will be acceptable overseas. In addition it would be useful, if possible, to derive classifications of the suitability of the timber for pressure and other forms of preservative treatment.

5.2.8 Seasoning

If it is not undertaken elsewhere in Guyana, the Timber Research Laboratory should undertaken the classification of Guyanese timbers according to their seasoning characteristics. This would be primarily for use by importers of this timber. It is probable that for timbers seasoned within Guyana, the optimum method would be to season all timber by use of a pre-dryer, i.e. a shed with a constant mild kiln schedule of about 40°C dry bulb temperature and a wet bulb depression of 3° to 5°C. Such a schedule would be inexpensive to run, would be able to handle a mixture of a wide range of hardwoods with negligible resultant degrade, and in reducing the moisture content down to the fibre saturation point, it would be about as fast as any other method.

5.2.9 Timber grouping

A detailed literature survey should be made of the various structural grouping and stress grade systems used around the world. The intention here is to provide adequate background information so that Guyana can supply structural timber to any of these systems. Also, this information will assist in the selection of a suitable system for use within Guyana. The grouping systems to be considdered are those that are rigorously defined with respect to classification and design properties such as those discussed by Leicester and Keating [16], rather than those in the nature of a Preliminary Classification, such as the systems described by Kauman and Kloot [17] and TRADA [18]. Useful discussion on the use of grouping systems are given in references [19] and [20].

5.2.10 Structural design standards

Scientists of the Laboratory should assist in any on-going efforts to write structural timber engineering codes for Guyana. If such efforts are not in progress, then the Laboratory should undertake to initiate such an exercise. One simple method to do this would be to accept in toto, or simplify by abbreviation as required, the set of standards produced by the Standards Association of Australia cited in references [10], [11], [12] and [13].

5.2.11 Prototype tests

In the first few years of the development of a timber engineering infrastructure in Guyana, the Laboratory should offer to test any prototype structures and structural elements as requested by industry or consulting engineers in order to provide confidence in the development of local timber engineering expertise.

5.2.12 Notable timber structures

The scientists of the Laboratory should be encouraged to develop and/or assist in the development and construction of spectacular timber structures, particularly those of long span. The purpose of this is to demonstrate and promote the quality of Guyana's timber engineering technology.

5.2.13 Dwellings

The use of the lesser-known species in the construction of dwellings for Guyana should be investigated. At the easiest level, this could include the production of standard designs and tables of acceptable sizes and spans. At the most sophisticated level, it could include such matters as attempts to produce designs that mitigate the effects of crytotermes attack. One approach to the latter could be to reserve the use of greenheart for a few critical members, and to use a lesser-known species for the remainder, perhaps with 'body mayonnaise type' preservative coatings at critical areas. During this exercise some consideration should be given to the architectural aspects of the dwellings in order to present timber construction with a 'new' and hopefully improved quality image.

5.3 Manpower and Equipment

Appendix D gives a proposal for research activities, together with building, staff and equipment requirements for the first five years of the proposed Timber Research Laboratory. Details of these proposals are given in Appendix E. Suggestions for suitable laboratory buildings are given in Appendix F.

The basic proposals for staff requirements of a viable laboratory are as follows:

No. off	Staff	Qualifications
1	Technical Director	PhD in Structural Engineering
1	Research Scientist	BE in Structural Engineering
2	Technical Assistants	School Leaving Certificate
1	Typist/word processor	Typist keen to be involved in acquiring high technology skills

The suggested buildings comprise an air conditioned main research laboratory, estimated to cost about $US150,000 and an environmental test shed, estimated to cost about $US20,000. The total cost of the equipment proposed is estimated to be about $150,000.

The specific items of equipment mentioned in Appendix E are intended to be considered purely as indicative examples. In the selection of equipment for purchase, a prime consideration should be the facility for its rapid maintenance and repair. If for any particular piece of equipment, the manufacturer cannot offer this service either for logistic or currency considerations, then that equipment should not be purchased unless the engineering infrastructure within Guyana can cope with it.

These proposals represent the minimum requirements for a viable Laboratory, and unless really exceptional people are recruited, the manpower level is quite inadequate to achieve all aspects of the suggested research program at the rate proposed in the time table. To do this would require doubling the manpower.

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APPENDIX A
MISSION BRIEF DOCUMENT

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO

Project for the Republic of Guyana

UC/GUY/83/062/11-51

JOB DESCRIPTION

Post title Consultant in Timber Engineering

Duration One Month

Date required As soon as possible.

Duty station Georgetown, Guyana

Purpose of project To generate basic engineering knowledge so that timber may be used more in construction. The project will develop a programme of technical assistance to create testing facilities at the Institute of Applied Science Technology (IAST) that will be proposed for funding and support to the Republic of Brazil.

DUTIES The consultant will work with counterpart staff of the IAST and with University of Guyana staff from the Department of Civil Engineering and the Faculty of Technology to develop a long range programme to suite the needs of the country for domestic construction and also with a view to increasing the chances of export. In particular, he will:

(1) Appraise the existing facilities at the IAST and the University of Guyana (U of G) for timber testing;

(2) Determine the priorities that a testing programme would serve and recommend measures for its implementation;

(3) Travel with two counterpart staff to Sao Paulo, Brazil to discuss these recommendations with the Director and staff of Instituto do Pesquisas Tecnológicas (IPT) and agree informally on a long-range programme including detailed specifications for equipment that will be needed, size and types of new buildings (if needed), training and promotion activities, and the role of computer-assisted structural design and analysis;

..../...

Applications and communications regarding this Job Description should be sent to:

Project Personnel Recruitment Section, Industrial Operations Division

UNIDO, VIENNA INTERNATIONAL CENTRE, P.O. Box 300, Vienna, Austria

(4) Return to Georgetown and discuss these informally agreed recommendations with the Government, modifying as deemed necessary;

(5) Prepare a report summarizing the work done and including a detailed proposal and costs for formal submission to UNIDO and the Governments concerned.

QUALIFICATIONS — Civil Engineer with timber structures experience or wood technologist with engineering qualifications, familiar with timber testing procedures and stress grading and preferably from an Institute or University specializing in such work.

LANGUAGE — English

BACKGROUND INFORMATION

The Department of Civil Engineering of the IAST has begun a programme to test wood samples (small clear specimens), and the Department of Chemistry is developing a curriculum of wood technology in order to train Guyanese in the fundamentals relating to one of their main natural resources. A technical cooperation agreement has recently been signed between Brazil and Guyana. The Director of IAST has already been in some contact with the Instituto do Pesquisas Tecnológicas (IPT) in Sao Paulo which has a well-developed research programme in this area and is listed as the Brazilian executor to this agreement. The coordinating agency for the programme is FUNDAP - Fundac~ao para Estudes Administratives.

For proper working stress levels to be determined, and for the existing Forestry Commission timber strength groups based on density to be checked in view of technical developments in the field of stress grading, strength grouping and design procedures, it is proposed that a cooperative programme be prepared for Guyana. In this way, domestic use of timber in engineered structures will be increased and will also demonstrate to prospective importers the potential of Guyanese species and so promote exports. The establishment of such a programme particularly the negotiations with Brazilian technical personnel requires specialized expert knowledge of a kind not found in Guyana and assistance is therefore needed to ensure a well-founded basis for technical cooperation.

APPENDIX B
DISTRIBUTION OF GUYANA TIMBER EXPORTS

TABLE B1
VOLUME OF GUYANA TIMBER EXPORTS ACCORDING TO SPECIES, 1978
(After Haspey [4])

Species	Timber export				
	Sawn (10^3 cu.ft.)	Dressed (10^3 cu.ft.)	Hewn (10^3 cu.ft.)	Piles (10^3 lin.ft.)	Poles (10^3 lin.ft.)
Greenheart	155	171	231	330	
Purpleheart	11	37			
Wallaba					256
Silverballi	6	1			
Karkaralli				24	
Kabukalli	2				
Baramalli		1			

TABLE B2
VOLUME OF GUYANA TIMBER EXPORTS TO VARIOUS COUNTRIES, 1978
(After Haspey [4])

Country	Timber export				
	Sawn (10^3 cu.ft.)	Dressed (10^3 cu.ft.)	Hewn (10^3 cu.ft.)	Piles (10^3 lin.ft.)	Poles (10^3 lin.ft.)
USA	36	90		282	
UK	72		205	3	
Canada	5	1			
Holland	11		8	16	27
Germany	2		14	44	
Barbados	27	29			82
Trinidad	8	24			76
Grenada	1	34	4		14
Jamaica	8				
St. Vincent	3	24			9
St. Lucia		8			28

APPENDIX C
BOTANICAL NAMES OF SOME COMMON GUYANESE TIMBER SPECIES

Trade Name	Botanical Name
Aromata	Clathrotropis brachypetala
Baromalli	Catostemma spp.
Cedar, red	Cedielaodocaia
Crabwood	Carapa guianensis
Dalli	Virola surinamensis
Determa	Octea rubra
Greenheart	Octea rodiaei
Haiariballi	Alexa imperatricis
Hububalli	Loxopterygium sagotii
Kabukalli	Goupia glabra
Karkarelli, black	Eschweilera odora
Kereti	Octea puberula, O. wachenheimii, O. oblonga
Kurokai	Potium decandrum
Locust	Hymenaea courbaril
Manni	Symphonia globulifera
Mora	Mora excelsa
Morabukea	Mora gongrijpii
Purpleheart	Petoygne pubescens
Shibadan	Aspidosperma
Silverballi	Licaria canella, Aniba ovalifolia, Octea puberula, O. wachenheimii, O. oblonga, O. glomerata, O. canaliculata, O. schomburgkiana
Simarupa	Simaruba amara
Tatabu	Diplotropsis purpurea
Turoniro	Humira balsamifera
Wallaba	Eperua spp.
Wamara	Swartzia leiocalycina

APPENDIX D
PROPOSED TIMETABLE FOR THE TIMBER RESEARCH LABORATORY

YEARS 1 AND 2

1.	Buildings	($US)
1.1	Design and construction of main laboratory	150,000
2.	Equipment Purchase	
2.1	2 Universal testing machines	80,000
2.2	2 Continucus proof testing machines	30,000
2.3	2 Microcomputer systems	20,000
2.4	3 Graphics plotters	5,000
2.5	Workshop equipment	30,000
2.6	Video camera and video recorder	5,000
2.7	Film camera and accessories	1,000
2.8	Typewriter	1,000
2.9	Basic reference library	3,000
3.	Staff	
3.1	Recruit technical director	-
3.2	Recruit secretary/word processor operator	-
4.	Research Activities	
4.1	Construction of laboratory, purchase and commissioning of equipment	
4.2	Technical director on overseas tour	10,000
4.3	Commence drafting quality control and design standards	

YEARS 3 AND 4

		($US)
5.	Buildings	
5.1	Construct environmental test shed	20,000
6.	Equipment Purchase	
6.1	Components plus labour to construct a tension testing machine	20,000
6.2	Hydraulic tension jacks (10 off)	20,000
6.3	Special equipment for tests on small clear specimens of timber	10,000
6.4	Drying oven	1,000
6.5	Balance	2,000
6.6	Utility vehicle	8,000
7.	Staff	
7.1	Recruit one research scientist	
7.2	Recruit 2 technical assistants	
8.	Research Activities	
8.1	Focus on defining targets for the Timber Research Laboratory and on the role of the Laboratory relative to other relevant Guyanese organizations	
8.2	Commence systematically evaluating small clears properties	
8.3	Concentrated effort on Standards work	
8.4	In-depth study of overseas grading and strength classification systems for the purpose of penetrating overseas markets	

8.5 Construct the tension testing machine

8.6 Design and build one or two novel or spectacular timber structures

8.7 Design and buld a house from lesser-known species

YEARS 5 AND 6

9. Buildings

None

10. Equipment

None

11. Staff

11.1 Recruit one more research scientist
11.2 Recruit one more research assistant

12. Research Activities

12.1 Concentrated effort on in-grade testing of important grades intended for both export and domestic use
12.2 Attempt application of proof grading and grading methods for mixtures of unidentified species

YEAR 7

Evaluate effectiveness of Timber Research Laboratory. If it is proving highly successful, recruit an additional research scientist and research assistant and increase the size of the main laboratory to include at least two additional offices and one conditioning room. At this stage, the Laboratory should not only be involved in strength classification studies, but also in durability and seasoning classification.

APPENDIX E
COMMENT ON ITEMS OF THE PROPOSED TIME-TABLE GIVEN IN APPENDIX D

In the following, the item numbers used refer to the topic of the same item numbers in Appendix D.

1.1 Air conditioning of the main laboratory space may be delayed until years 3 and 4 (or later!).

2.1 Universal machines are to be used for both small clears and structural size testing. A suitable model is the Shimazdu 300 kN capacity machine, manufactured by Shimazdu, Japan.

2.2 One continuous proof testing machine is to be used by the Timber Research Laboratory for rapid in-grade evaluation. The other proof testing machine is to be used by GFC or a mill to study the commercial application of proof grading. A suitable model to purchase is the Hilleng Timber Proof Grading Machine, manufactured by Hilleng of Brisbane, Australia.

2.3 The two microcomputer systems are to be compatible, preferably the same.

System 1 includes floppy disc and a good quality printer
System 2 includes floppy disc, hard disc and a poor quality printer.

A suitable model is the IBM Personal computer manufactured by IBM, USA. Choice of machine should depend on the availability of maintenance and servicing facilities.

2.4 Two of the plotters should be digital plotters that can be interfaced with the microcomputers. Accordingly, the choice of model depends to some extent on the choice of microcomputer. Examples of suitable models are the WATANABE WX4675, the BAUSCH and LOMB EDMP-29, and the NATIONAL DIGITAL PLOTTER VP-6802A.

The third plotter should be one that can be driven by an analogue input. A suitable model is the WATANABE WX440.

2.5 Workshop equipment to include the following:

(a) For cutting small clears accurately, a good quality 250 mm diameter carbide tipped saw, powered by a 500 to 700 W motor.

(b) A 20 mm wide, 500 mm wheel diameter band saw.

(c) A buzzer (or planer) with a 200 mm wide blade.

2.6 The video equipment is for two purposes. The first is to make training films. The second is to make tapes for trouble shooting purposes, i.e. to make tapes that can be posted to overseas experts for the diagnosis of problems related to equipment or structures.

2.7

2.8

2.9 The basic reference library will be selected by the Technical Director during his overseas tour.

3.1

3.2

4.1 Some timber structures that may be considered are glulam, nail-glued box beams, beams with webs formed from one inch boards, folded plate construction.

4.2 Tour should include attendance at some international conferences such as CIB or IUFRO meetings in order to make suitable personal contacts.

4.3 Drafting should commence with a timber engineering design code, written in terms of strength group properties.....this will then lead to the necessity of drafting quality control codes to provide timber, connectors, etc. with the guaranteed structural properties.

5.1 The environmental test shed should afford protection from rain, but should be sufficiently open that the internal temperature and humidity reflect exterior conditions. The purpose of the shed is to provide an environment in which to measure climate effects. In particular, it is to be used for evaluating the long duration creep and strength of structural timber components.

6.1 This refers to a fast acting testing machine for measuring the tension strength of structural size timber. The cost is roughly $10,000 for hydraulic components and load cell, and $10,000 for the construction of the support frame. Design specifications and a suitable model for this machine have been described in detail by Lhuede [22]. A tension load capacity of at least 800 kN would be desirable.

6.2 Tension jacks are useful for prototye testing of structures. Jacks with a 4 kN capacity and 200 mm stroke, such as the RR 308 Model manufactured by ENERPAC of USA would be suitable. Associated hand pumps and manifold distribution systems would of course have to be purchased with the jacks.

6.3 This includes grips for torsion tests, etc. and also some impact testing equipment. These can usually be obtained from manufacturers of universal testing machines. A description of some suitable equipment has been given by Mack [21].

6.4

6.5

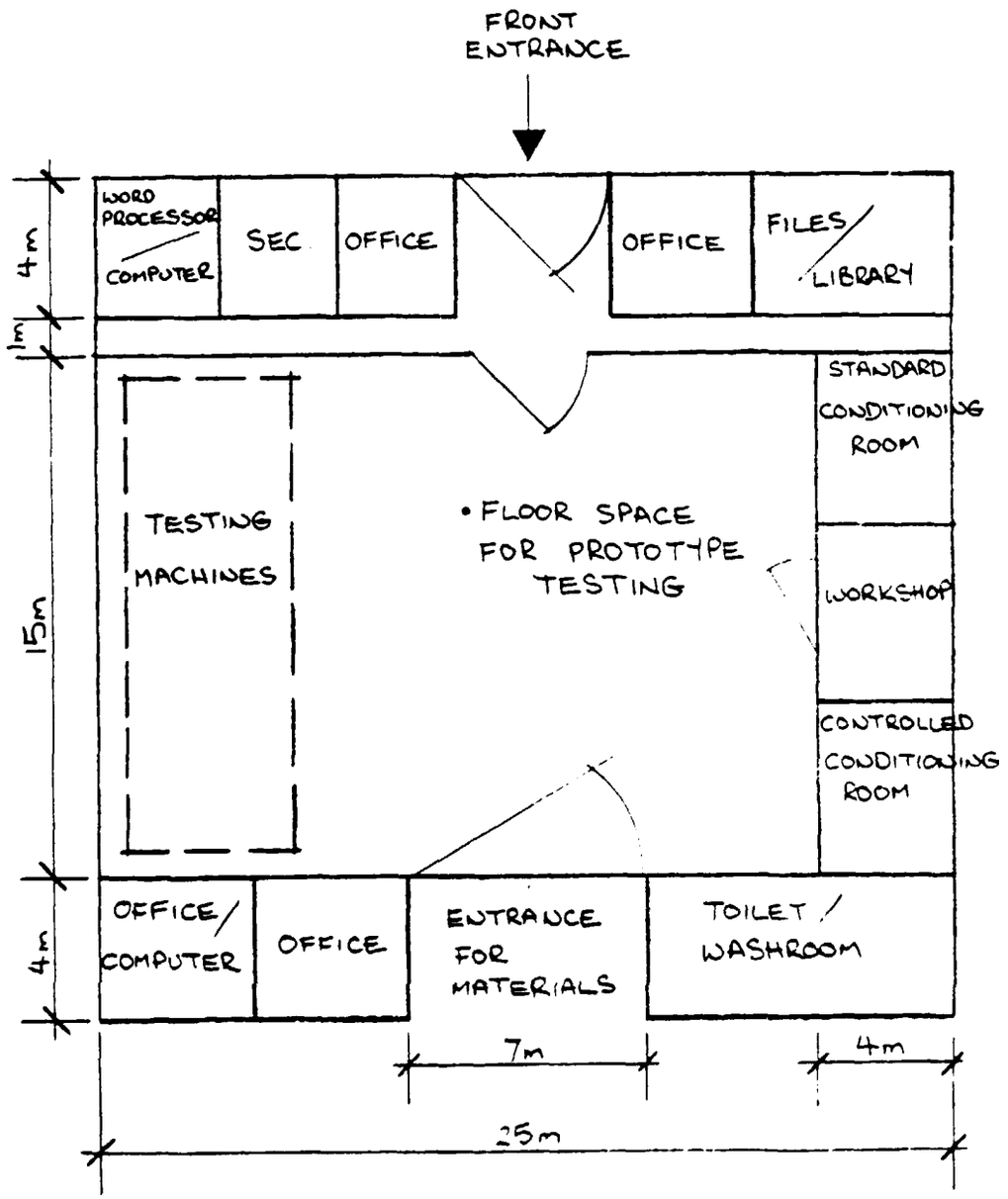
6.6 Vehicle for carrying timber and the proof testing machine.

APPENDIX F
SUGGESTED BUILDING DIMENSIONS

F1. MAIN LABORATORY

(Air conditioned)

Estimated Cost: $150,000 (US)



F2. ENVIRONMENTAL TEST SHED

(Not air conditioned, free movement of air in and out of shed encouraged)

Estimated Cost: $20,000 (US)