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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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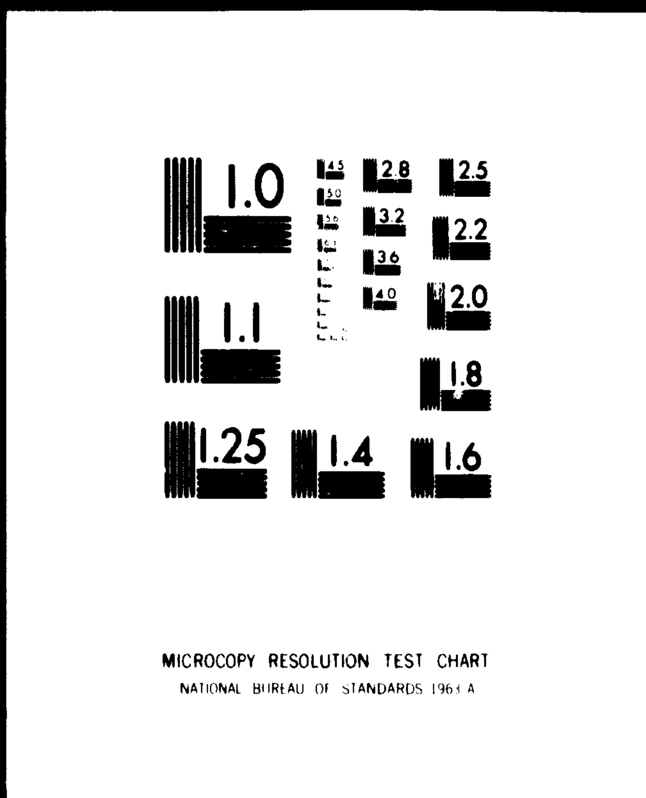

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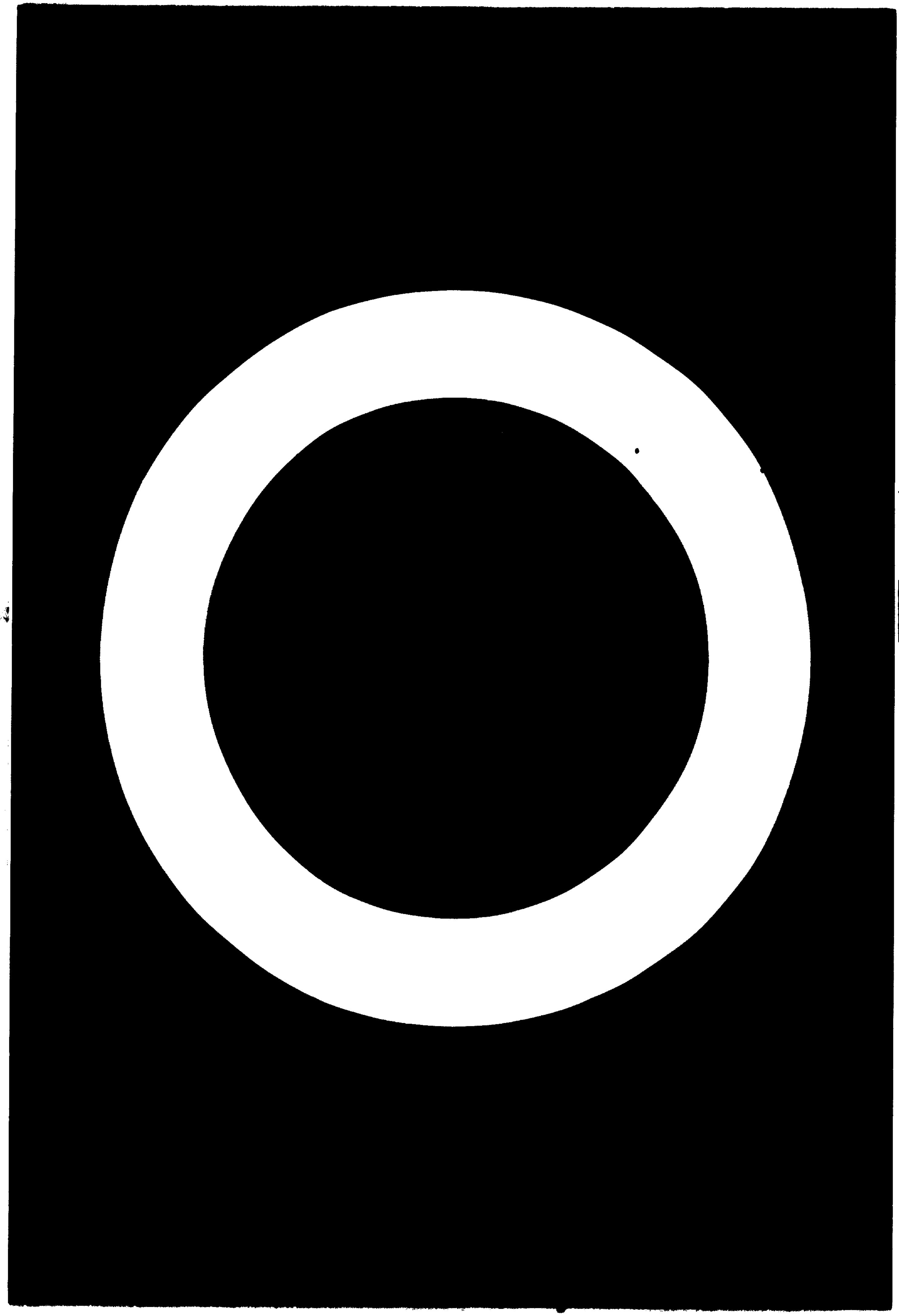
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

WOOD PROCESSING FOR DEVELOPING COUNTRIES

Report of a Workshop

Vienna
3–7 November 1975



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References to dollars ($) are to United States dollars, unless otherwise stated.

Abbreviations of organizations

ECE	Economic Commission for Europe
FAO	Food and Agriculture Organization of the United Nations
GATT	General Agreement on Tariffs and Trade
NHLA	National Hardwood Lumber Association (USA)
TRADA	Timber Research and Development Association (UK)
UNCTAD	United Nations Conference on Trade and Development

Other abbreviations

CCS	copper chrome arsenate
WWS	wood-wool cement slabs
WCS	wood-chip cement slabs

INTRODUCTION

The Workshop on Wood Processing for Developing Countries, organized by the United Nations Industrial Development Organization (UNIDO), met at Vienna from 3 to 7 November 1975. Its main purpose was to examine the processes currently available for manufacturing the main wood-based products, with attention being paid to characteristics that might influence their application in developing countries. The Workshop brought together participants from both developed and developing countries to compile appropriate data and guidelines on the wood-processing industries that UNIDO might disseminate in the developing countries to potential investors and industrialists on the one hand, and financiers, government agencies and other regulatory bodies on the other hand, to ensure the establishment of economically viable wood-processing industries in the developing countries, compatible with local climatic, infrastructural, raw material, manpower, economic and other relevant conditions.

Participants were requested to establish guidelines for assisting the developing countries to invest in types of machinery, equipment and technological processes that would be best suited to their local conditions, which would permit countries still relying on the importation of manufactured forest products to begin local production, and countries exporting their forest resources in an unprocessed or semiprocessed form to move towards a vertical integration of this sector by establishing export-oriented secondary wood-processing industries.

The Workshop was a direct follow-up of a Technical Meeting on Selection of Woodworking Machinery, which UNIDO convened at Vienna in November 1973, the purpose of which was to identify criteria for selecting individual wood-processing machines and equipment best suited to the needs of developing countries. The convening of both the Workshop and the Technical Meeting reflects the awareness of UNIDO that developing countries lack knowledge of what technologies are available and are thus unable to decide which technology is best for them. At the same time many developing countries have concluded that timber exported in round log form, while providing income for the business community, has not contributed sufficiently to the national economy by alleviating unemployment or increasing foreign currency earnings per unit exported. Furthermore, their own wood-processing plants have been unable to produce at maximum capacity, owing to a shortage of raw material at reasonable prices. Because of this situation, some developing countries are moving to ban log exports, which means that greater emphasis will be placed on modernizing and expanding existing plants and erecting new ones. Thus an investment of tens of millions of dollars will be required for equipment using appropriate technologies.

RECOMMENDATIONS

The Workshop recommended that:

1. UNIDO study the possibility of establishing a body that would bring together local or regional associations of wood-processing industries and other government and non-government bodies concerned with wood processing in developing countries, since no forum exists where persons engaged in the wood-processing industry in developing countries can meet to discuss common problems.

2. The Food and Agriculture Organization of the United Nations (FAO), the International Organization for Standardization (ISO) and other international agencies examine the harmonization of national standards for hardwoods.

3. UNIDO prepare:

   Curricula for all types of training (in-plant, vocational, university) in wood processing

   A list of national and international standards for joinery products.

4. Developing countries prepare manuals for both technical and industrial training; if necessary, they should request UNIDO assistance in this effort.

5. A United Nations code of conduct relating to security of investments for both the host country and the investing enterprise similar to the proposals of Kenneth King, Assistant Deputy Directory General, Department of Forestry, FAO, be put into effect and that such code be given teeth so as to protect the rights, assets and resources of both parties.

6. Contractual forest concessions or leases be granted for a duration commensurate with the life expectancy of the equipment invested in.

7. Developing countries pay considerable attention to the problem of pollution, since it can no longer be treated lightly.

8. At least a two-year supply of spare parts be purchased along with the main machinery when new plants are being planned.

9. The turn-key system as defined in document ID/WG.200/13 be adopted in setting up panel plants.

10. UNIDO expand existing training manuals prepared for use in UNIDO projects to cover basic topics on woodworking technology and make these manuals available to all developing countries.

11. UNIDO convene:

In collaboration with ECE, a technical meeting to be held in the near future as a follow-up to the Workshop;

A meeting on the chemical processing of wood; production of methanol fodder yeast from sawdust, charcoal, furfural; and other topics.

Alternatively, UNIDO could commission studies on these subjects.

I. ORGANIZATION OF THE WORKSHOP

M. G. Watson, Chief of the Chemicals Pharmaceuticals and Building Materials Industries Section of UNIDO opened the Workshop with an address of welcome in which he referred to the Lima Declaration and Plan of Action on Industrial Development and Co-operation[1/] as it pertained to development, particularly in the wood-processing industry.

The Workshop was attended by 33 participants from the following countries: Australia, Austria, Belgium, Czechoslovakia, Costa Rica, Finland, Federal Republic of Germany, Ghana, Guyana, India, Indonesia, Ireland, Italy, Kenya, Laos, Norway, Romania, Sierra Leone, Singapore, Sweden and the United Kingdom of Great Britain and Northern Ireland. They comprised individuals occupying managerial or policy-making positions in the wood-processing industries in their countries, technical specialists from woodworking machinery manufacturers, specialists from engineering firms and wood-processing research institutes and senior staff of specialized consulting firms. The ECE/FAO Timber Division was represented by one participant.

Eighteen observers attended whose background was similar to that of the participants and actively took part in the Workshop. They came from the following countries: Austria, Canada, Czechoslovakia, France, Federal Republic of Germany, Italy and Switzerland.

L. J. P. Willems was elected Chairman, D. S. Latta, Rapporteur, while A. V. Bassili and E. A. Morrow of the UNIDO secretariat served as secretaries to the Workshop. The following participants served as discussion leaders:

Discussion leader	Agenda item	
A. H. Page and T. J. Peck	4	Sawnwood
R. Brichta	5	Wood-wool and wood-chip/cement slabs
G. P. Heilborn	6	Wood-based panels: veneer
G. P. Heilborn	7	Wood-based panels: plywood and blockboard
D. S. Latta and P. Tack	8	Wood-based panels: particle board
A. Kaila and K. Eisner	9	Wood-based panels: fibreboard
H. Eldag	10	Joinery

1/ A/10112, annex, chapter V.

J. G. Stokes	11 Building elements
J. G. Stokes	12 Prefabricated structures
D. Haas	13 Solid-wood furniture and furniture components
D. Haas	14 Panel furniture (case goods)
D. Cody	15 Upholstered furniture

The Agenda given in annex I was adopted unanimously. The participants wished to include under "Miscellaneous wood products" (item 16) the following topics: wood flooring, toys, brushes and brooms, plywood components and handicrafts. However, when it appeared that they merely wished to obtain information and there was not sufficient expertise present to enable these topics to be discussed, only handicrafts was dealt with. Agenda items 3, 17 and 18 were considered in plenary sessions, the others, in two groups that met concurrently. The first dealt with primary wood-processing industries (agenda items 4-9), while the second covered secondary wood-processing industries (agenda items 10-15).

Eleven documents specially commissioned for the Workshop and a further eight documents prepared for previous meetings were made available to the participants to serve as background material for the discussions. (See annex II.) English was the working language of the Workshop.

II. GENERAL CONDITIONS IN SOME DEVELOPING COUNTRIES

At the opening of the Workshop, the Chairman requested participants from developing countries to describe to the Workshop general conditions in their countries, particularly as they affected the wood-processing industries, placing emphasis on:

Size of local markets

Availability of skills and capital

Existing infrastructure

Prerequisites for export-oriented industries

Services needed by export-oriented industries

The statements made are summarized below.

West Africa

Import statistics do not give an accurate picture of the size of local markets, since the quantities imported are restricted by foreign exchange resources. Potential home markets are larger than those the statistics indicate, particularly when account is taken of imported goods, such as plastic and aluminium chairs and steel bedsteads, items that could readily have been made from indigenous forest products. In Ghana, timber industries have tended to be export-oriented, which has led to the neglect of home markets. It may therefore be necessary to impose import restrictions to oblige local industry to produce for the home market.

The main skill lacking is managerial skill. Investment partners should pay attention to making up this deficiency. The main problem is to ascertain which plant and machinery are suitable for local conditions. Ghana's own organizations will decide on suitable types, sizes etc.; and once they have been determined, capital should become available. However, there is a tendency to supply Ghana with obsolete or obsolescent equipment that is unlikely to produce competitive products. Further, labour costs are no longer low, owing to social security costs and the improving educational standard. More sophisticated equipment is required to make exports more competitive.

In general, Ghana has adequate port facilities and has been handling trade for neighbouring countries. However, these facilities must be further expanded to meet future needs. Internal communications are adequate.

The most secure base for an export market is a flourishing home market, with exports representing the surplus over local consumption. However, exporters have to work through existing marketing networks in developed countries, and local industries should take this into account, as well as the requirements of the export markets.

With regard to integration of existing industry, little progress has been made. Feasibility studies and plans for integration are being prepared and will form part of the national plan for the renovation of existing industries. The Timber Board has decided to assist the traditional rural carpentry business by installing kilns and lumber depots in strategic areas, thus supplying these businesses with timber to meet their specific requirements.

East Africa

Although Kenya, Uganda and the United Republic of Tanzania actively co-operate, the differences in their educational systems give rise to differences in their industrial structures. For example, the Tanzanian system brings a university education within the reach of many; however, the graduate subsequently has to work for the Government for five years. As a result, such graduates go into industry often at too high a level and hold managerial positions without having had sufficient practical experience. In Kenya, on the other hand, students frequently have to leave school early for financial reasons, with the result that they start farther down the industrial ladder; and, if they reach the managerial level, they have amassed sufficient experience to make them competent managers.

In Kenya, the sawmilling and related industries are based mainly on softwoods, whereas in the United Republic of Tanzania hardwoods are largely used, some of them with an extremely high export value. The United Republic of Tanzania is currently developing softwood plantations for future exploitation.

Differences also exist in the ways in which the timber industries of the two countries have developed. In Kenya, the private sector, with its more commercial outlook and its need to show a return on capital, has led development. Automated plants are not common, and wood processing starts with a sawmill (some of a very high standard), with plywood and fibre-board plants being added on the same site later. Likewise, no furniture factory exists, although the market to support one is slowly being developed. The United Republic of Tanzania, on the other hand, gets advice, capital and loan aid from developed countries, which often do not fully understand local conditions. Plants are highly automated and break down because of lack of maintenance and foreign exchange for spares. The planning and siting of plants have also been haphazard, with sites being selected that are often far from raw material sources, and with sawmills being added to board mills rather than vice versa.

India

The plywood and panel industry has made great headway in India; production has increased more than 20 times over the past 10 years. Exports and per capita consumption have increased substantially, although the latter is still very low in comparison with that of the developed countries. In recent years manufacturing costs have greatly increased owing to the tremendous rise in the prices of imported raw materials based on petroleum crude for adhesive manufacture; this situation has created major problems for exporters. Timber prices, too, are increasing, but more and more secondary species are being tested and used for panel products. The high cost of ocean freight places some countries at a disadvantage with respect to other developing countries; it is one of the major factors affecting India's export performance. The high cost of machinery from developed countries is making it impossible for Indian enterprises to import it; therefore, some way should be devised to supply such machinery on a deferred-payment basis or to manufacture it in India, which has the necessary infrastructure for entering this field. Through local manufacture of machinery, India could assist other developing countries to meet their needs.

Leading Indian panel manufacturers are now concentrating on the development, manufacture and export of special plywoods and improved wood products for several industrial applications. Research institutes are providing technical personnel, but plant personnel must be trained. This view was expressed at the FAO World Consultation on Wood-Based Panels held at New Delhi in February 1975.

Plants to manufacture prefinished plywood and knockdown furniture have good prospects. UNIDO could assist, by providing the design and essential equipment, in establishing such plants in India to supply the markets in developed countries. India has three hardboard plants, but UNIDO could assist in establishing a plant to manufacture bitumen-treated fibreboard that could be used in the construction of low-cost housing. The concept of low-cost housing in India differs from that in developed countries in that housing must be fire-resistant, since open fires are used for cooking. The design of the housing and material to be used requires systematic study, which UNIDO could undertake.

South-East Asia

The Lao People's Democratic Republic is one of the least developed countries in the area. The needs of local markets have been badly neglected, since the country's natural resources have been exploited almost solely for export. For instance, no control existed over the export of logs until early 1975, when the Government placed a ban on log exports. The new Government, however, has now obtained UNIDO help in strengthening local efforts to exploit the country's natural resources, particularly for the benefit of the local inhabitants.

As the infrastructure is inadequate, it is necessary to have locally based production for local consumption. The Government is therefore promoting the design of a standard wooden house to permit rural schools and villages to undertake their own building; TRADA in the United Kingdom is under contract to UNIDO to develop this design. The local manufacture of standardized wooden furniture is the goal of another project.

The situation with respect to availability of skills and capital is much the same in the Lao People's Democratic Republic as in other developing countries. It was hoped that the technical colleges could produce the required skilled personnel, but the graduates of these colleges have failed to bring the required skills into industry. The Government has asked UNIDO to prepare training manuals for both technical and industrial training.

Other countries in the area, such as Indonesia, Malaysia, and the Philippines, have also been obliged to introduce legislation to limit log exports. They expect to increase the added-value component of their wood products in order to benefit their economies. In general, national markets have been neglected. A further irritant, particularly in the Philippines, is the plundering of choice trees from the forests by the local population.

Although the wood-based industries in the area are fairly well developed and are not big energy users and the timber itself is available, the problem is how to finance the plants to produce goods with added value and the supporting infrastructure. Both technology and finance will have to be injected.

Industrial development in much of the area, e.g. in Malaysia, the Philippines, the Republic of Korea and Singapore, was, until recently, oriented almost exclusively towards the changing export market. Production was organized to meet the requirements of this market, and industry developed accordingly. For example, Japan imported logs from the Philippines and exported wood-based products to the United States of America. Production, therefore, was not suited to small runs of a diverse product range. However, fluctuations in the United States plywood market led industry to become interested in markets in the United Kingdom and the Middle East, where smaller quantities of a variety of products were required; as a result, industry, particularly in Malaysia and Singapore, has adapted itself to produce these smaller runs on a mass-production basis.

The timber resources in the area are still large, particularly in Indonesia, where development is now starting. Skills were developed early and are being well disseminated, since technicians move from country to country to train local personnel. However, management and maintenance skills are generally non-existent. The infrastructure ranges from good in western Malaysia, in the Philippines and in Singapore to poor in the Indonesian islands (with the exception of Java).

The products sold on local markets, often second- or third-quality goods, are generally not acceptable for export. Another factor inhibiting the development of a prosperous industry oriented to the home market is the local custom of having furniture etc. made by craftsmen working directly in the home. The quality is good and the price is sufficiently low to discourage the establishment of a local furniture manufacturing industry.

The tendency in the area is to set up integrated timber projects rather than single plants, chiefly to ensure flexibility in meeting export requirements, but also to make better use of the forests and of individual logs.

In Singapore, where a new Timber Industry Board has been set up, timber was the third largest foreign exchange earner in 1974, with the United States being the biggest market. Interest is also being directed towards the European Economic Community and the Middle East countries. Further effort, however, is required in marketing, promotion and product presentation for export. It was suggested that the training seminars conducted and publications produced by the UNCTAD/GATT International Trade Centre were useful aids in this connexion.

Throughout the area the processing and marketing of secondary species should not be neglected in order to obtain a fuller and more economic use of forest resources.

The use of wood in housing in the area is limited by the lack of architects and engineers trained to design using timber as a construction material. Timber housing components, unlike concrete, for example, can be produced without major energy consumption, and factories to produce such components would not be expensive. The initial step towards a timber-based building programme is the education of architects and engineers in structural design criteria and design methods that will protect timber against fungal and insect attack and meet the requirements and standards of government authorities.

South America

In Guyana, where the timber industry has been built on greenheart production in long lengths mainly for export, the Government's decision to expand the local housing programme has necessitated major changes in the sawmilling industry.

Since new capital necessary for increasing production is not immediately available, the industry must depend on what capital it can generate. It is difficult to retain skilled personnel, who tend to migrate to developed countries. The lack of trained personnel leads to less sophisticated production lines and labour-intensive mills. Although national unemployment figures are high, the timber industry is affected by urban drift in that workers flock to the city rather than face the isolation of logging camps and rural sawmills.

The infrastructure in terms of roads and electric power poses some difficult problems for development. While it is possible to drive into the interior of Guyana, the mixture of species in any one area makes large-scale exploitation uneconomic. However, consideration is being given to the use of small local operators working parallel with the major companies to extract the minor species while the companies extract the major ones. Electric power is not available outside small communities and, at present, the economics of sawmilling are such that a sawmill project that would be viable using a public utility could not also support the additional cost of running a private power plant. As a major hydroelectric scheme is now under consideration within the country, the power position can be expected to improve in the future.

Since particle board production in countries having only a small home market and where export freight rates are high would be uneconomic, it may be more advantageous to export primary timber products than not to export at all.

In general, there appears to be considerable scope for developing wood-processing industries in South America, particularly where timber operations are currently concentrated on sawmilling.

III. SAWNWOOD

The paper "A basis for establishing criteria for the choice of processes and equipment in the sawmilling sector" (ID/WG.200/2), by T. J. Peck, was referred to in the Workshop group's discussion.

The choice of the best method of conversion of roundwood into sawnwood depends on many factors, the more important of which are:

Diameter and physical properties of the raw material

Availability and skill of labour

Location of the industry in relation to the raw material supply and to markets

Availability and dependability of after-sales service and spare parts supply

Nature of markets and outlets for sawnwood and by-products (residues)

No two cases are exactly the same, and hence no standard prescriptions can be offered, especially under the extremely diverse conditions found in the developing countries. The important point is that all the factors that will influence the viability of operations should have been identified, evaluated as far as possible and taken into account before the final decision to install or modernize a sawmill is made.

Log reception and handling

The logging truck is, and will remain, the most common form of transport from the felling site to the mill in developing countries, with floating or rafting important in some areas. Whether the logs are delivered barked or debarked will depend on several factors - debarking facilities, labour, difficulty of debarking certain species in certain seasons, danger of bark beetle infestation, bark disposal problems by the mill etc. If the logs are delivered and sawn unbarked, dirt and stones may have to be removed by spraying to prevent damage to saws. In some areas it may be necessary to install metal detectors for the same reason.

Logs may be stored in water or on land. Prolonged storage in brackish water brings the danger of attack by marine borers. Many floating and sinking species can be stored for much longer periods in fresh water.

Under tropical conditions logs can be stored on land, usually only for a limited period and if measures to reduce degrade are taken - for example, sprinkling with water (under specific conditions, adding suitable fungicides, where blue stain or fungal attack is a problem); end-coating with petroleum-based products; or use of "S" hooks or other more effective metal devices to prevent end splitting.

The choice of log handling and sorting equipment and systems will depend on several factors, including the type and capacity of the headrig and the availability of labour. As with all other parts of the production process, care has to be taken to balance the capacity of one part, e.g. log handling, with that of the rest of the operation to avoid bottlenecks and/or underutilization of equipment.

Sawmill equipment

The bandsaw is the predominant type of headrig in developing countries, by virtue of its suitability for cutting large-diameter tropical hardwood logs, relatively fine kerf and accuracy. However, frame saws or circular saws may be suitable in certain conditions. They may be preferred for breaking down smaller logs such as plantation-grown softwoods or even hardwoods, or where long lengths are cut.

The advantages of the vertical over the horizontal bandsaw headrig are well known, the main one being that boards, cants or flitches drop immediately onto off-take rollers. The sawn face is always visible as the log is cut, and the position of the log on the carriage may be adjusted as necessary to eliminate defects and produce better-quality lumber with less waste. This type of machine is used in most countries of the world.

The small horizontal headrig (saw widths usually between four and five inches) is used mainly in rural areas and operated by the smaller sawmillers, but the lumber produced from these machines is often poorly sawn. This type of machine can be used as a mobile sawmill and taken into the forest for small stands of trees etc. In some areas of the world where the horizontal frame saw is used, saw maintenance is much easier and capital costs are low.

Chipping headrigs, increasingly common in the more developed softwood-growing countries, could be considered for use in developing countries only where outlets for chips in large quantity exist (pulping or particle board).

The choice of resawing equipment depends on the species, on the dimensions of the material coming from the headrig and on the markets, or downstream integration. An interesting development is the multiblade circular saw with narrow kerf.

The bulk of sawing equipment now in use in developing countries was manufactured in the industrialized countries, and often designed primarily for conditions there. When ordering such equipment for a developing country, great care should be taken to see that it can be adapted to the specific conditions of the location in respect of climate, labour, raw material, power supply etc. Availability of spares and technical servicing are also important considerations. Similarly, a decision to install second-hand machinery - which should be reconditioned - should take into account the danger of early obsolescence.

Some developing countries are now manufacturing equipment such as sawblades and even whole mills. Many advantages can be gained thereby, including lower prices; suitability of equipment to local requirements in terms of labour intensity, degree of automation, ruggedness etc.; development of local manufacturing and servicing skills; and reduced foreign currency expenditure.

Where log supplies are sufficient and adequate maintenance skills are available, the establishment of more sophisticated sawmills involving a degree of automation should be investigated.

Utilization of residues

An important factor affecting layout is the existing or prospective utilization of residues. Making use of residues is a problem for many primary processing mills in developing countries and has often hindered them in competition for raw material with overseas processors. Numerous possibilities exist for utilizing residues, and technical barriers have largely been overcome, even for sawdust, sander dust and other fines; but whether the residues can be exploited depends on such factors as distance to economic outlets, markets for the products made from them, quantities involved, pollution questions, know-how and techniques. Among the possibilities are the production of charcoal from solid residues; land filling; pulp and particle board manufacture; and the generation of heat, steam and power. With the sharply increased cost of fossil fuels in recent times, the use of residues to produce energy has become of major interest. The Lurgi gas producer (which uses green wood) was quoted as an example. Residues from the sawmill, e.g. for conventional steam boilers, are also a potential source of fuel.

Downstream integration and the development of larger domestic markets for sawnwood and its products, notably joinery and furniture, not only would permit the fuller use of the log input, but equally important, would help towards the more rational use of forest resources (less selective cutting) and their conservation.

The design of residue-handling systems can be varied according to the labour available and the outlets.

Saw doctoring

There is a general tendency to increase the pitch (the space between the saw teeth) on the wide bandsaws used on headrigs and to reduce the teeth speed of the saws. Both of these moves should result in a cutting rather than a rubbing action, which prolongs the period between sharpenings. Research seems to indicate that slower running speeds may also reduce power consumption. Residue utilization (sawdust for pulping and particle board) may call for a longer bite per tooth.

Stellite tipping of bandsaw teeth is being used more and more, particularly in South-East Asia, and this trend should continue in other parts of the world as saw doctors become trained in handling such saws. A machine manufacturer in Europe has recently started to market a side grinding machine, which grinds swaged saw teeth in batches of three: the first tooth is ground the full width of a normal swaged tooth; the second is reduced in width by approximately 0.010 in. (0.25 mm); and the third is reduced by a further 0.010 in. Experiments carried out with a saw side dressed in this manner showed that the working life of the saw was increased by approximately 50 per cent between sharpenings.

In view of the importance of saw doctoring to developing countries, the group requested UNIDO to compile a selected bibliography on the subject and distribute it to all interested persons in developing countries.

Headrig carriage feed speeds vary considerbbly from 180 ft/min (55 m/min) on the larger machines down to 20 ft/min (6 m/min) on smaller machines, cutting medium-density hardwood logs of approximately 40 in. (100 cm) diameter.

Quality control

Grading and standardisation

Grading in a number of developing countries is based on the cutting system or on defects.

The Malaysian grading rules, as applied to exports of sawn hardwoods from Malaysia and Singapore, which were first issued in 1949, formed the basis of rules accepted by FAO in 1957 for application in South-East Asia. Guyana has recently published grading rules for hardwood timber, which were developed after considering the Malaysian rules and the grading rules of NHLA in the United States of America. Ghana also has issued grading rules.

To achieve satisfactory results, quality control should begin at the headrig and be maintained through to final despatch. Mill personnel at all stages of production should be trained to appreciate the importance of careful grading. Actual grading is carried out by specially trained personnel and in exporting countries is normally certified by an official inspectorate to ensure that grading standards shall be properly maintained.

In the long run, grading of tropical timbers will probably need to be based on the intended end use to rationalize marketing, distribution and utilization. The Workshop agreed that efforts to harmonize national standards for hardwoods at the international level should be intensified, but fully recognized the complexity of the problem. It felt that any international standardization would not necessarily replace national standards, at least initially, but would rather have harmonization as a goal. The ECE standard for the stress grading of coniferous sawn timber being developed by the ECE Timber Committee was cited as an example of what could be done.

Improved grading and quality control will also assist developing countries in their efforts to add value to their exports of tropical timbers through further processing, for example, for furniture and joinery components.

Linked to the question of standardization is the trend towards unification of measurement according to the metric system. Standardization and metrification should progress together. In this connexion, it was noted that two of the major markets for tropical timbers, Europe and Japan, were using the metric system almost entirely. Moves are being made in North America to convert to that system in due course.

Seasoning

Kiln drying is being increasingly used, both in tropical and temperate-zone regions. Air drying cannot reduce the moisture content to the level required for many purposes and, depending on the time involved, is costly in terms of capital tied up. It also reduces flexibility in production schedules and delivery.

Several kilning methods exist, varying widely in degree of sophistication. The cost per unit of throughput must be kept as low as possible, and this consideration as well as the value and properties of the timbers to be seasoned will determine the best method of kilning. Among new developments or improvements on existing technology are a natural draught system using hot-water pipes, high temperature drying of softwoods (with prospects of adapting the system for hardwoods) and vacuum predrying. For all kilning methods, correct schedules must be worked out for each species and dimension to ensure good results. Because wood is hygroscopic, proper post-kilning handling and storage are important, that is, packages should be suitably wrapped for shipment.

Kilning may also permit the processing and use of a wider range of species, including those unsatisfactory or difficult to use in the green or air-dried state.

Preservation

Preservation of timber under tropical conditions is often a critical problem. It may be necessary to apply preservatives against blue stain, fungal and/or insect attack from the moment of felling on. Application may, according to circumstances, be by spraying, dipping or brushing, dip diffusion or impregnation. Attention should be drawn to any environmental or health hazards in the treatment process and in the use of treated timber.

Untreated timber is often unmarketable in tropical countries. Hence, the development of local markets may depend on the installation of preservation plants. Absence of legislation relating to the treatment of timber and its use in developing countries appears to be hampering its wider application. The oost of suoh treatment, which may amount to a third of the production costs, may also be a handicap. The most suitable location of such plants, at the mill or nearer the point of use, depends on several factors, notably whether the timber is likely to deteriorate in transit or is to be further machined before final use. In the case of exports, care must be taken to ascertain whether there are import regulations and environmental and building codes in the importing oountries oonoerning the use of treated timber.

Labour availability and oapital investment

In most developing countries, the supply of unskilled and semi-skilled labour is, and is likely to remain, adequate, contrary to the situation in developed regions, which are experiencing increasingly tight labour situations and a tendency for labour costs to rise relative to other inputs. For social and economic reasons, therefore, investment in labour-saving equipment may be inappropriate in developing countries; up-to-date equipment should be selected that is not highly automated. For example, in conveyor systems, rollers may be preferable to automatic chain feed.

Labour productivity in many tropical sawmills is still low, attributable largely to the lack of training and of adequate supervision. In some instances it may also be partly due to climate, health or diet deficiencies.

Training of sawmill personnel

As noted earlier, absence or inadequacy of training at all levels of operation is a principal reason for the low productivity of sawmilling in many developing countries. UNIDO, FAO and other international agencies, as well as Governments and individual firms, should give considerably greater emphasis to this question in their programmes. Generally speaking, training gives the best results under local conditions, either in-mill or in situations similar to those the trainees are likely to experience in their own mills. Certain types of training abroad may be valuable, for instance, the training that equipment manufacturers provide for personnel who will operate the new mills. An example was given of an equipment manufacturer who, as standard procedure, added 2-3 per cent to his quotations for such training.

In some developing countries it may be counterproductive to appoint a university graduate to a middle management or senior management post unless he has also received proper technical training. Thus, technical training should go hand in hand with university education.

Economies of scale

The average size of sawmills is increasing. Modern mills producing for the export market are generally of medium-to-large capacity. However, the size of mill serving mainly the domestic market in developing countries must be based on factors besides the usual ones of economic supply and type of raw material and the size of market. The competence of management to operate a large mill and the adequacy of the supporting infrastructure have to be considered. Where mills are labour intensive, as most are in developing countries, economies of scale are not so important as in highly automated mills, given the lower capital per labour unit of the former.

In the short time available, the Workshop was unable to lay down guidelines on economies of scale. For similar reasons, it was felt that little purpose would be served in attempting to suggest the best sawmill layouts for tropical conditions or in indicating investment costs for given sizes of mills.

IV. VENEER AND PLYWOOD (INCLUDING CORE PLYWOOD)

The paper "Production of veneer, plywood (including core plywood) in developing countries"(ID/WG.200/4), by G.P. Heilborn, was referred to in the Workshop group's discussion, at the conclusion of which the group requested UNIDO to reissue the document to include items discussed. The revised document (ID/WG.200/4/Rev.1) can be considered the group's report to the Workshop on veneer and plywood.

Definition of plywood

Plywood consists of a multilayer combination of veneer sheets normally produced in standard sizes with varying thicknesses. As for the veneer itself, it can be peeled on a rotary lathe or sliced on a veneer slicer. Core plywood (formerly known as blockboard), consists of a core of wooden lathes glued together to form a block. It is normally produced from mill residues.

Uses of veneer

There are two types of veneer: the first is merely peeled and considered an intermediate for plywood production or packing cases; the second is known as sliced or decorative veneer and is invariably used as a natural wood surface in a wide range of wooden products, such as doors, partitions, wall panelling and furniture.

Uses of plywood and core plywood

Although plywood is widely used in the construction industry throughout developed countries, it has in recent years lost ground in Europe, primarily in the furniture industry, because of the inroads made by particle board, which is cheaper there. In developing countries the situation is different because plywood rather than particle board is normally produced at an early stage in a country's development.

Future trend of plywood versus particle board

The use of particle board instead of plywood in developed countries is normally based on economic rather than technological reasons. In other parts of the world, and in particular in developing countries, where large, high-quality logs are still available, it is cheaper at present to produce plywood than particle board, mainly because of the lower investment cost, availability of cheaper labour, and high relative cost of adhesives.

Log handling at plant

When logs are stored at the factory site in tropical countries, they should be stored in a log pond, which could be a fenced part of the sea or a river bed, mainly because it permits green peeling. (The logs can be taken direct from the pond to the rotary lathe for peeling without pre-steaming.) This method protects the logs to some extent from insect damage and from further splitting.

Wherever labour is cheap, it is invariably more economical to debark the logs, before processing, manually with the aid of debarking irons, instead of using conveyors and mechanical debarkers.

Steaming - boiling for the production of fancy sliced veneer

The steaming of logs reduces the danger of cracking. The steaming of flitches has become more common because the steam pits can be filled more completely (i.e. there are fewer voids) and steaming occurs more quickly because of the faster heat transfer. The decision as to whether a wood species should be steamed or boiled must be determined by experience. While steaming is used more extensively, certain species must be boiled so as to protect the colour or maintain a smooth surface, especially if the species has interlocked grain.

Slioing

Of the three types of slicers available (horizontal, slanting and vertical), the group felt that the horizontal type was the most accurate, the vertical type being considered the fastest in operation.

Peeling and drying

The selection of the machines for peeling and drying depends on the size of the logs to be processed. Whereas in certain countries it is necessary to peel as many as 200-400 logs per hour to aohieve a certain output, factories that operate on tropioal timbers may need to peel only 6-8 logs to obtain the same output. In the former case, infeed of logs and ejeotion of oores may have to be mechanized, whereas in the latter oase it need not be.

For drying veneer, the oontinuous drying system is preferable to the roller system, sinoe it allows the veneer to shrink before cutting, thereby oreating a 3-6 per oent saving of material. This system requires, however, mass production. Where it beoomes neoessary to produoe a variety of thioknesses, both the oontinuous drying and the green olipping systems should be combined. In the latter case the different veneer thioknesses are staoked separately.

Jointing and splicing

Investment in adequate jointing and splicing equipment to make full use of veneer that has been produced undersized or is defective is necessary. However, the technological and economic efficiency must be checked individually.

Gluing and pressing

Recognizing that the pressing section begins with the glue spreader, where the core veneer is sent through and is glued on both sides, it was generally agreed by the group that the roller method of gluing was superior to others, such as curtain coating, spraying, or even simple application by hand. Pressing faults are usually caused by precuring or incorrect moisture content of the different veneers. If pressing defects show up, it is always best to check first the moisture content of the veneer. High priority must be given to quality control to avoid a high percentage of rejects.

In the case of mass production, the plywood from the hot press is sent direct to the sizing and sanding section. However, where the plywood consists of a variety of thicknesses and sizes, requiring continuous adjustment of the machines, it is better, after the hot press, to build up many plywood stacks according to size and thickness before sending the material through the sizing and sanding section. When considering sanding it is important to know what the sanding operation is supposed to do. It is common practice to operate with one bottom wide-belt sander for calibrating the plywood and providing a rough sanding of the plywood back. In this operation an 80-grit sanding paper is used followed by a three-head top wide-belt sander, with the first head operating as a contact roller with an 80-grit sanding paper. The second and third heads are equipped with cushions, with the paper being 150 and 250 grit.

Core plywood material and production

Core plywood has as its source peeler cores from plywood factories, as well as inferior logs. In some developed countries separate plants are established for its production, but in developing countries the normal approach is to add to a plywood factory a manufacturing line for this item.

Cost-price structure

It is rather difficult to determine a cost-price structure because both costs and prices are subject to certain fluctuations. Price of logs, which represents normally the highest cost factor, tends to fluctuate because of the economic climate. Other parameters (labour, recovery, overhead etc.) are more stable. A recovery factor of approximately 50 per cent of round wood input for large-diameter logs is considered an accpetable yield.

Balancing capacity of production machines

When producing wood-based panels of any kind it is essential to have the capacities of the machines in balance with previous and subsequent operations to minimize investment costs, and a system must be selected for each step of production so that they will be. The main objective should be to have the factory so organized that all machines will be working at maximum capacity for the entire duration of the plant's operation. An exception could be the driers, which could initially have a lower capacity so that they operate three shifts as against two for the rest of the plant.

Shipping

When goods are to be shipped overseas, storage space for up to two months' production must be assured. Goods must also be adequately protected from damage in transport by using strong crates with lumber or low-quality plywood faces.

V. WOOD-WOOL CEMENT SLABS AND WOOD-CHIP/CEMENT SLABS

The paper "Technical processes for the production of wood-wool/cement boards and their adaptation for the utilization of agricultural wastes" (ID/WG.83/4 and Corr. 1), by W. Sandermann, was referred in the Workshop group discussion.

Description

Wood-wool cement slabs and wood-chip cement slabs (hereafter referred to as WWS and WCS) are building boards made from wood wool or coarse wood chips and a mineral binder, such as Portland or Sorel cement, and a mineralization agent like calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$) and silicates like water glass ($Na_2O \cdot xSiO_2$).

The dimensions, weights and properties of WWS and WCS have been standardized in some countries, with application instructions issued by the manufacturers and by various interested official bodies.

The most common standard sizes of these slabs are (mm):

Length/width	-	2,000 x 500 and 2,500 x 500
Thickness	-	25, 35, 50 and 75

WWS and WCS have valuable properties that make them well suited as building materials in a wide range of applications, in particular the following:

Low specific gravity, 350-650 kg/m^3
Good sound and thermal insulation
Fair elasticity and bending strength
Non-inflammability
Relative durability against fungi and insect attack
Good workability and transport-endurance

They absorb less water than solid wood and have good weather resistance, which depends upon the treatment or finishing applied.

Besides WWS and WCS, large panels, hollow blocks or roofing tiles can be obtained from softwood shavings and mineral binders by moulding under pressure.

Non-porous cement-bound boards are also manufactured. Their density is much higher, ranging from 1.0 to 1.2.

Raw material

WWS and WCS are produced from two categories of wood: solid timber (small logs and solid wood residues like slabs, edgings, offcuts); and chipped wood (shavings and chips). A wide range of wood species is suitable for production. However, there are some limiting factors such as the content of sugar, tannin and other extractives. These substances retard or even inhibit the curing of the cement, and it is therefore advisable to test the wood species intended to be used for their suitability.

New types of machines and processing lines have been developed to make greater use of wood residues and refuse.

Production process

WWS

WWS is produced by plants differing in the degree of mechanization according to plant capacity and local conditions. Fully automated lines are also operating now. The manufacturing process is basically similar and consists of several operations, described below.

Producing the wood wool

The small logs (or wood residues - edgings, offcuts, slabs and other waste) are cut into pieces 50 cm long and fed into horizontal or vertical wood-wool machines that produce the wood wool in threads 4-5 mm wide and 500 mm long, with a moisture content not exceeding 20 per cent.

Mineralization of the wood wool

The wood wool is weighed and then dipped into a mineralization solution. The surplus solution is wrung out by pressing rollers.

Blending with cement

The wood wool is mixed with cement and some additives in a continuous working mixer.

Forming and pressing

The wood wool is formed either continuously by a mat-forming station and a cut-off saw or by a mould-filling unit. The "cakes" obtained after the cutting-off or from the moulds are piled and pressed vertically and simultaneously on two or four edges.

Cement hardening and slab storing

After removal from the press, the pile is eventually kept under pressure and stored until the cement sets. Air drying or artificial drying of the slabs is performed by some technologies, as well as supplementary trimming.

WCS

The production process for WCS differs from that for WWS only in that chips from wood residues are processed instead of wood wool.

Processing chips

The wood residues are disintegrated by a rotary chipping machine, after which the coarse chips are converted into uniform-sized particles by a hammer mill. The particles are then screened and separated from refuse and pneumatically transported to a dosing silo.

Mixing and forming

From the silo, the particles fall into a continuous mixer, where they are mixed with cement and additives. Then the coated particles are brought to the mat-forming station, where a "cake" is formed in two stages, i.e. two layers of particles are spread into the mould, with reinforcing sawnwood lath, slit bamboo or other material being inserted between.

Pressing and cement hardening

The filled moulds are fed into a hydraulic vertical press that shapes the final form of the slabs. The stack of filled moulds, which is held under pressure by iron hooks, is brought to a drying storage area and left until the cement has hardened and the slabs can be taken out of the moulds. The slabs are then trimmed on four sides.

Uses

All cement-bound products like WWS, WCS, blocks and moulded elements are basically used as building elements for prefabricated houses, schools, hospitals, factories, exhibition halls, storehouses, garages, farm buildings and other types of buildings of one or more storeys. These products are used especially for exterior and interior walls, partitioning, flooring and ceiling, roof lining and concrete shuttering.

Some particular methods of using these building elements are worth mentioning. The so-called "coated concrete wall" consists of a concrete core lined with WWS or WCS on both sides. It is obtained by pouring concrete into the space between the slabs. Another building element consists of a slab formed by three 40-mm-thick slabs, the inner layer being shifted lengthwise and laterally to form a tongue-and-groove wall panel. During the erection, reinforcing steel rods are placed in the hollow spaces, after which concrete is poured.

A cheap and simple method of wall construction is to use hollow blocks. The blocks are laid in wallwork and the cavities are then filled with concrete.

WWS and WCS may be fastened with cement-coated or galvanized nails or expanding plastic bolts on wooden frames or bolted on steel frames. The surface may be plastered or painted.

Owing to their insulation properties, cement-bound WWS and WCS find their major field of application whenever thermal and acoustic insulation is required. In hot climates, the use of these slabs has been found satisfactory.

Limitations

When the establishment of WWS or WCS plants in developing countries is under consideration, factors limiting the use of these materials should be taken into account. The first concerns the suitability of the wooden raw material in terms of compatibility of the available species with cement bonding, particularly with regard to their content of hydrolized polysaccharides, like pentosans, which are strong inhibitors for the cement. The second is the variable degree of the resistance of WWS and WCS to decay, fungi and insect attack and moisture. Preservative as well as fire-retardant treatment is strongly recommended. However, these improvements in quality will raise the cost price of the board by about 4 per cent.

One danger is that termites may infest the hollow spaces of the slabs. Such infestation can be controlled by termite-proofing the product chemically and plastering the slabs to seal the cavities or by adding more cement to obtain a closer surface of the boards.

Besides the technological factors mentioned above, many economic and psychological factors may limit the use of WWS and WCS. Erratic supply of suitable cement in several developing countries makes the production of cement-bound materials questionable. The local architects and housing authorities are unaware of the real advantages of using these materials, and the lack of proper design of buildings made of WWS and WCS or other wood/cement-based building materials also hampers the growth of the industry.

Other competing building materials do not impede the development of WWS and WCS products to the extent that they are "complementary", co-existing with the traditional ones like bricks, "sandcrete" blocks, heavy and light concrete prefabs, wooden prefabs and sawn timber.

Investment considerations

Developing countries are showing great interest in small- and medium-capacity WWS and WCS plants because the degree of mechanization of the process is reasonable, operations are safe, and maintenance is easy.

The importance of the availability and suitability of the raw material was stressed.

Preference is given to the integrated plants working within a woodworking complex or near an industry producing wood residues (sawmill, plywood etc.) or a convenient forest resource of small logs or low grade timber. In all these cases, the economic output of production is 500-800 slabs in 8 hours. For developing countries the capital investment for a line producing 800-1,200 WCS in 8 hours is estimated to be about $300,000, assuming that all prerequisites have been met and the market is properly prepared to consume this commodity. Smaller plants with a capacity of around 500 slabs per day would cost as little as $100,000, based upon 1975 prices.

Summary

The establishment of a WWS and WCS industry in a developing country is subject to the qualifying factors mentioned above. A thorough feasibility study should be carried out, based on a comprehensive market survey, on an accurate inventory of the available raw materials, and on reliable laboratory tests to determine the suitability of the local wood species for manufacturing WWS and WCS.

Before a plant is set up, a promotion campaign among future consumers, architects and building contractors should be launched. Standard designs and samples of building elements made of WWS and WCS will support this campaign effectively and demonstrate the economic use of the proposed products.

An efficient WWS and WCS plant will undoubtedly fill part of the acute demand for cheap building materials in the developing countries.

VI. PARTICLE BOARD

The following papers were referred to in the discussion: "Adhesives for wood" (ID/WG.200/3), by J. Reinhardt; "Particle board production for developing countries" (ID/WG.200/7), by P. E. Tack; Production of Panels from Agricultural Residues, Report of an Expert Working Group Meeting, Vienna, 14-18 December 1970 (United Nations publication, Sales No. 70.II.B.4); and the FAO document "Guidelines before establishing a wood-based panels operation"(FOI/70/4.1 rev).

Finally, the group, having examined the topic thoroughly, instructed the discussion leaders to redraft document ID/WG.200/7 to reflect the results of their discussion and requested UNIDO to reissue the text as a post-Workshop document (ID/WG.200/13), which the group would then consider its report on particle board.

Establishing a particle board industry

A feasibility study carried out by consultants or institutions whose qualifications are internationally recognized and that are totally independent of any plant or equipment supplier is a prerequisite for establishing a particle board industry. Such a study should examine the extent of the market, technical aspects and the feasibility of integration with other wood-processing industries.

Local manufacture of resin

It is doubtful whether the local manufacture of resin will result in reduced resin costs. A plant with a capacity of 20,000 tons per year of resin is the smallest that would ensure a commercially viable operation. The estimated cost of such a plant is $1.1 million - $1.8 million. Few developing countries have wood-based panel industries large enough to absorb such a large production.

Desired specifications for particle board

Developing countries should adopt the standard quality specifications and standard methods of quality testing used in one of the developed countries rather than formulate new national standards. If local markets can accept less high quality for certain applications, the standard adopted can be varied accordingly. At the request of the group, UNIDO annexed to the revised document a list of such standards.

The properties of flat-pressed particle board make it technically suitable for the manufacture of the following products, though certain limitations may arise from the type and quality of the board manufactured:

(a) Veneered, laminated or painted furniture. When thin veneers or laminates are to be used, the surface quality of the board must be high enough to prevent "telegraphing". If a decorative melamine film is to be applied direct to the board surface, the particle board itself must be of an extremely high quality; otherwise there will be many rejects and consequent waste of imported materials;

(b) Joinery products such as built-in furniture or partitions where continuous humidity or dampness is unlikely to occur;

(c) Building applications where adequate ventilation and protection from dampness, condensation and insect attack can be ensured. For load-bearing floors, particle board of a higher density is required, the uniformity of density over the board area being extremely important;

(d) Packing materials, switchgear mounting panels, coffin bottoms or ironing boards.

Choice of board size

In developing countries the greatest end use will initially be in the housing sector, for which 4 ft x 8 ft (122 cm x 244 cm) board is adequate. It must be borne in mind that for furniture, larger dimensions are preferred, since large boards will yield a wider range of components and less waste will occur in cutting to size.

Choice of manufacturing systems

The following systems are normally installed:

(a) Steel-belt system, which uses a single daylight press in which the mat is spread continuously on an endless steel-forming belt;

(b) Textile or flexible-mesh belt system, which allows the use of single- or multi-daylight presses;

(c) Tray-belt plant system, which operates with Deckle Boxes, equipped with a bottom belt;

(d) Caul-type system, which operates with rigid cauls;

(e) Flexible caul system, which operates on a similar principle to the rigid caul system, indicated above.

More low-quality wood waste can be used in the calender press system than in the cold-hot pressing system.

Handling and storage of raw material

The use of a mobile crane for handling logs in the woodyard is preferable to using other equipment or manual labour. The bulk storage of residues is to be avoided if possible, particularly in open storage, because of the fire hazard.

Flaking; conveying systems and storage of wet chips

Space should be left in the building for the later installation of a simple mechanical feed system for the flaker. It could be made locally and would improve flaker utilization time and reduce handling costs. Where a plant's planned future output warrants the installation of a high-capacity drum-type flaker, space should be left in the building for a full mechanical feed system, since it is not humanly possible to feed such a flaker manually when it is operating at full capacity.

Of the various types of conveying systems, the belt or screw conveyors are normally recommended for use in plants in developing countries because their power requirements are low, they are easy to maintain and they may be manufactured locally.

Wet-flake storage should be of sufficient capacity to enable operation to be continuous. The bin-discharging device must be manufactured by a company specializing in that particular type of discharge. The correct design of the bin itself is important.

Driers

Of the many types of driers used in the production of particle board, the following four are the most commonly used:

(a) Jet drier, with its stationary, horisontal, cylindrical drying chamber; this type may be heated by oil; gas; or a combined wood-dust, oil or gas system;

(b) Rotating drum drier, with induction fan, using a high temperature gas as drying medium;

(c) Rotary tube-bundle drier, with either a single or double rotor and consisting of a bundle of heating coils with peripheral scoops and paddles;

(d) Flash drier or predrier, which consists of a vertical drying duct, top bend, cyclone, a recirculating gas fan and furnace. This type of drier is normally installed before a jet drier and is completely independent of it.

Owing to continuing rises in fuel prices, preference is now being given to driers heated by steam or hot water.

Dry chip conveying and storage

Use of flat belt conveyors usually leads to dust problems. A fully enclosed conveyor of the screw type, which can be made locally, is more suitable. Since it is so important to maintain continuity of production, the storage capacity of the dry-flake silo should be adequate.

Glue/chip mixers and dosing systems

The type of glue blender that has been introduced in recent years should be installed wherever possible because of its many desirable features, some of which are:

(a) There is no need for a supply of compressed air. A supply of cooling water is, however, necessary;

(b) Cleaning requirements are reduced considerably in comparison with the older blenders;

(c) Power requirements are greatly reduced;

(d) An adhesive economy of a minimum of 5 per cent and sometimes up to 10 per cent (compared with older blenders) is guaranteed.

Quality control

Although process and quality control equipment is expensive, it is essential throughout the plant to obtain products of acceptable quality with minimum rejects. It is important to maintain records for continuous and immediate use by management and shop floor supervisors. Tests should be carried out immediately upon receipt of the samples, and the results should be communicated to all concerned as soon as they are available.

Stocking of spare parts

When equipment is purchased for a new plant, it is important to buy a supply of spare parts and expendable materials for at least two years' operation.

Heating and energy supply

Since fuel is no longer cheap, industrialists in developing countries should study all possible ways to generate efficiently the thermal energy required, including the full utilization of waste products.

Pollution control

Pollution control should be given serious consideration when setting up a new plant, and capital should be provided for installing the necessary equipment.

Personnel training

Financial provision should be made at the inception of a project, and adequate time should be allowed for training skilled electricians and fitters required for the proper operation of the plant. The cost of in-plant training of plant management by a qualified expert should also be included in the total budget cost.

Turn-key plants

The group stressed the importance of adopting the turn-key system as defined in document ID/WG.200/13 when new panel-based plants are set up.

VII. FIBREBOARD

The following papers were referred to in the discussion: "Fibreboard production in developing countries" (ID/WG.200/5), by K. Eisner; "General selection guidelines for woodworking machinery" (ID/WG.151/6), by A. Travnik.

Findings of FAO indicate that production of fibreboard has increased very slowly in the developing countries.

Types of fibreboard are classified as compressed and non-compressed or, in relation to its density, into insulation, medium density, hardboard and super-hardboard. Depending on the technology used, the production methods can be divided into a wet process, a semi-dry process and a dry process. The semi-dry process is used little at present.

Fibreboard has a great potential for application in furniture, construction, transportation and packaging. The largest field in furniture is kitchen equipment. (In the United Kingdom of Great Britain and Northern Ireland 70 per cent of kitchen equipment is made of fibreboard.) Insulating board impregnated with asphalt or bitumen for use in the construction of wooden houses has a very interesting market in some developing countries. Of similar importance for wooden houses are oil-tempered hardboards. There is little risk of fire in using asphalt-impregnated boards according to tests carried out in Sweden.

The properties of fibreboard should correspond with ISO requirements. If that is not the case, the quality should correspond to utility grade. A short description of the properties is given in the paper "Wood-based panel products" by Schultz, presented at a meeting of the Institute of Wood Science, Australian branch, on 17 February 1975.

If sufficient reserves of raw materials are available, all the factors influencing the successful operation of a plant to meet the required production must be analysed in a preliminary, detailed feasibility study.

Hardboard appears to be the most suitable type of fibreboard for use in developing countries. In choosing between the wet and the dry process, the wet process is preferable in spite of some advantages of the dry method, mainly because it uses machinery that has been well proved over many years of service and can be handled better by low-skilled operators.

In Kenya, a hardboard plant using a wet-batch (Deckle Box) system has started production successfully. It is part of an integrated wood-processing plant (sawmill and plywood mill) and produces 15 m^3 hardboard in three shifts, with 171 workers in the factory, from residues that are two thirds eucalyptus and one third cypress and pine. A similar plant is operating in Madagascar. Two similar plants (also using the discontinuous Deckle Box) in Indonesia and Yugoslavia, respectively, stopped production in the 1950s. A new, small factory in the United Republic of Tanzania, using the conventional (continuous) wet process is giving satisfactory results in quality and is profitable. A comparison of costs for this particular plant with conventional ones having more sophisticated equipment is contained at the end of this chapter.

Board sizes considered most suitable for developing countries to produce are sizes 4 ft x 8 ft (122 cm x 244 cm), 4 ft x 9 ft (122 cm x 274 cm) or 4 ft x 16 ft (122 cm x 488 cm).

The development of hardboard production has advanced gradually, depending on local demand. If the market is small, batch production with many manual operations may be sufficient. For greater capacities, continuous forming (dewatering) machines with 20-30 daylight presses must be installed. In designing the plants, the possibility of future expansion and automation must be taken into account.

Comparisons of production and investment costs indicate that a production capacity of approximately 70 tons per day would prove economic in some developing countries.

For surface finishing, all the traditional methods used for plywood and particle board can be used, such as coating with lacquers, printing, laminating with melamine or polyester papers and gluing of plastic foils.

Turn-key plants

Factory equipment delivered on the basis of turn-key contracts is the best guarantee of good production.

A turn-key plant normally implies that one contractor is legally responsible for all the items listed below, which must meet all the specification requirements of the single contract before the plant can be handed over to the buyer in operating order. Buyers should be aware that serious problems may arise if they contract separately for any part of the supply of equipment or buildings. These problems, in the event of non-compliance of any plant of the total project, may result in the principal contractor's disclaiming responsibility for such non-compliance. Unless the turn-key plant contractors themselves subcontract with the proposed local suppliers, serious and expensive problems almost invariably arise.

The whole turn-key project should include the supply of:

- Production equipment
- Preparation equipment
- Defibration and forming equipment
- Press plant
- Finishing line
- Auxiliary equipment
- Electrical equipment
- High-tension cabinet
- Low-tension distribution cabinet
- Switchboards and complete control equipment
- All electric cables and accessories
- Equipment for supplying heat and energy
- Compressed-air equipment
- Cold-water equipment
- Additive preparation equipment (if needed)
- Transport equipment
- Fire-extinguishing equipment
- Laboratory equipment
- Complete workshop equipment
- Erection equipment
- Equipment for improving the surface, such as veneering and coating line
- Spare parts and consumption materials for a minimum of two years
- Erection of buildings, including complete civil engineering
  - Buildings for production equipment
  - Buildings for auxiliary equipment
  - Foundations, for above-mentioned equipment
  - Buildings for offices, stores etc.
  - Complete office equipment

Lighting equipment for all buildings, offices, stores, woodyard etc.

Complete process know-how

Complete erection, start-up and running-in of plant

Training of new plant's technicians

Technical assistance after start-up

All costs for erection and start-up, including travelling expenses, board and lodging for the seller's specialists, should be fixed and included in the contract's total price. Machinery should be quoted c.i.f. (i.e. include transport costs).

This check list should be drawn to the attention of all responsible decision makers in developing countries, since major errors have been made in the past.

The cost of solving pollution problems in existing plants in Europe is approximately $2-$10 per ton.

Feasibility study for a fibreboard plant

The outline of a feasibility study for a fibreboard plant is given below.

Feasibility studies

1. Basic raw materials

    Species and density

    Wood raw material

    - Homogeneous
        - Selective cutting
        - Industrial waste
    - Heterogeneous
        - Mixed raw material
        - Clear cutting
            - Whole-tree cutting
            - Tops, branches
            - Forestry thinnings
            - Roots

    Non-wood raw materials

    - Bagasse
    - Cereal stalks

    Other material inputs

    - Adhesives
    - Other chemicals
    - Preservatives
    - Wrappings

    Transport facilities and costs for the items listed above

2. Production level

Non-integrated

Vertically integrated

Horizontally integrated

3. Preliminary marketing and capacity studies (determination of potential demand)

Quality considerations
Type of product
Quality of product

Production volume

Import of boards and price

Local markets and selling price

National markets and selling price - inland transport

Export markets and selling price - costs of freight, insurance, duties and packing for export

Outlets for by-products

Present and future markets

Selling price of competitors and substitutes

Possibility of selling total output

Standardization

Estimated capacity

Influence on balance of trade

Industrial development expected in the area

4. Preliminary engineering studies

Batch-scale studies

Laboratory and research work

Commercial-scale trial runs

Consultant's advice

Degree of rationalization and mechanization

Efficiency of production

Climatic features

Manpower requirements, skilled and unskilled

Energy requirements, electric power and heat energy

Water requirements, drinking and process

Corrosion problems (pH during steps of process)

Land and storage facilities

Economic comparison of capacities and equipment

Waste disposal and pollution problems

5. <u>Plant location investigation</u>

Integration of whole wood resource

Wood waste as fuel wood
Logging operation: transport of merchantable species to sawmills and plywood mills
Transport and communication facilities

Infrastructure costs that are lower than average in remote areas:

Economical use of waste wood
Clear cutting operations
Whole-tree harvesting
Combined raw material transport
Combined administration, management and common service facilities

Infrastructure costs that are higher than average in remote areas:

Skilled labour and management
Energy
Environmental engineering
Freight of end-product
Capital investment

In selecting a site, the sum of manufacturing and freight costs must be a minimum.

6. <u>Preliminary financial resources</u>

Own capital

Loans from suppliers

Loans from government agencies

Co-operatives or partnerships

Loans from international bodies

<u>Economic analysis</u>

7. <u>Manufacturing cost estimates with a rated capacity of X tons/year</u>

Raw material

Auxiliary material

Process water, boiler water

Fuel oil and/or fuel wood

Electricity

Materials for maintenance and repair

Other operating supplies

Direct and indirect labour

Labour supervision

Administration and management

Depreciation - 10 years using straight line

Property taxes and insurance

Other overhead costs

Interest on working capital

Warehouse and packing costs

Environmental costs (effluent control)

Sum of manufacturing costs

Manufacturing costs versus plant capacity for various options (dollars per ton per day)

8. Manufacturing method

Continuous

Discontinuous

9. Manufacturing process

Wet process, with water as a transport media

Hardboard, with a specific gravity of more than 0.8
Medium-density board, with a specific gravity of between 0.35 and 0.8
Softboard, with a specific gravity of less than 0.35

Semi-dry process, with water as a transport media

Hardboard
Medium-density board
Softboard

Dry process, with pneumatic transport

Hardboard
Medium-density board

10. Finishing of boards

Painting

Printing

Laminating
Soft-plastic laminates
Hard-plastic laminates

Overlaying
Papers
Foils, plastic, metal

11. Plant capacity

Comparison of different processes

Decision on final capacity and process

Decision on board size

Choice of machines

Handling, cutting to size and fabricating

Investment costs

12. Investment cost estimates (plant capacity and board size must be known)

Plant investment costs

Major equipment

Auxiliary equipment

Freight and installation

Plant site and site preparation

Energy development

Buildings and structures

Interest during two years of construction

Miscellaneous (contingencies)

Preliminary engineering and marketing studies
Contractor's fee
Insurance and taxes during construction
Legal fees and consulting fees during construction
Initial supplies of spare parts and operating supplies
Equipment for laboratory and machine shop
Research and know-how
Vehicles
Office and office equipment
Social and sanitary facilities

Training expenses

Start-up expenses

Working capital (25% of plant investment)

Unit investment costs

Dollar per ton per day
Dollar per ton per annum

Profitability

13. Estimated selling price (unit and annual)

14. Annual cash flow - sum of net profit and depreciation charge

15. Rate of return on investment - interest rate at which the present value of the net cash flow during a 10-year period is equal to zero

Planning and start-up

16. Action after establishing decision

Final layout

Equipment list

Invitation for binding quotations - date of delivery, guarantees and penalties

Time schedule

Network analysis

Selection of contractor

Contracts with suppliers

Installation

Operation trials

Quality running - quality control

Take-over of the factory

Marketing and selling operations

Contact between manufacturer and customers (promotion and marketing channels)

Quality improvement and new development of uses of board - special qualities

Source: UNIDO, "General selection guidelines for woodworking machinery", paper prepared by A. Travnik for the Technical Meeting on the Selection of Woodworking Machinery, Vienna, 19-23 November 1973 (ID/WG.151/6); Economic Considerations of the Wet and Dry Processes (Portland, Oregon, Defibration, 1975); FAO, "Economic aspects of hardboard manufacture from mixed tropical hardwoods", paper presented by L. Bratt at the World Consultation on Wood-Based Panels, New Delhi, February 1975 (FAO/WCWBP/75/5).

Comparison of investment and production costs for fibreboard mills of various capacity

Mat-forming process	Deckle Box system, wet process			Conventional system, wet process					
Plant capacity									
Tons per 24 hours									
(for 3.2 mm board)	12	24	50	20	30	45	90	140	200
Tons per year (330 work days)	3 960	7 920	16 500	6 600	9 000	14 850	29 700	46 200	66 000
Square metres per day	3 750	7 500	15 625	6 300	9 450	14 175	28 350	44 100	63 000
1,000 square feet per day	40.7	81.3	169.5	67.8	101.7	152.55	305.1	474.6	678.0
Major equipment:									
Defibrators	-	-	-	1	1	1	1	1	2
Raffinators	-	-	-	-	1	1	1	1	2
Spherical digesters	1	1	2	-	-	-	-	-	-
Defibrating refiners	2	2	3	-	-	-	-	-	-
Forming presses	1	2	2	-	-	-	-	-	-
Hot presses	1	1	1	1	1	1	1	1	1
Press size ft	4 x 8	4 x 8	4 x 18	4 x 9	4 x 8	4 x 9	4 x 18	4 x 24	7 x 21
Press openings	8	16	16	12	20	25	25	30	30
Capital investment (million dollars):									
Equipment, buildings, interest etc.	2.13	3.19	5.41	3.69	3.43	6.20	10.16	13.70	18.23
Unit investment:									
Thousand dollars per daily ton	178	133	108	184.5	114.3	137.8	112.9	97.9	91.2
Dollars per annual ton	593	444	360	615	381	459	376	326	304
Labour requirements	80	105	140	44	86	52	78	88	114
Administration and supervisory personnel	12	14	16	16	18	17	18	27	29
Manufacturing costs (dollars per ton)[a/]	145	122	105	234	160	177	151	138	128

__Sources__: For Deckle Box system: Information supplied by the Overseas Industrial Consulting Firm, Vienna (promotors of the process). For conventional system: FAO, "Economic aspects of hardboard manufacture from mixed tropical hardwoods", paper presented by L. Bratt at the World Consultation on Wood-Based Panels, New Delhi, February 1975 (FAO/WCWBP/75/5), except for data related to 30-ton capacity, which are based on information supplied by the former manager of a plant in the United Republic of Tanzania who participated in the Workshop and relate to actual (as against hypothetical) figures.

a/ Cost comparison between the two systems should not be made, since the data used differ.

VIII. JOINERY

The paper "Joinery production in developing oountries" (ID/WG.200/6), by G. B. Crow, was referred to in the discussion.

Joinery is subdivided into standard and non-standard joinery, which often is a question of production. Most buildings use standard joinery, but most countries have different requirements for this standard. No product can be produced for any two countries in the same manner. The product has to be developed to correspond to the market requirements. Many published standards and regulations will give the information on the demand of the country in question.

The design of joinery products – doors, windows, stairs, flooring, beams and roof-trusses - should be based on standard sizes.

When it is planned to extend the export market, new market channels must be developed. A prior condition is to guarantee delivery dates. No company will store semi-finished products for its own produotion. Another important factor is that parts from tropical hardwoods have to be of the same quality of wood and consistent in colour for long periods. Thus, stringent quality control is required for exports.

Doors

Methods of door design have ohanged somewhat as a result of modern equipment and adhesives. The frame joints are either mortise and tenon or dowels. The dowel joint is muoh stronger and is easier to produce. Machining of rails and stiles is done on the same equipment and the tooling (boring bits) is the same, which facilitates tool maintenance. Flush doors oan be manufaotured with solid wooden or hollow cores. Doors with solid wooden cores are either made of block glued core or blook non-glued core. The hollow oores are of various construotions, such as box-type or honeycomb oores. Panelled doors differ in size and style. As exterior doors they are a good export item.

Windows and sash

Standards are established for stock sizes, determining height, width and thickness; number and shape of lights; size of rebate that holds the glass; and the kind of joints to hold the components of the frame together. In some countries combined glazed and screened windows are necessary because of their double use. Glazed sash gives light and protection against rain, while screened sash provides good ventilation and protection against insects. Sash mouldings could become an export product for developing countries if the equilibrium moisture content could be held to that of the country of destination. Different national standards apply to glued, nailed, or the combined glued and nailed assemblies. Wood processed should be at the local equilibrium moisture content for the intended market.

Louvre shutters and blinds

Louvre shutters are very popular in developing countries and can be manufactured there. They must, however, conform to the standard sizes of doors and windows.

Stairs

The design and manufacture of stairs are governed and limited by safety regulations and standards. Stairs should normally not be delivered preassembled. Laminated glued stair treads can be used instead of solid ones but are very expensive to produce, though markets exist for them under certain conditions.

Mouldings

Mouldings in the field of joinery products are mainly used for interior trim[2/] and exterior woodwork.

Wood frame partitions

The framework is based on elements of cross-sections 2 in. x 2 in. (50 mm x 50 mm) or 2 in. x 4 in. (50 mm x 100 mm). The framed construction can either be cladded with plywood panels or hardboard. Boards are more decorative for the interior panelling, surfaced one side, tongue and groove, or channel rustic. All these panels can be surface-textured and stained to match or mismatch. The same equipment can be used to manufacture both siding (boards for external cladding) and internal panelling boards (used for internal decorative purposes).

2/ The term "trim" is applied to the interior of a building and includes all finished woodwork required to cover spaces around openings, protective base boards at the floor line and decorative frame moulding on the ceiling line.

Preservation

Preservation should be considered for window frames in concrete block houses and joinery elements in prefabricated wooden houses that come in oontaot with the ground in unfavourable climatic conditions. The chemicals for preservation are either water- or oil-borne; creosote can also be used. A good process is double vacuum impregnation, which can be modified to achieve adequate standards of preservation of relatively impermeable species and also meet the various requirements of different standards. Joinery components should be impregnated or preserved by either seasoning to 18 per cent, impregnating and redrying to 14 per cent ± 1 per cent; or kiln-drying down to 14 per cent, followed by preservation vapour diffusion.

Drying of sawnwood

Since any joinery product has to be kiln-dried before the maohining operation begins, the question arises whether to install kiln-drying equipment at the joinery plant or to purchase kiln-dried sawnwood from the sawmills direot. If the plant is large enough to make full use of the kiln, it would be preferable to integrate kilns with it. However, if it is not and if there are several small joinery operations in any one vicinity, then it would be possible to establish co-operative drying kilns to cater for the needs of all such plants. These kilns could be attached to one of the joinery plants or set up as a separate unit.

Component machining, finishing assembly and product maohining and assembly

For a production of 25 m^3 of kiln-dried sawnwood per day, the investment would be approximately $10,000 per m^3. Additionally, to mould and cut the timber after drying, an investment of around $4,000 per m^3 would be needed. A specialized facility capable of producing 150 standard-sized windows per day requires an investment of about $600,000. If more sophisticated equipment is used to raise production, a further investment of 40 per cent will be neoessary. An additional investment of 20 per cent will double production in developing countries. A factory of the latter size can be expected to operate with a labour force of 40.

Figure I shows the price of standard non-glazed window sash (size 198.5 cm x 143.5 cm) in relation to the annual turnover. Figure II shows power, utility and space requirements in relation to production capacity.

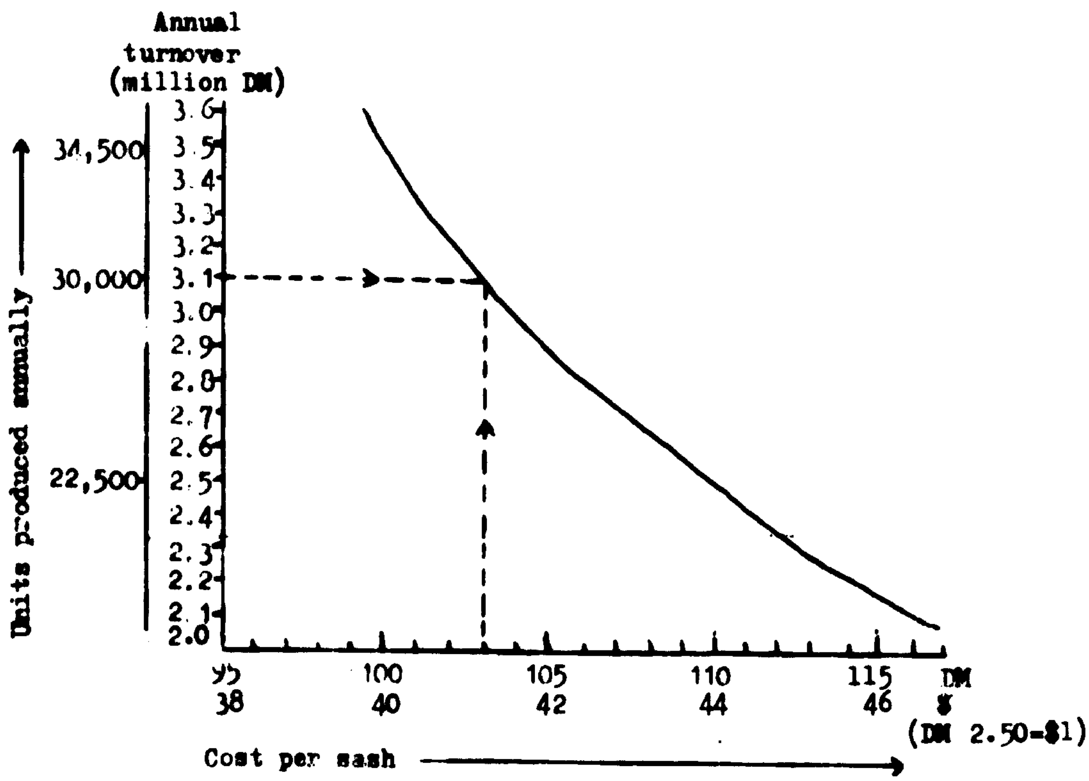
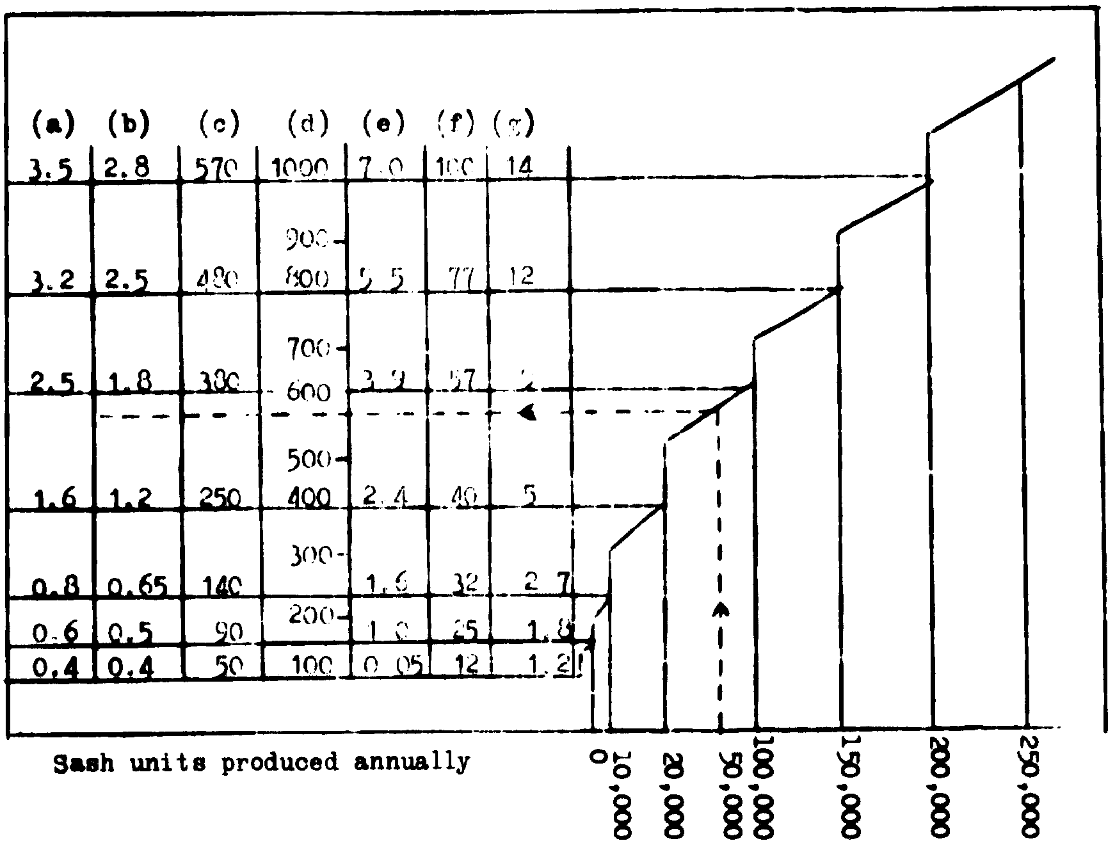


Figure I. Price of a standardised window (size 198.5 x 143.5 cm, with one side and one bottom hinged sash, non-glazed) in relation to production capacity and annual turnover (data based on medium-sized factory)



(a) Heating requirement with lacquer coating section (millions of kcal)
(b) Heating requirement without lacquer coating section (million of kcal)
(c) Electric power (kW) - consumption
(d) Electric power (kW) - available
(e) Compressed air requirement - (1 000 litre/min)
(f) Exhaust requirement - (1 000 m^3/h)
(g) Production space required - (1 000 m^2)

<u>Source</u>: Dieter Haas, "Zeitnahe Betriebs- und Einrichtungsplanung in der Holzfensterfertigung", <u>Die Holzverarbeitung</u>, No. 2 (Stuttgart, DRW-Verlag, February 1972).

Figure II. Power, utility and space requirements for window factories in relation to production capacity

Beoause of the quality of the timber in developing countries, finger-jointing is normally not necessary.

Surface coating and finishing

Flush doors can be primed and/or finished by using a mechanical brush-coating system operating at a feed speed of 1 m/sec. For window frames and sashes the dip-coating process is best when applying prime coats. If the dipping method of prime coating is used, production must be at a rate of 250-300 units per day. For lower output, a spray-coating system is preferable. The vats should be large enough to allow four frames to be dip-coated simultaneously.

Common practice is that joinery products are only prime-coated in the plant, the finish coat being applied at the building site. Glazing operations are normally done at the building site. However, glazing may take place at the faotory, particularly when it relates to windows used in prefabricated wooden housing elements.

Choice of process and equipment

Panelled doors, windows, sashes and louvre shutters are produots assembled from components that need the same sequenoe of machining operations, as shown below.

Operation	Proposed process
Drying of sawnwood	Kiln drying
Machining oomponents	Cross-cutting Ripping Surfacing Thicknessing Moulding Panel gluing Panel raising Slot mortising and tenoning Boring Dowel driving
Component finishing	Sanding
Component assembly	Glue spreading Clamping Nailing
Product maohining	Sizing Sanding Hardware recessing

Surface finishing	Painting Drying
Final assembly	Glazing Hardware fitting Fitting of door in casement Fitting of sash in casement
Product storage	Packing

IX. BUILDING ELEMENTS AND PREFABRICATED STRUCTURES

The following papers were referred to in the discussion: "Wooden load bearing building component production in developing countries: an analysis of alternatives" (ID/WG.200/1), by J. G. Stokes; "Selection of equipment for assembling wood structures and frame using metal connectors" (ID/WG.151/31), by J. G. Stokes; and 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 publication, Sales No. 70.II.B.32).

Structural solid wood piles, poles and beams

In Malaysia and Singapore, 6 in. x 6 in. + 8 in. x 8 in. (15 cm x 15 cm + 20 cm x 20 cm) sawn square hardwood pressure-treated piles have been developed in random length 12-20 ft (3.7-7.0 m) that are joined by a metal shoe as a replacement for long hardwood piles. An important part of this method is the use of metal anti-splitting connectors on the ends of each point of sawnwood to prevent splitting.

In the Federal Republic of Germany, tongued-and-grooved round logs are used as wall elements in block house construction.

Squared round logs are used to produce a 4 in. x 4 in. (10 cm x 10 cm) section with round corners for traditional Japanese house frames. This system might be improved by nailing two pieces each with dimensions of 2 in. x 4 in. (5 cm x 10 cm) together to produce a similar 4 in. x 4 in. (10 cm x 10 cm) section. In Japan, the above-described system is being replaced by the 2 in. x 4 in. (5 cm x 10 cm) house-framing system developed in the United States.

Pressure impregnation has made significant progress in India and in many other developing countries. A choice has to be made in each instance as to which form of pressure impregnation is to be used. The relative merits of oil-based pentachlorophenol and copper chrome arsenate (CCA) and creosote were discussed and suspected problems of inadequate performance of poles treated with CCA in tropical Australia were mentioned. Developing countries now considering the installation of more expensive double-purpose impregnation plants to handle CCA and oil-based pentachlorophenol should be aware of these problems.

Structural wall units and panels

The use of simple wall panel systems using 100 mm x 50 mm studs at 60-cm centres was discussed for simple prefabricated housing panels. Hand nailing is still probably the best means of producing such panels in developing countries.

As for nailing systems, nails with blunt points are more suitable for use in tropical hardwood (see paragraph 33 of document ID/WG.200/1).

The relative merits of proprietary nailing systems were discussed. If air-operated nailing systems are to be used in the developing countries, the equipment should be capable of driving normal nails, preferably manufactured within that country. European air guns are capable of driving common nails, and Swedish hand-loaded plastic magazines use common nails in air-nailing guns.

The question of splitting the hardwoods through nailing was discussed at length and reference was made to the work of George Stern of Virginia Polytechnic Institute, United States of America.

The corrosion of metal timber connectors was discussed, particularly with relation to CCA-impregnated wood. No problem will arise if the wood is properly air-dried after pressure treatment.

Flat-headed nails should not be used in hardwood because of the tendency of the nail head to be partially broken off in the driving process, whereas diamond-head or bullet-head nails especially developed for hardwood do not have this weakness.

Structural wood flooring and floor panels

In the developing countries the use of strip floor will continue because of its structural strength, its low price and other advantages. An alternative may be to use plain square-dressed boards with a gap as a floor system with floor beams at closer centres (45 cm). Plywood flooring will be used in developing countries when economically feasible.

Alternative wall systems

Certain wall systems for housing involve the use of 3 in. x 3 in. (75 mm x 75 mm) or 4 in. x 4 in. (100 mm x 100 mm) columns of solid wood to produce solid-wood walls joined by a wood spline inserted in tenons machined from the solid wood. This system has the advantage of being easily demountable.

Nail laminated beams and trusses

Mention was made of the work on nail laminated beams and trusses done in India by N. J. Masani. The merits of using dry or green wood for this purpose were discussed. It was agreed that only durable species should be used if the wood is green. Discussion also ensued on quality control and the maintenance of regular nail patterns. The use of shadow line units to identify the nail pattern was discussed, as well as quality control problems arising from worker fatigue. It was agreed that there was a good potential for nail laminating in the developing countries and a considerably smaller potential for glue nailed lamination. On the question of use of casein glues and melamine glues, it was agreed that they should be protected against insect and fungal attack through the inclusion of appropriate insecticides and fungicides.

Nail laminated plywood or hardboard box beams

In developing countries, a potentially large demand for beams using plywood or hardboard members joining dry hardwood top and bottom chords with an appropriate nail pattern to achieve the designed structural strength exists. (Paragraphs 66, 67 and 68 of document ID/WG.200/1 give references on this subject.)

Glue laminated beams

More sophisticated processes for the production of beams have been developed in Europe, including a process for producing longitudinal finger joints to achieve 60 per cent bond between laminates, without consideration of the glue line. This process has been modified to achieve a 45 per cent strength without consideration of the glue line. This method of jointing laminates, said to reduce glue consumption considerably, will be of interest to developing countries where soft wood is available. Figure III gives teeth profiles and cutter details.

The use of glue laminated timber beams merits special consideration in the developing countries because they are attractive, highly fire-resistant and, in many countries, cheaper than steel structures.

Light-weight timber trusses

A considerable potential exists for using light-weight timber trusses with spiked metal connector plates for housing, rural buildings, factories etc.

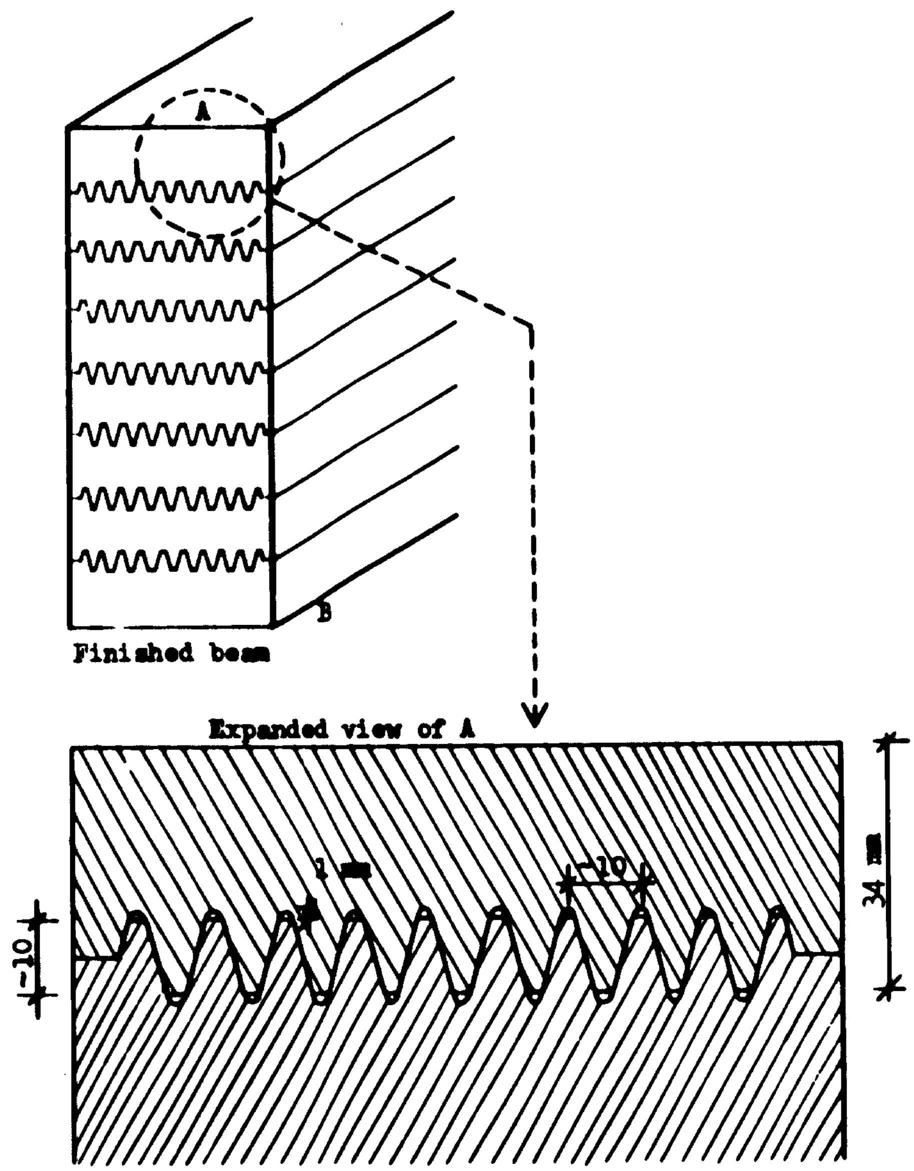
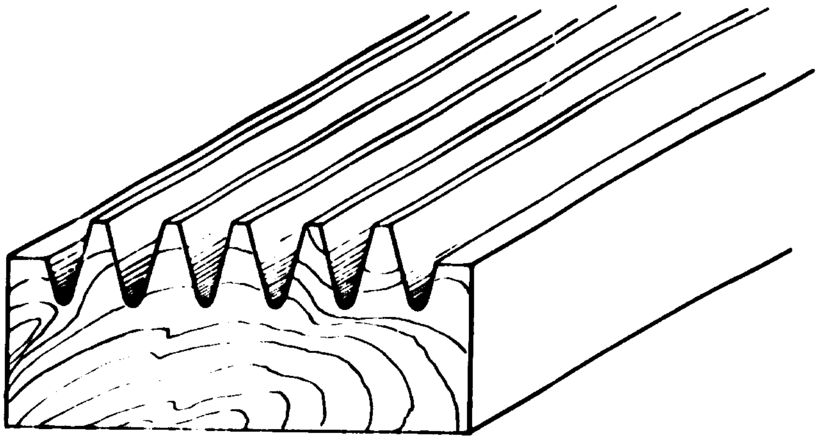
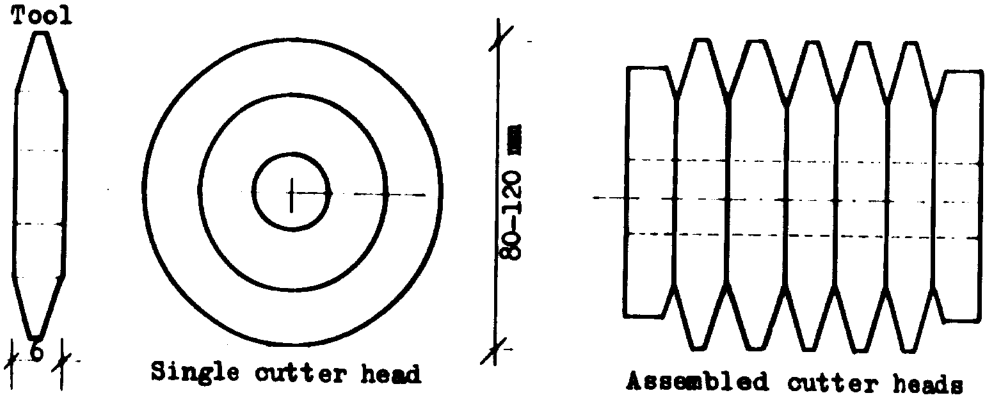
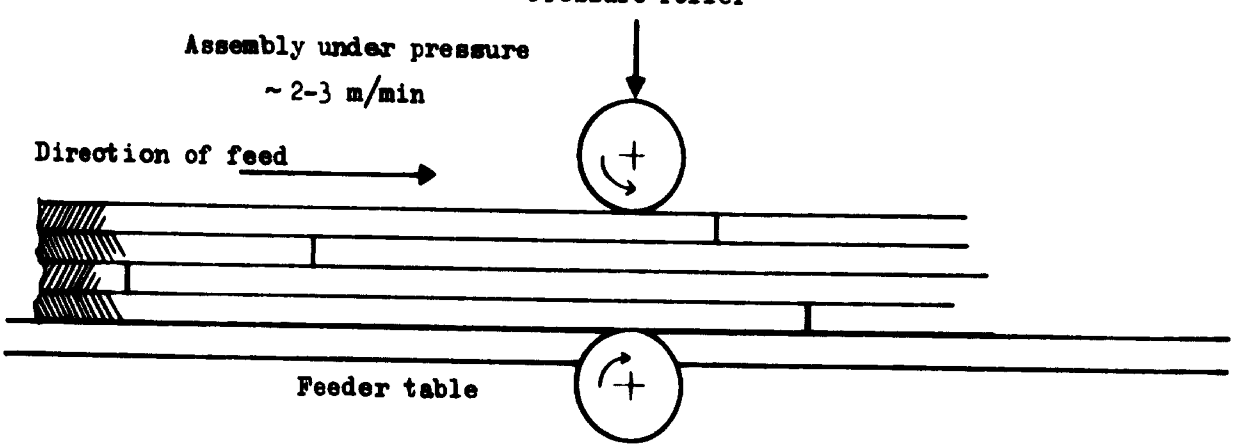


Figure III. Glue laminated timber system for straight beams



B Unassembled machined element
(bottom of beam)





For tropical hardwoods, special connectors made of semi-high-tensile steel needing heavier galvanizing than those used in connexion with northern hemisphere softwoods are required. Direct hydraulic pressure is considered the only desirable means of manufacturing trusses, using tropical hardwoods with spiked metal connector plates.

Fire resistance

The excellent fire-resisting performance of a building in which lightweight timber trusses and metal connector plates were used in Malaysia during a recent fire was discussed as well as the general performance of wood in fire. The attention of the Meeting was drawn to the forthcoming seminar organized by the ECE Timber Committee on the performance of wood in fire, and it was agreed that the circulation of documentation for this seminar would be highly desirable. At the same time support was expressed for the findings of the Seminar on Industrial Production and Use of Wood-Based Products in the Building Industry organized by the ECE in Sandefjord, Norway, in June 1975.3/

Production Techniques for the Use of Wood in Housing Under Conditions Prevailing in Developing Countries, Report of a study group 4/

The group reviewed the report and generally endorsed it, agreeing that there was a need to establish information on production costs for low-cost housing in developing countries. In some developing countries both government and private enterprises are involved in the large-scale manufacture of low-cost factory-fabricated housing. It was agreed that it would be highly desirable to obtain cost information from these enterprises and to circulate it on a case-study basis throughout the developing countries.

Proper quality control procedures should be instigated to ensure the success of all projects involved in the manufacture of wood components, wood structures and wood-based housing.

3/ See "Report of the Seminar on Industrial Production and Use of Wood-Based Products in the Building Industry" (HBP/SEM.8).

4/ United Nations publication, Sales No. 70.II.B.32.

X. FURNITURE

The group felt that Agenda items 13, 14 and 15 (solid wooden furniture, furniture components and panel furniture (case goods), and upholstered furniture) were interrelated and consequently should be reported on as one item, particularly because during the initial stages of the industry's growth in developing countries market requirements forced manufacturers to be involved in every aspect of furniture production. At a later stage, as the market developed, an opportunity arose for greater specialization and consequently greater efficiency.

The following papers were referred to in the discussion: "Production in developing countries of wooden case furniture" (ID/WG.200/8), by D. Haas; "Production of solid wood furniture in developing countries" (ID/WG.200/9), by E. Maendlein; "Furniture upholstering for developing countries" (ID/WG.200/11), by D. Cody; "General selection guidelines for woodworking machinery" (ID/WG.151/6), by A. Travnik; "Selection of equipment for joining" (ID/WG.151/18), by E. van der Straeten and J. Reinhardt.

Factory establishment

When factories are planned in developing countries, the availability of markets, managerial and operative skills and the extent to which they can be developed in relation to the growth of the factory itself should be considered. The plans should provide for the factory's achieving a level of technology similar to that in developed countries.

Product design

Product design is based on marketing considerations relating not only to the country of origin, but also to export markets to which the product may be directed. The size of markets in developing countries is limited, and the design of the product or range of products must reflect this limitation. Thus the kind of specialization that exists in developed countries is not possible; and most factories, initially at any rate, will be obliged to manufacture a range larger than is justifiable on purely economic grounds. For instance, factories will be obliged to manufacture both solid-wood and panel furniture in the same building. In these circumstances the initial investment in capital equipment will be much higher, which shows the need for greater specialization as the business develops.

Construction and processing techniques

Manufacturing procedures in new factories will, in general, be similar to those in established factories. In certain circumstances, however, it may be necessary to introduce alternative methods because of the nature of the equipment available and the constructional details of the product. For example, dowel jointing should be preferred to mortise-and-tenon joints because (a) the equipment needed is cheaper; (b) production is simple and faster; (c) there is greater adhesion; and (d) a greater accuracy is obtained. It should be emphasised that the dowels should not have a moisture content exceeding 8-10 per cent and should be grooved.

If the mortise-and-tenon method of construction is adopted, the appropriate machinery has to be used. For square mortise-and-tenon joints, an oscillating mortising machine or a hollow chisel mortiser is necessary. The equipment for round-end tenoning is, however, more suitable. It consists of a slot mortiser and a tenoner with a planetary action.

Special emphasis should be placed on the design and layout of the wood-finishing section. Because the intensity of light can vary during a normal working day, many problems associated with colouring and matching arise. It is, therefore, recommended that all work be done in conditions of artificial lighting because its intensity and colour remain constant. Components stored in intermediate storage areas should be protected from the direct rays of the sun.

Selection of machinery and equipment

The choice of machinery and equipment is dictated by the design of the product and the required level of output. It should also take into consideration normal growth. For example, a dimensioning saw, whether double or single cut-off, should incorporate scoring heads, even though there may not be an immediate need for this extra equipment.

An edge-banding machine should be capable of applying solid edge lippings as well as edge veneers.

In general, single-end machines should be chosen because they are relatively simple to operate, can be set up quickly and are easy to maintain.

Internal transport and means of handling

In a factory manufacturing a wide range of products, the most suitable form of internal transport is the castorized trolley, which should be designed to suit the various components manufactured. The wheels should be of the appropriate plastic material rather than rubber-tired to minimize friction. The use of dead pallets is not recommended. Examples would include platform transport carriers for machined components, and these would be enclosed for small and shaped items. Veneer trolleys should have special racks with two or three shelves. Special racks with 15-18 shelves are also necessary in the finishing department.

For ready lacquered and polished components, trolleys should be designed so as to ensure that there shall be no danger of damage from chafing. For high-volume output in large batches the use of roller conveyors is recommended. They reduce transport time and are very economical.

Installation

All services such as compressed air, dust and waste extraction and electric power should be supplied by overhead ducting, since it offers the greatest degree of flexibility in layout and permits additional machines and equipment to be installed as the business develops.

It is also recommended that separate exhaust systems be provided for individual groups of related machines. This arrangement permits greater economy in the use of exhausted air and reduces power consumption.

The use of compressed air, even though initially expensive, is recommended in all circumstances, not only in relation to the use of various types of machinery but also as an aid to clamping and assembly. The availability of compressed air permits the purchase of cheap and safe power-operated hand tools. The compressed-air system should include appropriate traps and filters to extract excessive moisture and ensure the efficient running of the system.

Organization

The success of any manufacturing concern depends almost entirely on the quality of its management. Management must be not only technically qualified but also familiar with the organizational and procedural techniques associated with good management. These include product development, production planning and control, design and layout of work areas, method study, quality control, staff supervision, costing and the preparation of realistic financial projections and marketing.

Upholstering

Products

Design considerations should take into account the special requirements of individual countries, one of which would be, for example, open-type cool seating to reduce the discomforts associated with warm climates. Cover materials should as far as possible be sweat-proof and easy to clean. Removable covers would, therefore, be an advantage.

Production technique

Frames for upholstery should, in the main, be manufactured from wood. Almost any type or species of wood, including soft woods, will do, and thus many local timbers that might be unsuitable for other types of furniture manufacturing can be used. Frame components should be carefully machined but could be jointed together by nailing or by the more conventional methods of construction such as dowelling or screwing.

Manufacturing facilities

The capital investment required for an upholstery factory is low, and, therefore, it is comparatively easy to set up either an independent plant or one that is a section of a larger manufacturing concern. In either case, a decision has to be made as to the relative merits of manufacturing the frames at base or having them made elsewhere. Quality control considerations suggest that the former is advisable; but in this eventuality, further investment is required for buildings and wood-processing machinery.

Almost any type of building is suitable for upholstery manufacturing, but it is generally accepted that an allowance of 35 m^2 should be made for each direct operative employed, excluding provision for storage of work-in-progress and finished goods. This allowance may seem somewhat excessive, but it allows for normal expansion and provides for the siting of additional work places, machinery and equipment as the business grows. Special provision should be made for a production planning workshop in which forms and gauges would be made and used for fixing and pressing. These have to be especially designed to suit the varying contours of the upholstery and to hold the components in position while they are being stapled to the frame.

Where there is little or no experience on which to build the specialized skills of upholstery, it is advisable to have the frames manufactured so that the various elements may be upholstered separately, e.g. arms, backs and seats. After upholstering they may then be assembled by bolting or other fixing methods. Sewing tables should be extendable to accommodate all types of upholstery fabrics and should incorporate a special stretching device for individual materials. Special jigs should be devised for assisting the sewing operator in linear and curved sewing operations. These jigs would be roughly similar to the guides used for dimension sawing and routing. Special arrangements must also be made for the handling and storage of rolls of materials for covers, which are both heavy and bulky and are normally worked on by female operators. These rolls can be stored with the aid of cylindrical pipes made of plastic or fibreboard, into and out of which these heavy materials can be easily slid. They are then transferred to especially designed trolleys and brought to cutting tables as required.

Installation and general organisation

The earlier observations made regarding installation of the various services required and the satisfactory management of the organization apply to upholstery production, but particular emphasis should be laid on quality control and final inspection of the finished goods.

XI. MISCELLANEOUS WOODEN PRODUCTS: HANDICRAFTS

Developing countries should be encouraged to examine possibilities for exporting wooden handicrafts in either the contemporary or traditional style by taking advantage of their cheaper labour and lower production costs. However, the following points should be carefully investigated before full-scale production is attempted:

Availability of wood for the basic materials

Designs and forms of wooden handicrafts to be marketed; packaging; method of shipping, such as fully assembled or knocked-down

Management and organisation required

Types of machinery and equipment to be used; degree of automation

Desired level of value added for work done

Stock requirements

Conditioning of the products for export

Shipping costs of finished products

XII. INTEGRATED WOOD-PROCESSING COMPLEXES

The Workshop noted the report of the Symposium on the Integration of the Forest Industries organized by the ECE Timber Committee and held in Geneva in 1967.

Existing integrated complexes

A principal purpose of integration is to make the best use of timber resources to ensure maximum profitability. Two examples of successful integration are described below.

In Nigeria, a sawmill, plywood mill, blockboard mill, joinery factory and timber house component factory have been integrated in a complex; a particle board mill is now being added. In addition, logs are being exported in the round. Such a complex permits a better and fuller utilization of forest resources, since in developing countries higher-grade logs are often exported or used for plywood, while lower-grade and secondary species, amounting to approximately 50 per cent of the forest output, can be used in the sawmill. The development of the particle board plant to run on wood residues from the other units has become possible because natural-gas firing is now used in the power plant, which had previously burned all wood wastes.

In Kenya, a sawmill has been combined with a plywood factory and a fibreboard factory, while a core plywood factory and a factory for prefabricated rural housing are shortly to be added. This complex has proved successful. Each factory is responsible for its own power and steam generation. Common logging facilities are used and common services in respect of wages, office services, industrial relations, electrical maintenance, mechanical repairs, store purchasing and rail dispatch. Group facilities are available for invoicing, relations with the Government, finance and future planning.

Prerequisites for establishing a wood-processing complex

The steps in establishing a wood-processing complex are: to assess raw materials and other technical questions; to investigate markets - world, regional and local; to plan and design the complex in detail; and to implement these plans. A stable supply of raw material should be assured.

Outline form of integration

The wood-processing industry, also in the developed countries, is characterised by many small operating units. Integration can be achieved either by encouraging small firms to merge at a central location to form a new company or by encouraging an existing company to take on additional production.

While there may, on average, be between four and six factory units in a single complex, there must be at least one primary processing unit together with the secondary processing units and plant to process wood residues.

A successful wood-processing complex should be built up in stages. For example, a thorough check of all timber species should be made first, using a large sample from a large forest concession to establish quantities available of each type. Then a sawmill can be installed, followed, as appropriate, by a veneer line, a plywood plant and a timber-drying plant (particularly for exports). In this way the market for the company's product can be established before secondary processing plants are installed.

Wood residues in a particle board mill can be used from the beginning. Further, during the initial phase, the infrastructure (roads, power supply and housing) can be established.

A large factory or complex does not come on stream as quickly as a small factory. However, small factories can be used as a basis for development. For example, where small quantities of usable timber are available, small sawmills can be started using this raw material and wood-wool sheets manufactured from their residues.

Integration with the pulp and paper industry and with charcoal-producing plants is also possible. A complex may also include the manufacture of adhesives.

Advantages of integration

The numerous advantages to be obtained by integrating woodworking process plants into central complexes are described below.

Utilisation of resources

Resources can be better utilized in two ways:

(a) Forests can be better utilised, since all species, including secondary species, can be extracted and processed at one centre;

(b) Timber delivered to the complex can be fully utilized, since secondary production can be used and wood residues recycled.

Cost savings and organization

Lower manufacturing costs may be obtained by rationalization. Considerable savings can be achieved by having common services, such as:

- A more economical central power plant that can be extended progressively
- A central steam plant in several units, including, if feasible, a wood-waste burning unit
- Central electrical and mechanical maintenance, including a service workshop
- Central facilities for storing spare parts

It is easier to rationalize management at a single site, and such rationalization will lead to improved plant performance. Also, fewer senior managers will have to be trained. A further advantage is that technicians and managers will be able to discuss their problems with colleagues at the same level.

Marketing

Common marketing, including a common marketing staff, is possible; and, in general, the position of the company in the market is more secure. This last aspect, however, may be the case only if considerable flexibility and independence have been provided for the individual plants. Integration implies heavy capital commitment, from which it follows that equipment must be kept working. If the market for one product slumps, the integration of all plants must be sufficiently flexible to avoid the necessity of shutting down or disrupting other units.

Infrastructure

An integrated complex benefits from centralized road and rail systems, telecommunications, banking and insurance facilities, shipping arrangements and port facilities.

Employment

Integrated complexes, normally established in rural areas, increase employment opportunities in these areas and also permit social facilities to be created that would otherwise be uneconomical. Additional vocational training facilities may be set up, since integrated complexes contain many types of wood processing.

Potential risks of integration

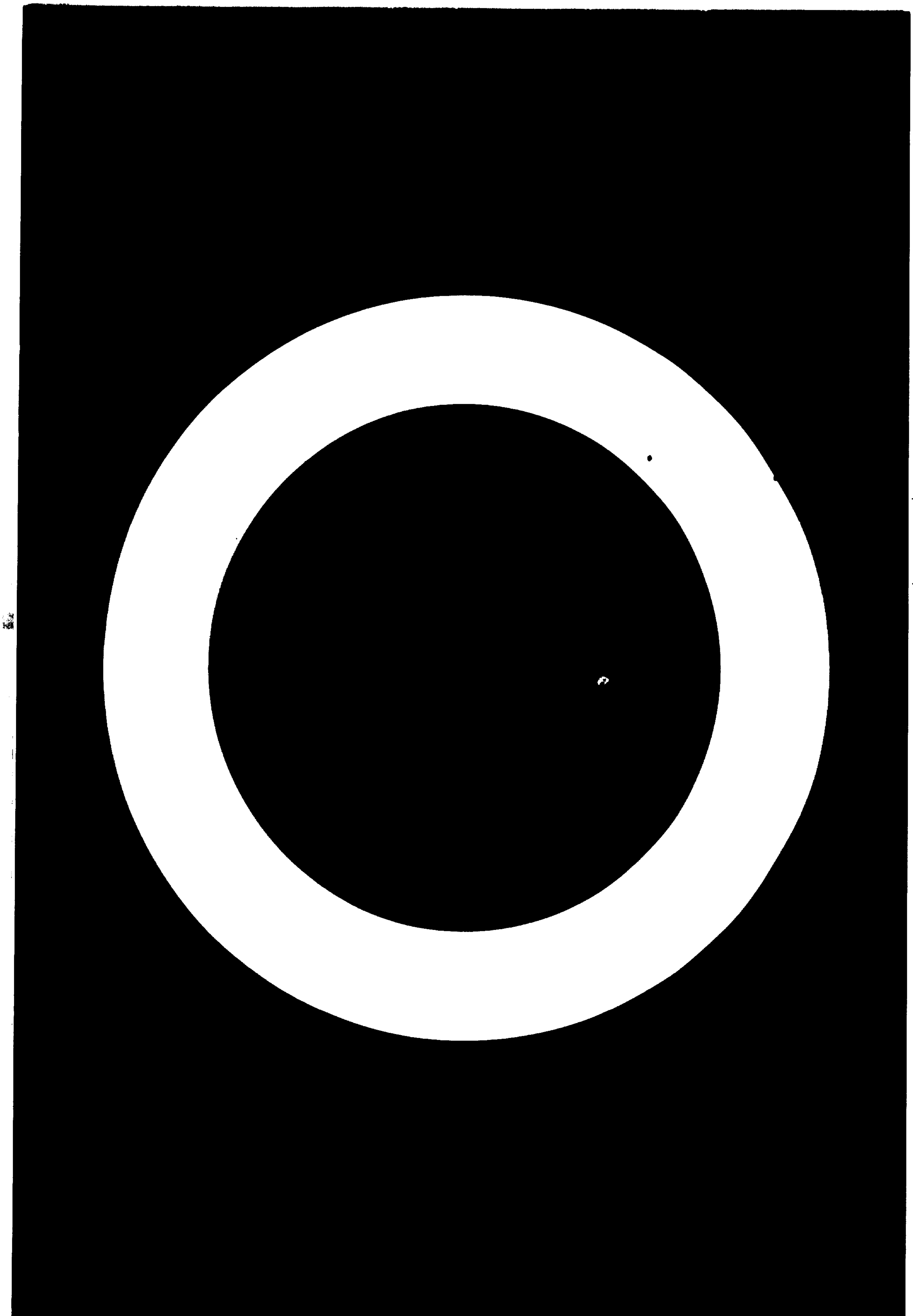
If the planning and design of the complex are inadequate and if the management lacks experience, it may be difficult to maintain a balance among the various production units with respect to raw material supplies and wood-residue disposal. Also, the breakdown or overloading of any of the services, such as steam, electricity or compressed air, that are common to all factories will stop or reduce production in all units of the complex.

The demands on the time of central service facilities may periodically be conflicting, leading to the neglect of, for instance, the maintenance requirements of one plant. Sometimes plant utilization has been more effective in individual factories than in complexes.

If more than one private company is involved in the various units of a complex, conflicts of interest can arise. For instance, wood-residue-transfer prices may be adjusted for reasons unconnected with their cost. Consequently, a jointly financed venture is considered the only feasible solution.

Establishment of a central laboratory

The establishment of a central laboratory requires careful consideration of the factors involved in each case, such as the effectiveness of centralization where there may be a need for quick testing facilities adjacent to the production line. Research on new products may be better carried out in a laboratory in a central location, not necessarily in the plant area.



Annex I

AGENDA

Plenary session

1. Election of officers
2. Adoption of the agenda
3. General conditions in some developing countries

Primary conversion group

4. Sawnwood
5. Wood-wool and wood-chip/cement slabs
6. Wood-based panels - veneer
7. Wood-based panels - plywood and blockboard
8. Wood-based panels - particle board
9. Wood-based panels - fibreboard

Secondary conversion group

10. Joinery
11. Building elements
12. Prefabricated structures
13. Solid-wood furniture and furniture components
14. Panel furniture (case goods)
15. Upholstered furniture
16. Miscellaneous wood products

Plenary session

17. Integrated wood-processing complexes
18. Adoption of the report and recommendations

Annex II

LIST OF DOCUMENTS[a]

Background documents

Symbol	Title and author	Agenda item
ID/WG.200/1	Wooden load bearing building component production in developing countries: an analysis of alternatives by J. G. Stokes, Automated Building Components, Springvale, Victoria, Australia	11, 12
ID/WG.200/2	A basis for establishing criteria for the choice of processes and equipment in the sawmilling sector by T. J. Peck, ECE/FAO Timber Division, Geneva	10
ID/WG.200/3	Adhesives for wood by J. Reinhardt, Ciba-Geigy (UK) Ltd, Plastics Division, Duxford, Cambridge, United Kingdom of Great Britain and Northern Ireland	6, 7, 8
ID/WG.200/4	Production of veneer, plywood (including core plywood) in developing countries: an analysis of alternatives by G. P. Heilborn, Heilborn Engineering, Singapore 1 and Rosenheim-Schlossberg, Federal Republic of Germany	6, 7
ID/WG.200/5	Fibreboard production in developing countries: an analysis of alternatives by K. Eisner, University College of Forestry and Wood Technology, Zvolen, Czechoslovakia	9
ID/WG.200/6	Joinery production in developing countries: an analysis of alternatives by G. B. Crow, consultant, Midhurst, United Kingdom of Great Britain and Northern Ireland	10
ID/WG.200/7	Particle board production for developing countries by P. E. Tack, consultant, Kuurne, Belgium	8
ID/WG.200/8	Production in developing countries of wooden case goods furniture (flatboard furniture): an analysis of alternatives by D. Haas, Gerhard Schuler Consulting Agency, Pfalzgrafenweiler, Federal Republic of Germany	13, 14, 15

a/ A limited number of copies of these documents are available upon request in the language in which they were issued (mainly English).

Symbol	Title and author	Agenda item
ID/WG.200/9	Production of solid wood furniture in developing countries: an analysis of alternatives by E. Maendlein, Gerhard Schuler Consulting Agency, Pfalzgrafenweiler, Federal Republic of Germany	13, 14, 15
ID/WG.200/11	Furniture upholstering for developing countries by D.P. Cody, consultant, Dublin, Ireland	13, 14, 15

Documents issued after the Workshop at recommendation of participants

ID/WG.200/4/Rev.1	Production of veneer, plywood (including core plywood) in developing countries: an analysis of alternatives by G. P. Heilborn, Heilborn Engineering, Singapore 1 and Rosenheim-Schlossberg, Federal Republic of Germany. (This document has been re-issued by the author and discussion leader of this topic to incorporate points raised during discussion at the Workshop.)	6, 7
ID/WG.200/13	Particle board production for developing countries by D. S. Latta, consulting engineer, Newbury, United Kingdom of Great Britain and Northern Ireland and P. E. Tack, consultant, Kuurne, Belgium, discussion leaders of this topic	8
ID/WG.200/14	Report of Workshop on Wood Processing for Developing Countries	18

Other UNIDO documents used as background material

ID/10	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 publication, Sales No. 70.II.B.32)	11, 12
ID/61	Production of Prefabricated Wooden Houses by Keijo M. E. Tiusanen, Oy Wilhelm. Schauman AB, Jyväskylä, Finland (United Nations publication, Sales No. 72.II.B.13)	11, 12

Symbol	Title and author	Agenda item
ID/79	Production of Panels from Agricultural Residues, Report of Expert Working Group Meeting, Vienna, 14-18 December 1970 (United Nations publication, Sales No. 72.II.B.4)	8
ID/133	"Selection of woodworking machinery", Report of a Technical Meeting, Vienna, 19-23 November 1973	10
ID/WG.83/4 and Corr. 1	"Technical processes for the production of wood-wool/cement boards and their adaptation for the utilization of agricultural wastes" by W. Sandermann, Federal Research Organization for Forestry and Forest Products, Reinbek, Hamburg, Federal Republic of Germany	5
ID/WG.151/6	"General selection guidelines for woodworking machinery" by Arnost Travnik, Lignoprojekt Bratislava, Czechoslovakia	13, 14, 15
ID/WG.151/18	"Selection of equipment for joining" by E. van der Straeten and J. Reinhardt Ciba-Geigy (UK) Ltd, Plastics Division, United Kingdom of Great Britain and Northern Ireland	13, 14, 15
ID/WG.151/31	"Selection of equipment for assembling wood structures and frames, using metal connectors" by J. G. Stokes, Automated Building Components, Springvale, Victoria, Australia	11, 12

Miscellaneous documents

ID/WG.200/10	Agenda and programme of work for the Workshop	
ID/WG.200/12	List of participants	
ID/WG.200/15/ Rev. 1	List of documents	
UNIDO/LIB/ SER.D/9	Information sources on building boards from wood and other fibrous materials	

The following studies on uses of wood have been published by the United Nations Industrial Development Organization.

ID/10	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 publication, Sales No. 70.II.B.32
ID/61	Production of Prefabricated Wooden Houses Keijo N. E. Tiusanen United Nations publication, Sales No. 71.II.B.13
ID/72	Wood as a Packaging Material in the Developing Countries B. Hochart United Nations publication, Sales No. 72.II.B.12
ID/79	Production of Panels from Agricultural Residues. Report of Expert Working Group Meeting, Vienna, 14-18 December 1970 United Nations publication, Sales No. 72.II.B.4
ID/108	Furniture and Joinery Industries for Developing Countries Part One: Raw Material Inputs Part Two: Processing Technology Part Three: Management Considerations
ID/133	Selection of Woodworking Machinery. Report of a Technical Meeting, Vienna, 19-23 November 1973
ID/154	Low-Cost Automation for the Furniture and Joinery Industry
UNIDO/LIB/SER.D/4	UNIDO Guides to Information Sources No. 4: Information Sources on the Furniture and Joinery Industry
UNIDO/LIB/SER.D/9	UNIDO Guides to Information Sources No. 9: Information Sources on Building Board from Wood and other Fibrous Materials

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