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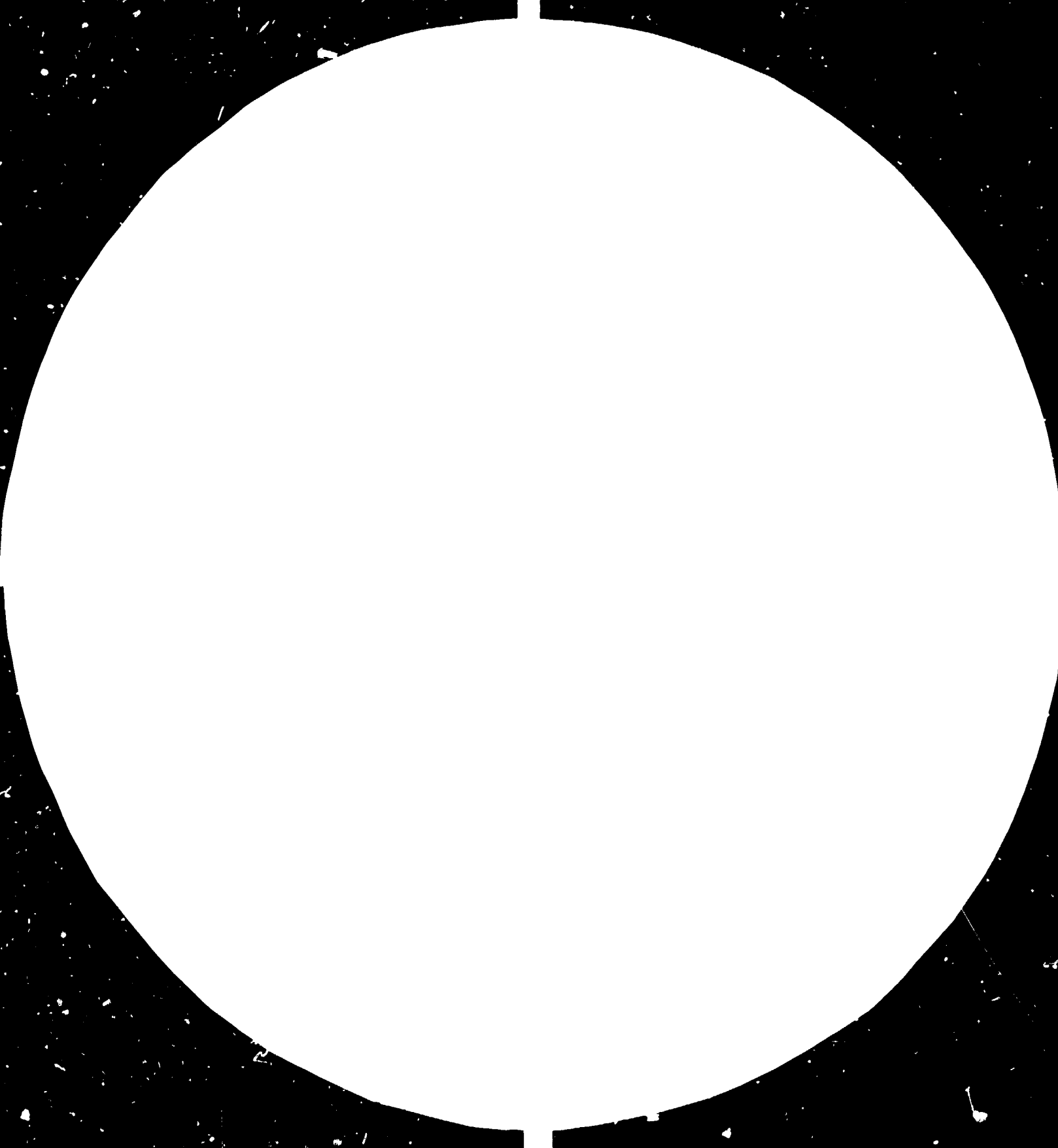

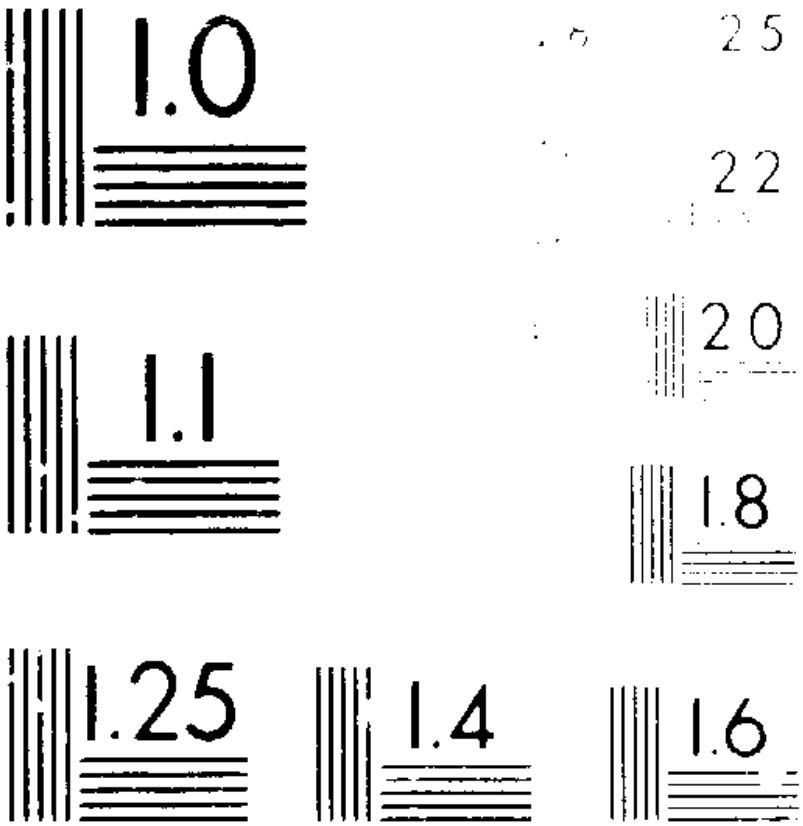
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UNIDO Contract No. 83/068
Project No. UC/RLA/83/143

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REPORT ON TECHNICAL COURSE

ON TIMBER STRUCTURES ,

Held in San José and Cartago, Costa Rica,
and Tegucigalpa, Honduras, between
2d March and 14 April 1984

Based on the work of

C. J. Mettem,
Technical Course Director.

Timber Research And Development Association,
Hughenden Valley, High Wycombe,
Buckinghamshire, HP14 4ND,
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June, 1984.

REPORT ON TECHNICAL COURSE ON TIMBER STRUCTURES HELD IN COSTA RICA AND HONDURAS 1984

CONTENTS PAGE NO.

SUMMARY

A three week theoretical and practical course was held, to introduce modern timber engineering design into the Latin American region. In the selection of candidates, special consideration was given to Central American and other smaller countries. The content of the course, and the third week's activities, emphasised the UNIDO modular wooden bridge system and associated methods of construction, but the programme was not exclusively devoted to this subject.

A preparatory visit was made by TRADA to the Instituto Tecnologico de Costa Rica (ITCR). Subsequently, other requirements of the contractor, stated in the terms of reference, were fulfilled.

Evaluating the effectiveness of the course in general, it is concluded that it was a considerable success, with keen and sustained enthusiasm on the part of all the participants throughout. Appropriate candidates were selected, and similar procedures would be recommended by TRADA if the course were to be repeated in the future.

Because of its special needs, the course was run at various locations, but this might be reconsidered for future events. Certain details, such as the sending of more information in advance to participants, and the pr preparation of press releases, are suggested improvements.

A detailed commentary on the actual programme is provided. This was thought to be generally appropriate, and no major changes are suggested, either by TRADA's experience, or from feedback received. If possible, even greater care to ensure the relevance of visits and to curtail loss of time should be taken in planning future programmes, although it must be recognised that some chance circumstances are practically unavoidable.

Design projects were thoughly carried out, according to the strict requirements laid down by the organisers. Two of the three project groups turned out above average work, under conditions that were less than ideal. It is pointed out that project work is one of the aspects of a course that benefits from a settled, academic environment with facilities rather than a hotel-based event with changes in location.

An evaluation of the candidates, based entirely upon TRADA's opinion, is included.

RESUMEN:

Un curso teórico y práctico fue llevado a cabo, a fin de introducir los conceptos del diseño moderno para estructuras de madera hacia la América Latina. Los candidatos fueron seleccionados teniendo en cuenta consideraciones especiales para América Central y otros países de menor desarrollo. El contenido del curso en general y las actividades de la tercera semana pusieron énfasis en el sistema de puentes prefabricados de madera de la OEA/DDI, sin embargo el programa fué mas amplio y general y no se dedicó exclusívamente a puentes.

TRADA hizo una visita preliminar al Instituto Tecnológico de Costa Rica (ITCR) y posteriormente completó todos los requerimientos que como contratista le fueron exigidos en los términos de referencia.

Como una evaluacion de la efectividad del curso en general, se concluye que tuvo mucho éxito, despertando en los asistentes un entusiasmo vibrante y sostenido a lo largo de todo el curso. La seleccion de candidatos fue apropiada y si el curso se repitiera, TRADA recomendaría que se sigan similares patrones de seleccion.

Debido a consideraciones especiales el curso se llevó a cabo en varias localidades, lo cual se puede modificar o reconsiderar para eventos futuros. Ciertos detalles tales como el envio de una mayor infomacion de antemano a los participantes y la preparacion de informacion de prensa son mejoras recogidas de la presente experiencia.

Se proporciona, ademas, un comentario detallado del programa del curso. En general se encontró apropiado el programa, tanto por TRADA como por las opiniones de los asistentes. De ser posible un planeamiento detallado cuidadosamente para asegurar la calidad de los visitas técnicas y eficiencia en los horarios debiera realizarse en futuros programas aun cuando se sabe que es inevitable las circurstancias fortuitas.

Los trabajos de diseño de los participantes fueron realizados completamente, ajustándose a los requerimientos específicos de los organizadores. Dos de los tres grupos de trabajo realizaron proyectos superiores al promedio, en condiciones de tiempo y ambientacion por debajo de los ideales.

Cabe senalarse que los trabajos prácticos de un curso se logran óptimamente si se realizan en ambiente estable, académico, con facilidades de trabajo, en vez de hacerse dentro de los facilidades de un hotel-convencion con cambios de localizacion.

Una evaluacion de los candidatos basada integramente en la opinion de TRADA se incluye.

CAPTIONS

Plate 1 Delegates and staff, photographed at ITCR, Cartago, Costa Rica.

Key:

1. M. Fernández Núñez, República Dominicana
2. E. Vásquez Merino, Ecuador
3. J.B. Tuk, ITCR
4. E. Delgado Valverde, Costa Rica
5. F. Picado, ITCR
6. D.E. Roque Rojas, Honduras
7. A. De Gracia, Panama
8. R.M. Hallett, UNIDO
9. V. Salazar de Vanegas, Nicaragua
10. R. De Cuestra, Honduras
11. J. Chavez, El Salvador
12. E.R. Alvarado, El Salvador
13. G. Debroy, Guatemala
14. C.A. Díaz Gutiérrez, Perú
15. J.C. Cano, UNIDO Expert
16. E.J. Canessa, ITCR
17. C.E. Zúñiga Leitón, Costa Rica
18. P. Gachet Giacometti, Ecuador
19. C.A. Suarez Pañoni, Bolivia
20. M. Molina Mena, El Salvador
21. R. Genet M., Nicaragua

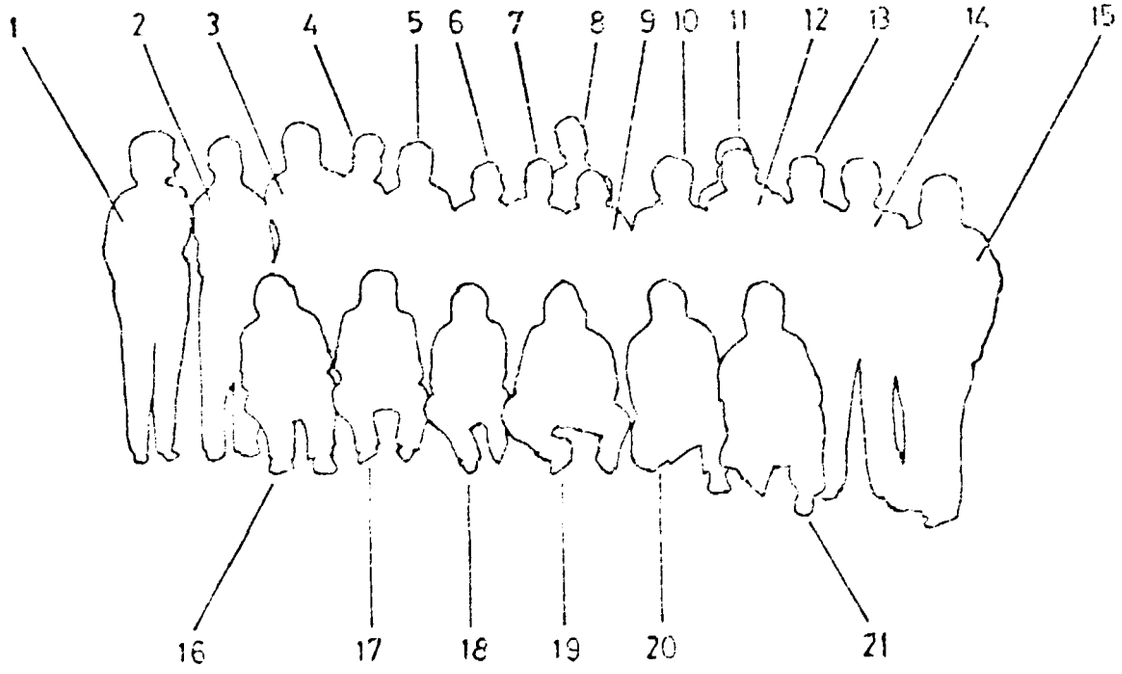
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Plate 2 Constructing model truss, subsequently to be prototype tested, at the ITCR workshop.

Plate 3 Housing Project Group A, with their completed model truss.

Plate 4 Housing Project Group B, with their completed model truss.

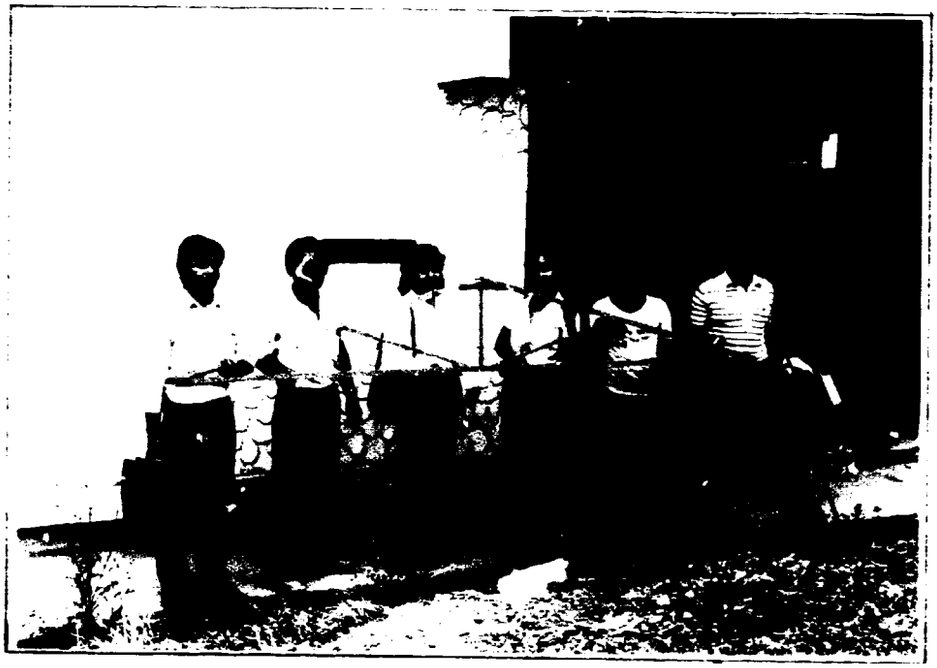
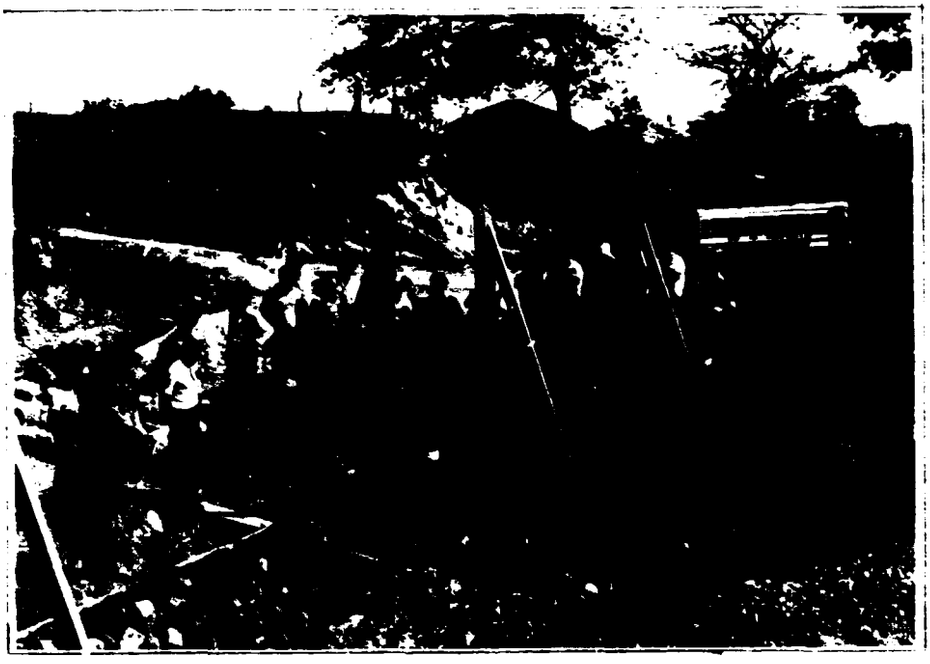


Plate 5 Bridge Project Group, with completed model truss.

Plate 6 Visit to Centro Agricola Cantonal, Turrialba, C.R.

Plate 7 Visit to bridge abutments under construction, Santa Rosa, Choluteca, Honduras.

Plate 8 Housing Project Group A, ready to make their presentation, 8.00 a.m., Friday 13 April 1984.



REPORT ON TECHNICAL COURSE ON TIMBER STRUCTURES

San José and Cartago, Costa Rica,
Tegucigalpa and Choluteca, Honduras,
26 March to 14 April, 1984.

INTRODUCTION

A technical course on timber structures was held as described above, under UNIDO project number UC/RLA/83/143 with the following objectives:

(a) To introduce modern timber engineering design principles into the Latin American region (with special reference to Central America and other smaller countries) so that timber may be used more in construction that at present, thus contributing to proper use of a valuable natural resource as well as stimulating the wood processing and building industries.

(b) To enable qualified engineers and architects to design structures using timber, including bridges.

A project proposal was agreed within UNIDO, after submission on 10 March, 1983; the original proposed start date for the project was deferred for several months. Substantive terms of reference, drafted by Mr. R. M. Hallett, were dated 14 September, 1983 and were provided to TRADA with a request for a project proposal, which was subsequently prepared and accepted. Included in the terms was a requirement to submit the report which follows.

IMPLEMENTATION

The proposed activity and course implementation were discussed with the UNIDO substantive officer before embarking on the project, and advantage was taken of a visit to the region, to go to Costa Rica on 10 and 11 November, 1983. On this visit, arrangements were discussed with the Institute Tecnologico de Costa Rica (ITCR) staff. Later, TRADA's proposals were also discussed with Mr. J. C. Cano, UNIDO expert serving in Honduras, who participated as a senior lecturer.

Responsibilities of individual course officers were drafted to assist UNIDO, and detailed timetables planned. Twelve lectures were prepared in Spanish, together with a substantial amount of visual material for overhead and slide projection. Comments were provided on draft lectures to be given by the national lecturers. Assignments were prepared, and are commented upon in this report. A detailed description of the course proceedings, and assessments of the participants are also given.

GENERAL OBSERVATIONS

An important requirement of this report, mentioned in the terms of reference, is to give a general evaluation of the course's effectiveness, including suggestions on any improvements should it be repeated. Before summarizing the programme and giving other details, this general assessment is as follows:

The course was regarded as a considerable success with keen and sustained enthusiasm on the part of all of the participants throughout. Good candidates had been selected by UNIDO; no doubt this was possible because of the considerable competition for places on the course, which had to be restricted to sixteen. The mixture of ages, experiences and professions was suitable, and most candidates came up to the expectations suggested by their c.v.'s. The general high standard of the project work, described later in more detail, was especially rewarding to TRADA, who in this way gained feedback for possible future events. The need for good timekeeping and attendance was stressed by ourselves and UNIDO to all participants at the outset, and this was achieved.

Because of the special requirements of the course to cover both general structural timber design and to specialise in timber bridges, split venues were planned, with two weeks in Costa Rica, and a final week in Honduras. Inevitably, this had a somewhat disruptive effect on the continuity of the course. Furthermore during the time spent in the last week visiting remote bridge sites and staying in a rural hotel, project work was impossible. On the other hand, the programme provided a unique opportunity for most of the participants, and for some it was especially relevant as they are expected to be involved in UNIDO wooden bridge projects.

There was some difficulty in impressing upon the Costa Rican staff the need to conserve time on local visits and periods at the institute. The engineering staff were unfortunately weaker in this respect than the biologists and technicians.

A practical difficulty encountered by ITCR for all its courses, and its own student accommodation, is the lack of hotel and hostel facilities in Cartago. For this reason it was necessary to use accommodation in San José, and quite some time was wasted on every journey to the institute. For future courses, if there are no special constraints, it would be better to centre the whole programme on a single research institute or academic establishment. Accommodation should be considered, and if possible lectures given in a classroom or lecture theatre, rather than a hotel conference room. Also, projects would be even better carried out, and TRADA and UNIDO's expectations of the participants' performance would be more realistic, if facilities such as permanent desks and drawing boards could be provided.

A few difficulties arose through arrangements failing to materialize. All candidates should have received 'aide memoires' giving instructions on information and publications to bring to the course, and apparently some did not. In certain cases, this was because late selection was forced upon UNIDO through circumstances beyond control. It had been hoped to provide all attendees with copies of the Andean Pact timber engineering design manual, an important and relevant text in Spanish, which was unfortunately out of print.

Another point which UNIDO especially wished to mention, and which is supported by TRADA, is the need to prepare in advance press releases on the course in general, and any particular aspects of special note (such as a bridge launching). There was interest, and press and television coverage, at several points throughout the course, but through absence of prepared information on the organisers' part, not surprisingly reporting was inaccurate.

FOLLOW-UPS

It is recommended that UNIDO should consider repeating the course, or planning a similar programme at an alternative Latin American venue, after a suitable period of time. The interest generated and the number of applicants rejected, would warrant this.

Possibilities include the following:

(a) A repeat, following similar arrangements, in either Costa Rica, Honduras or both.

(b) A collaborative programme between some of the ITCR staff engaged in the previous course, and a new country or institution.

(c) A new venue and collaborating body.

Since the previous course was dedicated especially to Central American and other small developing countries in the Latin American region, and interest was also expressed by several larger, or partially industrialised countries, such as Chile, Mexico and Venezuela, the possibility of a somewhat different selection could be borne in mind. It is TRADA's experience that timber engineering is so under-developed in this important world region whose forest resources are vital, that both large and small countries can benefit from the opportunities UNIDO is able on occasions to offer.

PROGRAMME COMMENTARY

The following commentary on the programme should be read in conjunction with the actual course timetable, which differed in details slightly from that planned, and which is provided at the end of this section of the report.

WEEK 1

Inauguration

Welcoming speeches were made by the Minister of External Affairs (Costa Rica); a Principal of ITCR; UNIDO on behalf of Dr. Abdel Rahman Khane, and TRADA. The time allocated for these opening proceedings was appropriate, the addresses were not too long, and it was particularly gratifying to note the importance the government had attached to the event as indicated by the presence of the minister.

Lecture 1

Timber in the history of construction, and modern applications:

Aimed to set the keynote to the course, and to stimulate interest in the importance of timber in construction, this illustrated lecture, in two parts, was said to have been worthwhile by the students in their commentaries. A considerable amount of supplementary material illustrating cases of timber in modern construction was provided by TRADA and interspersed between later lectures and in informal periods.

The modern construction part of the lecture was structured around notes based on the PADT Timber Design Manual section dealing with "Sistemas Estructurales."

Lecture 2

Wood as a material, its biological basis; wood as a material of construction; identification of timbers:

Although starting with a strong biological emphasis, this talk contained information said by the participants to have been useful. However it would have been better to relate the subject more closely to considerations of end use - the interaction of wood's biological nature with its mechanical properties, drying characteristics etc.

A good suggestion was also made for future courses, to relate the identification topic to a practical session giving the students small wood samples to determine growth directions and to compare conifers and broadleaved species.

Colloquium

Presentation of country documents:

All countries represented had prepared good country documents describing the state of their forest and timber industries, and uses and problems of timber in construction. The majority of these were tested and presented at the colloquium, a few were brought to the course later. In addition comparative timber prices were collected for the following:

Bolivia, Costa Rica, Dominican Republic, Ecuador, Honduras, Panama, Peru and Salvador.

The information, which is being collated by Mr. J. C. Cano, will be of value to future UNIDO projects in the region, in addition to being relevant to the specific course.

Lecture 3

Strength of timber and factors influencing it:

It was felt that the presentation of this essential lecture was somewhat lacking in orderliness.

Lecture 4

Structural grading of timber:

Structural grading systems in various countries; visual grading for conifers and broadleaved species; mechanical grading; quality control.

Being a specialist subject of the writer, this could have tended to have been too detailed, however a great effort was made to keep it simple, with plenty of visual material in Spanish and emphasis on practical and developing country considerations. The talk seemed to be well received.

Lecture 5

Causes of deterioration in timber; biological and decay agencies:

Well presented and documented lectures, which were understood and appreciated. As previously noted could in future be combined with a practical session.

Colloquium

Presentation of the project and division into project groups:

Personality and skills had been assessed by Mr. R. Hallett and C. Mettem to 'steer' the students into suitable working groups and fortunately they 'elected' more or less to follow these groupings, although only three rather than four groups were formed. Excellent project topics were settled upon, as noted later, but although these had been prepared, and material brought to the course, in general terms, there was some lack of detailed instruction at the early stage on TRADA's part. This had been through pressure of work on the more formal parts of the course. Experience has shown that in general, Latin American students expect to be 'assigned' projects rather than 'choose'them, and the detailed specifications evolved during the course will serve well for future use.

Lecture 6

Approaches to the design of timber and the dimensioning of simple members:

a) TRADA Objectives of design, limit states, permissible stress; grade stress; modification factors; tension, compression and bending members.

b) ITCR Structural principles; design of beams and columns.

There is a great deal of ground to be covered in this general subject area, and here the different approaches needed for engineers on the one hand, and architects and technologists on the other, become apparent. The theme should in future be covered by a single lecturer, or a very well co-ordinated team (two persons from the same organisation), with more time allowed for each stage.

Practical

Mechanical testing laboratory, ITCR:

Compared with later practical sessions,which took place more smoothly and usefully due to better planning and preparation, this was rather a waste of time, especially in view of the need, mentioned above, to spend more time on each sub-topic of the theory.

Visits

a) STABAPARI sawmill
b) Sawmill: Miguel A. Esquivel e Hijos, to demonstrate grading of timber.

Although on questioning it was evident that most of the students had visited some form of sawmill before, most felt the visit to STABAPARI worthwhile.

This was a modern mill, with a fairly large primary bandsaw, cutting a selection of Costa Rican species. Unfortunately most end-uses of the sawmill were decorative or utility, rather than structural. The facility also had drying kilns, which few had seen before.

The second sawmill visit was not worthwhile, and not in accordance with the arrangements requested by TRADA, since it had been hoped to carry out a practical grading session at the ITCR.

Lecture 7

Commercial aspects of timber supply:

Thanks to the ability of the person presenting this lecture (from ITCR), it was successful and useful. For the future however it is suggested that this topic be tied in more closely with the saw-mill visit. A better conception of variations in prices and factors affecting them should be sought.

The incompleteness of information brought to the course by candidates concerning supplies and prices in their own countries was partly due to lack of communication (not all had received the 'aide mémoire' which should have been circulated). Obviously it would be better if this could be avoided in future.

Lecture 8

Preservation and drying of timber:

An ably presented lecture dealing with preservative types, factors in efficacy of treatment, methods of treatment, methods of chemical analysis, testing for durability.

Visit

Centr Agrícola Cantonal de Turrialba

Situated some 42km east of Cartago, Turrialba is a town with relatively good communications, in an important agricultural region. The objective of the centre which was visited is to seek alternative methods of production and crops for small farms in the region, in order to reduce dependence on monocultures.

The centre has the most modern pressure treatment plant in Costa Rica, and also a pole drying building which is under construction. The treatment plant, with a 1.8 x 18m cylinder using CCA salts, was thoroughly explained to the party which was divided into three groups for this purpose. Posts being treated were of pine and eucalyptus species.

This was a worthwhile visit, but the journey time was considerable, and the day would have been better spent if additional points had been included. One which was mentioned but apparently not possible, was a site of timber framed housing. Another possibility which would have interested some participants, would have been a more comprehensive explanation and tour of the agricultural centre itself.

Project session

Further detail of the design projects and of the tasks required of the student groups was given in this session.

Lecture 9

Nailed joints:

This dealt with standard dimensions of nails and descriptions of similar fasteners with reference to the code tables distributed for the course; design tables and formulae for lateral and withdrawal resistance; factors affecting the strength of nailed joints, and recommended spacings, concluding with a design example.

Lecture 10

Bolted joints:

A similar approach to the above for bolted joints.

It was decided by TRADA to concentrate on these simple standard, mechanically fastened joints throughout the course, as being most universally applicable to work in developing countries. The project groups experienced some difficulties in arriving at permissible fastener loads and spacings whilst carrying out their assignments, and this tended to confirm the opinion previously held, that it is necessary to allow ample time for this topic. The possibility of interspersing the joint lectures with another unrelated topic, to avoid boredom and allow a gradual development, should be borne in mind for future courses. Even more time, in future should be allowed if possible for this theme.

Lecture 11

Trusses and trussed rafters:

One of the most important structural forms for timber, trusses and trussed rafters were described in general; types of member and joint were outlined; design methods described; dimensions of member and bracing requirements were also discussed. Considerable effort was spent in preparing this lecture. As will be mentioned later, a feature of the second week was a computer analysis of a truss, and a related model-making and testing session. Ideally the lecture, and the events of the second week would have been better co-ordinated to include a design example leading up to the truss type analysed and modelled in the second week.

Lecture 12

Introduction to the construction of timber framed housing:

A lecture and presentation of slides based on experience of timber framed housing prototype projects in the Andean Pact countries.

Lecture 13

Properties and structural uses of plywood:

Based in part upon a lecture by Dr. L. G. Booth, of Imperial College, London, which had kindly been translated by UNIDO, and also calling upon technical literature in Spanish published by the American Plywood Association, this lecture dealt with the benefits of introducing wood-based sheet materials into timber construction; structural forms using plywood beams and panels, and suitable qualities and grades.

Although this is obviously normally an important timber engineering theme the amount of time spent in any individual course must be gauged according to the present and likely supply positions in the participating countries.

WEEK 2

Project Work

Since by this time detailed specifications for projects had been agreed, with rather exacting requirements for their final presentation, it was decided to revise the timetable to allow the whole of the first morning of the second week to be spent on group project work, with the lecturers in attendance for assistance. The re-arrangement was satisfactory, and it is recommended that similar periods be allowed in future courses, as it is unrealistic to expect serious, professionally presented projects to be carried out on the basis of work done entirely after a long day of lectures and visits.

Lecture 14

Planning structural models for computer analysis:

The steps taken to describe the applied forces, reactions, members and joints of a framework to be analysed by a computer program were described by the ITCR Department of Timber Engineering staff.

Practical

Use of the computer for structural analysis:

Programs available at the centre for timber engineering problems included one for analysis of trusses, with indeterminate members if required; a version of Purdue University's plane frame analysis program, suitable for trusses, rigid frames, continuous beams etc.; a program for design of box beams which had been written by a member of the staff of the department.

It had been requested in advance that ample terminals should be made available for the computer demonstration, so that students would be able to get 'hands on' experience, and also that other work would not be run whilst the computer was in use. Unfortunately neither promise was completely fulfilled, and some members of the course were obviously frustrated or bored during the computer sessions.

Purely from a point of view of physical access to the facilities, the arrangements were not a complete success. It is recommended that computer work only be included in future courses if it can be guaranteed that similar problems will not arise. The examples used on the computer should be closely related to those included in the classroom sessions. It may well be that in future, more modest programs run on microcomputers which can be made available in quantity to smaller groups will be of greater benefit than demonstrations of fairly large programs on a single, bigger computer.

Lecture 15

Interpretation of results of computer analysis:

Some use was made of the computer facilities for analysis of trusses used in the project design work, particularly by the bridge group.

Lecture 16

Behaviour of timber construction under live loads: horizontal diaphragm action; shear walls; considerations of hurricane and earthquake design.

This talk drew upon notes specially prepared at TRADA, plus an APA publication in Spanish, and lecture material from Washington State University which had been translated. The theme included much that was relevant to the students' design problems and to their regular work in their own countries. It is a topic which could beneficially be allowed more scope in future.

Project Work

With further assistance and advice from the regular lecturers, another half day was beneficially spent on the group assignments.

Lecture 17

Technical and legal aspects of the use of timber in construction:

This lecture dealt with some of the practical problems of bringing timber into use in construction, especially in countries lacking a strong tradition. Covering regulations, code, insurance and commercial problems, the talk was successful, thanks to the experience of the speaker.

Lecture 18

Design of timber housing for fire resistance:

The development of fire in a building with regard to structural risk; definitions of fire resistance, spread of flame and other terms; calculations of residual sections in solid and laminated members and protection of joints were described in this talk. Illustrations of TRADA's fire testing facilities and tests conducted therein were included. Not surprisingly this topic included many facts quite unknown to the course participants.

Video and Film

A TRADA video film introducing the benefits and methods of timber frame housing had been converted to a suitable audio visual system for showing in Costa Rica, and the UNIDO 'Short Cut' film, describing the modular wooden bridge system, was shown in its Spanish version.

Colloquium

Housing for social needs, and self-construction and self-help building schemes were to have been discussed in this session. Whether from tiredness or shyness, the participants seemed reluctant to contribute much on these themes, which are of great importance for developing countries. If possible, more material will be prepared in advance for future courses, in order to stimulate discussion.

Practical

Construction using the good facilities of the ITCR Woodworking Workshop to make model trusses, and subsequent testing in the laboratory of the Timber Engineering Department.

A large scale model of a truss of the configuration demonstrated in the computer analysis was to be made by each of the project groups. Testing arrangements for this had been set up in the laboratory during the earlier stages of the course, and were reasonably satisfactory.

Much was learnt from this work, and good 'espirit de corps' generated through competition between the groups to produce the strongest truss and to finish first.

The section of material provided by the ITCR (7 x 30mm) was rather slender, and this brought out some relevant problems in the testing, when lateral buckling occurred in several instances.

This helped the lecturers to emphasise the importance of good design of packing in spaced rafters and the need for lateral bracing. Other points emphasised included the usefulness of overhanging rafters in tropical construction; the need for practical design in joints, avoiding complicated fasteners and wide pieces of wood which will subsequently give problems due to shrinkage, and finally the necessity to avoid excessive weight in the design, especially when using tropical hardwoods.

Similar practical sessions should be planned in future courses, taking as much advantage as possible of local facilities. The time is better spent on such activities rather than on lengthy field trips or visits of dubious value, although obviously the organisers are dependent upon good support from the local institution , which in this case was fortunately forthcoming.

Lecture 19

Cost analysis in timber construction:

The subject was thoroughly dealt with by a lecturer having good practical experience in timber housing construction and costing. Inevitably a somewhat dull topic, the lecture could perhaps have been made less boring by greater use of illustrations on the overhead projector, showing site preparation and the parts of a structure, and dealing with the costs of these step-by-step.

Lecture 20

Uses of timber in civil engineering; piling, decking and bridges; temporary works and formwork:

The topic was illustrated with diagrams prepared in Spanish at TRADA and with translations of notes provided for slide sets, plus extensive explanations of additional slides. A considerable collection of timber bridge designs other than the UNIDO Modular System was included, to broaden the outlook.

Lecture 21

Timber bridges:

A well prepared and enthusiastic contribution by a local lecturer, having some experience in civil engineering and a certain amount of bridge construction. The lecture dealt with typical constructions, factors affecting design, loading considerations, and included a good set of notes and references.

WEEK 3

The third week took place in Honduras, where it had been arranged to visit the prefabricated wooden bridge workshop, and various sites in Choluteca District, including the witnessing of a bridge launching. Lectures and the final presentation of the project also took place, and these were held in the Hotel Alameda conference rooms.

CURSO TECNICO SOBRE ESTRUCTURAS DE MADERA

PRIMERA SEMANA 26 de marzo - 1 de abril 1984 HORARIO

	26 LUNES	27 MARTES	28 MIERCOLES	29 JUEVES	30 VIERNES
9.00	Inscripción	3. Conferencia Resistencia de la madera y factores que influyen sobre ella.	6. Conferencia Enfoques de diseño y dimensionamiento de miembros sencillos. a) TRADA b) ITCR	8. Conferencia Preservación y secado de la madera.	9. Conferencia Uniones clavadas
10.00	Inauguración - Bienvenidas por parte de la ONUDI; Ministerio Relaciones Ext., C.R.; ITCR; TRADA. Introducción general - ONUDI.			Visita: Centro Agrícola Cantonal de Turrialba - Diversificación Agrícola.	
11.00	1. Conferencia: La madera en la historia de la construcción y aplicaciones modernas. Una revista de sistemas estructurales.	4. Conferencia Clasificación estructural de la madera; sistemas de clasificación en varios países; clasificación visual para coníferas y latifoliadas; clasificación mecánica	Práctica Laboratorio de ensayos mecánicos, ITCR.		10. Conferencia Uniones con pernos
12.00					
14.00	2. Conferencia: La madera como material. Origen vegetal; material de ingeniería; identificación.	5. Conferencia Aspectos de deterioro de la madera; bióticos; protección.	Visitas Aserradero STABAPARE, segundo aserradero pequeño para practicar la clasificación de la madera.		11. Conferencia Armaduras y pórticos ligeros
15.00	Coloquio: Presentación de los documentos de país.				12. Conferencia Introducción a la construcción de uniones de madera.
16.00		Coloquio: Presentación de los proyectos para grupos de trabajo.	7. Conferencia Comercialización de la madera.	Proyectos Exposición de los proyectos de diseño, descripción de las tareas y las exposiciones para los grupos.	13. Conferencia Propiedades y usos estructurales de la madera laminada.
17.00					
Noche					

CURSO TECNICO SOBRE ESTRUCTURAS DE MADERA

SEGUNDA SEMANA 2 - 8 de abril 1984 HORARIO

	2 LUNES	3 MARTES	4 MIERCOLES	5 JUEVES	6 VIERNES
9.00	Proyectos Trabajo en grupos, toda la mañana, según los requisitos dados.	16. Conferencia Comportamiento de construcciones de madera frente a cargas vivas; técnicas horizontales con diafragmas, muros de cortante y [illegible], y [illegible]	17. Conferencia Aspectos técnicos legales del uso de la madera en la construcción	Práctico: Construcción en el taller de [illegible] de elementos de armadura y ensayos de los mismos (ambos en grupos).	20. Conferencia Usos de la madera en obras civiles: pilotes, plantillas y puentes; construcciones provisionales, encofrados.
10.00					
11.00		Proyectos Trabajo en grupos	18. Conferencia Diseño de la vivienda de madera para piroresistencia.		21. Conferencia Puentes de madera.
12.00					
14.00	14. Conferencia Planteamientos de modelos estructurales para análisis.	Proyectos Trabajo en grupos	Videos de TRADA sobre la construcción de casas de madera con sistemas entramados	19. Conferencia Análisis de costos de la construcción en madera.	Proyectos Discusión sobre los trabajos de los grupos.
15.00	Práctica Uso de la computadora con programas de análisis estructural.		Película de la ONUDI sobre puentes de madera		
16.00				Proyectos. Trabajo en grupos	Coloquio: Discusión del curso por los técnicos del mismo y presentación de los programas para la tercera semana.
17.00	15. Conferencia Evaluación e interpretación de los resultados del análisis estructural.		Coloquio: Vivienda de interés social y la autoconstrucción.		
Noche					

DESIGN PROJECTS

It was explained to the course participants that importance was attached by the organisers to design projects, that would be an integral part of the course. These were intended to reinforce the information given in formal lectures, and to enable participants to question the lecturers on details they had not been able to understand, but needed for the designs. Adequate time was programmed for this activity.

A memorandum was circulated on 29 March (see Appendix 1) explaining this and setting out the standard required, in general terms, together with the choice of subjects. By the end of the first week, the students had divided into groups, and chosen their projects. These groupings are shown on the following page. Although industrial and agricultural structures were suggested as a topic, there was insufficient interest in this subject to form a group, and so two housing groups and one bridge group were arranged.

Appendix 2 gives the full details of the project requirements, setting out the information required in the final public presentations, which took place in the Hotel Alameda conference room on Friday, 13 April. The full specifications for each project are also included. It should be noted that the housing groups were also required to design a simple bridge, and the bridge group a simple house.

GROUPING OF PARTICIPANTS FOR PROJECTS

Housing Group A

Chavez
Díaz
De Gracia
Roque
Vásquez

Housing Group B

Alvarado
De Cuadra
Delgado
Fernández
Gachet

Bridge Group

Debroy
Genet
Molina Mena
Salazar
Suarez
Zúñiga

Names underlined indicate group leader

ASSESSMENT OF PROJECTS

Housing Group A

Leader - Arq. Jorge Chavez, El Salvador

The concept of this group's project was imaginative, combining in a single hypothetical site the needs for very low-cost suburban housing for low income families, community buildings, a workshop, school and footbridge.

The design of the low cost housing was intended to allow progressive development of each individual site, taking into account legal considerations, and the financial needs of families whose wage earners could not necessarily obtain regular work.

The plan of the whole site was explained by the Group Leader, who drew attention to the community buildings as well as the housing, and who explained the co-operative principles of the envisaged financing, which would permit credit to be provided to the occupants.

It was emphasized that there was a need to consider the design of the low cost house in three dimensions in order to optimise the use of space, with economy. The design included the minimum of passageways and tried to make the best use possible of the small plan area. Each house included an area for out-work activities such as sewing, shoe repairing or light assembly processes.

Production procedures for the low-cost housing panels were explained by Ing. Vásquez of Ecuador. They were to be made on a semi-industrialized basis, using small scale woodworking machinery such as a surface planer and radial arm saw. A CCA dip treatment was envisaged for the timbers, which would be of mixed tropical species belonging to Andean Pact strength group C. Air drying after treatment was proposed. The woodworking workshop for the housing would be situated in the area proposed later for development of a factory whose production would be related to the community needs of the site occupants.

The design envisaged use of standard width panels, with some half width types also included in each house. A typical dwelling would contain about 14 panels in total. The manufacturing would be undertaken by three carpenters, six semi-skilled workers and a labourer, and this group would be intended to complete the components for one house each working day.

Ing. Díaz of Peru described the site construction work, which included several interesting traditional Latin American house building methods which permitted costs to be kept low. In dry zones, strip foundations would consist of boulders set by dry stone building methods, topped by a layer of smaller stones set in concrete. In wetter zones, an under-layer of graded pebbles would be provided over the entire floor, to avoid capillary action of damp. Bitumen paint would be used to form a damp proof course beneath the wall panels.

The basis of the structural design was a very simple post and beam system, with pressure treated, or naturally durable, sap-free 75mm square section posts. These were to be sunk into the ground, with simple anchors against uplift in the form of side-driven nails. Various forms of cladding were suggested, including 'trenzado', a form of plaited bamboo strip, interspersed with clay to make a wall similar to the vernacular European construction known as 'wattle and daub.'

Ing. Cano commented on the roof design in this project, suggesting that it might have been more economical to use larger purlins and eliminate the need for rafters. The structural calculations were outlined by Ing. Roque Rojas of Honduras, who explained the vertical and wind loadings, and gave the section sizes determined for the members. A comment was made by TRADA on the careful consideration required for design against wind uplift, and the need for thorough anchorage, right through to foundations.

The design and structural calculations of the footbridge located on the site suggested by this housing design group were also provided. These were described by Arq. De Gracia of Panama. The actual stresses and deflections had been calculated as percentages of the permissible values, and in general adequate details were provided for what was fundamentally a sound design. The drawings provided were however rather sketchy, and better details of the supports for the bridge beams, including a consideration of avoidance of decay hazards would have been welcome.

In general, it was felt that this project group's work was very good; in some parts excellent. There was not only good leadership, but strong back-up from several quite expert and experienced members of the group. Even the more junior participants were encouraged to participate and contribute usefully.

Housing Group B

Leader - Arq. Gachet Giacometti, Ecuador

The design concept was for an urban housing development of moderate low-cost social housing, consisting in total of about 180 units, each on a $200m^2$ lot. The construction was designed to allow staged development of each house, a good idea adopted by both design groups, and now a popular concept in Latin American schemes of this type.

The areas of the dwelling units at each stage were as follows:

Stage 1	$27m^2$,	single bedroom
Stage 2	$36m^2$,	two bedroom
Stage 3	$50m^2$,	four bedroom

The structural module was 1.2m, a common and sensible choice. In the first stage of development of each house, the roof would be a monopitch, subsequently an alternate pitch would be added, with a vertical light left at the ridge. The roof construction was of a simple and appropriate design, having joists supported on an all-nailed solid wood I beam at the ridge. The concept of the roof design was good, but a few details would need revising by designers with more practical experience, before using this project work as a prototype.

Details of all the wall panel intersections were provided. Junctions of two, three and four panels were explained on well-prepared overhead transparencies. Window panels were also included, with details of joinery.

The foundations had also been considered, and plans and sections of these were shown. They consisted of a masonry-concrete strip base, topped by a concrete ribbon which included anchorage details for the sole plates. Damp proofing methods were shown. The interior floor was of solid construction.

The timber framed wall panels included a few rather impractical details and framing arrangments, but were conceptually sound. Interior linings were to be of decoratively-faced particleboard, whilst exterior sheathing was of cement-particleboard. As the housing was semi-detached in plan, further information on fire resistance between adjacent dwellings should have been considered.

Design calculations were thoroughly carried out, and handed in at the end of the project. These included an analysis of loadings, vertical and horizontal, categorised under dead, vertical live, wind and earthquake. The lateral stability and shear resistance of the walls was checked under wind and earthquake conditions.

Appropriate members were calculated using the recommendations for combined compressions and flexure given by the Andean Pact timber design manual.

Flowcharts were worked out by Arq. Gachet for the design calculations of housing of this type using a programmable calculator.

Most of the work of the presentation of this group was undertaken by only three members, and although these three worked diligently, the group as a whole presented the organizers with the difficulty of encouraging full participation and sharing of tasks. Also, the design was less original than the work carried out by Housing Group A, as it closely resembled one of the Andean Pact group's timber framed prototype schemes, constructed in Bolivia, details of which had been provided to the course in a manual.

Housing Group B undertook quite considerable work on a footbridge, possibly a more interesting, complete and original effort than the housing, and some details of this follow:

The elementary bridge design project called for a 7m span footbridge, with a 1.2m useable width of deck. A uniformly distributed load was specified; support conditions anddeflection limits were given. The group decided to use this exercise to examine alternative designs. A bridge with a braced truss, which could also serve as a handrail, was compared with an alternative consisting of solid wood beams, with a non-structural handrail.

A parallel-chord Howe truss was used for the trussed bridge. Member forces were analysed by the method of sections. For the beam bridge, ordinary engineering equations were sufficient, given the simple nature of the loading. All critical members were satisfactorily checked, assuming use of timber of Andean Pact group C. Bolted joints were considered, and spacing details were provided by the students.

Advantages and disadvantages of each form were listed. The trussed bridge saved about half the timber of the simple beam type. It was recognised that the penalty for this would be increased labour costs, and possible more difficult erection, but an convincing case was made for choosing the structure with the more sophisticated timber engineering design.

A list of materials for the selected bridge was prepared and a total cost of $US2400 was estimated. A launching scheme was prepared, entailing use of a single derrick on the far bank, to suspend the paired trusses, whose initial launch would be by cantilevering. This seemed a sound proposal, in view of the lightness of the structure.

Bridge Group

Leader - Ing. Salazar de Vanegas - Nicaragua

The leader introduced the problem which was to design a light timber bridge of 15 metres span, capable of carrying pedestrians, horse-riders, cyclists and light vehicles up to a maximum weight of 2 tonnes laden.

This is a common requirement in rural areas in many of the countries represented on the course. The problem had been set with this in mind, and with sufficient span to ensure that it could not be solved simply by the use of single-piece solid wood beams.

Unfortunately it has not been possible to provide as much commentary on this group's effort in these notes, since less written and drawn work was handed in. Generally it was the least thoroughly executed of the three projects, although in view of the general high standard expected and achieved, the work was reasonably satisfactory and helped to consolidate the theoretical aspect of the course for the group concerned. The group showed practical ability in other respects, for example their prototype truss model was the best and strongest design.

The group spent rather a long time on an analysis, using the ITCR computer program, of a proposed Warren truss for use in their bridge, which therefore became their fixed solution to the problem. In the short time available (about which they were reminded by the instructors) it would have been better to explore alternative frameworks with more rapid and appropriate structural analyses. A uniformly distributed load had been specified in the project brief, rather than point loads necessitating influence diagrams, to make this possible.

At rather a late stage in the project, during one of the last review sessions, it became apparent that there was inadequate clearance for headroom under the overhead, portalised lateral bracing system which had been chosen. Reluctant to abandon this scheme completely, in favour of a diagonal bracing outside the trusses, carried down to extended transoms, they introduced a joint in the centre of the overhead brace, turning it into a triangular arch. Whilst thus demonstrating originality, it was felt that this solution was rather impractical, both from a point of view of economy and also through risk of damage to the entire structure by collision, from a laden pick-up truck, for example.

The group attempted to come to grips with problems in the design of joints in a structure of this nature. Questions were dealt with throughout the project, work on determination of basic loads for bolts, spacing requirements, and the use of Hankinson's formula, so it is felt that some of the lecture information was reinforced by this means. The solutions proposed to several of the individual joints whose details were presented, used rather a large number of small diameter bolts where fewer, larger ones would probably have been better, had time been available for redesigning these details.

The structural calculations relating to the design were presented by Ing. Zúñiga; details of the joints and their calculations were given by Ing. Genet, whilst Ing. Molina Mena presented a proposed launching method, which was very similar to that used for the UNIDO system. It would have been interesting to have considered an alternative, for example the bridge was probably light and stiff enough to have been pushed across using a simple counter-balanced cantilever system.

Ing. Debroy presented the simple, individual house design which had been carried out by the bridge group. This was a moderate-cost, conventional timber framed single storey solution, having an area of $70m^2$ on a $200m^2$ plot. Plain pitched rafters spanning 3.5m, and supported on a ridge purlin and eaves beam were a reasonable solution for the roof. Some details were included of foundations and anchorage and holding-down arrangements.

SUMMARY OF PROJECT ASSESSMENTS

Housing Group A: An original and creative project, dealing in the main with the difficult problem of using timber in a very low cost manner. The imaginative combined scheme enabled housing and a footbridge to be included in a single project. The success was due largely to the creativity of two key people, but the whole group participated well.

Housing Group B: Less original than the design of Group A, but diligently executed. There was some difficulty in integrating this group. The subsidiary project, dealing with a timber footbridge, was more imaginative, and included a comparison of designs and cost estimates.

Bridge Group: The least-well attempted of the three projects, although reasonably satisfactory. A lot of time was spent on an analysis, leaving less to modify the structural form and to reconsider some inappropriate details. Nevertheless, something was learnt of the problems thrown up by the design.

EVALUATION OF PARTICIPANTS

1. Alvarado, Ernesto René (El Salvador)

Expressed an interest in revising timber design which had been included in his university course but not put into practice. Rather a shy individual, did not participate well and was absent altogether from the final project presentation.

2. De Cuadra, Benigna (Honduras)

Chief counterpart, Timber Bridge Project, Honduras. She contributed practical experience to the first two weeks of the course, and her attendance was worthwhile. Unfortunately during the final week she was distracted by problems with the bridge project, and unable to participate fully. She fulfilled duties involving presentation and explanation of the project to other participants.

3. Chavez, Jorge (El Salvador)

An excellent member of the course, with experience, ability and leadership to ensure that all members of his project group contributed.

4. Debroy, Gabriel (Guatemala)

Due to a superficial shyness, seemed at first to have little to contribute, but came into his own in the project work, in which he took most of the initiative in the housing design part of the bridge project group's work. He presented this well, and showed leadership in thanking UNIDO and the other organisers on behalf of the students, at the end of the course. Possibly has contacts in Guatemala which would permit setting up a future course.

5. Delgado Valverde, Egérico (Costa Rica)

A younger member of the course, rather shy, but attentive. He was able to answer questions knowledgeably when questioned on the design project.

6. Díaz Gutiérrez, Carlos Anibal (Peru)

A great asset to the course, he was keen at all times, and contributed greatly to the design project. Showed evidence of both practical experience and theoretical knowledge.

7. Fernández Núñez, Manuela (República Dominicana)

Took a lively interest throughout, co-operating well with rather a difficult project leader. Presented her part of the project work and answered questions confidently. Would be a suitable contact for possible future projects in Dominican Republic.

8. Gachet Giacometti, Paul (Ecuador)

His quiet voice, diffident manner and excessively studious approach to all aspects of the course made him unpopular with the other students, and his project group found him difficult to work for. However, he worked very hard and produced a good set of drawings and specifications. More of an architect than engineer, although qualified in both subjects.

9. Genet M., Roberto (Nicaragua)

Keen and questioning throughout the course. Showed evidence of practical experience in housing and bridging. His design ideas were sometimes rather impractical but be worked hard and presented them well. Would be a suitable member of a counterpart team in any future project in Nicaragua.

10. De Gracia, Argelis (Panama)

Attentive and interested throughout, inevitably rather inexperienced, she did not always appreciate which were important points and which details. Undoubtedly benefitted from participating in the course.

11. Molina Mena, Mario (El Salvador)

His c.v. indicated a perfect choice as a counterpart, and his practical experience in bridging, civil engineering, temporary works etc. was evident throughout the course. He showed maturity and responsibility. The project work was somewhat lacking in originality.

12. Roque Rojas, Dora E. (Honduras)

A keen and attentive younger member of the course, who felt it had benefitted her career. Was willing to accept guidance and was present on all occasions.

13. Salazar de Vanegas, Violeta (Nicaragua)

An outstanding leader. Responsible, sensible and showed a good appreciation of technical aspects. She benefitted from the course as she needed timber design information in her regular work.

14. Suarez Pañoni, Carlos A. (Bolivia)

Rather a rash personality, he traded on his practical experience to try to incorporate ideas into the design projects without having fully absorbed the theoretical work. Might be of doubtful reliability as a counterpart, after a good initial impression.

15. Vásquez Merino, Edgar (Ecuador)

A diligent member of the course, with practical experience which came to the fore in making the model truss and in the project work. Should be considered for inclusion, if relevant, in any future project in his own country.

16. Zúñiga Leitón, Carlos, E. (Costa Rica)

A well balanced younger member of the course, neither too shy nor too impulsive. Attentive throughout the three weeks. Would benefit from any future experience that might be obtained in further co-operation with UNIDO projects.

Attending other than official delegates:

Two architects from Costa Rica attended a number of the lectures which were held in their own region, and seemed to have benefitted from doing so.

The following two Chilean engineers were present under UNIDO Fellowships in Honduras during the third week of the course and gainfully took part in lectures and projects:

Manuel Barrera Leíva
Carlos Ilabaca Vearte

Both from Universidad del Bío-Bío, Concepción, Chile, these persons expressed interest in providing facilities and co-operating in a course in their own country for Latin American regional participants.

TRADA would like to commend the decision of UNIDO to use funds saved in other parts of the course to enable Biol.Edwin Canessa to travel to Honduras and participate in the third week. He was the linchpin of the organisation provided by ITCR, gave well prepared lectures himself, and at the same time tried as hard as possible to follow the rest of the course. It is hoped that it will be possible to maintain contact and co-operation with Costa Rica through Sr. Canessa.

A LOS PARTICIPANTES

PROYECTOS DE DISEÑO

Se le solicitará a los participantes organizarse en grupos de cuatro para llevar a cabo la selección de los proyectos de diseño, que se desarrollarán durante el curso. Para discutir los problemas que se encuentren durante la ejecución de esta tarea, se han programado varias sesiones. Cada grupo deberá presentar los resultados de estos proyectos al final del Curso y defenderán las decisiones para llevar a cabo los diseños de la forma escogida y para contestar las preguntas del resto de los participantes y conferencistas.

Se espera una presentación profesional con ilustraciones de los diseños, dibujos ingenieriles o arquitectónicos con los datos de apoyo detallados para cada proyecto.

los proyectos se dividen en tres grupos, de la siguiente forma:

1. Vivienda y edificios pequeños
2. Puentes
3. Estructuras industriales y agrícolas

Cada grupo de proyectos consiste de tres tareas de diseño individual, clasificados por orden de dificultad de la siguiente forma:

a. Elemental
b. Intermedio
c. Solicitud de proyecto profesional completo

Es requisito indispensable para los grupos, completar por lo menos dos tareas de la categoría a.(elemental), seleccionadas de los diferentes grupos de proyectos, por ejemplo estos podrían ser 1.a y 2.a o 1.a y 3.a, etc. Luego podrían escoger trabajar en un grupo particular de tareas, por ejemplo un grupo de participantes que quiera concentrarse en vivienda,haría el 2.b luego el 2.c, después de los problemas elementales.

REQUISITOS GENERALES DE PRESENTACION

- Memoria explicativa de la solución adoptada acompañada de esquemas y/o planos de planta, elevación y/o cortes.

- Memoria de cálculos de elementos y uniones.

- Hojas de materiales básicos con cantidades y costos.

- Breve secuencia constructiva y especificaciones de la madera (No referirse a técnicas de concreto, eléctricas, sanitarias, etc.)

M A T E R I A L E S

Cualquiera adoptada pudiendo escogerse el Grupo A o B para puentes, B o C para casas.

Usar dimensiones en tablas del PADT. Cualquier método de unión mecánico, excepto conectores patentados.

DISEÑO DE PUENTES

G R U P O S D E T R A B A J O

Proyecto Puente Elemental

Se requiere el diseño de un puente peatonal usando vigas de madera sólidas de secciones redondas o rectangulares.

Especificaciones técnicas

Luz libre	7.0 metros
Ancho útil	1.2 metros
Carga uniforme repartida total	300 Kg/m^2
Deflexión máxima	L/250

Especificaciones generales

- Incluir barandas y pasamanos
- Asumir que el diseño y construcción de las obras civiles han sido hechas y dar un esquema de solución a los apoyos, pero se requiere detalles de las uniones y apoyos de la madera.

DISEÑO DE PUENTES

G R U P O D E T R A B A J O

Proyecto Puente Intermedio

Diseño de un puente peatonal de madera que pueda soportar hasta carros livianos o camionetas de 1 o 2 toneladas máx., incluye pase de animales, jinetes, bicicletas, etc.

Especificaciones técnicas

Luz libre	15.0 metros
Ancho útil	3.2 metros
Gradiente máx.(puente y/o aproximaciones)	10°
Carga uniforme repartida total	500 Kg/m^2
Carga horizontal máx. en barandas	75 Kg/m lin.

Generales

Las bases deberán estar elevadas al Nivel de Aguas Máximo Esperado (NAME) 1.5 metros.

Se requiere de 2.0 metros libres entre el NAME y el nivel más bajo del puente.

CASAS Y EDIFICACIONES CON MADERA

Vivienda Simple Elemental

- Casa social media
- Costo moderado
- Calidad apta para financiar por cooperativas-bancos naciones de desarrollo, etc.
- Area sugerida 50 a 75 m^2
- Un piso - 3 dormitorios y demás facilidades tradicionales
- Se esperan además soluciones de revestimientos de paredes y techos externos e internos; tipos de pisos, cielo razos y detalles constructivos importantes.

CASAS Y EDIFICACIONES CON MADERA

Vivienda industrializada de interés social (problema intermedio (a))

- Casa para bajos recursos económicos.
- Nueva o destinada a remodelar áreas urbanas.
- Costos compatibles con ingresos en programas de ayuda social nacional o externa.
- Area no mayor de $45m^2$
- Soluciones en construcción mixta que pueden plantearse
- Pensar en la posibilidad de vivienda que crece.

CASAS Y EDIFICACIONES CON MADERA

Edificación de 2 pisos (problema intermedio (b))

- Dos pisos y piso 1º elevado.
- Destinado a oficinas, colegios, laboratorios, comercial, etc.
- Clima tropical o subtropical con enfriamiento nocturno.
- Area aproximada 200 m^2 cada piso.
- Carga de diseño por piso 300 Kg/m^2
- Costos razonables.