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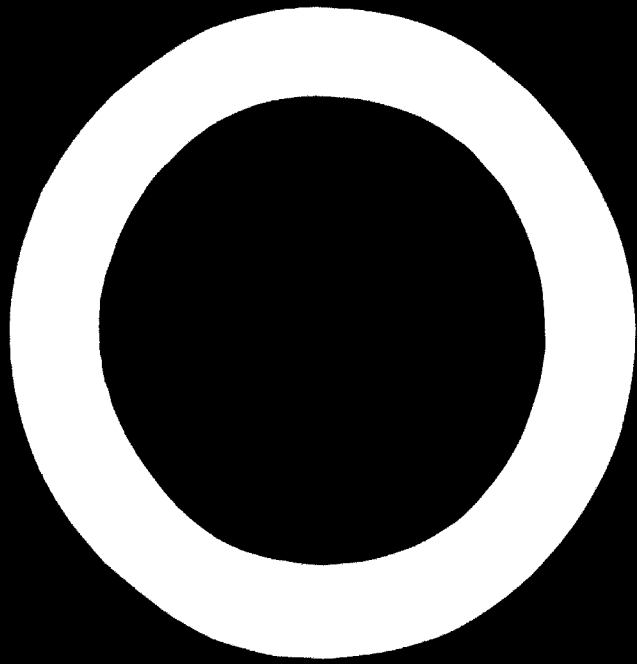
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PRODUCTION  
TECHNIQUES  
FOR THE USE OF WOOD  
IN HOUSING  
UNDER CONDITIONS  
PREVAILING  
IN DEVELOPING  
COUNTRIES



UNITED NATIONS

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION  
VIENNA

**PRODUCTION TECHNIQUES  
FOR THE USE OF WOOD IN HOUSING  
UNDER CONDITIONS PREVAILING  
IN DEVELOPING COUNTRIES**

**Report of Study Group  
Vienna, 17-21 November 1969**



UNITED NATIONS  
New York, 1970

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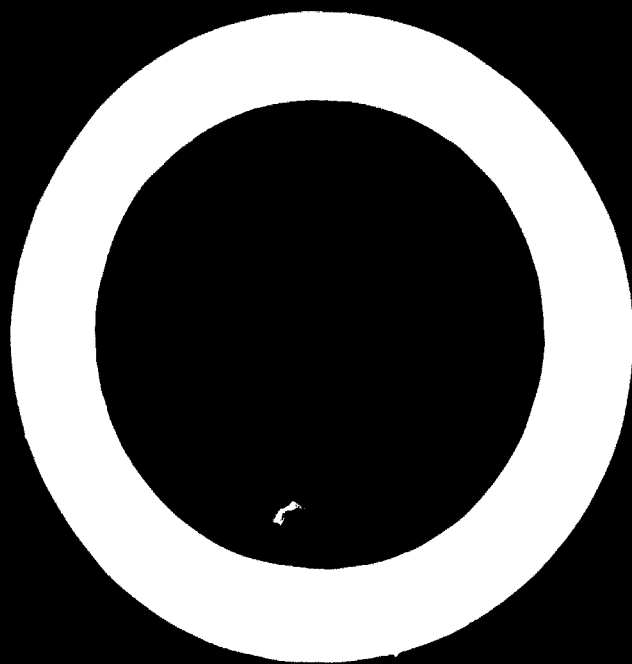
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Contents

	<u>Page</u>
Introduction	5
Chapter 1    Recommendations	9
Chapter 2    Present situation in developing countries	12
Chapter 3    Technical and economic aspects of building materials used in conjunction with wood	15
Chapter 4    Utilization of tropical woods and their derivatives	17
Chapter 5    Wood preservation in the developing countries	20
Chapter 6    Production techniques for wooden houses	22

Annexes

Annex 1    List of participants	33
Annex 2    Statement by Mr. I. H. Abdel-Rahman, Executive Director of UNIDO	37
Annex 3    List of documents presented to the meeting	39





Introduction

1. A recommendation<sup>1/</sup> adopted at the International Symposium on Industrial Development held in Athens in November and December 1967 called upon UNIDO, in co-operation with the Food and Agriculture Organization and other appropriate United Nations bodies, to organize a study group to evaluate the role of wood-based products as building materials under the specific conditions prevailing in developing countries.
2. Preparations for the study group, to be called Study Group on Production Techniques in Wooden Houses Under Conditions Prevailing in Developing Countries, were made by UNIDO in collaboration with FAO and the United Nations Centre for Housing, Building and Planning. The terms of reference were the following:
  - (a) To analyse the existing practice in building techniques and to select the most appropriate methods for industrial production and construction of wooden houses in developing countries;
  - (b) To present the role of wood in housing as compared with other building materials and to prepare recommendations that will contribute to the increased use of wood in housing in developing countries.
3. The Study Group met at the UNIDO Headquarters in Vienna from 17 to 21 November 1969. Mr. I. H. Abdel-Rahman, Executive Director of UNIDO, opened the meeting with a statement which is attached to this report as annex 2.
4. The Group elected as Chairman Mr. D. D. S. Scorer, Technical Superintendent of Timsales Ltd., Nairobi, Kenya, and as Vice-Chairman, Mr. Richard F. Blomquist, Project Leader, Housing Research, Forest Sciences Laboratory, Athens, Georgia, USA. Mr. V. R. Sonti, Managing Director of A&C-HICKSON Ltd., Calcutta, India was elected Rapporteur. Mr. Antoine V. Bassili of UNIDO served as Technical Secretary.

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<sup>1/</sup> ID/CONF.1/59/Annex A/9, p.5.

5. UNIDO invited fourteen experts to participate in the meeting. They were from: Australia, Brazil, Czechoslovakia, Finland, France, India, the Ivory Coast, Kenya, Malaysia, Nigeria, the Philippines, Surinam, Thailand and the United States. Fifteen observers from the following countries also attended: Austria, Belgium, Canada, the Federal Republic of Germany, Romania, Sweden and the United Kingdom. The observer from the Federal Republic of Germany also represented the European Confederation of Woodworking Industries. Representatives of UNIDO and of the Food and Agriculture Organization and the International Atomic Energy Agency attended the meetings. The list of participants is reproduced as annex 1 of this report.

6. A decision was taken by the Group to change its title from Study Group on Production Techniques in Wooden Houses Under Conditions Prevailing in Developing Countries to Study Group on Production Techniques for the Use of Wood in Housing Under Conditions Prevailing in Developing Countries. This change reflected the understanding of the Group that its mandate included also the increased use of wood in houses built with other building materials.

7. The agenda included the following substantive items: -

Present conditions in developing countries

Comparison of wood and other building materials

Possibilities for use of wood and wood products for building in tropical climates

Wood preservation for tropical countries

Production techniques for wooden houses and their components:

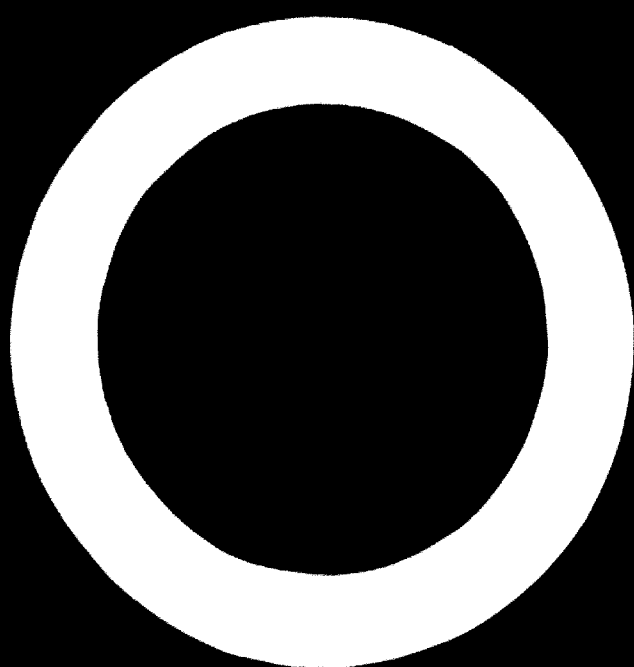
- (a) Timber-framed construction for tropical climates
- (b) Precut wooden houses for tropical climates
- (c) Production of prefabricated wooden houses
- (d) Production of joinery.

8. In adopting the report of the meeting, the Group recommended that UNIDO make it available inter alia to the following organisations in developing countries: industrial development corporations and banks, national housing corporations, national sawmiller and timber products manufacturers' associations, and forest products

and building research institutes, with a view to increasing the use of wood in housing and encouraging Governments, industries, institutions and individuals concerned to help put into effect the recommendations agreed upon, which are set out in Chapter 1 below. UNIDO was requested to distribute the documents issued for the meeting to all interested persons and organisations. The participants from French-speaking countries stressed the necessity of distributing French translations of the report and the papers presented. (A list of documents issued for the meeting is attached to this report as annex 3.<sup>2/</sup>)

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<sup>2/</sup> A limited number of copies are available upon request.



CHAPTER 1

RECOMMENDATIONS

9. The Study Group adopted the following recommendations:

A. International Organizations

1. The manufacture of agricultural fibre cement boards, similar to wood-wool boards, should be included on the agenda of the meeting to be held by UNIDO in 1970 on the production of panels from agricultural wastes, and research institutes should proceed with the testing of species and bonding agents for use as raw materials in these boards.
2. Regional standardization of housing components and adequate quality control of raw material should be developed by the agencies of the United Nations system dealing with housing, in collaboration with the national bodies and industry, to facilitate the acceptance of these products.
3. The United Nations and its specialized agencies should grant fellowships to production managers and designers to visit woodworking industries utilizing tropical species of wood in developed countries, to acquaint themselves with modern production and marketing techniques.
4. A means should be devised for the collection and dissemination of existing information on the preservation of tropical timber species by all known methods.
5. UNIDO should make this report available to the following organizations in developing countries, over and above its normal channels of distribution: industrial

development corporations and banks, national housing corporations, national sawmiller and timber products manufacturers' associations, forest products and building research institutes. The participants from French-speaking countries stressed the necessity of distributing French translations of the report and the papers presented at the meeting.

B. Governments and Public Administrations  
in the Developing Countries

1. In order to overcome the psychological resistance to the use of wood in housing, the following measures should be taken: (a) demonstration units, using extensively lesser known species of wood, should be erected, furnished and displayed in high density localities; (b) the use of wood in prestige projects should be promoted.
2. Governments should be urged to update codes of practice so as to allow the maximum utilization of wood, as has been done successfully in countries with temperate climates.
3. Public administrations should be urged to amend their policies, particularly in respect to tenders, design of buildings, inspection of buildings and their components, so as to facilitate the use of timber.
4. Governments should be urged to devote more attention to the training of skilled workers and wood technicians from the developing countries to operate wood processing industries, either through technical assistance by delegating experts to train local staff, or through fellowships.
5. The attention of Governments should be drawn to the fact that there is a surplus of graduates in engineering and in science in some developing countries and endeavours should be made to utilise their skills in other developing countries.

6. Government bodies should ensure that electrical wiring, cooking and heating installations in wooden houses are carried out according to the recognized standards.
7. Government authorities and lending and financing institutions in developing countries that possess well established and readily identified species of wood should have careful studies made by specialized laboratories to establish whether or not preservation is required for each specie in particular types of usage.

C. Industrialists in the Developing Countries

1. In order to overcome the psychological resistance to the use of wood in housing, the promotion of well planned mass advertising should be consumer-oriented.
2. Manufacturers' associations should devote more attention to the dissemination of technical knowledge on available species of wood and up-to-date design procedures.
3. Associations of manufacturers of wooden houses and their components should ensure that all electrical wiring, cooking and other electrical installations are carried out according to the recognized standards.
4. The use of mobile pressure preservation plants should be considered in order to overcome the difficulties of transport and location of wood preservation plants that exist in developing countries.
5. Due consideration should be given to training of artisans to erect timber-framed houses, prior to embarking on large-scale production of such houses.

## CHAPTER 2

### PRESENT SITUATION IN DEVELOPING COUNTRIES

10. Participants familiar with conditions in developing countries spoke on the state of the housing industry in their country.

#### Africa

11. Although wooden houses built in the traditional methods do exist in the developing countries of Africa, those constructed by industrial processes are as yet not common. In some of Africa's developing countries, however, a good start has been made. Several speakers explained why there are major difficulties facing the housing industry in Africa in spite of the quite favourable raw material situation.

12. In Kenya, particularly, secondary hardwoods are now of less importance because of the availability of plantations growing softwoods in increasing quantities. Good markets exist in Africa for the use of wood-wool cement boards, and it was noted with interest that a relatively economical process developed in Austria produces similar panels based on wood chips and not on wood-wool.

13. The main problems retarding the acceptance of wooden houses are:

- (a) Traditional building materials (such as mud and bricks) used in rural areas are still acceptable and are competing with wood.
- (b) Consumer resistance to wooden houses exists under the present conditions in many developing countries.
- (c) Because of the heterogeneity of the African forests, the difficulties of using mixed and new species of wood have not yet been solved. Although considerable work has been done, there still remains much to be done on marketing the lesser known species locally and for export, and gaining their acceptance in housing.



- (d) The introduction of lesser known species of wood is hindered by the fact that in some countries the fees and royalties levied by the government forestry authorities is uniform regardless of the market value of the species.
- (e) Because of the lack of standards and codes of practice and the use of mixed species of wood, it is necessary to use higher safety factors in design than those required for better known species covered by the current standards.
- (f) Inherited building codes have so far hampered the development of wooden houses in urban areas. In certain countries it has been noted that the resistance of the building authorities to wooden houses is weakening.
- (g) The fact that in some countries sawnwood is produced in many small inefficient mills has tended to increase prices, even though the timber thus produced is often badly cut and poorly graded.
- (h) Qualified labour is usually available only in the large urban centres.

#### South America

14. In spite of an exceptionally serious housing shortage in South America, and the vast wood resources of the subcontinent, the acceptance of wooden houses is marginal. In addition to most of the difficulties enumerated under Africa above, other problems are:

- (a) Poor construction methods used in building wooden houses have resulted in premature deterioration which has created a severe consumer resistance. Furthermore in many South American countries wooden houses were at no time accepted by the indigenous population.
- (b) In most tropical areas endowed with forests, the primary wood processing industry is perhaps not sufficiently developed to ensure the suitability of their products in wooden houses.

#### South East Asia

15. In Malaysia, the Philippines and Singapore, houses utilizing considerable quantities of wood have a far larger market than in the two regions mentioned above. This can be attributed to:

- (a) The ready adoption of modern house-building technology;
- (b) Appreciation by the authorities that housing finance must be provided on an economic basis to the prospective occupier;

- (c) The acceptance of wood for houses in these areas because it is available at economic prices and because the indigenous species are known to have natural resistance to fungus and insect attacks;
- (d) Optimum design practice that has led to the availability of adequate finance.

16. Many of the problems in Africa and South America enumerated above apply also to other developing countries in South East Asia.

CHAPTER 3

TECHNICAL AND ECONOMIC ASPECTS OF BUILDING MATERIALS  
USED IN CONJUNCTION WITH WOOD

17. The Study Group took note of the paper prepared by the United Nations Centre for Housing, Building and Planning on Technical and Economic Comparisons between Wood and Other Building Materials Commonly Used in Tropical Regions (ID/WG.49/3).

18. The Study Group discussed the position of wood compared with other building materials, and considered in detail two products related to wood, namely bamboos and wood-wool board.

19. It was pointed out that in certain regions and for certain uses, especially in rural housing, bamboo is commonly accepted by house owners. However, its use is limited because a satisfactory method for joining it without undue loss in strength at the joint has not yet been devised for industrial production, and because not all species of bamboo can be treated satisfactorily against insect attack. Several research institutes have worked on the utilisation of bamboos and information on this subject is available; the work of ECAFE and the United Nations Regional Housing Centre in Bandung and in New Delhi were mentioned. It was also pointed out that certain species of bamboo are being used as reinforcements in concrete construction.

20. Wood-wool boards are another material that the Group believed merited further study because of their favourable qualities for use in housing. It was pointed out that this material is not very popular as yet, but that its intrinsic thermal and acoustic properties; its resistance to fire, fungus and insect attacks; and its relatively low cost make it suitable for use in conjunction with wood in low-cost housing.

21. The Study Group recommends that UNIDO include the manufacture of wood-wool boards as an agenda item in the meeting it will hold in 1970 on production of panels from agricultural wastes, and that research institutes should proceed with the testing of species of wood and bonding agents for use as raw materials in these boards.

22. Some participants recommended that the appropriate bodies in the United Nations or related organizations should encourage and support the establishment of an effective international office to collect, catalogue and distribute information on housing research and developments throughout the world. This office would also compile and make available a list of academic, industrial and governmental institutions currently conducting research and development in housing design and in building materials.

CHAPTER 4

UTILIZATION OF TROPICAL WOODS AND THEIR DERIVATIVES

23. The Study Group took note of the paper prepared by the Centre Technique Forestier Tropical, Nogent-sur-Marne, France, entitled Possible Uses of Tropical Woods and their Derivatives for Building Purposes in Developing Countries (ID/WG.49/4).

24. In discussing the technical characteristics of tropical woods, the general feeling was that in order to increase the utilization of such wood the rational testing of lesser known species and components made from them must be actively pursued, especially on the points pertaining to physical and mechanical properties. With regard to the durability of wood, sapwood should not be regarded as defective because of the possibilities of its use through preservative treatment.

25. As the increased international demand for the popular species of tropical hardwoods is creating a shortage of these species, it was suggested that all species with similar properties be grouped together and marketed for similar use. The results of testing their suitability for machining, drying and assembly should be taken into account when grouping these species. The utilization of wood-based panels, namely particle board made from hitherto unutilised tropical woods, should be fully tested prior to their use in buildings.

26. Prices of commercially accepted species of timber have increased substantially owing to increased extraction costs making it vitally essential to find a use for the lesser known species. It was felt that the domestic use of these species in construction and furniture would help to increase their acceptability on foreign markets. It was suggested that government

royalties and fees on these species should be lowered to facilitate their introduction. Furthermore, it was pointed out that exports could be increased by developing domestic uses of the lesser known species.

27. The present situation with respect to utilization of wood in building and recommendations that would help to increase its use were discussed at length. To overcome the psychological resistance to the use of wood in housing, the Group recommended that:

- (a) Promotion of well planned mass advertising should be consumer-oriented;<sup>3/</sup>
- (b) Demonstration units using extensively lesser known species of wood should be erected and furnished and displayed in high density localities;
- (c) The use of wood in prestige projects should be promoted.

28. Technical aspects of the use of tropical woods were discussed and the following recommendations made:

- (a) Governments should be urged to update codes of practice so as to allow the maximum utilization of wood as has been done in countries with temperate climates.
- (b) Regional standardization of housing components and adequate quality control of raw materials should be developed by the agencies of the United Nations dealing with housing, in collaboration with the national bodies and industry, to facilitate the acceptance of these products.
- (c) Manufacturers' associations should devote more attention to the dissemination of technical knowledge on available species of wood and up-to-date design procedures.

29. To increase the acceptance of wood its aesthetic aspects should be actively pursued. It was felt that in many instances wooden houses were held in disfavour because the existing examples were of poor design. The Study Group recommended that the United Nations and its agencies grant fellowships to production managers and designers to visit woodworking industries utilizing tropical species of wood in developed countries to acquaint them with modern production and marketing techniques. The Group recommended that government administrations, large corporations and the like should

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<sup>3/</sup> A specific instance of a campaign oriented to housewives was pointed out.

be urged to amend their policies particularly in respect to tenders, design of buildings and inspection of buildings and their components, so as to facilitate the use of timber. This would open the door to mass production and thus enable timber to compete with other materials.

30. The Study Group called attention to the fact that unless the same financial facilities are accorded to construction using wood extensively rather than the present conventional construction methods, the use of wood in housing will be seriously curtailed. To Governments and manufacturers the Group wished to stress the importance of introducing industrial production methods with adequate quality control and attendant economies of scale so as to rationalize the price structure and bring about lower prices.

31. Governments should be urged to devote more attention to providing training to produce skilled workers and wood technicians from the developing countries who could then operate successfully wood processing industries. Training could be provided through technical assistance (foreign experts training local staff) or through granting fellowships for training abroad. Attention was drawn to the fact that there are surpluses of graduates in engineering and in science in some developing countries, and it was recommended that endeavours be made to utilize their skills.

CHAPTER 5

WOOD PRESERVATION IN THE DEVELOPING COUNTRIES

32. The Study Group took note of the paper prepared by Mr. V. R. Sonti of Calcutta, India, entitled Wood Preservation for Tropical Climates (ID/WG.4/8). Many aspects and methods for preserving timber from biological deterioration in all its forms were discussed fully. Drawn from these discussions, the following important points emerged:

- (a) It was clear that the timber resources in developing countries would be largely wasted unless adequate preservative techniques and facilities were made available for preserving non-durable species.
- (b) It was noted that many tropical species which hitherto have not been used could be utilized successfully in construction work after a suitable preservation treatment. Some tropical species actually in use are in fact uneconomical because the sapwood is wasted, but with suitable preservation the sapwood could be utilized as well.
- (c) It was noted that in some developing countries little work had been done to determine which tropical hardwood species could be preserved and by what method.
- (d) It was further noted that in some developing countries considerable work had been done on the preservation of tropical timbers but that such information was relatively unknown to other countries possessing the same species. Hence a means for collecting and disseminating information on the subject should be devised.
- (e) It was noted that in developing countries where board products were manufactured, their use in construction could be increased considerably if the products were suitably preserved.
- (f) Fire-retarding processes for wood and its derivatives are available but their use is not common because of the high cost of the treatment in many developing countries. In the opinion of the Study Group the fire risk from timber in general was minimal. It was pointed out by many participants that fires hardly ever occur



in wooden buildings if the buildings are equipped with electrical installations that comply with adequate safety regulations. The Study Group urged government bodies and manufacturers' associations of wooden houses and their components to ensure that electrical wiring, cooking and heating installations are carried out according to the recognized standards.

- (g) It was seen that with the use of non-durable species of wood, careful building and surface application and reasonable protection under normal conditions could ensure against deterioration. It was agreed that the most reliable process for the preservation of non-durable, permeable species and all sapwood, including bamboo, was the vacuum/pressure method, using fixed preservatives. It was noted that other non-fixed preservatives might be cheaper, but that the matter of cost had to be considered over a period of time, rather than upon the basis of initial cost.
- (h) It was noted that in developing countries preservation which did not cover the full range of hazards in each particular country would ultimately tend to be costly in remedial repairs.
- (i) Participants from developing countries, realizing that difficulties of transport and location of preservation plants exist in their countries, recommended the use of mobile pressure preservation plants to overcome these difficulties.
- (j) Considering the durability and resistance to insect and fungus attacks of many wood species found in developing countries, the Study Group recommended to government authorities and to lending and financing institutions that, where species are well established and readily identified, a careful study should be made to establish whether or not preservation is required for each species in particular types of usage.

## CHAPTER 6

### PRODUCTION TECHNIQUES FOR WOODEN HOUSES

33. The Study Group investigated production techniques for wooden houses. Three papers were presented covering production aspects of timber-framed designs for on-site construction, precutting timber for wooden houses, and factory-built prefabricated wooden houses using various methods. These papers were: Timber Framed Construction for Tropical Climates, prepared by Mr. R. F. Blomquist of the Forest Sciences Laboratory, Athens, Georgia, USA (ID/WG.49/2); Precut Wooden Houses for Tropical Climates, prepared by Bruynseel Suriname Houtmaatschappij N.V., Paramaribo, Surinam (ID/WG.49/7) and Prefabricated Wooden Houses prepared by Mr. Keijo Tiisanen of Jyväskylä, Finland (ID/WG.49/5).

34. The wide acceptance of on-site timber-framed construction in a number of developed countries was emphasized. The recent work done by the United States Forest Service in the design of low-cost wooden houses for rural populations was drawn to the attention of the participants.<sup>4/</sup> The Study Group believed that these designs incorporated useful ideas, some of which warrant serious consideration by developing countries. The use of pole-framed and wood-pier construction for wooden houses was mentioned as being particularly suitable for hilly sites as it eliminated the need for costly foundations. Further advantages of these systems are that the elevation of houses facilitates regular inspection of the under side of wood floors, thus localizing at an early stage any fungus or insect attack. Furthermore, such construction

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<sup>4/</sup> Summaries of these designs are available from the Division of Information and Education, Forest Service, U.S. Department of Agriculture, South Building, Washington, D.C. 20250, USA.

ensures good ventilation around the floor structure thus reducing accumulation of moisture and minimizing the possibility of decay. From a cost consideration, the pole or post construction gives larger usable area per plot, as the floor area of the lower level can be used for storage, or in hot climates in lieu of a veranda, with no increase in the cost of the land or construction, while at the same time the increase in height above the ground level provides better air circulation through the living quarters.

35. Participants from African countries pointed out their need to utilise fully small-dimension timber for cladding and other non-structural requirements in their designs; also well fabricated finger-jointed timber had been successfully introduced. It was agreed that these steps should prove to be highly beneficial in view of the general need for these countries to export prime-quality long-length timber. In discussing the surface cladding of the frame, it appeared that in many developing countries with low labour costs there is a tendency to use siding, sometimes narrow tongue-and-groove, instead of wood-based panels, for economic reasons.

36. The Study Group recommended that due consideration should be given to training artisans to erect timber-framed houses prior to embarking on large-scale production of such houses. It was pointed out that effective quality control can be achieved more efficiently under factory conditions than in on-site construction. Participants believed that prefabrication is better suited to countries with a large supply of unskilled labour and few skilled artisans even though capital investment is required for factory equipment.

37. The Group wished to draw the attention of housing corporations and government authorities to the faster erection time and quicker occupancy of wooden houses as compared with concrete block or other non-wood houses. It was recognised, however, that concrete blocks have economic and other advantages in some developing countries.

It was pointed out that prefabrication not only ensures a quicker erection time but also reduces the possibility of damage due to rain and other elements before the house is fully enclosed.

38. The Study Group also investigated the relative merits of pre-cutting timber in factories for assembly on the site. The relative advantage of this method over the typical timber framing method on site is that it is possible to ensure greater precision in fit under factory conditions with more mechanization and adequately-trained manpower under qualified supervision. Precutting allows preselection of species and grades of wood for each specific structural use, reduces the amount of materials transported, and eliminates the waste that occurs when cutting is done on the job. Precut lumber should be complemented by a supply to the site of all other components such as preassembled doors, windows, cabinetry and the specified hardware, so as to achieve the maximum economy in the cost and time of erection. Proper packaging of the precut elements and related materials is essential to reduce damage or loss by pilferage. Proper identification of each component part by numbering with an accompanying manual is essential for effective erection of precut items. It must be borne in mind in choosing the precutting method that skilled workers are still necessary for the proper assembly of the components on the site.

39. In considering the prefabrication of wooden houses, four types were identified, namely: in-plant production of modular panels (such as 4 ft x 8 ft units), large-size panels (spanning a complete wall) and a three-dimensional modular unit (comprising a fully assembled section of the house), and lastly the foldable modular system (basically the same as the previous one but with a collapsible design).

40. The Study Group considered the design and production problems pertaining to the modular panel system and felt that this system is applicable to conditions in many developing countries for the following reasons:

- (a) It ensures the maximum possible flexibility in architectural design, while at the same time taking full advantage of in-plant production, namely in respect to

quality under well controlled conditions, making possible the production of large outputs with semi-skilled workers.

- (b) Handling of panels during shipping and assembly is relatively simple and does not require mechanization.
- (c) Panels damaged during transport and erection can be replaced at lower cost and more simply than on larger prefabricated units.
- (d) Modular panels can be stocked for prompt sale and delivery; this is less practical with the other prefabricated systems envisaged.
- (e) The production of modular panels requires little extra investments over those needed for pre-casting.

Among the disadvantages of the modular panel system are the problems caused by the presence of numerous joints that have to be weatherproofed which increases the on-site labour costs. The problems involved in laying electrical and plumbing installations through all components must be borne in mind.

41. The next system to be studied was the large-panel construction method. The advantages of this system are: less labour is required on site, and fewer joints are involved than in the modular panel system. The Study Group believed, however, that the following disadvantages make this system less applicable for many developing countries:

- (a) This type of construction is not as feasible for production, transport and erection under the conditions prevailing in many developing countries.
- (b) The great weight of these panels necessitates the use of heavy moving and lifting equipment, both in the plant and on site.
- (c) Damage due to mishandling of panels could be more frequent and would be more difficult and costly to repair.

42. The Study Group also considered the potentials of the three-dimensional modular units and believed that under the present conditions in developing countries there are only very limited applications for this system. The main reservations were with respect to the unwieldiness of these units in delivery and positioning on the site (except when used in large-scale urban developments). The Group believed that this recently developed prefabrication technology might be applicable in the future in

developing countries. One participant pointed out the significant merits of the folding type of three-dimensional modular construction over the previous system: this method allows for complete factory fabrication while facilitating the transport and handling problems involved, and at the same time minimizing on-site erection.

43. The Study Group deliberated at length on the relative merits of including in its report specific recommendations on the choice of production techniques for the use of wood in houses in developing countries. It came to the conclusion that, owing to the many factors that must be considered before any industrialist or prospective investor in this industry could make a decision on this subject, and the wide spectrum of conditions in the developing countries themselves, it would abstain from making clear-cut recommendations, while at the same time drawing the attention of the readers of the report to the following important factors that should be considered prior to taking any decision:

- (a) Size of market for the products to be manufactured and its location;
- (b) Type of market, whether urban or rural;
- (c) Availability of raw materials in suitable species, quality and specification;
- (d) Availability of sufficiently trained labour;
- (e) Availability of transport facilities;
- (f) Design requirements for the products to be manufactured, bearing in mind that the actual design envisaged should be acceptable to prospective utilizers and to finance authorities;
- (g) Soil conditions in the area where the products are to be marketed;
- (h) Climatic conditions of the region, as they affect design, production and erection;
- (i) Availability of equipment for production and facilities for its adequate maintenance;
- (j) Methods of marketing the product, including promotional aspects;
- (k) The necessity of training staff in the required skill prior to start of production;
- (l) Cost of materials, labour and overhead charges;
- (m) Time required for completion related to urgency of occupancy;

(n) Capital available for the efficient operation of the plant utilizing the process chosen.

44. The Study Group also included in its consideration of production techniques the manufacture of joinery elements, and noted the study prepared by Messrs. J. Bim and M. Koukal of Prague, Czechoslovakia, entitled Production of Joinery for Tropical Countries (ID/WG.49/6). In reviewing these techniques, it was pointed out that the plants producing joinery in developing countries were utilizing techniques and equipment common throughout the world, and common to other secondary wood-processing industries such as furniture. It was felt that this paper gave much information, in a concise form, on production techniques and also included information on machinery used in the manufacture of joinery. It was suggested that this paper be given serious study by all interested in this topic in the developing countries.

45. The Group also discussed the need for visual and machine-stress grading of timber and timber products and suggested that developing countries give this subject extensive study as it was felt that machine-stress grading would facilitate the use in housing of more species of wood to their best advantage.

46. The need for quality control in the production of sawn timber and for manufactured items was highlighted. It was believed that much of the work would have to be done by trade associations; nevertheless it was considered essential that Governments be requested to ensure the participation of all pertinent trade and manufacturers' associations in order to draft standards that would be enforceable, bearing in mind the present situation of the particular industry in the country concerned, until such time as the quality of products would allow the introduction of ISO standards.

47. In discussing the merits of various production techniques, many technical aspects were reviewed. The Study Group wished to draw the attention of industrialists in developing countries to the following processes which were considered in the discussions and which may not yet be well known in all countries.

### Dehumidification of timber

48. Seasoning of timber in many developing countries is frequently a problem, particularly in respect to the high cost of conventional seasoning kilns. It was strongly stressed that the possibilities of seasoning timber by dehumidification should be investigated. The equipment necessary is not costly as chambers can be built easily at a low cost. Furthermore, the process is simple to operate. Timber, particularly softwoods, can be seasoned from about 75 per cent moisture content to 15 per cent moisture content as rapidly as by conventional methods without undue degrading.

### Forced-air drying (pre-drying technique)

49. Forced-air drying is used for pre-drying timber, that is, to bring the moisture content of green timber down to 25 to 30 per cent moisture content before it is put into a high temperature kiln for final kilning. A forced-air drying chamber consists of ten or more 72-inch fans, which are laid in the middle of the chamber. The rotation of the fans is reversed every two hours for the entire duration of the pre-drying. Steam coils are also installed in such a chamber but operate only at a very low temperature. The heat helps to bring down the moisture content of the timber more quickly. The chambers for forced-air drying are made as big as possible, up to 240 tons capacity (of 50 cubic feet each) per chamber, i.e. 340 cubic meters. The quality of wood pre-dried by forced-air drying is much better than that dried conventionally. Furthermore, forced-air drying lowers the time of seasoning of timber. The method of stacking on bogies is just the same as for high-temperature kilns and the same stacks can be moved to these kilns. It has been found that the cost of installing forced-air drying chambers is not high when steam is available on site.

### Special construction for use in conjunction with prefabricated components

50. For countries producing plywood, beams with plywood webs and sawwood flanges can be produced either by nailing or by gluing. The advantages of this beam compared with those made from solid



timber are: exact measurements, no twisting or splitting, easy stress grading of the thin flanges and easy jointing. These beams could be used as structural units.

51. "Stressed skin" panels in which plywood skins on one or both sides of the rib take care of the load-carrying and are tied together with solid or plywood beams. Such panels used for roofing need only be supported by outside walls, thus enabling the quick roofing of houses.

52. Butt-end joining of studs and fabrication of studs from boards into patterns through stapling is being done successfully in one country by stapling two 1 in x 4 in boards into one 2 in x 4 in using staggered stud staples. Small-size wood is being utilized for posts in the same country by joining four 1 in x 3 in planks together to form a 4 in x 4 in post. This constructed post is accepted by the local building authorities as being equivalent to a solid 3 in x 3 in post. Attention was drawn to the usefulness of mechanical lamination as an alternative to glue lamination under certain circumstances.

#### Surface finishing of exterior wood in houses

53. Because of the problems indicated by some representatives of developing countries concerning failures of conventional exterior paints on wooden houses, the advantage of non-film-forming wood finishes were discussed. These are now widely and effectively used in North America, primarily on exterior softwood lumber and plywood siding, weather board, or cladding. These finishes penetrate the surface of the wood but do not form a film over the surface, hence there is no problem of adhesion, or of cracking of films as is commonly encountered with conventional oil-base exterior paints. A typical non-film-forming finish is a water-repellent preservative. Its components include paraffin wax as the water repellent, pentachlorophenol as the preservative, boiled linseed oil (which tends to reduce accumulation of the preservative on the surface), and mineral spirits or other similar low-boiling petroleum hydrocarbons as the solvent. This is brushed or sprayed easily, and

can be renewed every year or two with little cost or effort. A modification of this simple treatment is the pigmented natural finish, achieved by incorporating suitable colours in the above solution. This is a suitable means of providing a variety of attractive colours, allowing the natural grain of the wood to show.

54. An alternate means of providing water repellency to preservative-treated wood is a proprietary process used in the United Kingdom which incorporates a water repellent in emulsified form in conventional water-borne preservative treatments. Potentially this process could reduce dimensional changes and checking of the wood surfaces exposed during use to alternate wetting and drying.

#### The use of factory-fabricated building components

55. One of the most popular and useful building components that helps to reduce costs and speeds up erection time in mass housing projects or low-cost housing projects is the gang-nail type, factory-fabricated roof truss. Using spiked metal connector plates specially developed for use in either tropical hardwoods or softwoods, these trusses can be made at a rate of up to 300 per eight-hour day, employing a small, unskilled labour force with only one skilled operative.

56. The use of this type of truss is not confined to large production runs of any single type or pitch or span of truss. Because of the rapidity and facility of altering the jig, economic production runs of as little as ten trusses of any type with span increases of as little as 1 inch increments, up to 100 ft clear spans, are possible.

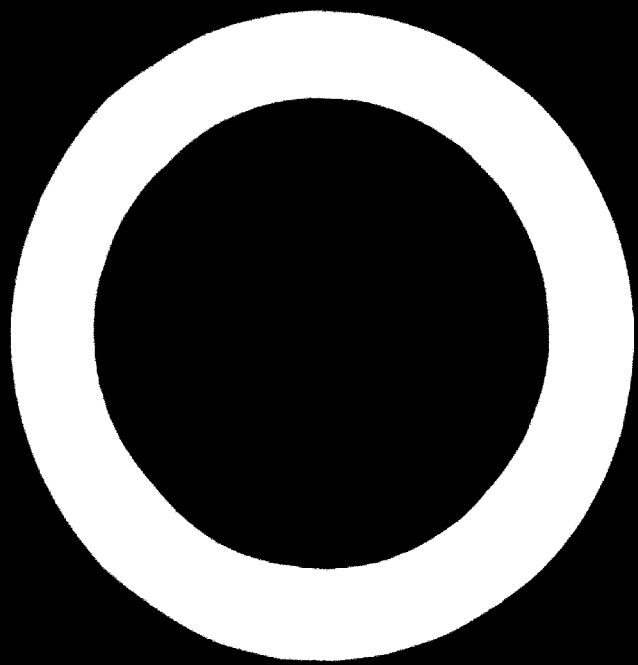
57. The metal connectors are placed on each side of the joints; in hardwoods a pressure of up to 60 tons is required to press the connectors home. It should be noted that connectors presently available can only be applied by direct hydraulic pressure into dense hardwoods; as compared with the process of rolling connectors onto joints, which has been found satisfactory with softwoods.

58. Because the members of finished trusses are in one plane, a tropical hardwood truss of a 10-metre span and 17.5° pitch for

use at 2-metre centres with an asbestos or corrugated iron roof is only 7.5 cm thick and hence can be economically transported for considerable distances. Such a truss weighs approximately 80 kg and hence can be handled easily. The use of these components reduces on-site losses from various causes, and a typical house roof can be erected in less than one hour.

Use of sulphite waste from pulp mills as adhesives

59. A Danish process which is expected to be commercialized in a large factory in Finland bonds chipped waste-wood with a sulphite waste residue obtained from sulphite pulp cooking in pulp factories. The board produced is fully resistant to exterior weathering conditions existing in developing countries.



Annex 1

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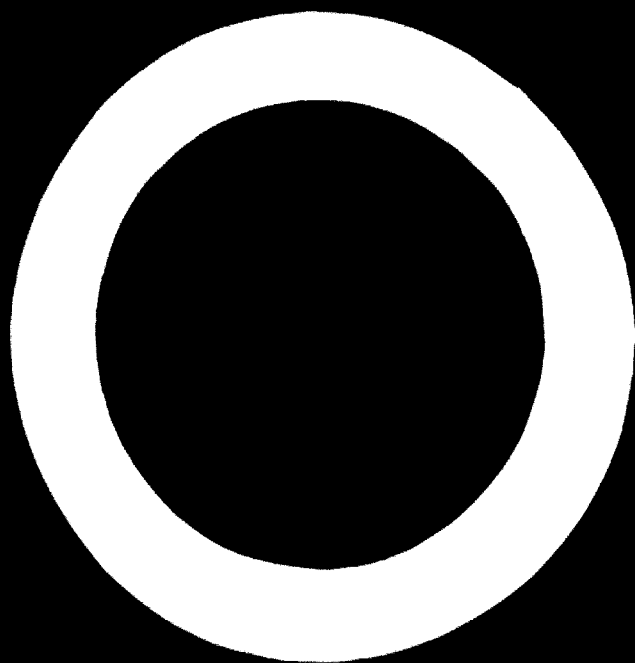
Mr. Anders EKLUND

UNITED KINGDOM

Mr. Lionel G. BOOTH

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✓ This observer also represented the European Confederation of Woodworking Industries.





Annex I

STATEMENT BY MR. I. H. ABDEL-RAHMAN,  
EXECUTIVE DIRECTOR OF UNIDO

This meeting is convened by UNIDO in collaboration with FAO and the United Nations Centre for Housing, Building and Planning in New York. It is the first meeting to be arranged by UNIDO on the subject of wood processing industries.

Some of you have had previous contact with UNIDO in one capacity or another, in the preparation of this meeting or in other connexions, but I take it that some of you may be having your first opportunity to see UNIDO and to collaborate with it.

On this occasion I would like, in a few words, to tell you that UNIDO is attempting to accomplish its main task of giving assistance to the developing countries in their field of industrialization. This is our objective and since we are a new organization, less than three years old, and less than two years here in Vienna, we are trying a variety of methods and your meeting here represents one of the means by which UNIDO is seeking to fulfil its objectives.

The production of housing, including the utilization of available raw materials, is of basic importance to the developing countries. Of course it will not be of the same importance to every developing country, but certainly a large number of those countries will benefit from whatever recommendations or observations will come out of this meeting.

The type of recommendations or observations we expect from you certainly will be helpful to UNIDO and to the other United Nations agencies participating in this meeting, namely, FAO and the United Nations Centre for Housing, Building and Planning, and your final conclusions, I am sure, can also be addressed not to the United Nations agencies alone, but also to the developing countries themselves since, after all, they are the primary agents of action and we on the United Nations side, in the family of agencies, would only be able to help the developing countries

inasmuch as they themselves act upon your recommendations and follow-up.

The guidance that will issue from your recommendations, whether of a technical nature or of an economical or administrative nature will be quite valuable to the developing countries. For our part, in UNIDO, we give particular stress to the technical and engineering aspects of the subject, to the adaptation of technology which is known in the advanced countries, and to how it can be best adapted to the conditions and resources available in the developing countries. In addition to the adaptation of transfer of technology, there will be problems that exist only in the developing countries and can only be solved there, including the situation of marketing and small production, and of course also the priority that the subject of wooden houses would have. As I said, there will certainly be different priorities in each country.

Our method of action - our instrument of action - is essentially the technical assistance programme. We have developed in the last two or three years fairly large programmes of technical assistance and I am sure that your recommendations here could be put through the UNIDO machinery of technical assistance usefully in collaboration with the developing countries. In the technical assistance approach as well as in our research and studies we try to combine these two, research and technical assistance, to have some effective development in any particular branch.

It is too early at this moment to anticipate the recommendations to come out of this meeting in one week or the follow-up that will come as a result of your recommendations. I can only say that we in UNIDO will give equal attention to the follow-up and to what happens during this meeting. We do not consider these meetings as events in themselves, but only as the starting point of a series of measures in collaboration with the developing countries within our own programme of research and studies and within our programme of technical assistance. Naturally, in the follow-up work I hope there will be continued contact and collaboration with you in one form or another.

Annex 3

LIST OF DOCUMENTS PRESENTED TO THE MEETING<sup>1/</sup>

<u>Symbol</u>	<u>Title</u>
ID/WG.49/1	Provisional Agenda and Programme of Work
ID/WG.49/2	Timber-Framed Construction for Tropical Climates, paper prepared by Richard F. Blomquist, Project Leader, Housing Research, Forestry Sciences Laboratory, Athens, Georgia, USA
ID/WG.49/3	Technical and Economic Comparisons Between Wood and Other Building Materials Commonly Used in Tropical Regions, paper prepared by the United Nations Centre for Housing, Building and Planning, United Nations Secretariat
ID/WG.49/4	Possible Uses of Tropical Woods and Their Derivatives for Building Purposes in Developing Countries, paper prepared by the Centre Technique Forestier Tropical Nogent-sur-Marne, France
ID/WG.49/5	Prefabricated Wooden Houses, by Keijo Tiusanen, Director of Product Development, Oy Wilhelm Schauman AB, Jyväskylä, Finland
ID/WG.49/6	Production of Joinery for Tropical Countries, by J. Bim, Chief, Department for Long-range Planning, General Directorate of State Wood-working Industries, Prague, Czechoslovakia; and M. Koukal, Chief, Institute for Developing Countries, Timber Research and Development Institute, Prague, Czechoslovakia
ID/WG.49/7	Pre-cut Wooden Houses for Tropical Climates, by Bruynzeel Suriname Houtmaatschappij N.V., Paramaribo, Surinam
ID/WG.49/8	Wood Preservation for Tropical Climates, by V. R. Sonti, Managing Director, ASCU-HICKSON Ltd., Calcutta, India



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<sup>1/</sup> A limited number of copies are available upon request.

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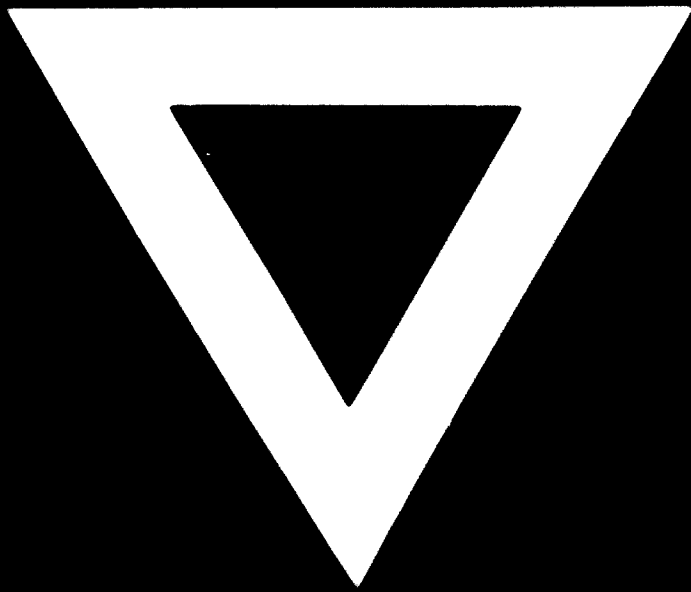
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