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ASIA AND PACIFIC FOREST INDUSTRIES DEVELOPMENT GROUP

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Technical report: A Study of Potentials for Downstream Timber Processing in Developing Countries of the Asia/Pacific Region*

Prepared for the project's participating governments in the Asia/Pacific Region by the United Nations Industrial Development Organization acting as associated agency in the project executed by the Food and Agriculture Organization of the United Nations

Based on the work of Horatio P. Brion
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* Mention of company names and commercial products does not imply the endorsement of UNIDO. This document has not been edited.

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EXPLANATORY NOTES

The monetary units of the countries visited by this mission and their cooresponding current official exchange rates are:

Papua-New Guinea Kina:	K1	= US$1.18
Indonesian Rupiah:	Rp 1,788	= US$1.00
Malaysian Ringgit:	M$ 2.74	= US$1.00

The following acronyms are used in this Report:

APFIDG	-	Asia Pacific Forest Industries Development Group
ASEAN	-	Association of South East Asian Nations
FAO	-	Food and Agriculture Organization of the United Nations
FIA	-	Forest Industries Association of Papua-New Guinea
FIC	-	Forest Industries Council of Papua-New Guinea
MTIB	-	Malaysian Timber Industry Board
PIKA	-	Pendidikan Industri Kayu Atas (Industrial Woodworking Institute), Semarang, Java, Indonesia
PNG	-	Papua-New Guinea
RAPA	-	Regional Office for Asia and the PACIFIC, FAO, Bangkok, Thailand
UNDP	-	United Nations Development Programme
UNIDO	-	United Nations Industrial Development Organization

A hyphen between numbers (e.g., 1-5) indicates the full range involved, including the beginning and end points.

A full stop (.) is used to indicate decimals.

A comma (,) is used to indicate thousands, millions, billions.

The following symbols and/or abbreviations are used in this Report:

M$	-	Malaysian Dollar, Ringgit, currency unit of the Federated States of Malaysia
K	-	Kina, the currency unit of Papua-New Guinea
Rp	-	Rupiah, the currency unit of the Republic of Indonesia
US$	-	U.S. Dollar, the currency unit of the United States of America
Bd. Ft.	-	board foot or board feet
cu.m.	-	cubic meter
dia.	-	diameter
DTP	-	Downstream Timber Processing
EMC	-	Equilibrium Moisture Content
etc.	-	"et cetera", and so forth
ft	-	foot; feet; 12 inches
hrs.	-	hours
hrs./day	-	hours per day
K.D.	-	kiln dried, kiln-drying
mc or MC	-	Moisture Content
ml	-	milliliter
mm	-	millimeter
m/min	-	meters per minute
m^3/yr.	-	cubic meter per year
%	-	per cent
RPM	-	revolutions per minute
S4S	-	surfaced on four sides
sq.m.	-	square meter
TCT	-	Tungsten Carbide Tipped
vs.	-	"versus", compared with, against

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I. INTRODUCTION

1.1 Project Background

The Food and Agriculture Organization of the United Nations (FAO), in its capacity as an implementing arm of the United Nations Development Programme (UNDP), in order to pursue a technical assistance project in the Asian/Pacific Region, established the "Asia Pacific Forest Industries Development Group" (APFIDG), with head office in Kuala Lumpur, Malaysia. The APFIDG has launched this study project with a view to implementing the following goals, among its six immediate objectives:

i. To strengthen the capability of national governments to evaluate the industrial development potential of their forest sectors leading to plans for increasing the effectiveness of the structure and operations of the existing forest industry and to the phased overall development of this industry.

ii. To improve the managerial efficiency and operational performance of existing forest industries through the training of personnel, the provision of advisory services and the identification of opportunities for reinvestment, with particular reference to the small and medium scale producers.

iii. To provide extension advisory services and assistance which is designed to have an impact on the large number of small and medium sized sawmills. Many of these sawmills are technologically obsolescent and would respond significantly to the introduction of simple improved operational procedures and more efficient low-cost equipment. Simple Demonstration Mills, strategically located, designed to illustrate the above benefits and to act as focal points for industrial extension activities, will be encouraged.

iv. To diversify current industrial output through encouraging manufacture of an increased range of secondary and tertiary wood-based products.

1.2 Project Objectives

Timber rich developing countries in the Asian/Pacific Region are being urged and encouraged by various international economic bodies and aid agencies to engage in more vigorous industrial activities with a view to manufacturing (and exporting, if possible) more higher value-added products instead of the traditional exports of industrial logs and sawn timber. Recent country reports have indicated that some "DOWNSTREAM" timber processing is being done by a number of sawmillers both in the private and government sectors of the industry. However, the activities leading to a more desirable development of the secondary wood processing industry in developing countries of the Region have apparently been stymied or blocked in some countries by factors which need immediate consideration by the affected countries. Although both the public and private sectors "are generally convinced and willing to initiate or expand existing downstream timber processing activities, the rate of development is considered to be slow" and one that needs rationalization, both in direction and scope.

To this end, the FAO has contracted the services of the United Nations Industrial Development Organization (UNIDO) to undertake this Review Project with the following immediate objective: "Develop further industrial secondary processing of timber products for local and export markets", coupled with the following goals for the sawmilling industry:

i. To improve its efficiency and income generating capacity from the current level of resource utilization;
ii. To reduce wastage; and
iii. To increase productivity from existing raw material.

UNIDO has therefore hired the services of Horatio P. Brion to undertake the Review Study, with the following duties and responsibilities:

"Under the overall guidance of the Project's Team Leader, and in cooperation with its Forest Industries Expert, the Consultant will be expected to:

1) Review the current status of secondary wood processing industries in Malaysia, Indonesia and Papua New Guinea.

2) Identify the investment opportunities and recommend the types of downstream processing best suited for integration into the existing primary forest industries (sawmilling and plywood and veneer production).

3), Review and indicate the suitability and price range of the most relevant equipment which would reduce mill waste and promote the production of value-added products for both the domestic and export markets.

4) Evaluate the productivity and profitability of selected product ranges and volumes, based on the machines selected and putative production costs.

5) Determine the training needs for the supervisors and managers of plants established using the equipment proposed.

6) Incorporate the above, as well as recommendations addressed to potential industrialists and government bodies, in a technical report."

(See Annex I for more details of the Consultant's Terms of Reference).

II. BRIEF SUMMARY OF CURRENT WOOD PROCESSING IN SELECTED ASIA/PACIFIC DEVELOPING COUNTRIES

2.1 General Considerations & Methodology

The funding and time constraints of this Project led to the decision that the sawmilling industry in three timber rich countries of the Region will be studied and visited within a period of one month. Furthermore, it was held that sawmilling plants with outputs in excess of 30,000 cubic meters of sawn timber per annum were big enough to take care of their own downstream processing programmes. Thus, the plant visits to sawmilling facilities were confined to the small and medium scale sawmilling operations, and to which this Study Project is primarily addressed, in each of the three countries selected for the study to visit: Papua New Guinea, Indonesia and Malaysia, during the period 8 November to 7 December 1989.

Table I shows the number and approximate size grouping of sawmills visited under this mission.

Table I.
Sawmilling Plants Visited During
Conduct of Industry Survey

Country	No. of Mills with estimated annual outputs Below 15,000 cu.m/year	Between 15,000 and 30,000 cu.m/year
Papua New Guinea	2*	1
Indonesia	2	4
Malaysia	3**	3
Totals	7 mills	8 mills

Note:

* One of these is a "Wokabaut" sawmill (mobile sawmilling machine), while the other mills tropical hardwood timber solely for furniture manufacturing.

** Two of these process rubberwood only. All three small sawmills mill pre-cut components for furniture manufacturing.

2.2 Timber Resources and Log Production

Table II summarizes the forest timber resources and log production industry of the three countries visited under this Project, for the period 1986-87.

Table II.
Forest Resources & Log Production of
Selected Asia/Pacific Countries

Country	Operable Forest Area (million Ha)	Operable Timber Stand (million m^3)	Annual Log Production 1987* (thousand m^3)
Papua New Guinea	15	500	2,698
Indonesia	67	3,833	28,228
Malaysia	9	253	36,351

Sources:

Facts & Figures, 1987, PNG Dept. of Forests

FAO Yearbook, Forest Products, 1987, FAO Forestry Series No. 22; FAO Statistics Series No. 87, Rome, 1989.

Forestry in Malaysia, Ministry of Primary Industries, Kuala Lumpur, 1989.

Note: * Rounded-off to the nearest 1,000 cu.m.

It is evident in Table II that the forest resources of the three countries visited under this project can support a sizable volume of mechanical wood processing activities.

2.3 Primary Wood Processing

2.3.1 Sawmilling

While the sawmilling industries of Malaysia and Indonesia are both well-developed, that of Papua New Guinea is less developed and has great potentials for further development. Table III shows some important data on the sawmilling industries of the three countries.

Table III.
Sawmilling Industries of Selected Developing Countries in the Asia/Pacific Region

Country	No. of Sawmills (1986)	Total Rated Input Capacity (1,000 m^3/yr)	Total Sawn Timber Output (1,000 m^3/yr)	
			1986	1987
Papua New Guinea	60	500	117	117
Indonesia	2,724	15,789	7,442	9,170
Malaysia	902	10,473	5,480	6,285

Sources:

Forest Industries Council of Papua New Guinea.

FAO Yearbook, Forest Products, 1987, FAO Forestry Series No.22; FAO Statistics Series No. 87, Rome, 1989.

An update of the study on ASEAN Pulp and Paper Industries, FAO, Rome, 1988.

Table III indicates a significant amount of unused sawmilling capability among the three countries visited under this Project. This also indicates a very good potential for Downstream Timber Processing from the viewpoint of availability of capacity for input materials of secondary and tertiary wood processing activities.

2.3.2 Wood-Based Panels Manufacturing

The manufacture of veneer and plywood compose the major portion of the wood-based panels manufacturing activities of the three countries. In fact, Indonesia has developed its plywood manufacturing industry to become the world's biggest supplier of plywood products during the last 5 years. On the other hand, the plywood industry of Papua New Guinea has not grown during the last 5 years, while that of Malaysia has almost fully recovered from the downtrend which started in 1984 and started to change for increased production in 1987. Only Indonesia has plans to further increase its plywood production capacity.

Table IV presents some important data on the plywood manufacturing industry of the three countries visited under this Project.

Table IV.
The Plywood Industry of Selected Countries in the Asia/Pacific Region

Country	Existing Total Manufacturing Capacities (1,000 cu.m/yr)	Annual Production (1,000 cu.m)	
	1985	1986	1987
Papua New Guinea	59	9	9
Indonesia	6,172	5,750	6,800
Malaysia	1,737	711	857

Sources:

FAO yearbook, Forest Products, 1987 FAO Forestry Series No. 22
FAO Statistics Series No. 87, Rome, 1989.

Perhutanan Semenanjung Malaysia, Penyata Tahunan 1986, Jabatan Perhutanan Semenanjung Malaysia, Kementerian Perusahaan Utama Malaysia, Kuala Lumpur, 1987.

Compendium of Statistics, 1981 Department of Primary Industry, Office of Forests, Papua New Guinea, Port Moresby, 1982.

Among the three countries only Malaysia produces and exports particle board, while Indonesia alone produces fibreboard.

2.3.3 Other Wood Products (Woodchips, etc.)

In general, it can be considered that the production of woodchips and other wood products in the three countries is not a significant contributor to the economy of any of the three nations visited under the Project.

2.4 Secondary and Tertiary Wood Processing

The secondary and tertiary wood processing industry of Indonesia and Malaysia have continuously grown during the last 5 years. This growth, however, is primarily composed of significant developments in the furniture and joinery manufacturing industry of both countries. Nevertheless, the governments of both countries plan for faster rates of development of the industry sub-sector with a view to attaining more value added to the log or sawn timber produced in both countries. Thus, Indonesia has announced a significant increase of export taxes on sawn timber (air-dried or kiln-dried) for the coming year and banned the export of logs a few years ago. Similarly, Malaysia has restricted the export of roundwood of certain timber species and is now considering a significant increase in the export tax on sawn timber. Both countries expect great strides in the growth of their secondary wood processing industries, with larger exports of secondary and tertiary wood products.

On the other hand, Papua New Guinea's secondary wood processing industry has barely moved during the last five years. In fact, interviews with industry leaders indicated a possible decline in this industry sub-sector during the period.

The industry sub-sector in the three countries were highly fragmented in both composition and distribution in each country so that accurate industry data were hardly available and usually not up-to-date. The following industry characteristics gathered through interviews with

industry leaders and visits to furniture and joinery manufacturing shops in the three countries (see Annex II) generally confirm the industry characteristics observed during a 1986 APFIDG study under Project No. RAS/78/010:

i. Industry units range in size from a family affair shop with less than 10 workers operating at craftsman levels of manufacture to factories employing more than 300 workers equipped with the latest models of basic woodworking machinery and equipment. A great majority of the manufacturing units were located around urban centers of each country. Except in isolated cases, like the wood-carving and carved furniture industry of Cepara, Indonesia, only a few are engaged in export-oriented operations. Most of these establishments cater only to the furniture and joinery needs of the immediate vicinity;

ii. Productivity is low due to the use of antiquated production techniques, poor machinery lay-out and undesirable housekeeping practices;

iii. Reliable and up-to-date data about the industry, at both national and local levels, were hardly available. Accurate industry data were available only with respect to the operations of the organized sections of the industry;

iv. The industrial infrastructure and research institutions that are available to the industry in developed countries are not found in the corresponding furniture and joinery industries of the developing countries; and

v. The industry sub-sector is still handicapped with the same set of technical problems (as discussed in later paragraphs of this Report) that prevents a desirable rate of growth and further development.

Latest estimates by industry leaders indicate that:

i. Malaysia had at least 2,000 shops and factories, of which around 90% may be classified as small and medium scale operations;

ii. Indonesia had no less than 4,000 establishments of which again 90% are small and medium scale operations; and

iii. Papua New Guinea had less than 100 establishments of which not more than 5 (in the Port Moresby area) may be classified as medium scale operations, while the rest were all small scale or cottage industry level.

Only the furniture and joinery industries of Malaysia and Indonesia, among the three countries visited under this Project, have attained significant export levels of operations. Papua New Guinea's furniture/joinery products exports during the last five years were hardly noticeable at all. In fact, its tertiary wood products industry (principally the manufacture of chopsticks) has declined to almost non-existence during the last two years.

III. IMPROVING INCOME GENERATION CAPABILITIES OF EXISTING SAWMILLING FACILITIES

3.1 Improving Sawmilling Operations

3.1.1 Commercial Size Boards Vs Specific Board Sizes for Secondary Wood Processing

Current sawmilling practice is to cut boards with sizes needed by the building and construction industry. Thus, board lengths are usually even multiples of one ft (600 mm) with 8 ft (2400 mm) as the shortest acceptable commercial length. Furniture and joinery components usually require odd lengths so that even before the board is fed to the first woodworking machine, there is already a potential of a built-in loss attributable to the board lenght vis-a-vis the furniture (or joinery) component length.

Similar situations also exist in the case of cutting boards with commercial thicknesses and widths.

Thus, a sawmill cutting boards for the furniture and joinery industry could increase its overall yield or recovery rate by as much as 10%, by bucking logs and sawing for boards with sizes specifically needed by the furniture and joinery industry.

3.1.2 Primary Log Breakdown, Small and Medium Size Sawmill

Certain characteristics and features of the primary log breakdown machinery facilities have a direct bearing on the final yield or recovery rates, the distribution of sawn timber grades among the sawmill output and the output levels at the main saw during primary log breakdown operations.

3...2.1 Narrow Kerf Saw Blades

Main saws with narrower kerfs on the sawblades can definitely cut from the same log bolt more boards than sawblades having wider kerfs. Since the rule of thumb calls for kerfs less than twice the sawblade thickness, then the use of thin bandsaw blades and bandsaws rather than circular saws (which have kerfs as wide as 9 mm) during the primary log breakdown operations will help increase the overall sawmilling yield rate by decreasing the volume of wood converted into sawdust.

3.1.2.2 Log Tapering and Turning Devices

Experience in the Philippines has shown that the grade distribution of the sawn timber output in bandsawing operations can be improved significantly (with increased percentage in No. 2 Common and Better grades) by cutting along the longitudinal orientation of the timber fibers, rather than the conventional method of cutting parallel to the axis of the log bolt. This is normally done with the use of a sawmilling carriage equipped with a log tapering device. The device allows the positioning of the log bolt on the carriage such that its longitudinal orientation of timber fibers is parallel with the width of the bandsaw blade. A tapering device may be approximated by the use of wedges or shims in bandmill carriages fabricated without built-in tapering devices, provided the dogging pedestals will allow such move. The end result (specially when milling according to the quarter cut

technique, or its Japanese variation) is a last board (usually from the log core area) which is a truncated prism or pyramid in shape. Increased productivity is also attained by the use of an efficient log turning device, to complement the log tapering device of the main saw set-up. (See Figure 1.)

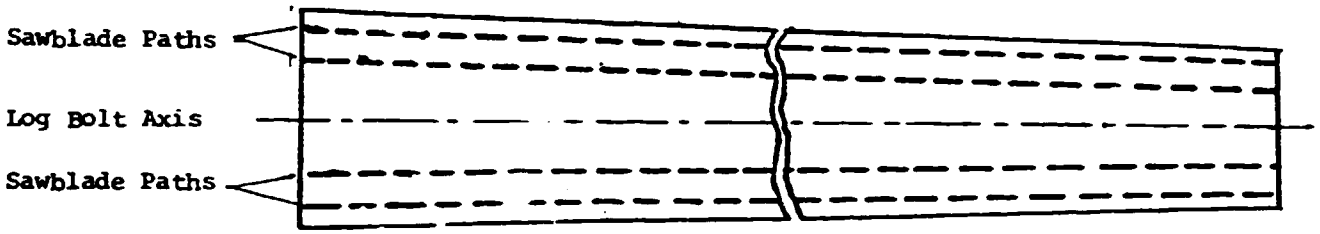


Fig. 1 - Bandsaw blade paths on log bolt when using tapering device on bandsaw carriage

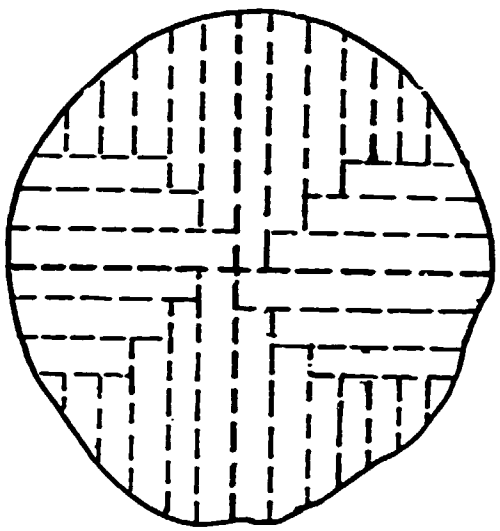
This Consultant's experience in using the sawing devices described above led to a 3% to 5% increase in the volume of No. 2 Common and Better boards and a corresponding 5% to 8% increase in overall sawmilling yield rate when milling tropical hardwood (Philippines Mahogany species).

3.1.2.3 Sawmilling Patterns

Sawmilling patterns adapted to the cross-sectional and longitudinal shape of the log bolt also helps increase the overall yield of better quality and/or higher priced boards. It is widely accepted in the sawn timber market that quarter-sawn boards command higher prices than flat-sawn boards. This is related to the better stability characteristics of quarter-sawn than flat-sawn boards.

Conventional quarter-sawing techniques still produce flat-sawn together with quarter-sawn boards. The Japanese sawmillers have attained higher percentages of quarter-sawn boards by alternately cutting boards from each flat surface of the quartered log bolt (See Figure 2).

Figure 2
The Japanese Improvement of the
Quarter Sawmilling Technique



3.2 Conversion of Manufacturing Residues into Marketable Products

Further increase in total revenue of sawmilling operations may be attained by converting its manufacturing residues into marketable products.

With the aid of a few simple and low-cost woodworking machines, log ends and sawmilling slabs can be converted into handicraft products, cable drums and reels, novelty items such as kitchen accessories (knife racks, chopping boards, etc.), wooden pegs, dowels, etc.

Sawmilling by-products, usually wooden pieces with sub-standard (commercial-wise) dimensions and known as SHORTS-NARROWS-STRIPS, can be converted into packing boxes, fish trays, fruit crates, etc.

Briquetting machines which can covert even wet sawdust into fuel briquettes are now available at reasonable prices for various levels of output volume.

IV. DOWNSTREAM PROCESSING OF SAWN TIMBER OUTPUT OF SAWMILLING OPERATIONS

Visits to sawmilling plants and interviews with managers and executive officers during the conduct of this Project revealed the following:

i. A number of the sawmilling firms have started downstream timber processing operations, and conversely, some furniture manufacturing firms have engaged in kiln-drying and sawmilling in order to assure their furniture manufacturing operations of a continuous supply of adequately seasoned sawntimber with the desired sizes;

ii. Among the sawmills which were found already engaged in downstream processing activities of one form or another, only one firm (in Papua New Guinea) was engaged in the production of pre-fabricated housing; all the others were engaged in producing pre-cut components for the furniture and joinery industry;

iii. All the sawmills engaged in downstream processing activities have their own kiln-drying facilities; and

iv. Invariably, however, except for the sawmilling plant in Papua New Guinea, the sawmilling managers were not sufficiently aware of the types and range of values of secondary/tertiary wood products that their resources and facilities will allow them to produce, nor do they possess the technical know-how that will enable them to do so.

The following paragraphs are presented to provide the sawmill operators at small to medium levels of operations information on potential target products and the mechanics and guidelines on how to start and proceed with Downstream Timber Processing activities.

4.1 Target End Products & Sawmilling Capacities

The choice of target end products for Downstream Timber Processing requires, in addition to the capabilities of existing/available resources of the sawmiller, a good understanding of the product specifications, its manufacturing process, the market for the product and, of course, the profitability potential of the product.

4.1.1 General Specifications of Possible End Products

In general, the initial and primary requirement of secondary wood processing is the availability of adequately seasoned sawntimber. This condition may be met either by:

i. The sawmiller erecting his own timber drying facilities; or

ii. Timber drying services from other business establishments may be availed of if such are available to the sawmiller at acceptable costs.

Several types of timber drying facilities are now available in the market. However, the sawmiller must bear in mind that each type (and size) of drying facilities have minimum economic operating capacity levels. Thus, the sawmiller must consider the acquisition of timber drying facilities whose capacities match his current sawmilling output plus an added volume to allow for future expansion.

In operations where the sawmilling output is significantly lower than the minimum economic operating capacity of the timber drying facilities, the sawmiller is advised to choose end products which require the use of air-dried sawntimber. Cable drums/reels, pallets, packing boxes, fish trays, chopsticks, fruit boxes, etc., are some secondary/tertiary products which require only air-dried sawntimber.

The choice of the proper type of timber drying equipment also depends on the moisture content (mc) requirements of the wooden end product. In general, the equilibrium moisture content (E.M.C.) of the market area for the end product determines the final moisture content required of the wooden components of the product at the end of the production line, before it is packed for shipping purposes. For example, the U.S. market normally requires 8% to 10% mc for wooden furniture products. However, 6% to 8% mc's are sometimes required for wooden goods destined for the drier interior areas of the country. On the other hand

12% to 14% mc's are acceptable in the more humid tropical coastal areas of the country.

Another set of important specifications refer to the acceptable deviations from specified end product dimensions. These are called machining TOLERANCES, and are usually required by buyers of components or of complete furniture items in knock-down condition. Due attention should be given to this matter when choosing woodworking machines if the sawmiller has planned to go into ex port production. Each woodworking machine is designed and fabricated to give a certain range of machining precision, which should match the range of machining tolerances specified by buyers of the secondary wooden product lines the sawmiller plans to produce.

4.1.2 Level of Sophistication of Manufacturing Process

The level of precision required in most of the secondary wood processing activities is significantly higher than those normally encountered in sawmilling operations. Similarly, the degree of sophistication in the manufacturing processes for secondary wood products also vary according to the nature and end use of the wooden product. Thus, fabrication of packing crates and fish trays require a much lower degree of precision than that for household furniture items. Correspondingly, the level of sophistication of manufacturing process for packing crates and fish trays is much lower than that for household furniture. Consequently higher skills are required in the manufacture of furniture items than those for the fabrication of packing crates and fish trays.

The sawmiller is thus advised to exercise appropriate consideration of availability and/or attainability of skills required by the manufacturing processes for the selected end product.

4.1.3 Transport Needs of End Products to Target Markets

Availability of adequate transport, infrastructure and facilities

is a primary condition for the choice of the market area for the secondary end products selected by the sawmiller.

In most cases, the choice of the end product is simultaneously done with the selection of the target market area, for transport costs participate to a significant extent in the determination of the marketability of the product in the selected market area.

Some factors affecting the success of choosing end products and corresponding markets include:

i. Availability of facilities for handling containers or shipping vans in both the shipper's and buyer's port;

ii. Availability of carriers which can transport the goods directly from the shipper's port to the buyer's port;

iii. In case direct shipment services are not available, existence of alternate shipping routes via not more than one transhipment port; and

iv. Availability of "BREAK BULK" container shipment services for shipment of volumes too small to fill one container.

4.1.4 Sawmilling Capacities to Meet Market Needs for Downstream Timber Products

Initial efforts to engage in Downstream Timber Processing must take serious consideration of the sawmiller's capability to provide the downstream processing activities with the required volume and quality of sawn timber needed in the manufacture of the selected end product.

It is obvious that domestic demand for secondary wooden products in developing countries with small populations and growth rates is also much lower than potential demands for the same products in the export markets. Thus, the small-scale sawmiller planning to engage in Downstream Timber Processing must consider only small volume end products. However, there is nothing that should prevent the small sawmiller from joining forces with other small sawmillers in considering the manufacture of high volume secondary

wood products, provided the mechanics of co-operation is acceptable to all concerned and is workable within the limitation of resources, manufacturing facilities and respective corporate arrangements of the working group.

4.1.5 Estimated Value Added for Each Type of Downstream Wood Product

Value added to sawn timber is directly proportional to the amount and precision level of additional work performed on the sawn timber. Normally, the higher the value added, the more the amount and the higher the precision of additional work done on the piece of wood. Commensurately, higher initial capital investments and more operating capital is required for end products which command higher added values.

The following schedule of added values, in terms of multiples of basic cost of sawntimber, is presented as a tool for small and medium scale sawmillers who wish to engage in Downstream Timber Processing. The data are based on market conditions and observed sawmilling costs in some developing countries of Southeast Asia in 1988.

End Product	Value Added (Multiples of basic sawn timber cost)
Secondary Products	
Dressed Lumber Products	1.25
Packaging Containers (fruit crates, fish trays, etc.)	1.40
Cable/Wire Reels/Drums	1.53
Mouldings & other Profiled Items	2.00
Components of Furniture/Joinery Products	2.5 to 3.5
Furniture, Complete, Knock-down	2.0 to 5.0
Wood Carvings	3.0 to 5.0

Tertiary Products

Wooden Toys	2.0 to 3.5
Handicraft Items	2.0 to 3.0
Sawdust Briquettes	1.5 to 2.0

4.2 Identification of Appropriate and Desirable Downstream Wood Products

The following points are presented to help make the sawmiller aware of some aspects of his sawmilling operations which are important factors in the choice of downstream wood products.

4.2.1 Effect of Sawmiller's Operating Status & Conditions

4.2.1.1 Volume of Sawmilling Output

In general, approximately 70% of the sawn timber input in woodworking operations is converted into marketable goods. Thus, it is suggested that the sawmiller consider secondary or tertiary wood products with volume ranges to about 70% of his sawmilling output. Cooperative endeavors with other sawmillers, if based on feasible conditions, may help the sawmiller consider secondary or tertiary wood products in excess of 70% of his sawmilling output.

4.2.1.2 Timber Species Processed

The timber species output of sawmilling operations also help determine the type of secondary or tertiary wood products for Downstream Timber Processing. Teak, Rosewood, and other exotic timber species are in great demand for furniture products. Mahogany finds great use in both furniture and builders woodwork items, including mouldings and other moulded products. Pine wood is sometimes used for lower priced furniture items, but finds most use in packing crates, fruit boxes, etc.

The colour of wood also indicates the market for the secondary or tertiary wood product. Some markets, like Japan, favour light coloured wood, whereas dark coloured wood finds more demand in some European countries.

The hardness, toughness and other physical characteristics of the timber species also participates to a great extent in determining the end product. Structural components of buildings require strong and tough timber species, while tongue depressors, chopstick, matchsticks, etc., require soft and very light coloured wood. These mechanical/physical properties of wood also determine the machining characteristics of the woodworking machines for secondary wood processing activities. Higher feed and cutting speeds may be used for machining medium hard and soft woods, than those required for very hard woods.

4.2.1.3 Organizational Aspects

The type of organizational relationship between the manufacturer and buyer of secondary/tertiary wood products, under certain favorable circumstances, could accelerate the transfer of technical know-how to the manufacturer, thereby contributing to the faster development of Downstream Timber Processing industry. Thus, the sawmiller wishing to engage in Downstream Timber Processing would do well to give serious consideration to the benefits to be derived from certain organizational relationships with potential buyers.

a) Marketing Affiliations and Contacts

One of the most critical phases in the development of the secondary wood processing industry is the initial effort to establish a solid foothold in the market. Some firms in developing countries met with success in attaining a good foothold in the market

through one or more of the following:

i. Joint venture arrangements with foreign (or local) buyers who are engaged in the distribution of the wood product;

ii. Joint venture arrangements with foreign (or local) buyers who are engaged in the manufacture of wooden products that make use of the furniture component to be produced;

iii. Expansion of marketing operations of foreign affiliate, in the case where the manufacturer of secondary wood products (from the developing country) is an affiliate of the marketing firm, to include secondary wood products.

b) Corporate Structural Constraints

At times, the foreign sources of needed technology for development of the secondary/tertiary wood processing industry are reluctant to enter into big scale joint venture arrangements with firms in developing countries unless they are given ample participation in both the corporate and management structure of the wood processing firm. The sawmiller wishing to engage in Downstream Timber Processing must be ready to understand this position of the potential foreign partner, if the former looks forward to a successful relationship with the latter. Technology is not obtained free-of-charge. It is something that represents expenditure of time, money, and efforts to develop. Thus, subject to the provisions of national laws on foreign investments, the sawmiller wishing to engage in Downstream Timber Processing must be ready to forego some of the corporate and management powers it exercises under its original corporate structure, and share them with partners (foreign or local).

c) Financial Capability

Some sawmillers are shocked at the "large" financial outlays, both capital and operational, required to establish Downstream Timber Processing activities. The longer "cash turnover period" usually builds a stiffer resistance to making the sawmiller decide for Downstream Timber Processing. A formal Project Feasibility Study should help the sawmiller make his final decision to engage in Downstream Timber Processing. The study will also indicate the market direction and technical feasibility, aside from the financial viability of the Project. The amount of money spent for a Feasibility Study is more than justified by the great risk taken when industrial projects are implemented based on "guesswork".

d) Other Factors

Among other operational requirements, a secondary/ tertiary woodworking plant requires a strong middle management and effective floor supervisory force, something that, more often than not, is usually absent or undefined in sawmilling operations. The sawmiller therefore, should be prepared to share his powers and delegate authority to properly and adequately trained middle management and floor supervisory personnel, to help assure himself of a more smoothly runs manufacturing operations.

Day-to-day problems on production management, quality control, materials management and personnel management will be minimized if not effectively prevented, with a strong and effective middle management and floor level supervisory personnel.

4.2.2 Effect of Environmental and Prevailing Socio-Economic Factors

In general, sawmilling plants were erected in areas closer to the source of its raw material input, i.e., the forests. On the other hand, secondary wood processing factories were built closer to the market, i.e., urban centers of the population. These diverse practices in locating processing plants gave rise to problems which the sawmiller wishing to engage in Downstream Timber Processing must anticipate and adapt remedial actions therefor even as early as the planning stage of the proposed forward integration plans for the sawmilling operations.

4.2.2.1 Availability and Cost of Electric Power

The industrial power cost item is usually referred to the cost of energy to run the machines in the processing plant. In many cases, sawmilling plants generate their own electric power. With the advent of Downstream Timber Processing for these mills, the cost of power takes on another aspect: i.e., the cost of energy needed to sustain the normal livelihood of the families of the woodworks labour force who may have to be moved to a new factory site. The sawmiller planning to engage in Downstream Timber Processing must therefore consider this additional energy cost when selecting the site for the woodworking plant.

4.2.2.2 Transportation and Communication Infrastructure

Availability of transport facilities is essential to the successful operations of a woodworking plant not only from the industrial point of view, but also for the transport of the factory personnel to and from their homes to the factory and for such modern day daily family chores which are better and faster done with the use of transportation facilities. Thus, where the sawmilling plant is located at some distance from urban

areas, the sawmiller intending to engage in Downstream Timber Processing, must consider this requirement when deciding on the location of the woodworking factory and the type of secondary wood product to be manufactured.

The need for effective and speedy communications facilities also becomes more urgent when the planned expansion into Downstream Timber Processing is export-oriented.

4.2.2.3 Availability of Manpower with Desirable Skills and Training Institutions for Labour Skills

As explained in previous sections of this paper, the fragmented nature of the secondary wood processing industry, together with its characteristic evolution from cottage type craftsman endeavor to industrial scales of activities, has made the supply of adequately & properly trained manpower a major deterrent to a more desirable development rate of the industry. Yet, economic planners have more often than not, assumed that establishment of trade/vocational schools is the answer to the problem. The slow development of the secondary wood processing industry, even in developing countries with an extensive vocational/trade school system, is a visible proof of the inadequacy of such systems to supply the needs of the industry. The situation also indicates the need for industry-oriented training programmes, if a desirable pace of development is to be expected of the secondary wood processing industry.

Thus, in situations where skilled and highly skilled labour is not readily available for the secondary wood processing industry, it is suggested that the sawmiller planning to engage in Downstream Timber Processing, consider simple products which do not require a high degree of sophistication to manufacture.

4.2.2.4 Other Socio-Economic Considerations

During the last few years, up to the present, governments of developing countries have considered, and some have launched, the establishment of "FURNITURE VILLAGES" (industrial processing areas solely for the woodworking industry) as a vehicle for the faster development of the industry. Experience gained through unsuccessful "Furniture Villages" in some developing countries indicated that socio-economic factors (which are often ignored or given inadequate emphasis during the planning stage) play equally important roles in the successful development of the "village" Project. Such factors as availability of good and adequate supply of water (both for industrial and home use), community market/shopping facilities, schools, places of worship, etc., affect the Project's ability to attract the skilled, highly skilled, middle management and supervisory manpower that are needed by the growing industry.

Again, the level of sophistication of manufacture of the chosen secondary wood product will be greatly affected by the degree of skills which available labour could provide the industry. On the other hand, higher skilled industrial personnel are better attracted to seek employment where their families' socio-economic problems are better taken care of.

4.2.3 Marketing Requirements

In general, the sawmiller will find that marketing requirements for secondary wood products differ greatly in various respects than those that he has been familiar with in sawmilling products.

4.2.3.1 Product Specifications

The set of specifications that identify the secondary wood product normally include the cardinal dimensions

of the product (together with acceptable machining tolerances), the required timber specie (and colour, if the species come in a wide range of shades of the same colour), the cross-sectional profile (particularly in moulded or carved items), further machining operations (such as tenons/mortices, woodscrew pilot holes, bolt holes, grooves, etc.) and, of course, the required moisture content.

The secondary wood products which, in essence, have the same set of specifications as sawn timber are the blanks for furniture component parts. The only difference is that the cardinal dimensions for furniture blanks are smaller and the moisture content much lower than those for sawn timber.

More advanced secondary wood products will require surfacing (as in S4S) or profiling (as in mouldings) operations. Machining tolerances in these products are more restrictive than those for furniture component blanks, which is the general trend as the end product takes on more advanced types of machining operations. Where sawmilling tolerances are specified in millimeters and centimeters (big fractions of an inch), corresponding specifications for secondary wood products are set in tenths of a millimiter (thousandths of an inch).

Thus, a sawmiller intending to engage in Downstream Timber Processing must take serious efforts to learn and familiarize himself with an entirely new and more diversified set of product specifications, related to the type of end use of the secondary wood product he is planning to produce.

4.2.3.2 Packaging/Crating and Shipping Requirements

Packaging (and crating, whenever required) instructions for secondary wood products vary according to the type of end product and operational requirements of the buyer. Unlike sawn timber (whether air-dried or kiln-dried) which are bundled to meet a specific width and height of the standard bundle, secondary wood products are packaged in numerous ways, according to the size and shape of the product. More advanced types of secondary wood products have certain critical dimensions and/or shapes which must be protected and preserved during shipment. Special packaging requiremerts are therefore imposed by the buyer to assure that the wooden products are received (at the buyer's end) intact.

Another aspect of packaging requirements for secondary wood products (particularly knock-down furniture) has to do with assuring that so many sets of the product (or its component parts) are packed in distinct and accountable bundles, crates, etc., whichever is most applicable and acceptable to the buyer. This is something entirely new to the sawmiller, and requires extra efforts to learn and be familiar with. With the advent of containerized type of shipping facilities, the "seemingly" complex nature of shipping numerous bundles, packages, etc. of wooden products is more or less simplified. The only major requirement is to be able to pack all components of one product in the same container, in order to assure the buyer of receiving so many complete sets of parts for the secondary wood product.

The choice of shipping routes, however, is not as wide as it was during pre-containerized shipping years, for directional control of containerized shipment is dictated at and by the location of major transhipment ports for sea-going containers.

4.2.3.3 Pricing/Payment Terms

Pricing levels and payment terms for secondary wood products follow, more or less, the prevailing sawn timber practices, with additional amounts alloted for value added to the product as a result of more advanced machining and handling operations.

4.3 Technical Aspects of Downstream Manufacturing Operations

4.3.1 Major Technical Constraints

A desirable rate of development of the secondary wood processing industry is greatly hampered by prevailing technical constraints in many developing countries of the Asia-Pacific Region. Some of these constraints indicate solutions from sources outside the developing country itself, while others require a more industry-oriented approach to currently-implemented solutions.

4.3.1.1 Inadequate Seasoning of Sawntimber and Lack of Kiln-Drying Facilities

In most of the developing countries of the Asia-Pacific Region, a great majority of the sawmillers and secondary wood processors do not have timber drying facilities. Whatever kiln-dried sawn timber is available is not enough to meet the needs of the industry. In fact, among the three countries visited under this Project, it appears that only Indonesia has manifested positive signs of solving this problem, mainly due to the existence of a local firm manufacturing kiln-driers of the type (hot water heated) which is readily affordable to small and medium secondary wood processing firms.

The urgent need for more kiln-drying facilities is emphasized by the fact that the machining workmanship in furniture/joinery firms using adequately seasoned sawn timber is markedly much better than those which

use "dried" lumber. In fact, the primary pre-requisite for export-oriented secondary wood processing operations is the use of properly seasoned sawn timber.

A problem corollary to the lack of adequate kiln-drying facilities is the lack of adequately trained kiln-drying technicians. The Indonesian kiln-dryer manufacturers mentioned in a preceding paragraph appears to have devised an effective solution to this problem by providing a regular training course for kiln-drying technicians together with the purchase of their kiln-driers.

4.3.1.2 Lack of Properly and Adequately Trained Manpower

The next major technical constraint that needs to be immediately addressed to assure a healthy development pace of the secondary woodworking industry is the need for properly and adequately trained manpower. The need covers sensitive and pivotal positions in a woodworking factory that requires industry-oriented training programmes to supply the growing secondary wood processing industry with:

i. Skilled & Highly Skilled Production Workers; and

ii. Woodworking Technicians (such as Millwright, Finishing Technicians, Product Engineers, etc.)

Most distressing was the fact that except in woodworking firms affiliated to transnational groups of companies, all furniture and joinery factories visited under the Project had very weak or inadequately trained middle management and floor supervisory personnel. And in some of the firms visited, the middle level of management did not exist at all. This situation has to be addressed vigorously and immediately if it is desired to help the industry attain a more desirable pace of development.

4.3.1.3 Time Element

Interviews with industry leaders indicated that so much has to be done within so short a time period that a serious rationalization of development plans for the secondary wood processing industry should be a joint effort between the government of the developing country and the private sector of the industry. As each timber-rich developing country in the Region takes concrete steps to restrict (and eventually ban) the export of wood products in raw material or semi-manufactured form (logs and sawn timber) the corresponding secondary wood processing industry is put under heavy time pressure and is thus, led to take costly short-cuts to keep abreast of the pace set by the country's industrial/economic development authorities.

The manpower shortage problem is one that must be addressed properly and immediately. It appears that the following steps should be taken in order to rationalize the solution to this problem:

i. Existing training facilities for the industry manpower should be reviewed and revised to make the courses and facilities more industry-oriented;

ii. The initial training activities should be designed to develop TRAINERS who in turn will be expected to train workers for skilled and highly skilled positions in industry; and

iii. Wherever needed, technology for the industry must be brought in from sources outside the developing country.

Most important of all, however, the country's economic planners and industry leaders should consider a development programme for the industry based on realistic time periods within which training activities can turn out sufficiently trained workers for the industry who

could become productive components of the industry's work force within the shortest possible time.

4.3.2 Industry Needs

In order to successfully overcome the technical constraints enumerated in the preceding paragraphs, the industry, with the help of government, must provide itself with the ingredients needed to initiate and sustain the rate of growth and development set for it by the national economic planners. Again, it is emphasized that this study is addressed to the small and medium scale component of the sawmilling industry which is being encouraged by their governments to engage in Downstream Timber Processing. It is further recognized that this is the industry component whose physical and financial resources and technical capabilities are not sufficient to enable them to successfully engage in Downstream Timber Processing without assistance from outside sources.

These ingredients for industrial development are discussed in the following paragraphs.

4.3.2.1 Training Centers for Key Industry Personnel

Among the three countries visited under this Project, only one institution was found to be totally industry-oriented (P.I.K.A., in Semarang, Java, Indonesia). However, its facilities and faculty can train annually only less than 50 young people for key positions in industrial production operations. All other training institutions visited under this Project and other UNIDO missions, were geared and operate to train craftsmen, who, when hired by industry, require a number of years to become sufficiently useful in industrial operations. The same situation, some even worse, was observed by the Consultant in other Asia-Pacific countries which were visited in the course of other UNIDO projects. It appears that national industrial development plans

for the secondary wood processing subsector is faultily based on the hopes that existing institutions providing training courses for carpenters and tradesmen will provide the skilled and highly skilled workers urgently needed by the industry. This being the case, governments need to take the initiative to review and revise existing facilities and curricula of labour training institutions to make them more industry-oriented. The industry needs assistance in translating technical brochures on wood-working operations into the country's national language. Serious efforts need also be exerted to determine the number and nature of key industry personnel required under the approved national industrial development plans, so that the capacities of training institutions could be commensurately allocated.

4.3.2.2 Kiln-Drying Facilities

As discussed in preceding sections of this report, the primary input of Downstream Timber Processing is adequately seasoned sawn timber. The apparent solution to this problem is the erection of kiln-drying facilities with ample drying capacities to meet the industry's growing requirements. Again, not only facilities are urgently needed, but also, industry will need more adequately trained kiln-drying technicians and kiln operators.

Similarly, recognizing the financial and physical resource constraints of the small and medium scale sawmillers, the government should take the initiative to help the industry by promulgating industry assistance programmes which will:

i. Re-direct the orientation in existing labour training institutions to allow training courses for more industry-oriented work positions coupled with simultaneous up-grading of training facilities and teaching staff to meet the new objectives of their training programmes;

ii. Encourage the formation and provide the needed atmosphere for continued and effective operations of industry cooperatives which will partially finance and wholly operate kiln-drying facilities for the cooperative members; and

iii. Provide the basic stimuli for these development activities in the form of much needed financial assistance to the industry.

4.3.2.3 Well-Planned Development Programmes

In view of the industry's needs discussed in the preceding paragraphs, it is indicated that current development plans for the secondary wood processing industry in developing countries of the Asia-Pacific Region be thoroughly reviewed and re-formulated to include measures designed to overcome the development problems discussed in this paper and make them more responsive to the immediate needs of the industry. A regular periodic review and re-work of the plans is indicated in order to make the development activities correspond to the needs of the growing industry.

4.3.2.4 Importation of Technical "Know-How"

Only a few of the developing countries in the Asia-Pacific Region possess some of the technical "know-how" needed for the development of Downstream Timber Processing industries. Yet, availability of this "Know-How" is a sine qua non condition to be the desired development pace for the industry. Thus, there is no other recourse but to "import" the technology from sources outside the developing country. Considering the meager financial resources of the small and medium scale sawmillers, it is indicated that assistance for the purpose of importing technical "know-how" is needed in the following manner:

i. Outright participation of the government in importing the technology into the country, using methods and arrangements now being effectively pursued in other sectors of the national economy;

ii. Setting up incentives for the private sector to encourage them to "import" the needed technology, in terms of tax deduction or such similar devices which have tremendously boosted the growth of other industrial sectors of the developing country; and/or

iii. Providing funds from which industry may borrow (at realistic interest rates affordable by the industry) for the specific purpose of importing technical "know-how".

4.3.3 Machinery/Equipment Complement For Downstream Timber Processing

The following paragraphs give the small and medium scale sawmillers a general idea of the production operations and machinery/equipment complement required for the manufacture of selected secondary/tertiary wood products. The sequence of operations thus described represent the basic techniques to produce the selected wooden product.

4.3.3.1 Simple Wood Products Using Only Air-Dried Sawntimber Inputs

Among the numerous wooden products under this category are: Fish Trays, Fruit Boxes and Cable/Wire Reels. These are low valued items and are therefore usually produced out of residues that are generated during sawmilling operations. Log ends usually offer a good source of material for these products. Edgings, cants and trimmings from 38 mm (1½ inch) and thicker boards also provide almost valueless raw materials for the

manufacture of these products.

The production operations, when using log ends as raw material source, start with the conversion of the log end into short slabs with thicknesses and widths in multiples of the final dimensions of the wooden slats, using a standard 900 mm (36-inch) chain saw. A set of narrow-blade band saws (50 mm sawblade width) is then used to cut the slabs into slats having the desired width and thickness. A circular saw (table model, 300 to 400 mm diameter sawblade, cross-cut type) is then used to cut the slats to the desired lengths.

For the end pieces of the cable/wire reel, however, a similar bandsaw is equipped with a jig which enables the sawblade to cut circular arcs on the edges of the workpiece.

Assembling work on fish trays and cable/reels most usually require hammering nails to put the pieces together. In the case of cable/reel drums with large diameters (900 mm and larger), carriage bolts may be specified by the buyer. Hence, a manually-operated drill press (19 mm maximum chuck capacity), is needed to bore holes for the carriage bolts.

Assembling operations for fruit boxes of more recent designs require the use of baling wire to hold the slats in a pre-designed arrangement which allows the box to be folded flat for shipment and storage purposes. The baling wire is held onto the wooden slats by means of appropriate size wire staples. Combination baling/ stapling machines which allow higher volume outputs for these operations are now available in the market.

4.3.3.2 Drying Facilities for Secondary Wood Products

The primary requirement for products in this category is the use of adequately seasoned sawntimber as material inputs. Several types of drying equipment are currently available in the market. Each type has price ranges depending on the volume capacity of charge, the sophistication of monitoring and controlling devices and standard accessories that make the drier work effectively. The cost of course, is a direct function of the volume capacity, the sophistication of the design of monitoring and controlling devices and the types and quantities of accessories (such as kiln trucks, rails, transfer car, etc.) required for regular normal operations.

In contrast to manual piling of sawn timber inside the kiln chamber, loading systems (more commonly using rails and kiln trucks) help cut short the idle time of the kiln (during loading and unloading activities) and consequently cut short (by as much as 1½ days in some cases) total kiln-drying period. This is possible because the shorter kiln idle time allows only small cooling off of the kiln walls and internal fixtures, so that the kiln atmosphere can be raised to operating temperature levels within a significantly shorter period after completion of kiln loading activities.

Some of the driers more commonly used in industry are described in the following paragraphs.

i. Conventional Steam-Heated Kiln-Driers

This type of drier has two major components: a) the steam generating unit and b) the drying chamber/s. Driers of this type have been designed and proved effective for chamber capacities ranging from 24 cu.m. (10,000 Bd.Ft.)

to 435 cu.m. (185,000 Bd.Ft.). Before the advent of electronic kiln monitoring and control devices, the most popular and commonly used type is the cam-recording and control device.

Steam from the generator is led through a system of asbestos-insulated steel pipes into the drying chamber/s, where the lumber boards (to be dried) are arranged in neatly stickered box-piles. The steam is made to pass through a system of heat exchangers, usually made of steel pipes with circular radiating firs welded on the external surfaces of the whole length of the heat exchanger piping system. The desired air circulation within the chamber is activated by centrifugal fans which move the air at pre-determined velocities and direction of flow by means of a system of baffles and deflectors, through the heat exchanger system (thus heating the air to the desired temperature levels). The hot air is then moved to pass over and through the box-piles of lumber. The air spaces between board surfaces created by the placement of wooden stickers between boards (and wooden shims between box-piles when drying chamber loading operations is done with the use of a forklift), allow smooth passage of the hot air over the board surfaces. Some drying chamber designs call for a device for reversing the air flow after every pre-determined time period to attain more uniform drying of the boards on the heat exchanger side and those on the other side of the drying chamber. Air within the drying chamber becomes more laden with moisture as the lumber boards become drier.

Effective water evaporation process (from lumber to the hot air) is maintained at desirable rates by a system of air vents which are opened (and alternately closed) to allow an exchange of the now moist air from the drying chamber with the relatively drier air from outside the chamber.

Toward the end of the drying schedule, the air cannot be allowed to become too dry for this will create "case hardening" on the board surfaces, a condition which makes it difficult to plane or machine the kiln-dried boards. Thus, moisture (in the form of steam) is introduced into the chamber at controlled rates to allow what is called "Normalizing and Equalizing" process, which relieves internal stresses created within the boards by the drying process and makes the board more uniformly dry over its whole cross-section.

This type of kiln-drier has dried lumber boards down to 6-8% moisture contents with negligible kiln-drying degrades.

ii. Hot Water Type of Kiln-Drier

The hot water type kiln-drier uses basically the same air-heating and lumber drying principles as the conventional steam heated type of kiln-drier (described in the preceding paragraphs), except that the heating medium is HOT WATER at low pressure) instead of live steam. Thus, the over-all cost of the drying system is less for this type of drying since it needs only a water heater instead of steam generator.

The drying chamber features are about the same as those of the conventional steam heated type of kiln drier, except that atomized hot water is used to maintain kiln air relative humidity (RH) conditions at the desired levels.

The over-all cost (equipment acquisition and installation) and operating costs of Hot Water Type of kiln-driers is significantly lower than that of the conventional steam heated type.

Compared to the conventional steam-heated type of drier, the lumber drying performance of Hot Water Heated Kiln Driers is about the same when drying boards thinner than 50 mm (2 inches), but the drying period is longer when drying boards thicker than 50 mm.

iii. Hot Air, Flue Gas Heated, Wood Fired Type of Kiln-Drier

This type of kiln-drier uses the same heating and drying principles as the other two driers described in the preceding paragraphs. The main difference however is that flue gas, generated by burning wood waste is used as the heating medium. Thus, the costly steam generating or water heating devices are not needed, and the furnace design becomes simpler and less costly as those required for steam or hot water generating systems. The over-all installed cost and the operating costs of this type of drier is thus very significantly lower than the other two driers discussed in preceding paragraphs.

Driers of this type have been designed for capacities as small as 4 cu.m. (1,000 Bd.Ft.)

and up to 50 cu.m. (20,000 Bd.Ft.). This type of drier has met wide acceptance with small and medium size furniture and joinery factories in the Philippines. It was this type of kiln-drier which was used to dry coconut lumber during the conduct of two UNIDO projects (SI/PHI/83/801 and SI/PHI/84/801) in the Philippines to demonstrate the use of coconut lumber in housing and furniture construction. The lumber drying performance of this type of kiln-drier is comparable to that of the conventional steam heated type of kiln-drying systems.

iv. Electrically Heated Kiln-Driers

The drying principle used in this type of kiln-drier is the same as those used in the other three types of kiln previously described. However, the heating principle is significantly different, for this type of drier does not make use of a heat exchanging device. Instead, the kiln chamber air is directly heated by electrical "Fires". The air circulation system in this type of kiln-drier is very similar to those used in the three driers previously described.

Although the installed cost of this drier is much less than conventional steam heated kiln-driers of the same rated drying capacities, the operating costs are significantly higher due to the high cost of electricity as a heat source. However, this type of drier has been given good ratings by users in Singapore, where anti-air-pollution laws do not allow the use of conventional type of oil- or wood-fired furnaces.

v. Dehumidifiers

Dehumidifier type of driers operate on a principle similar to the dehydrating effect encountered inside refrigerators. Air inside the drying chamber is passed through a machine that compresses the air and then allows it to expand suddenly in a condensing apparatus, thus removing moisture from the air. The dried air is then moved through the stack of lumber inside the drying chamber to extract moisture from the relatively wet lumber boards. The moisture extraction process is better attained at higher air temperatures. Thus, air is heated (electrically) during the drying process to keep it at desired temperature levels.

The operation of this type of drier is apparently simple, but the technical skills required to keep the drying equipment in good operating condition at all times is much higher than the other driers described in preceding paragraphs.[1/] The over-all installed cost is much higher than those of the other types of driers (described above) per unit drying output. In places where the cost of electrical energy is high, operating costs of this type of drier is comparatively higher than the electrically heated, hot air type of drier.

This type of drier, however, has been successful in drying sawn timber with large cross-sections (75 mm. thick or larger) within reasonable periods of time. Drying to low moisture contents is however relatively slow and costly.

1/ It is however very similar to air conditioners, hence its maintenance usually poses no problems in urban areas.

vi. Vacuum Type of Driers

This type of drier should be known to sawmillers who are familiar with pressure-type wood preservation facilities. The system is composed of: a) the drying chamber, which is essentially the same type of vacuum sealed cylindrical tank used in pressurized preservative treatment of wood, and b) a vacuum pump. Moisture is extracted from the lumber boards by subjecting them to pre-determined vacuum levels inside the tank by drawing off air from the tank. The air thus drawn is "dried" by passing it through a condensing device and returned to the drying chamber. The vacuuming and "air-drying" process is then repeated until the moisture content of the lumber inside the drying chamber is brought down to desired levels.

This type of drier has been successfully used in drying boards with thicknesses over 50 mm. The unit drying cost, however, is comparatively higher than the other conventional type of driers, because the chamber capacity is relatively smaller. Correspondingly, the installed cost per unit lumber drying capacity is also high. Drying cycles are faster and it is claimed that degrade is slower.

4.3.3.3 Secondary Wood Products Requiring Adequately Seasoned Sawntimber Inputs

Except for mouldings and other profiled or carved wood products, the general sequence of operations is presented in Figure 3 . Production of mouldings and other profiled items differ slightly during the initial stages of machining operations in that re-sawing operations (to obtain desired thickness of boards) is done in the woodworking factory, rather than in the sawmill.

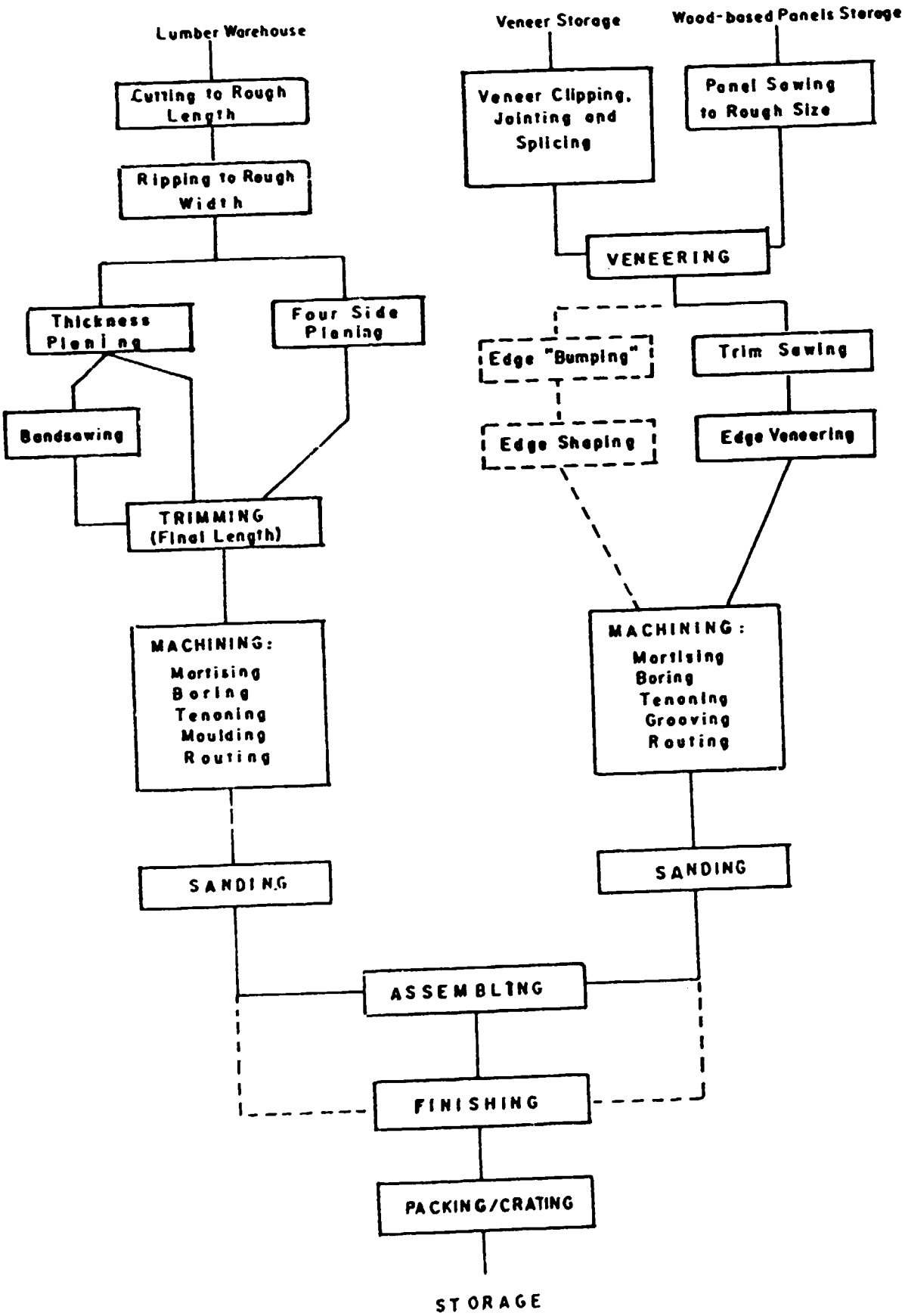


Figure 3 - General Operations Sequence for Manufacturing Furniture and Joinery Products

This has to do with the aim of the mouldings producer to maintain only a few thicknesses of sawn timber in his inventory of raw material, and correspondingly give him a good latitude of initial board thicknesses to start with.

The equipment complement given in the following paragraphs have been selected to attain an average processing input module of roughly 12 cu.m. (5,000 Bd.Ft.) per 8-hour working day for each type of secondary and tertiary wood product. However, the machinery/equipment requirements of woodworking factories with processing capacities larger than 12 cu.m./day is not necessarily direct linear multiples of the listed machinery units. The number of additional machine units for each production operation still requires computation using the rated capacities of the individual machines.

i. Profiled Items (Mouldings, Casings, etc.)

With thick boards for material input, the first operation in the production of mouldings is resawing the boards to desired thickness, using a bandsaw with thin gauge sawblade and an automatic feeding device. The next step is to obtain the desired profile on the boards by the use of a multi-head moulding machine. However, mouldings with simple profiles may be run through a planer-matcher, essentially a moulding-surfacing machine, with two horizontal and two vertical cutterheads. More complex profiles require the use of five or more cutterheads to allow progressive profiling operations. More recent models of moulding machines provide a tilting saw at the 7th working station of the machine.

The typical production equipment complement for the 12 cu.m./day processing module is as follows:

No. of Units	Machine Description
1	Band Re-saw, 110 mm bandwheel Diameter, up to 150 mm bandsaw blade width, 20 m/min feed speed
1	Radial Arm Saw, 355 mm. diameter TCT sawblade
1	Moulding Machine, 4 to 7 cutter-heads (according to profile requirements)

ii. Blanks for Carved Wood Products

Preparation of blanks for carved wood products require simple cutting and surfacing machines. Circular saws are used to cut the blanks into rectangular blocks while bandsaws are used to obtain curved shaped edges of the blanks. A thicknesser surfacer is used to dress the flat surfaces to the desired smoothness. The blanks are then ready for hand-carving operations. The output and productivity of fully-hand-carved operations is too low. Thus, for high volume carving operations, multi-spindle duplicating machines are used to gouge the preliminary relief of the design, and final carving is done by hand to bring out the fine details, contours or shapes of the carved design. The modular production equipment complement for this type of woodworking operations is as follows:

No. of Units	Machine Description
1	Radial Arm Saw, 355 mm. diameter TCT sawblade
1	Bandsaw, 600 to 750 mm. bandwheel diameter, sawblade width up to 50 mm.

No. of Units	Machine Description
1	Planer-Thicknesser, up to 600 mm. workpiece width x up to 200 mm. workpiece thickness capacity, single cutterhead, 5500 RPM cutting speed, variable feed speed up to 20 m/min.
1 (optional)	Multi-spindle Duplicating machine, up to 18,000 RPM cutting speed.

iii. Joinery & Furniture Products

Components of joinery and furniture products follow similar sequence of operations during the first stages of manufacturing operations (see Fig. 3). Differences in operations arise from the joinery design of the component parts, e.g., mortize and tenon; dowel-joints; etc. Specific types of machines designed to carry-out such operations are now available in the market. Variation in machine outputs is achieved through changing degrees of automation in machine feeding device design.

The modular complement of production machinery for this type of woodworking operations is as follows:

No. of Units	Machine Description
1	Radial Arm Saw, up to 400 mm. sawblade diameter, TCT, up to 450 mm. maximum saw travel, manually operated
1	Straight Line Edger, up to 400 mm. sawblade diameter, TCT, chain feed up to 20 m/min.
1	Jointer-Surfacer, 200 mm. (8-inch) work width capacity, 5000 RPM minimum cutterhead speed, hand operated

No. of Units	Machine Description
1	Planer-Thicknesser, 500 mm. work width & up to 300 mm. work thickness cpacity, minimum 3- Knife cutterhead, 5,500 RPM minimum cutterhead speed, infinitely variable feed speed up to 25 m/min, manually fed.
1	Tilting Arbor Saw, up to 400 m. sawblade diameter, 50°maximum sawblade tilt, with extension arm attachment for cutting panels.
1	Heavy Duty Over-arm Router, up to 19 mm. bit dia. capacity, 20,000 RPM minimum cutting speed, tilting table, with foot-pperated table raising mechanism.
1	Vertical Spindle Moulder, up to 150 mm. cutterhead diameter, 6000 RPM minimum cutterhead speed up to 100 mm. work thickness capacity.
1	Stroke Sanding Machine, single belt, work dimension capacity. 1220 mm wide x 2440 mm long x 900 mm thick.
1	Spray Booth, Dry Type, 3.5 m^3/min. minimum airflow through spraybooth face, 2440 mm wide x 1830 mm deep x 2130 mm high. Complete with exhaust fan and baffles.
1	Fluid Tank, with stainless steel insert container, 20 liters capacity pressurized type, complete with pressure gauge and safety devices.
2	Spray Gun, Conventional Pressure Feed Type, up to 600 ml/min. material delivery.
1	Cup Gun, 950 milliliter capacity, pressure feed type.
1 set	Air and Fluid Hoses to Fit Spray Guns

Other special purpose woodworking machines (such as single-or double-end tenoners, automatic lathes, wood panel saw, etc.) may be added to the list depending on

the over-all volume output required of the operations.

4.3.3.4 Tertiary Wood Products Requiring Adequately Seasoned Sawntimber Inputs

i. Wooden Toys

The manufacture of wooden toys follow, more or less, the same sequence of operations as shown in Fig. 3 except that the machine capacities for workpiece dimensions are much smaller than those required for furniture and joinery items.

Additional equipment (such as screwdrivers, portable electric drills, etc.) will be required for assembling operations.

The equipment list therefore, will be similar to those for furniture and joinery products, but with smaller work dimension capacities.

ii. Handicraft Items

Among the more popular types of handicraft items which are produced and sold in big quantities are kitchen accessories such as chopping boards, towel racks, etc.

The sequence of operations to produce these items follow to a close degree those for wooden toys. Thus, the equipment complement for the production of handicraft items will be almost similar to those for wooden toys. In some cases, machine lathes are required for making turned components.

4.3.4 Estimated Plant and Machinery Cost

Rough estimates of woodworking plant and machinery cost, based on latest landed cost of machinery at Kuala Lumpur, Malaysia, and current factory building construction costs, also in Kuala Lumpur, are presented in the following paragraphs. The estimated costs refer to manufacturing modules having sawn timber inputs of approximately 12 cu.m./ 8-hr.day (5,000 Bd.Ft./8-hr. day). A shed type factory building (without walls) is used for manufacturing operations requiring air-dried lumber only, while a factory building, completely covered with side walls, is used for woodworking operations requiring kiln-dried lumber inputs.

The cost of kiln-driers is not included in the equipment cost as the decision whether to install kiln-drying facilities (or how much the minimum economic drying capacity should be) is subject to conditions specific to the manner of use and organizational arrangements of the proponent user/s.

4.3.4.1 Production of Profiled Items (Mouldings, Casings, etc.)

Cost of Factory Building, 700 sq.m. -----US$	77,000.-
Cost of Production Machinery and Equipment, Installed ----------	55,200.-
Cost of Maintenance Equipment ----------	35,000.-
Total ----------US$	167,200.-

4.3.4.2 Production of Blanks for Carved Wood Products*

Cost of Factory Building, 700 sq.m. -----US$	77,000.-
Cost of Production Machinery and Equipment, Installed ----------	18,500.-
Cost of Maintenance Equipment ----------	21,000.-
Total ----------US$	116,500.-

Note: * Includes floor space and machine cost for 6 spindle Duplicating Machine.

4.3.4.3 Production of Joinery & Furniture Products

Cost of Factory Building, 810 sq.m. ------	US$ 89,100.-
Cost of Production Machinery and Equipment, Installed ----------	40,500.-
Cost of Maintenance Equipment ----------	35,000.-
Total ----------	US$164,600.-

4.3.4.4 Production of Wooden Toys & Handicraft Items

Cost of Factory Building, 740 sq.m. ------	US$ 81,400.-
Cost of Production Machinery/ Equipment, Installed ----------	33,100.-
Cost of Maintenance Equipment ----------	26,250.-
Total ----------	US$140,750.-

4.3.4.5 Production of Fish Trays and Fruit Boxes

Cost of Factory Building, 500 sq.m. ------	US$ 45,600.-
Cost of Production Machinery/ Equipment, Installed* ----------	20,250.-
Cost of Maintenance Equipment ----------	17,500.-
Total ----------	US$ 83,350.-

Note: * 1) Add US$475.00 for cost of 1 unit portable type combination baling and stapling machine for the manufacture of Fruit Boxes (folding type).

2) Add US$2,100.00 for cost of 1 unit Bandsaw with Special Production Jig for the Manufacture of cable/wire drum/reels.

4.3.5 Guidelines on the Use of Estimated Plant and Machinery Cost

The machinery complement used in the above calculations for plant and machines cost is based on average machining outputs

for basic woodworking machinery as used in developing countries of Southeast Asia (Brunei, Indonesia, Malaysia, the Philippines, Singapore and Thailand). Thus, the outputs may not be accurately applied in operations which use semi- or fully automatic feed devices. Proper adjustments should be made therefor.

The building cost does not include space for showroom, administrative offices, employees' facilities and other support activities. Cost for such additional building spaces should be provided when calculating total building costs. The storage spaces for raw materials and finished goods are good for one month's supply and production volume, respectively. Thus, where local conditions require more storage areas for larger inventories of raw materials and finished goods, corresponding adjustments should be made on the cost of buildings.

The cost of building includes space for the maintenance shop, large enough to accommodate minor repair works on machine parts and fabrication of simple production jigs and fixtures. It is assumed that major repair works and machining and metal working jobs will be sub-contracted to outside firms. However, if such service facilities are not economically available in the locality of the proposed woodworking plant, proper adjustments should be made on both the cost of building and cost of maintenance equipment to meet the added space and equipment cost required.

V. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The preceding chapters of this study indicate good potentials for the small and medium size sawmilling firms to engage in Downstream Timber Processing. The Consultant has encountered similar situations during the last 3 years in other countries of the Asia/Pacific Region: for example, the Philippines, Vietnam, Thailand, Fiji, the Solomon Islands, Western Samoa, to mention a few.

In spite of current efforts of developing countries to encourage Downstream Timber Processing in their respective sawmilling industries, the corresponding rate of growth in the secondary wood processing remains at an undesirable slow pace.

The following factors have, more or less, contributed to the apparent reluctance of sawmillers to engage in further downstream processing activities:

i. Lack of adequate knowledge of the market, both domestic and export, for secondary wood products;

ii. The apparent higher precision required in the manufacture of secondary wood products as compared to that required by sawmilling;

iii. The additional capital expenditure required to establish appropriate kiln-drying or seasoning facilities in support of further downstream timber processing;

iv. Lack of adequately trained manpower: skilled & highly skilled production workers, technicians and floor level supervisory personnel, and in some cases, middle management personnel; and

v. The lack of funding facilities which will help sawmillers withstand the cash flow requirements of a longer cash turnover period, as compared to that encountered in sawmilling operations.

5.2 Recommendations

5.2.1 Downstream Timber Processing Industry Development Programmes

It is indicated by the preceding paragraphs that more realistic modular approaches to the development of secondary wood processing industries will have better chances of success than overall comprehensive programmes which are traditionally evolved and implemented on the basis of a "feasible medium or average level" of processing operations.

It is therefore recommended that existing programmes aiming to encourage Downstream Timber Processing and hasten the development of the secondary wood processing industry be reviewed and revised to consider the following country situations:

i. For developing countries with small and fragmented sawmilling industries; and

ii. For developing countries with well developed and organized sawmilling industries, and highly fragmented secondary wood processing industries.

The sawmilling industry of Papua New Guinea is small and fragmented. Correspondingly its secondary wood processing industry is also small and hardly contribute to a significant portion of the country's economy.

The recommended guidelines and mechanics for the development of further Downstream Timber Processing activity in countries with sawmilling industries similar to that of Papua New Guinea is given in Annex III.

The sawmilling industry of Malaysia, although well developed, is widely dispersed throughout the country. The secondary wood processing industry of the country is also highly fragmented and widely dispersed in urban centers of the country. Hardly any downstream processing activity exists in sawmilling plants. However, a significant number of furniture factories have integrated backwards (up-stream processing) by setting up their

own sawmilling and/or kiln-drying facilities. This situation is mostly encountered in the sub-sector of the industry devoted to the conversion of rubber wood into furniture (and other) products. The domestic market for wood products is small.

The recommended guidelines and mechanics for more accelerated development of Downstream Timber Processing in countries with sawmilling and secondary wood processing industries similar to those found in Malaysia are given in Annex IV.

Among the countries visited, the sawmilling industry of Indonesia has shown an encouraging amount of interest in Downstream Timber Processing, for most of the mills visited were already engaged in the manufacture of pre-cut components for furniture products. These items are all exported. Again, secondary wood processing industry in the country is fragmented and widely dispersed in the urban centers of the country. The existence of a firm which fabricated kiln-drying facilities provided a vital ingredient to more accelerated growth of the secondary wood processing industry of the country. Indonesia presents a classic example of a timber rich developing country with a huge domestic market for wood products.

The recommended guidelines and mechanics for further accelerated growth in Downstream Timber Processing in countries with a state of development of their sawmilling and secondary wood processing industries similar to those in Indonesia are given in Annex V.

5.2.2 Technical Support Needed by the Recommended Development Programme

The development schemes described in Annexes III, IV, and V require a parallel development in the technical resource and operations techniques which are currently non-existent or under-developed in the wood processing industries of developing countries in the Asia/Pacific Region.

5.2.2.1 Acquisition and Up-dating of Existing Manufacturing Techniques

The types, designs and finishes of export secondary and tertiary wood products are so varied that corresponding manufacturing techniques have to be acquired by the

industry in developing countries of the Asia/Pacific Region. To-date, none or very little of this technology is available within the developing countries themselves. The scope of any technical assistance to be provided to industry should include the following topics which need to be addressed immediately:

i. Serial Production Techniques;
ii. Quality Standards and Production Quality Control Techniques;
iii. Product Design and Engineering;
iv. Plant, Machinery and Cutting Tools, Repair and Maintenance Procedures;
v. Design, Fabrication and Effective Use of Production Jigs and Fixtures;
vi. Machine set-up Techniques for Serial Type of Production Operations;
vii. Finishing Techniques and Finishing Materials Systems; and
viii. Production Management Concepts as Applied to Small and Medium Scale Secondary Wood Processing Industries; and

Subsequent efforts should then be exerted to improve the following aspects of plant operations:

i. Documentation and Information Systems as applied to Secondary Wood Processing Operations;
ii. Product Costing and Pricing Techniques; and
iii. Materials Management.

The following new concepts in woodworking plant management and operations may then be introduced and adapted to medium scale Downstream Timber Processing operations:

i. Low Cost Automation as applied to Furniture and Joinery Factories;
ii. Value Analysis; and
iii. Limited and Selective Degree of Computerization.

5.2.2.2 Organization and Establishment of Support Facilities

Like any other manufacturing industry Downstream Timber Processing can develop only as fast as its support facilities and services will allow it to grow.

The establishment and effective operations of training facilities for the industry's development needs cannot be over-emphasized. In fact, the industry's capability to grow will depend, to a large extent, on the ability of its key personnel to assimilate the "Know-How" that is recommended to be acquired, as described in the preceding paragraphs. The primary objectives of the recommended training centers should be to provide the trainees with basic woodworking and timber drying knowledge at a desired level to enable them to assimilate effectively the updated techniques to be delivered from imported sources, most possibly by foreign experts and specialists. Annex VI gives a suggested course of study for the industry-oriented timber drying.

Another important support facility vital to a healthy development of the Downstream Timber Processing industry is the establishment of industry service centers which will dispense such common industry services as sawfiling, knife grinding and other cutting tool repair and maintenance activities; and the machine shop services for the repair and maintenance of machinery and equipment. This recommendation is based on the fact that a great majority of the small and medium scale timber processing plants do not have the financial and technical capabilities to establish nor operate such service facilities. Annex VII shows the list of equipment recommended for such repair and maintenance shops which will provide services common to the secondary wood processing industry.

5.2.2.3 Marketing Activities for Secondary Wood Products

A review of existing marketing policies, particularly strategies, product lines and target market areas should be done with a view to providing a foothold in the foreign market for the small and medium scale processing plants. Experience of the secondary wood industries in developed countries indicate that specialization and complementation of manufacturing activities will serve as catalysts for lateral development and symbiotic growth of small and medium size secondary wood processing factories in developing countries. This has been shown in the northern part of Italy, in South Korea and the Province of Taiwan, where satellite (small) workshops fabricate specific components or sub-assemblies which are made as inputs to the larger factories.

5.2.3 Follow-up Activities

The healthy growth of the Downstream Timber Processing industry is better assured by follow-up activities which aim to update the skills and techniques of the industry's current work force. Industry growth is usually characterized by key significant personnel turn-over which develops as the demands for such skills exceed the site at which key industry personnel are adequately trained. Unfortunately, however, effective training for such skilled and key industry personnels is more economically done on a regional level, rather than on an individual plant or localized area basis. Thus, it is recommended that during the more critical period of industry development (more usually the first 5 years of the development programme for wood-based industry) a series of regular training workshops be conducted with a view to updating the following specialized skills, among others, which are immediately needed by the industry:

i. Woodworking Millwrights;
ii. Kiln-Drying Technicians;
iii. Finishing Technicians;

iv. Product Engineering Specialists; and

v. Middle Management and Floor Level Supervisory Personnel.

It is believed that existing training facilities can be upgraded and corresponding course of studies be revised to meet the requirements of a growing industry. Annex VIII is a course of study suggested to train selected high school (Form 4) students in industry-oriented woodworking operations. The course is designed for students who have successfully completed the first and second years in trade school (high school level) and have been found to possess the desire and interest level for woodworking operations.

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UNIDO

ANNEX I

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Asia Pacific Forest Industries Development Group

JOB DESCRIPTION
DU/RAS/86/048/11-57 (J12209)

Title of the post	Consultant in Downstream Processing of Timber
Duration	1 month
Starting Date	As soon as possible
Duty station	Kuala Lumpur with extensive travel within Malaysia Indonesia and Papua New Guinea.

Purpose of the project

Develop further industrial secondary processing of timber products for local and export markets.

Duties

Under the overall guidance of the Project's Team Leader, and in cooperation with its Forest Industries Expert, the Consultant will be expected to:

1. Review the current status of secondary wood processing industries in Malaysia, Indonesia and Papua New Guinea.

2. Identify the investment opportunities and recommend the types of downstream processing best suited for integration into the existing primary forest industries (sawmilling and plywood and veneer production.

3. Review and indicate the suitability and price range of the most relevant equipment which would reduce mill waste and promote the production of value-added products for both the domestic and export markets.

4. Evaluate the productivity and profitability of selected product ranges and volumes, based on the machines selected and putative production costs.

..../..

5. Determine the training needs for the supervisors and managers of plants established using the equipment proposed.

6. Incorporate the above, as well as recommendations addressed to potential industrialists and government bodies, in a technical report.

Qualifications — Engineer or wood technologist with considerable on-the-job experience in secondary processing of timber (downstream from sawmilling). Experience in countries of South East Asia required.

Language — English

Background Information

The United Nations Development Programme (UNDP) has entrusted the Food and Agriculture Organization (FAO) to implement a technical assistance project in the Asian/Pacific Region entitled 'Asia and Pacific Forest Industries Development Group'.

This project has six immediate objectives, among which the following are relevant to this post:

1. To strengthen the capability of national governments to evaluate the industrial development potential of their forest sectors leading to plans for increasing the effectiveness of the structure and operations of the existing forest industry and to the phased overall development of this industry.

2. To improve the managerial efficiency and operational performance of existing forest industries in the period 1987 to 1990 through the training of personnel, the provision of advisory services and the identification of opportunites for reinvestment, with particular reference to the small and medium scale producers.

3 To provide extension advisory services and assistance which is designed to have an impact on the large number of small and medium-sized sawmills. Many of these sawmills are technologically obsolescent and would respond significantly to the introduction of simple improved operational procedures and more efficient low-cost equipment. Simple Demonstration Mills, strategically located, designed to illustrate the above benefits and to act as focal points for industrial extension activities, will be encouraged.

4. To diversify current industrial output through encouraging manufacture of an increased range of secondary and tertiary wood-based products.

In implementing this project FAO have subcontracted to UNIDO the conduction of the project's foreseen activities in the field of developing downstream processing of timber.

ANNEX II

LIST OF GOVERNMENT OFFICIALS
AND INDUSTRY LEADERS INTERVIEWED

Name	Title	Office/Firm Name
PAPUA NEW GUINEA		
M.N. AMIN	Chief Marketing Officer	Department of Forests P.O. Box 5055 Boroko N.C.D.
JIM BELFORD	Managing Director and Secretary	Forest Management Services (PNG) Pty. Ltd. P.O. Box 4037 Boroko, N.C.D. Forest Industries Association of PNG, Port Moresby
PETER J. EDDOWES	Executive Officer-Marketing	Forest Industries Council of Papua New Guinea P.O. Box 1829 Port Moresby
DAVID FAUNT	Manager	SATF Lae Programme So. Pac. Appropriate Technology Foundation
TOM FRY	Production Manager	PNG Forest Products Pty. Ltd. P.O. Box 88 Bulolo
BRIAN KINGSTON	Chief Technical Adviser	FAO Forest Management & Research Project, PNG/86/009 P.O. Box 314, Lae
C. KONABE	Assistant Director	Department of Forests Forest Products Research Br. P.O. Box 314 Lae
JOHN PACAK	Managing Director	JP Consultants P.O. Box 7585 Boroko N.C.D.
GODFREY PERCIVAL	Director & General Manager	PNG Forest Products Pty Ltd. P.O. Box 88 Bulolo
ERWIN WILHELM	Managing Director	Golden Square Pty Ltd. P.O. Box 1589 Boroko Port Moresby
SASA ZIBEKOKINO	Community Forest Officer	Village Equipment Suppliers V.E.S., P.O. Box 2172, Lae

Name	Title	Office/Firm Name
INDONESIA		
ADI WIDJAJA	President Director	P.T. Adi Nusantara Raya Mercia Knock Down Furniture Jalan Rungkut Industri 11/49 Surabaya 60292 P.O. Box 38 Surabaya 60401
J. BAGIO WIDJANARKO	Director	Forest Industries Div. Direksi Perum Perhutani Gedung Manggala Wanabakti Blok IV Lt. 4 Jl. Gatot Subroto, Senayan Jakarta Pusat
DJOKO PRAMONO	Managing Director and Founding President	JATI MURTI Meubel Uki Jl. Pemuda No. 66 A Jepara 59411-Jawa Tengah Koperasi Ukir "Jepara" Jl. K.H. Yasin Jepara Jateng
EDY SASTRODIRAHARDJO	Head, Bureau of Industry	Forest State Corp. Unit II (East Java) Jl. Gentengkali 49 Surab
DAVID HARDIE	Sawmilling Consultant	FAO/GOI Forestry Studies Project Allan View, The Haining, Dunblane, Perthshire. FK15 OAP. Scotland
HARJANTO	Sawmill Manager	PERUM PERHUTANI UNIT II JAWA TIMUR Kesatuan Industri Pengolahan Kayu Jati Gresik Jl. Kapten Darmo Soegondo
JANUAR	Technical Manager	P.T. Adi Nusantara Raya Mercia Knock Down Furniture Jl. Rungkut Industri 11/49 Surabaya 60292 P.O. Box 38 Surabaya 60401
M. DJALAL KAMAL	Director	MACROWOOD Wood & Rattan Furniture Jl. Pulolentut No. 9 Kawasan Industri Pulogadung Jakarta Timur

Name	Title	Office/Firm Name
KUSMANA ARIFIN SUKASYAH	Wood Processing Manager	KIPKJ. Jl. Wonosari, Cepu
VILLY NIELSEN	President/Director	Kingfurn International P.T. 6, Jl. Cimandiri 3rd Flr/ Flat 4, Jakarta Pusat
HLODVER OLAFSSON	Production Manager	Kingfurn International P.T. 6, Jl. Cimandiri 3rd Flr/ Flat 4, Jakarta Pusat
ROEDJAI DJAKARIA	Depala Biro Perencanaan	DEPARTEMEN KEHUTANAN RI Gedung Manggala Wana Bhakti Jl. Gatot Subroto - Senayan Jakarta 10270
SOEDJADI MARTODIWIRJO	Marketing Director	PERUM PERHUTANI (Forest State Corporation) Manggala Wanabakti Bldg. Blok IV, 4th Fl. Jl. Gatot Subroto, Senayan Jakarta Pusat
SOEMARMO ABD. KAHAR	Administrator	PERUM PERHUTANI UNIT II JAWA TIMUR Kesatuan Industri Pengolahan Kayu Jati Gresik Jl. Kapten Darmo Soegondo
SRIWIJANDJONO HARTOSOEDARMO	Wakil Kepala	PERUM PERHUTANI UNIT II Jl. S. Parman No. 151 Semarang
BAMBANG SUNARYO	Export & Production Director	Hadinata Brothers & Co., Pt Ligna Furniture Jl. Re. Martadinata 89 Bandung Jl. Blora 17, Jakarta
TEDDY WIDJAJA SURAWANA V.	Administrator	Kepala KIPKJ Cepu Jl. Wonosari - Batokan PERUM PERHUTANI UNIT I JAWA TENGAH Kesatuan Industri Pengolahan Kayu Jati

Name	Title	Office/Firm Name
MOCH. TOHA. M.B.	Director	Departemen Kehutanan Directorat Jenderal Pengusaha Hutan Direktorat Pemanfaatan Hasil Hutan Gedung Manggala Wana Bakti Jl. Gatot Subroto Blok 1-Lt.11 Tes. 381 - Jakarta
MALAYSIA		
KHONG LYE FONG	Marketing Division	LEMBAGA PERINDUSTRIAN KAYU MALAYSIA The Malaysian Timber Industry Board 5th & 6th Flr, Wisma DNP Jl. Ampang 50450 Kuala Lumpur
LEW WING HING	Director	ASEAN TIMBER TECHNOLOGY CENTER 4th Flr., Wisma DNP Jl. Ampang, P.O. Box 1088 50728 Kuala Lumpur
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LOW CHEE HOCK	Director & Manager	AIKBEE TIMBERS SDN. BHD. K. Lumpur Head Office: Batu 6½ Jalan Kepong 52000 Kuala Lumpur
MEGAT ADLAN BIN MEGAT SAID	Managing Director	Selangor Industrial Corporation Sendirian Berhad Grnd. Flr, PKNS, Persiaran Barat, Off Jalan Barat, 46505 Petaling Jaya
SIMON ONG	Executive Director	ONG JUK SOO SDN. BHD. Batu 3-1/3, Jl. Kapar Rantau Panjang 42100 Klang Selangor Darul Ehsan

Name	Title	Office/Firm Name
OSCAR PAMIO	Design Consultant	Italy-Malaysia Cooperation Programme LEMBAGA PERINDUSTRIAN KAYU The Malaysian Timber Industry Board 5th & 6th Flr Wisma DNP J.1. Ampang, 50450, Kuala Lumpur
SER CHENG-SAM	Head-Technology	ASEAN TIMBER TECHNOLOGY CENTRE 1st Flr, Wisma DNP, Jl. Ampang, P.O. Box 10887 50728 Kuala Lumpur
TEO ENG SENG	Production Manager	PERANGSANG DELIMA SENDIRIAN BERHAD Pandamaran Industrial Estate, P.O. Box 201, 42009 Port Klang Selangor
JOSEPH TURBANG	Former FAO Regional Forestry Officer for Asia-Pacific and MTIB Consultant	52 Rue Houte 6712 Toernich, Belgium
WONG T.M.	Director	Technical Division Forest Research Institute Kepong, Kuala Lumpur
WOO CHARK KUM	Proprietor	SYT. WOO WAI KEE Furniture Manufacturer, Rubberwood Sawmiller/Exporter Batu 8, P.O. Box 8, 43207 Cheras, Selangor Darul Ehsan
ZULKEFLI HARON	Act. Assistant (Technical Division)	LEMBAGA PERINDUSTRIAN KAYU MALAYSIA The Malaysian Timber Industry Board 5 & 6 Flr, Wisma DNP P.O. Box 10887, Jl. Ampang 50728 Kuala Lumpur

ANNEX III

DEVELOPMENT SCHEME FOR DOWNSTREAM TIMBER PROCESSING IN DEVELOPING COUNTRIES WITH SMALL AND FRAGMENTED SAWMILLING INDUSTRY AND A SMALL DOMESTIC MARKET

I- GENERAL CONSIDERATIONS

The development scheme and schedule of activities in the following sections are presented with a view to help serve as guidelines in the formulation of a national programme for the development of the secondary and tertiary woodworking industries. The take-off point is, more or less, the present situation in a developing country in the Asia-Pacific Region, which has the following characteristics:

i. Timber surplus situation where the current available forest timber resources and annual cut are in excess of the domestic timber requirements of the country and can still support additional processing capacities;

ii. The population density is very low (less than one person per ten hectares);

iii. The sawmilling industry is not significantly developed and sawmilling factories are widely scattered throughout the country;

iv. The secondary wood processing industry is barely recognizable as a significant economic sector and is concentrated in the principal urban centers of the country; and

v. The technological level in the country, particularly in the mechanical wood processing) industry, as a whole, has barely passed the semi-mechanized stage of development. Existing fully mechanized woodworking factories are either subsidiaries of trans-national corporations or are being managed and operated by expatriates.

The immediate concern of the country to attain a more desirable pace of development of its woodworking industries, therefore, is to:

a) be able to attract foreign investors to bring the financial and technology requirements of the industry development programme; and

b) train adequate numbers of qualified native talent, in various technical skills which will sufficiently prepare them to ASSIMILATE the various disciplines of "industrial know-how" to be transferred by expatriates under the development programme.

II- PRIMARY OBJECTIVE

The principal objective of this scheme is to prepare the available resources of the country for a RATIONAL development of its secondary (and tertiary) wood processing industry with a view to attaining the desired target level of industrial scale of operations within the shortest possible time and with minimum wastage of its timber and manpower resources, resulting in a more significant participation of the secondary/tertiary wood processing industries in the national economy.

III- SCHEME OF DEVELOPMENT ACTIVITIES

(Note: All time considerations are referred to the day the developing country decided to engage in more vigorous, possibly export-oriented, secondary/tertiary wood processing activities.

Year	Proposed General Activities
1st	a) Formulation and adoption of a rational development programme for the secondary/tertiary mechanical wood processing industry, aiming at significantly increased Downstream Timber Processing activities by the small and medium size sawmillers to attain the desired development pace;
	b) Assessment and evaluation of available information on both the domestic and foreign markets for wood products and formulation of marketing strategies & procedures;
	c) Assessment and evaluation of available skilled and highly skilled manpower and the currently operating training institutions for the secondary wood processing industry.
2nd	a) Enactment of legislations and adoption of rules and regulations that will provide a desirable atmosphere for foreign investors to participate in the industry's development programme;
	b) Enactment of legislations and adoption of rules and regulations which will encourage the small and medium size sawmillers to engage in Downstream Timber Processing;
	c) Initiate activities to train qualified local talents to become "technically prepared" to assimilate the "imported industrial know-how" as called for by the industry development programme;
	d) Start construction of the infrastructural needs of the development programme;

Year		Proposed General Activities
	e)	Start promotional activities to attract foreign and local investors to invest in the DTP industry of the country.
3rd	a)	Completion of about 50% of the infrastructural needs of the development programme;
	b)	Creation and start of operations of government agencies that will be responsible for the implementation of the industrial elements of the development programme;
	c)	Continue promotional activities to attract foreign and local investors to invest in the Downstream Timber Processing industry of the country;
	d)	Start of factory construction activities by the industry sector;
	e)	Continuation of training activities for the key personnel requirements of the industry.
4th	a)	Completion of infrastructural needs of the development programme;
	b)	Review and up-dating of marketing strategies and procedures;
	c)	Start of operations during the latter part of the year of about 10% (by output volume capacity) of the total targeted volume of Downstream Timber Processing facilities;
	d)	Continuation of training activities for key personnel of the industry;
	e)	Review and up-dating of existing legislations and corresponding rules and regulations to help accelerate development of Downstream Timber Processing (DTP) industries.
5th	a)	Continued operations of existing DTP plants and start of operations of another 20% of the total targeted volume of DTP capacity;
	b)	Continuation of promotional activities to attract foreign and local investors to invest in the DTP industry of the country;
	c)	Continuation of training activities for the key personnel of the industry;
	d)	Assessment of achievements of various aspects of the industry development plans; and up-dating wherever necessary.
6th	a)	Continued operations of existing DTP plants and start of operations of another 20% of the total Targeted volume of DTP capacity;
	b)	Continuation of promotional activities to attract foreign and local investors to invest in the growing DTP industry of the country;

Year	Proposed General Activities
	c) Continuation of training activities for key personnel of the industry;
	d) Review and up-dating of product line for the developing industry, study of other potential markets for the industry's output; and
	e) Annual assessment of achievements of various aspects of the industry's development plans and activities; and up-dating wherever necessary.
7th	a) Assessment of existing industrial infrastructures, their ability to support development programme, and revitalization of existing facilities (road & bridge, networks, ports & harbors, etc.) to enable them to effectively support the increased needs of the wood processing industry vis-a-vis other growing industries of the nation's economic structure;
	b) Continued operations of existing DTP plants and start of operations of another 25% of the total targeted volume of DTP capacity;
	c) Continuation of training activities for key personnel of the industry;
	d) Continuation of promotional activities to attract foreign and local investors to invest in the growing DTP industry of the country;
	e) Annual assessment of achievements of various aspects of the industry's development plans and activities; and up-dating wherever necessary.
8th	a) Continued operations of existing DTP plants and start of operations of the last 25% of the total targeted volume of DTP capacity;
	b) Continuation of training activities for key personnel of the industry;
	c) Annual assessment of achievements of various aspects of the industry's development plans and activities; and up-dating wherever necessary.
9th	a) Assessment of operations of all DTP units participating in the development programme; up-dating of rules and regulations to help assure continued profitable operations of the industry;
	b) Assessment and up-dating of existing training plans and activities for key personnel of the industry;
	c) Assessment of marketing strategies and activities, up-dating wherever necessary;
	d) Formulation and adoption of programme of annual activities relevant to the monitoring and control of the industry's operations.

IV- GUIDELINES FOR SMALL AND MEDIUM SCALE SAWMILLERS WISHING TO ENGAGE IN DTP ACTIVITIES

The scheme of activities presented below will serve as guidelines for the small and medium scale sawmiller in his efforts to plan his moves related to engaging in DTP. The activities are presented in the order of priority based on local conditions of the existing wood processing industry, and the industrial constraints commonly encountered in developing countries by the secondary wood processing industry.

Project Phase	Principal Activities
A. Planning Stage	1. Assessment of resources, both internal and external to the sawmilling firms: raw materials, manpower, land, industrial facilities and infrastructure, financial, etc. available to the sawmiller.
	2. Inquiry into markets and products lines for secondary (or tertiary) wood processing operations.
	3. Seek advice (from government or private sector agencies) on the proper choice of secondary/tertiary products and their corresponding markets, both domestic and foreign, for the products and the resulting by-products/residues generated by the DTP operations; and the skill levels of manpower required by the manufacturing process.
	4. Decide on the type and volume of product s to be manufactured, and the target market for the product(s).
	5. Decide whether to avail of financial, marketing and/or technical assistance from foreign sources, and survey interested parties (through government or private sources).
B. Pre-Operating Stage	1. Make final arrangements on manner of co-operation with selected foreign partner(s)& select factory site.
	The following activities may be conducted with the assistance of the foreign partner(s).

Project Phase	Principal Activities
	2. Prepare Project Feasibility Study, if required for financing arrangements.
	3. Select machinery and equipment for the manufacture of the chosen product at desired output volumes.
	4. Develop machinery/equipment lay-out plans and determine size and types of buildings and structures needed by the contemplated manufacturing operations, based on sequence of operations for the target products.
	5. Based on final machinery/equipment lay-out, design buildings and structures.
	6. Acquire machinery/equipment complement, through importation or local purchase.
	7. Construct buildings and structures and set up internal infrastructures (power, water, air, steam etc. lines).
	8. Select and train key factory personnel, seeking assistance of foreign partner, if necessary and possible.
	9. Install and test run all machinery/ equipment, with the assistance of foreign technicians (to be provided by foreign partner, if agreed upon).
C. Operations Stage	
1st Year	1. Operate at no more than 50% of rated capacity during 1st year of operation.
	2. Assess materials, manpower and financial needs for the succeeding phases of operations and arrange for the availability of such resources at the time they are needed.
	3. Start marketing activities.
	4. Continue training personnel for key positions in the operations set up.
2nd Year	1. Assess manufacturing and marketing performance during the previous year and correspondingly adjust operations plans for the 2nd year of operations.
	2. Operate at about 75% of rated capacity during 2nd year of operations.

Project Phase	Principal Activities
	3. Provide resource needs for the second stage of operations.
	4. Continue training personnel for key positions in the operations and management structures.
	5. Develop and install formally, the following management systems; i. Production management; ii. Quality control; and iii. Information and Documentation of Operations Monitoring Parameters.
3rd Year	1. Assess manufacturing and marketing performance during the previous year and correspondingly adjust operations plans for the 3rd year of operations.
	2. Operate at maximum operations level (100% of rated capacity if attainable).
	3. Provide resource needs for the third stage of operations.
	4. Continue training personnel for key positions in the operations and management set-up to meet manpower turn-over problems.
	5. Develop and install the following systems: i. Inventory Control and Materials Management; ii. Cost Control; and iii. Product Development and Engineering.
4th Year and On	1. Assess over-all project performance during preceding years and correspondingly adjust operations plans for the 4th and succeeding years.
	2. Evaluate turn-over rate of key project personnel and correspondingly adjust training programme.
	3. Explore possibility of or need for, product diversification and adjust operations plans for succeeding years based or such decision.

ANNEX IV

DEVELOPMENT SCHEME FOR DOWNSTREAM TIMBER PROCESSING IN DEVELOPING COUNTRIES WITH FRAGMENTED SAWMILLING AND SECONDARY WOOD PROCESSING INDUSTRIES AND A SMALL DOMESTIC MARKET

I- GENERAL CONSIDERATIONS

The development scheme and schedule of activities in the following sections are presented with a view to helping serve as guidelines in the formulation of a national programme for the development of the secondary and tertiary woodworking industries. The take-off point is, more or less, the present situation in a developing country in the Asia-Pacific Region, which has the following characteristics:

i. Available forest timber resources and annual cut are in excess of the domestic timber requirements of the country and can still support additional processing facilities;

ii. The population density is low (about 0.5 person per hectare) and the domestic market is small;

iii. The sawmilling industry is appreciably developed, but sawmilling factories are widely scattered throughout the country;

iv. The secondary wood processing industry is a significant contributor to the economy of the country but it is highly fragmented, its growth is still considered too slow by the government;

v. The secondary wood processing industry, as a whole, has attained a marked degree of mechanization but a low level of automation. Only a few furniture/joinery factories are comparable to their counterparts in advanced countries of the West; and

vi. The developing country has ample major non-wood material resources which can support the growth of other industries within the country.

The immediate concern of the country to attain a faster rate of development of its woodworking industries, is to:

a) be able to acquire more modern and higher volume output technologies for its woodworking industry; and

b) train adequate numbers of qualified native talent in various technical skills which will sufficiently prepare them to ASSIMILATE the new technical know-how to be introduced under the development programme.

II- PRIMARY OBJECTIVE

The principal objective of this scheme is to prepare the available resources of the country for a RATIONAL development of its secondary (and tertiary) wood processing industry with a view to attaining the desired target level of industrial scale of operations within the shortest possible time and with minimum wastage of its timber and manpower resources, resulting to a more significant participation of the secondary/tertiary wood processing industries in the national economy.

III- SCHEME OF DEVELOPMENT ACTIVITIES

(Note: All time considerations are referred to the day the developing country decided to engage in more vigorous, possibly export-oriented, secondary/tertiary wood processing activities.)

Year	Proposed General Activities
1st	a) Formulation and adoption of a rational development programme for the secondary/tertiary mechanical wood processing industry, aiming at significantly increased Downstream Timber Processing activities by the small and medium size sawmillers to attain the desired development pace;
	b) Up-dating of market information on secondary/tertiary wood products, and formulation of new marketing strategies and policies to meet the needs of the industry development programme;
	c) Up-dating of existing manpower training facilities and teaching staff, to make them industry-oriented and more responsive to the changing needs of the wood processing industry;
	d) Enactment of legislations and adoption of rules and regulations that will provide a desirable atmosphere for foreign investors to participate in the industry development programme;
	e) Enactment of legislations and adoption of rules and regulations which will encourage the small and medium size sawmillers to engage in Downstream Timber Processing;
2nd	a) Continue manpower training activities to develop sufficiently trained labour to assimilate the new manufacturing and management techniques as called for by the industry development programme;

Year	Proposed General Activities
	b) Up-dating of infrastructural needs of the development programme;
	c) Promotional activities to attract foreign investors and more modern woodworking technology;
	d) Start construction of additional manufacturing facilities.
3rd	a) Start of operations of new addtional manufacturing facilities to attain at least 40% of targeted total industry capacity;
	b) Continue manpower training activities to develop sufficiently trained labour to assimilate the new manufacturing and management techniques as called for by the industry development programme;
	c) Continue infrastructural build-up to meet requirements of growing industry (together with other industrial sectors of the economy);
	d) Promotional activities to attract foreign investors and more modern woodworking technology;
	e) Assessment of achievements of various aspects of the industry development plans; and up-dating wherever necessary.
4th	a) Start of operations of new additional manufacturing facilities to increase total capacity to about 60% of targeted total industry capacity;
	b) Continue manpower training activities to develop sufficiently trained labour to assimilate the new manufacturing and management techniques as called for by the industry development programme;
	c) Continue infrastructural build-up to meet requirements of growing industry (together with other industrial sectors of the economy);
	d) Promotional activities to attract foreign investors and more modern woodworking technology;
	e) Assessment of achievements of various aspects of the industry development plans; and up-dating wherever necessary.
5th	a) Start of operations of new additonal manufacturing facilities to about 80% of targeted total industry capacity;
	b) Continue manpower training activities to develop surficiently trained labour to assimilate the new manufacturing and management techniques as called for by the industry development programme;
	c) Continue infrastructural build-up to meet requirements of growing industry (together with other industrial sectors of the economy);

Year	Proposed General Activities
	d) Promotional activities to attract foreign investors and more modern woodworking technology;
	e) Assessment of achievements of various aspects of the industry development plans; and up-dating wherever necessary.
6th	a) Start of operations of new additional manufacturing facilities to full targeted capacity;
	b) Continue manpower training activities to develop sufficiently trained labour to assimilate the new manufacturing and management techniques as called for by the industry development programme;
	c) Continue infrastructural build-up to meet requirements of growing industry (together with other industrial sectors of the economy);
	d) Promotional activities to attract foreign investors and more modern woodworking technology;
	e) Assessment of achievements of various aspects of the industry development plans; up-dating wherever necessary.
7th	a) Assessment of operations of all DTP units participating in the development programme; up-dating of rules and regulations to help assure continued profitable operations of the industry;
	b) Assessment and up-dating of existing training plans and activities for key personnel of the industry;
	c) Assessment of marketing strategies and activities, up-dating wherever necessary;
	d) Formulation and adoption of programme of annual activities relevant to the monitoring and control of the industry's operations.

IV- GUIDELINES FOR SMALL AND MEDIUM SCALE SAWMILLERS WISHING TO ENGAGE IN DTP ACTIVITIES

The scheme of activities presented below will serve as guidelines for the small and medium scale sawmiller in his efforts to plan his moves related to engaging in DTP. The activities are presented in the order of priority based on local conditions of the existing wood processing industry, and the industrial constraints commonly encountered in developing countries by the secondary wood processing industry.

Project Phase	Principal Activities
A. Planning Stage	1. Assessment of resources, both internal and external to the sawmilling firms: raw materials, manpower, land, industrial facilities and infrastructure, financial, etc. available to the sawmiller.
	2. Inquiry into markets and product lines for secondary (or tertiary) wood processing operations.
	3. Seek advice (from government or private sector agencies) on the proper choice of secondary/tertiary products and their corresponding markets, both domestic and foreign, for the products and the resulting by-products/residues generated by the DTP operations; and the skill levels of manpower required by the manufacturing process.
	4. Decide on the type and volume of product(s) to be manufactured, and the target market for the product(s).
	5. Decide whether to avail of financial, marketing and/or technical assistance from foreign sources, and survey interested parties (through government or private sources).
B. Pre-Operating Stage	1. Make final arrangements on manner of co-operation with selected foreign partner(s) & select factory site.
	The following activities may be conducted with the assistance of the foreign partner(s):
	2. Prepare Project Feasibility Study, if required for financing arrangements.
	3. Select machinery and equipment for the manufacture of the chosen product at the desired output volumes.
	4. Develop machinery/equipment lay-out plans and determine size and types of buildings and structures needed by the contemplated manufacturing operations, based on sequence of operations for the target products.
	5. Based on final machinery/equipment lay-out, design buildings and structures.

Project Phase	Principal Activities
	6. Acquire machinery/equipment complement, through importation or local purchase.
	7. Construct buildings and structures and set up internal infrastructures (power, water, air, steam, etc. lines).
	8. Select and train key factory personnel, seeking assistance of foreign partner, if necessary and possible.
	9. Install and test run all machinery/ equipment, with the assistance of foreign technicians (to be provided by foreign partner, if agreed upon).
C. Operations Stage	
1st Year	1. Operate at no more than 50% of rated capacity during 1st year of operations.
	2. Assess materials, manpower and financial needs for the succeeding phases of operations and arrange for the availability of such resources at the time they are needed.
	3. Start marketing activities.
	4. Continue training personnel for key positions in the operations set up.
2nd Year	1. Assess manufacturing and marketing performance during previous year and correspondingly adjust operations plans for the 2nd year of operations.
	2. Operate at about 75% of rated capacity during 2nd year of operations.
	3. Provide resource needs for the second stage of operations.
	4. Continue traininy personnel for key positions in the operations and management structures.
	5. Develop and install formally, the following management systems; i. Production management; ii. Quality control; and iii. Information and Documentation of Operations Monitoring Parameters.

Project Phase	Principal Activities
3rd Year	1. Assess manufacturing and marketing performance during previous year and correspondingly adjust operations plans for the 3rd year of operations. 2. Operate at maximum operations level (100% of rated capacity if attainable). 3. Provide resource needs for the third stage of operations. 4. Continue training personnel for key positions in the operations and management set-up to meet manpower turn-over problems. 5. Develop and install the following systems: i. Inventory Control and Materials Management; ii. Cost Control; and iii. Product Development and Engineering.
4th Year and On	1. Assess over-all project performance during preceding years and correspondingly adjust operations plans for the 4th and succeeding years. 2. Evaluate turn-over rate of key project personnel and correspondingly adjust training programme. 3. Explore possibility of or need for, product diversification and adjust operations plans for succeeding years based or such decision.

ANNEX V

DEVELOPMENT SCHEME FOR DOWNSTREAM TIMBER PROCESSING IN DEVELOPING COUNTRIES WITH A LARGE DOMESTIC MARKET AND WELL DEVELOPED SAWMILLING INDUSTRY BUT FRAGMENTED SECONDARY WOOD PROCESSING INDUSTRY

I- GENERAL CONSIDERATIONS

The development scheme and schedule of activities in the following sections are presented with a view to helping serve as guidelines in the formulation of a national programme for the development of the secondary and tertiary woodworking industries. The take-off point is, more or less, the present situation in a developing country in the Asia-Pacific Region, which has the following characteristics:

i. Timber surplus situation, where available forest timber resources and annual cut are in excess of the domestic timber requirements of the country and can still support additional processing facilities;

ii. Although the country's population density is about 1 person per hectare, there are several islands which have very high population densities ranging from 2-6 persons per hectare; thus assuring a large domestic market for wood products;

iii. The sawmilling industry is markedly developed, but sawmills are still widely scattered throughout the country. However, a number of these mills have engaged in limited forms of DTP, principally the manufacture and export of pre-cut K.D. lumber pieces for furniture/joinery product components;

iv. The secondary wood processing industry is also markedly developed and is a significant contributor to the country's economy. Some furniture manufacturers have engaged in UPSTREAM Timber Processing (Backwards Integration to include kiln-drying and sawmilling operations) in order to assure themselves of a continous supply of a desirable quantity of properly seasoned sawn timber. However, the industry is still highly fragmented and its growth rate is still considered to be slow.

v. A sizable amount of the industry's output and 100% of its exports is contributed by a number of furniture/joinery porducts manufacturing plants which have attained a high degree of mechanization and conveyorization, but still a low degree of automation;

vi. The developing country has ample major non-wood material resources (petroleum, coconut, etc.) which can support the growth of other industries within the country.

The immediate concern of the country to attain a faster rate of development of its woodworking industries, is to:

a) be able to acquire more modern and higher volume output technologies for its woodworking industry;

b) train adequate numbers of qualified native talents in various technical skills which will sufficiently prepare them to ASSIMILATE the new technical know-how to be introduced under the development programme; and

c) attain an effective degree of specialization and complementation within the secondary wood processing industry, based on mutually profitable arrangements with the small and medium scale sawmillers in the country.

II- PRIMARY OBJECTIVE

The principal objective of this scheme is to prepare the available resources of the country for a RATIONAL development of its secondary (and tertiary) wood processing industry with a view to attaining the desired target level of industrial scale of operations within the shortest possible time and with minimum wastage of its timber and manpower resources, resulting to a more significant participation of the secondary/tertiary wood processing industries in the national economy.

III- SCHEME OF DEVELOPMENT ACTIVITIES

(Note: All time considerations are referred to the day the developing country decided to engage in more vigorous, possibly export-oriented, secondary/tertiary wood processing activities.

Year	Proposed General Activities
1st	a) Formulation and adoption of a rational development programme for the secondary/tertiary wood processing (mechanical) industry, aiming at significantly increased Downstream Timber Processing activities by the small and medium size sawmillers to attain the desired development pace;
	b) Up-dating of market information on secondary/tertiary wood products, and formulation of new marketing strategies and policies to meet the needs of the industry development programme;

Year	Proposed General Activities
	c) Up-dating of existing manpower training facilities and teaching staff, to make them industry-oriented and more responsive to the changing needs of the wood processing industry;
	d) Enactment of legislation and adoption of rules and regulations that will provide a desirable atmosphere for foreign investors to participate in the industry development programme;
	e) Enactment of legislation and adoption of rules and regulations which will encourage the small and medium size sawmillers to engage in Downstream Timber Processing;
2nd	a) Continue manpower training activities to develop sufficiently trained labour to assimilate the new manufacturing and management techniques as called for by the industry development programme;
	b) Up-dating of infrastructural needs of the development programme;
	c) Promotional activities to attract foreign investors and more modern woodworking technology;
	d) Start construction of additonal manufacturing facilities.
3rd	a) Start of operations of new additional manufacturing facilities to attain at least 50% of targeted total industry capacity;
	b) Continue manpower training activities to develop sufficiently trained labour to assimilate the new manufacturing and management techniques as called for by the industry development programme;
	c) Continue infrastructural build-up to meet requirements of growing industry (together with other industrial sectors of the economy);
	d) Promotional activities to attract foreign investors and more modern woodworking technology;
	e) Assessment of achievements of various aspects of the industry development plans; and up-dating wherever necessary.
4th	a) Start of operations of new additional facilities to increase total capacity to about 75% of targeted total industry capacity;
	b) Continue manpower training activities to develop sufficiently trained labour to assimilate the new manufacturing and management techniques as called for by the industry development programme;
	c) Continue infrastructural build-up to meet requirements of growing industry (together with other industrial sectors of the economy);

Year	Proposed General Activities
	d) Promotional activities to attract foreign investors and more modern woodworking technology;
	e) Assessment of achievements of various aspects of the industry development plans; and up-dating wherever necessary.
5th	a) Start of operations of new additonal facilities to increase total capacity to full targeted total industry capacity;
	b) Continue manpower training activities to develop sufficiently trained labour to assimilate the new manufacturing and management techniques as called for by the industry development programme;
	c) Continue infrastructural build-up to meet requirements of growing industry (together with other industrial sectors of the economy);
	d) Conduct promotional activities to attract foreign investors and more modern woodworking technology;
	e) Assessment of achievements of various aspects of the industry development plans; and up-dating wherever necessary.
6th	a) Assessment of operations of all DTP units participating in the development programme; up-dating of rules and regulations to help assure continued profitable operations of the industry;
	b) Assessment and up-dating of existing training plans and activities for key personnel of the industry;
	c) Assessment of marketing strategies and activities, up-dating wherever necessary;
	d) Formulation and adoption of programme of annual activities relevant to the monitoring and control of the industry's operations.

IV- GUIDELINES FOR SMALL AND MEDIUM SCALE SAWMILLERS WISHING TO ENGAGE IN DTP ACTIVITIES

The scheme of activities presented below will serve as guidelines for the small and medium scale sawmiller in his efforts to plan his moves related to engaging in DTP. The activities are presented in the order of priority based on local conditions of the existing wood processing industry, and the industrial constraints commonly encountered in developing countries by the secondary wood processing industry.

Project Phase	Principal Activities
A. Planning Stage	1. Assessment of resources, both internal and external to the sawmilling firms: raw materials, manpower, land, industrial facilities and infrastructure, financial, etc. available to the sawmiller.
	2. Inquiry into markets and product lines for secondary (or tertiary) wood processing operations.
	3. Seek advice (from government or private sector agencies) on the proper choice of secondary/tertiary products and their corresponding markets, both domestic and foreign, for the products and the resulting by-products/residues generated by the DTP operations; and the skill levels of manpower required by the manufacturing process.
	4. Decide on the type and volume of product(s) to be manufactured, and the target market for the product(s).
	5. Decide whether to avail of financial, marketing and/or technical assistance from foreign sources, and survey interested parties (through government or private sources).
B. Pre-Operating Stage	1. Make final arrangements on manner of co-operation with selected foreign partner(s) & select factory site.
	The following activities may be conducted with the assistance of the foreign partner(s).
	2. Prepare Project Feasibility Study, if required for financing arrangements.
	3. Select machinery and equipment for the manufacture of the chosen product at the desired output volumes.
	4. Develop machinery/equipment lay-out plans and determine size and types of buildings and structures needed by the contemplated manufacturing operations, based on sequence of operations for the target products.

Project Phase	Principal Activities
	5. Based on final machinery/equipment lay-out, design buildings and structures.
	6. Acquire machinery/equipment complement, through importation or local purchase.
	7. Construct buildings and structures and set up internal infrastructures (power, water, air, steam, etc. lines).
	8. Select and train key factory personnel, seeking assistance of foreign partner, if necessary and possible.
	9. Install and test run all machinery/ equipment, with the assistance of foreign technicians (to be provided by foreign partner, if agreed upon).
C. Operations Stage	
1st Year	1. Operate at no more than 50% of rated capacity during 1st year of operations.
	2. Assess materials, manpower and financial needs for the succeeding phases of operations and arrange for the availability of such resources at the time they are needed.
	3. Start marketing activities.
	4. Continue training personnel for key positions in the operations set up.
2nd Year	1. Assess manufacturing and marketing performance during previous year and correspondingly adjust operations plans for the 2nd year of operations.
	2. Operate at about 75% of rated capacity during 2nd year of operations.
	3. Provide resource needs for the second stage of operations.
	4. Continue training personnel for key positions in the operations and management structures.
	5. Develop and install formally, the following management systems; i. Production management; ii. Quality control; and iii. Information and Documentation of Operations Monitoring Parameters.

Project Phase	Principal Activities
3rd Year	1. Assess manufacturing and marketing performance during previous year and correspondingly adjust operations plans for the 3rd year of operations. 2. Operate at maximum operations level (100% of rated capacity if attainable). 3. Provide resource needs for the third stage of operations. 4. Continue training personnel for key positions in the operations and management set-up to meet manpower turn-over problems. 5. Develop and install the following systems: i. Inventory Control and Materials Management; ii. Cost Control; and iii. Product Development and Engineering.
4th Year and On	1. Assess over-all project performance during preceding years and correspondingly adjust operations plans for the 4th and succeeding years. 2. Evaluate turn-over rate of key project personnel and correspondingly adjust training programme. 3. Explore possibility of or need for, product diversification and adjust operations plans for succeeding years based or such decision.

ANNEX VI

INDUSTRIAL KILN-DRYING COURSE

The general objective of the technical course described below is to train and help develop Kiln-Drying Technicians equipped with the following knowledge and skills:

i. Mechanics of Extracting Moisture from Wood, at Commercial Scale;
ii. Design of Kiln-Drying Schedules;
iii. Laboratory Oven Drying Techniques for Measuring Moisture Content of Wood;
iv. Familiarization with currently available commercial types of wood drying equipment;
v. Operation & Maintenance of the Conventional Type of Hot-Air Kiln-Drier;
vi. Operation and Maintenance of Dehumidifier Type of Drier; and
vii. Train Kiln-Drier Operators to Assist in Over-All Lumber Seasoning Activities on Industrial Scale Levels.

The course has been designed for trainees with adequate knowledge of algebra and physics (college level, for K.D. Technicians; or high school level for K.D. Operators).

Kiln-Drying Technicians are required to take the full 450 hrs. course, as described in the paragraphs below.

The same course may be adapted for training kiln-operators by taking-up an abbreviated version (276 hrs.) of the course, i.e., without the following topics: I-D; I-E; I-F; and II-E.

I- ACADEMIC/LECTURE COMPONENT ---------- (54 Hrs.)

A- WOOD STRUCTURE AND MOISTURE CONTENT ---------- (8 Hrs.)

- Cellular Structure of Wood
- Free Water and Cellular Water
- Method of Wood Growth
- "Juvenile Wood" and "Tension Wood"
- General Composition of Wood
- Wood Drying Process & Moisture Transfer

- Dimensional Changes in Wood During Drying Process
- Moisture Content (MC) of Wood and Equilibrium Moisture Content (EMC)
- Wood Shrinkage, Types and Calculation
- Collapse

B- MEASURING MOISTURE CONTENT ---------- (6 Hrs.)

- Review of Basic Arithmetic and Algebraic Operations
- The Oven Sample Method
- Use of Sample Boards
- Moisture Meters, Types and Limitations in Use
- Temperature & Wood Species Corrections on Moisture Meter Readings

C- PHYSICAL LAWS APPLIED TO TIMBER DRYING ---------- (10 Hrs.)

- Heat, Temperature and Heat Transfer in Kiln-Drying
- Drying & Cooling in Evaporation Process
- Drying Parameters: Relative Humidity, Wet Bulb Depression and E.M.C.
- Measurement of Heat and Humidity in Kiln-Drying Chambers
- Automatic Controls in Kiln Operations: Vents Opening/ Closing, Pressure (Steam) Control; Fan Reversal; Time/ Temperature Schedules
- E.M.C. Chart and Its Use in Kiln-Drying

D- CONDITIONING AND EQUALIZING KILN-DRIED TIMBER ----- (12 Hrs.)

- Case Hardening and Tests
- Internal Stresses Developed During Drying Process
- Moisture Gradient in K.D. Timber and Joint Failures

E- SPECIFIC DRYING CONSTRAINTS ---------- (6 Hrs.)

- Drying Boards with Different Thicknesses in the Same Kiln Charge
- Drying Boards of Different Timber Species in the Same Kiln Charge
- Drying Timber with Thicknesses Greater than 50 mm.

F- TYPES AND USE OF DRIERS AVAILABLE FOR COMMERCIAL SCALE TIMBER DRYING OPERATIONS ---------- (12 Hrs.)

- Hot Air, Steam-Heated
- Hot Water Heated
- Hot Air, Flue Gas Heated
- Dehumidifiers
- Vacuum Driers
- Solar Driers

II- PRACTICUM ---------- (346 Hrs.)

A- PREPARATION & HANDLING OF SAMPLE BOARDS --------- (8 Hrs.)

- Choice of Material
- Technique of Cutting Sample Board
- End Grain Sealing
- Locating and Identifying Sample Boards in Lumber Box Pile
- Frequency of Checking Sample Boards and Parallel Oven Dry Tests
- Cutting For Case-Hardening Test

B- PREPARATION OF KILN CHARGE ---------- (40 Hrs.)

- Effective Lumber Box-Piling & Stickering Practices
- Locating Spaces for Sample Boards
- Air-Drying Preparatory to Kiln-Drying
- Air-Drying Yard Design
- Protection Against Excessive End Grain Evaporation

C- KILN-DRYING SCHEDULES ---------- (16 Hrs.)

- Nomenclature & Parameters
- Recognizing the Basic Stages in Kiln-Drying Operations, Their Functions & Objectives
- The Psychrometric Chart and Its Use in Kiln-Drying Operations
- Calculations of Moisture Content (MC) and Determination of Equilibrium Moisture Content (EMC)
- Equalizing and Conditioning Techniques

D- KILN-DRYING OPERATIONS, GENERAL ASPECTS --------- (138 Hrs.)

- Loading Kiln-Charge and Kiln Plenum
- Recording Instruments & Kiln Record-Keeping
- Critical Points, Transition to Next Drying Stage
- Kiln Operations in Hot-Air Type of Drier
- Operation of Dehumidifier Type of Drier
- Power Outage, Emergency Measures
- Identification and Minimization of Kiln-Drying Degrades

E- KILN-DRYING TECHNIQUES AND SCHEDULES FOR ABNORMAL KILN CHARGES ---------- (144 Hrs.)

- Kiln Charge Composed of Mixed Thickness: 25 mm, 18 mm & 12 mm
- Kiln Charge Composed of Mixed Thicknesses: 31 mm, 38 mm, 44 mm & 50 mm
- Kiln Charge Composed of a Mixture of Two or More Timber Species

III- CARE AND MAINTENANCE OF KILN-DRYING EQUIPMENT -------- (50 Hrs.)

A- COMMON KILN PROBLEMS AND TROUBLE SHOOTING -------- (10 Hrs.)

- Maintenance of Kiln Building
- Kiln Doors
- Air Vents
- Kiln Drainage
- General Housekeeping

B- PROPER CARE AND MAINTENANCE OF KILN EQUIPMENT MECHANICAL ---------- (28 Hrs.)

- Motors
- Lubrication Programme
- Recorders-Controllers
- Water/Steam Spray System
- Air Compressor
- Condensate Traps/Strainers
- Calibration of Recording Devices

C- SAFETY IN KILN-DRYING OPERATIONS ---------- (12 Hrs.)

- Steam/Flue Gas Leaks
- Faulty Box-Piling
- Defective Kiln Trucks
- Electrical Short-Circuits
- Man-Made Hazards

ANNEX VII

MACHINERY/EQUIPMENT LIST FOR
WOODWORKING INDUSTRY COMMON SERVICES CENTER
REPAIR AND MAINTENANCE SHOP

No. of Units *	MACHINE DESCRIPTION	ESTIMATED COST, 1989**
A - CUTTING TOOLS MAINTENANCE		
1	STRAIGHT KNIFE GRINDING MACHINE, automatic lubricating/cooling system, capacity up to 100 mm wide x 500 mm length.	US$ 2,730.00
1	UNIVERSAL GRINDING MACHINE, for profiled TCT knives up to 4 mm thick x 75 mm wide x 800 mm long, automatic grinding wheel feed (infinitesimal) with standard accessories for grinding solid cutterheads up to 1 50 mm diameter	10,950.-
1	KNIFE SETTING FIXTURE (on cutterback).	550.-
1	BANDSAW BRAZING (SPLICING) MACHINE, up to 50 mm wide sawblades	1,095.-
1	COMBINATION BANDSAW BLADE (up to 50 mm wide) and CIRCULAR SAWBLADE (up to 360 mm diameter) with automatic teeth feeding device	2,190.-
1	KNIFE BALANCING FIXTURE	600.-
1 set	CARBIDE TIPPING MACHINE and HANDTOOLS (GAUGES, etc.)	2,850.-
B - METALWORKING SHOP		
1	AIR COMPRESSOR, up to 3 cu.m./min. free air delivery, 6 atmospheres minimum working pressure, complete with air reservoir and standard safety devices	12,000.-
1 set	OXY-ACETYLENE WELDING EQUIPMENT, with standard accessories	730.-

No. of Units	MACHINE DESCRIPTION	ESTIMATED COST, 1989**
1 set	ELECTRIC ARC WELDING EQUIPMENT, 0-100 Amperes, complete with standard accessories	US$ 1,095.00
1	POWER HACKSAW, with sawblade cooling system and automatic stopping device	1,095.-
1	DRILL PRESS, up to 38 mm bit diameter chuck capacity, automatic variable bit feed into workpiece, with table raising/lowering device and workpiece holding fixtures/attachments	440.-
1	BENCH GRINDER, up to 200 mm (8 inches) grinding wheel diameter, double wheels, 0.56 kw (3/4 Hp) motor	350.-
C - GENERAL USE		
1***	DIESEL-ELECTRIC GENERATING SET, 75 KVA capacity, complete with switchgears and control panel, and appropriate diesel type prime-moving engine	21,900.-
Assorted	Hand Tools (Spanners, Socket Wrenches, Box Wrenches, etc.), Metric System Sizes, 4 mm to 50 mm	2,500.-
Assorted	Hand Tools (Spanners, Socket Wrench, Box Wrenches, etc.), English System Sizes, 3/16" to 2"	2,500.-

Note: * MINIMUM No. of Units
** Based on 1989 landed costs, Kuala Lumpur, Malaysia
*** OPTIONAL, to be acquired and installed only when there is no electric power available, or as a "STAND-BY" electric generating set.

ANNEX VIII

BASIC INDUSTRIAL WOODWORKING COURSE

I. BACKGROUND

A. Existing Vocational Training Program

In general, technical high school or equivalent trade schools offer general comprehensive shopwork courses under their industrial arts training program. The course covers a period of two (2) school years. It is offered to the Third and Fourth Year High School students. The course is designed mainly to train the students in some form of vocational learning which could help them earn a living in their respective communities and provide additional income to their families. Carpentry is one of the principal trade for which the students are trained. In addition, in some institutions, a few weeks' instruction is given them in other trades such as: sheet metalwork, cane and rattan furniture fabrication, masonry and wrought metal furniture fabrication. The job-seeking activities of the graduates of this training program, therefore, are limited to the immediate vicinity of their communities inasmuch as they do not have that level of skill or specialization which would qualify them to hold better paying jobs in industry. It is, thus, not surprising to find that most of the students are hired only as semi-skilled (a very few gifted ones are sometimes lucky to be hired as skilled) labourers in the construction industry of the country. Only a few of them could be hired as skilled labour in the country's woodworking industry.

B. Current Needs of the Woodworking Industry

The woodworking industries in many developing countries, like the Philippines, Thailand, Malaysia, Indonesia, China, etc., have an immediate and great demand for:

(1) adequately trained woodworking machine operators, woodworks millwright, and other skilled and highly-skilled labourers in furniture and/or joinery products manufacturing plants; and

(2) furniture designers, full-sizers and technical draftsmen (both furniture and joinery plants) are greatly needed in woodworking plants.

II. THE BASIC INDUSTRIAL WOODWORKING COURSE

A. Objective

The principal thrust of this course is aimed at contributing to the manpower resources needed by industry, in addition to providing trade skills, for qualified students at High School level. In particular, the course is designed:

(1) to train students in activities which will qualify them for skilled and highly-skilled labour in the woodworking industry of any developing country, and if possible, in other countries; and

(2) to set up a self-sustaining project in order to provide an independent source of income to support the operations of this course, by accepting contract jobs to produce woodwork products, which in turn, provides industrial woodworking experience to the students.

B. The Course Syllabus

The Basic Industrial Woodworking Course syllabus is give in Annex VIII-A.[1/] The first 10 quarters of the 4-year high school course remains unchanged, as prescribed by the country's education authorities. The industry-oriented portion of the training course starts during the Third Year of the high school curriculum. The first and second quarters of the course are exactly the same as the first and second quarter syllabus for the regular carpentry course (Woodworking III). The teacher is, thus, given the opportunity to select among the carpentry students those who are qualified to take the industrial woodworking course on the bases of criteria established by the school and the general qualifications required by the industrial woodworking course as stated in Annex VIII-A. The third and fourth quarters of Industrial

1/ On page 95. It is an adaptation of a syllabus used in the Philippines.

Woodworking III curriculum are principally devoted to familiarization and orientation of the students to the operations and care of basic woodworking machinery. The Fourth Year High school curriculum (Industrial Woodworking IV), starts with a continuation of the work done in Industrial Woodworking III, followed by specific topics covering actual industrial activities and practices.

By the end of the Fourth Year the students would have acquired specific skills in industrial woodworking operations and would have been introduced to the practices concerned with labour-management relations. It is expected that this novel feature of the proposed course will shorten the training period under actual plant conditions, so that the worker (who is graduate of the Basic Industrial Woodworking Course) will join the other regular workers in their company's effort to make profit, much earlier than they have even done before.

Exercises to be performed by the students are provided after each basic topic of the course. The exercises aim to provide the students the opportunity to apply under actual factory conditions the concepts and techniques demonstrated by the teacher under each topic of the course. There are a total of twenty-one (21) exercises for Industrial Woodworking III and another six (6) exercises for Industrial Woodworking IV.

In addition to the class exercises, class projects are required of the students taking the course. There are three (3) class projects: one (1) for Industrial Woodworking III and two (2) class projects, specifically set as partial requirement for the completion of Industrial Woodworking IV.

It will also be noted that specific parts of the lecture periods are devoted to demonstration of the concepts and techniques covered during the lecture. The teacher is advised to make maximum use of the demonstration kits during the demonstration period.

ANNEX VIII-A

PROPOSED SYLLABUS FOR BASIC INDUSTRIAL WOODWORKING COURSE

III YEAR

First and Second Quarters ---------- 240 hrs.

The Specific Objectives, Basic Concepts, Contents, Materials, etc., for the first two quarters of the course are exactly the same as those prescribed for the regular carpentry course (WOODWORKING III).

However, the following additional Specific Objectives shall be included :

i - to observe and determine the attitude, mental capability and interest of the students who may be selected to train for industrial labour (skilled and higher levels); and

ii - to select five to fifteen students, based on criteria established by the school, including the personal traits listed in (i) above, to be trained under this program. However, "ACCIDENT PRONE" students, although possessing the above listed qualifications are definitely EXCLUDED from this training course.

Third Quarter ---------- 120 hrs.

A. ORIENTATION and FAMILIARIZATION with INDUSTRIAL WOODWORKING CONCEPTS and OPERATIONS ---------- 6 hrs.

(1) Attributes of Industrial Woodworking Operations

(a) Mass Production

(b) Precision Machining

(c) Interchangeability of Product Components

(d) Standardization of Design of Product Components

(2) Comparison between Carpentry and Industrial Woodworking Operations

(3) Intensive Use of Woodworking Machines

(4) Formal Sequence of Operations

B. INTRODUCTION TO PRECISION MACHINING ---------- 24 hrs.

(1) Knowledge and Proper Use of Basic Measuring Tools and Gadgets ---------- (15 hrs.)

(a) Steel Tape with Metric and English Systems Gradations

- how to read measurements on each System ;
- how to take "inside" and "outside" dimensions ;
- how to convert English to Metric measurements, and vice-versa.

* EXERCISE No. IW-3.1

(b) Simple Calliper

- how to take measurements using the simple calliper ;
- when to use a simple calipher to take measurements of woodworks components ; and
- proper use and care of a simple calliper

* EXERCISE No. IW-3.2

(c) Micrometer Calliper

- how to read the Vernier scale of a micrometer calliper ;
- when to use a micrometer calliper ;
- how to take "inside" and "outside" dimensions of woodworks components using a micrometer calliper; and
- proper use and care of micrometer calliper

* EXERCISE No. IW-3.3

(d) Try-Squares

- 90° (Right Angle), its proper care and uses ; and
- Bevelling (Adjustable), its proper care and uses.

* EXERCISE No. IW-3.4

(e) Elementary Production Gauges

- what is a production gauge?
- proper use and care of production gauges ;
- types of production gauges and their uses in actual production operations (in checking thickness, width, length, profile, etc., of component parts of woodworks products); and
- the difference between a production gauge and a pattern.

* EXERCISE No. IW-3.5

(2) Working Drawings for Machining of Woodworks Components ---------- (9 hrs.)

(a) The purpose and role of working drawings in woodworks production operations.

(b) The important features of a working drawing

- identifying the product and product part/s represented by the working drawing: product name, product number, name of part, part number, number of parts per unit product, materials specification
- representation of dimensions in a working drawing: rough dimensions, final (or finished) dimensions, machining tolerances, machining allowances, sanding allowances, etc.

(c) How to read and interpret a working drawing

(d) How to take care and store (or file) working drawings

* EXERCISE No. IW-3.6

C. FAMILIARIZATION WITH THE DESIGN AND OPERATIONS OF BASIC WOODWORKING MACHINES ---------- 90 hrs.

(1) CROSS-CUT SAW ---------- (6 hrs.)

(a) Main Function of the Machine

- cutting pieces of lumber to desired rough length

(b) Identification of the Principal Parts of the Machine

- motor drive (voltage, power rating, etc.)
- circular sawblade (nominal diameter, type and number of teeth, diameter of bore, etc.)
- table or platform
- fence or guide

(c) Operating Limits of the Saw

- maximum thickness of wood
- maximum width of wood

(d) Demonstration of Sawing Operations using the Cross-Cut Saws

(e) Safety guidelines on the use of the Cross-Cut Saw

(f) Sawing exercises performed by each student

(g) Proper care of the machine and sawblade after use

* EXERCISE No. IW-3.7

(2) TILTING ARBOR SAW ---------- (9 hrs.)

(a) Main Functions of the Machine

- for cutting pieces of wood to the desired final length or width
- for cutting beveled edges

(b) Identification of the Principal Parts of the Machine

- motor drive (voltage, power rating, etc.)
- circular sawblade (nominal diameter, type and number of teeth, diameter of bore, revolutions per minute-RPM, etc.)
- sawblade tilting mechanism
- sawblade raising/lowering mechanism
- fence or guide
- table or platform
- extension arms/attachments

(c) Operating Limits of the Saw

- maximum thickness of workpiece
- maximum width of cut
- workable length of workpiece
- maximum bevel angle
- maximum height of sawblade topmost tooth above the table or platform

(d) Demonstration of Sawing Operations using the Tilting Arbor Saw

- free-hand feed rip-sawing, cross-cutting, rebating, etc.
- bevel cutting
- precision sawing with the use of sawing jig
- cutting laminated wood panels (plywood, plyboard, etc.) on the saw

(e) Safety Guidelines on the use of the Tilting Arbor Saw

(f) Sawing exercises performed by each student

(g) Proper care of the machine and sawblade after use

* EXERCISE No. IW-3.8

(3) HAND PLANER/JOINTER --------- ---------- (9 hrs.)

(a) Main Functions of the Machine

- to machine two adjacent faces of the wood piece square to each other, which can be used as reference surfaces for other woodworking operations
- to straigthen out curved or bent surfaces of the wood pieces

(b) Identification of the Principal Parts of the Machine

- motor drive (voltage, power rating, etc.)
- cutterhead (round or square, number and type of knives, diameter of cutterhead, revolutions per minute-RPM, etc.)
- fence or guide
- table or platform

(c) Operating Limits of the Machine

- maximum width of workpiece
- maximum thickness of workpiece
- maximum knife bite on wood surface
- workable length of workpiece

(d) Demonstration of Hand-Planing/Jointing Operations using the Machine

- planing two adjacent faces of workpiece to attain true squareness (as checked with a 90° try-square)
- planing curved or bent surfaces to obtain a straight face of the workpiece

(e) Safety Guidelines on the use of the Hand Planer/Jointer Machine

(f) Hand Planer/Jointer Operations performed by each student

(g) Proper care of the machine after use

*EXERCISE No. IW-3.9

(4) PLANER/THICKNESSER ---------- (15 hrs.)

(a) Main Functions of the Machine

- to obtain desirably smooth wood surfaces ready for finishing operations
- to obtain desired thickness of workpiece, within tolerance limits specified for the product component

(b) Identification of the Principal Parts of the Machine

- motor drive/s (voltage, power rating, etc.)
- cutterhead (round or square, number and type of knives, diameter of cutterhead, revolutions per minute-RPM, etc.)
- movable table or platform
- exhaust port for shavings
- table (or platform) raising/lowering mechanism and indicator
- workpiece feed mechanism and feed speeds

(c) Operating Limits of the Machine

- maximum width of workpiece
- maximum thickness (or depth) of workpiece
- maximum knife bite on wood surface
- maximum/minimum feed speeds for selected wood species
- minimum length of workpiece

(d) Demonstration of Planing and Thicknessing Operations on the Machine (using different wood species)

(e) Safety Guidelines on the use of the Machine

(f) Planing/Thicknessing Operations Performed by each student

- duties and responsibilities of machine operator/ feeder
- duties and responsibilities of catcher

(g) Proper care of machine after use

* EXERCISE No. IW-3.10

(5) VERTICAL SPINDLE MOULDER (SHAPER)-------- (15 hrs.)

(a) Main Function of the Machine

- for generating smooth (square, beveled or profiled) edges on the straight or curved edges of a workpiece, using one of its faces as the surface of reference for the shaping operation

(b) Identification of the Principal Parts of the Machine

- motor drive (voltage, power rating, etc.)

- cutterhead or shaping head or cutterblock (round or square, number and type of knives, diameter of cutterhead, revolutions per minute-RPM, etc.)
- fence or guide
- table or platform
- shaping collar
- cutterhead height adjustment mechanism

(c) Operating Limits of the Machine

- maximum thickness of workpiece
- maximum size (length and width) of the workpiece
- maximum depth of cut on the workpiece edge
- maximum feed rate of workpiece

(d) Demonstration of Shaping Operations using the Machine

- plain manual shaping
- shaping with the use of a jig

(e) Safety Guidelines on the use of the Machine

(f) Shaping operations performed by each student

- plain manual shaping
- shaping with the use of a jig

(g) Proper care of the machine after use

* EXERCISE No. IW-3.11

(6) DOVETAILING MACHINE ---------- (9 hrs.)

(a) Main Function of the Machine

- to rout dovetail shaped, identical-sized tenons and spaces on ends of workpieces to be joined together forming a right angle (90°) between them

(b) Identification of the Principal Parts of the Machine

- motor drive (voltage, power rating, etc.)
- routing spindles (size, RPM)
- workpiece feed control and feed lever mechanism
- routing waste disposal system

(c) Operating Limits of the Machine

- minimum/maximum thickness of the workpiece
- minimum/maximum width of the workpiece
- dovetail routing bit size

(d) Demonstration of Dovetailing Operations

- drawer sides
- drawer front and back

(e) Safety Guidelines on the use of the Machine

(f) Dovetailing exercises performed by each student

(g) Proper care of the machine after use

* EXERCISE No. IW-3.12

(7) CHISEL MORTIZING MACHINE ---------- (12 hrs.)

(a) Main Function of the Machine

- to machine mortises on the workpiece according to given specifications matching that of corresponding tenons

(b) Identification of the Principal Parts of the Machine

- motor drive (voltage, power rating, etc.)
- chisel-drill bit (chuck size and RPM of drill, size of chisel, etc.)
- fence (or guide) and adjustment mechanism
- table (or platform) and adjustment mechanism
- chisel driving lever and movement mechanism

(c) Operating Limits of the Machine

- maximum workpiece thickness and width
- maximum mortise dimensions

(d) Demonstration of Mortizing Operations

- through-and-through mortise
- shallow mortise

(e) Safety Guidelines on the use of the Machine

(f) Exercises on mortising operations performed by each student

- through-and-through mortise
- shallow mortise

(g) Proper care of the machine after use

* EXERCISE No. IW-3.13

(8) STROKE SANDER ---------- (18 hrs.)

(a) Main Functions of the Machine

- to obtain a degree of smoothness on wooden surfaces good enough for finish coatings
- to remove minor defects of the wood surface which were introduced or not removed in previous machining operations

(b) Identification of the Principal Parts of the Machine

- motor drive (voltage, power rating, etc.)
- sanding belt (type, width and circumference)
- sanding belt pulleys (drive and idler) and sanding belt tension adjustment mechanism
- stroking pad and lever
- table (or platform) and its raising/lowering mechanism
- roller system for forward and backward movement of table (or platform)

(c) Operating Limits of the Machine

- maximum width and length of workpiece
- maximum depth (or height) of workpiece
- minimum thickness of workpiece (for flat wooden panels)
- desirable grit (roughness grade) of sanding belt

(d) Demonstration of Stroke Sanding Operations

- on wood panels
- on assembled case goods

(e) Safety Guidelines on the use of the Stroke Sander

(f) Stroke sanding exercises performed by each student

(g) Proper care of the machine and the sanding belt after use

* EXERCISE No. IW-3.14

(9) BANDSAW ---------- (12 hrs.)

(a) Main Function of the Machine

- to allow non-straight sawing of wooden pieces

(b) Identification of the Principal Parts of the Machine

- motor drive (voltage, power rating, etc.)
- bandsaw blade (width and length, type of teeth and set, etc.)
- bandsaw pulleys (drive and idler)
- bandsaw blade guide and tension adjustment
- table (or platform), with/without fence

(c) Operating Limits of the Machine

- maximum thickness of workpiece
- maximum width and length of workpiece
- minimum radius of curvature of curved edges of workpiece

(d) Demonstration of Bandsawing Operations

(e) Safety Guidelines on the use of the Machine

(f) Bandsawing Operations performed by each student

(g) Proper care of the machine after use

* EXERCISE No. IW-3.15

Fourth Quarter ---------- 120 hrs.

A. FAMILIARIZATION WITH THE DESIGN AND OPERATIONS OF BASIC WOODWORKING MACHINES (continuation) ---------- 30 hrs.

(1) DRILL PRESS ---------- (6 hrs.)

(a) Main Function of the Machine

- to bore holes of desired diameter and depth on the workpiece

(b) Identification of the Principal Parts of the Machine

- motor drive (voltage, power rating, etc.)
- drill chuck (maximum bit diameter capacity)
- drill bit (type and diameter)
- chuck lowering mechanism and lever

- table or platform
- work clamping (or holding) accessories, if available

(c) Operating Limits of the Machine
- maximum hole diameter
- maximum thickness of workpiece

(d) Demonstration of Drilling Operations
- through-and-through holes
- shallow hollows

(e) Safety Guidelines on the use of the Machine

(f) Drilling Operations performed by each student

(g) Proper care of the machine and drill bit after use

* EXERCISE No. IW-3.16

(2) WOOD LATHE ---------- (12 hrs.)

(a) Main Function of the Machine
- to produce wood turnings of the desired cross-sectional profile

(b) Identification of the Principal Parts of the Machine
- motor drive (voltage, power rating, etc.)
- end chucks
- knife saddle (support)
- lathe knives (type and use)

(c) Operating Limits of the Machine
- maximum diameter (or cross-sectional dimensions) of workpiece
- maximum/minimum length of workpiece

(d) Demonstration of Wood Turning Operations

(e) Safety Guidelines on the use of the Machine

(f) Wood Turning Operations performed by each student (use Simple Profiles)

(g) Proper care of the machine and turning knives after use

* EXERCISE No. IW-3.17

(3) HYDRAULIC PRESS ---------- (12 hrs.)

(a) Main Function of the Machine

- to provide the desired amount of pressure needed to press together the components of a wood panel until glue setting time is attained

(b) Identification of the Principal Parts of the Machine

- hydraulic jacks
- platens (or platforms)
- pressure gauge
- press framework

(c) Operating Limits of the Machine

- maximum length and width of panels to be pressed
- maximum thickness of panel stack to be pressed
- need for pressing dollies or carts

(d) Demonstration of panel pressing operations

(e) Safety Guidelines on the use of the Machine

(f) Panel pressing operations performed by studetns

(g) Proper care of the machine after use

* EXERCISE No. IW-3.18

B. FAMILIARIZATION WITH OTHER WOODWORKING OPERATIONS ------- 51 hrs.

(1) GLUING OPERATIONS ---------- (15 hrs.)

(a) Types of Industrial Glue now commercially available

- UF - type (Urea Formaldehyde), pre-mixed single component and two component systems
- PVA - type (Polyvinyl Acetate)
- animal glue (Hide Glue)

(b) Applications of each type of glue in woodworks joinery

- panel forming operations (laminating veneer, formica, etc.)
- edge gluing (for core build-up)
- other applications

(c) Limitations on the use of each type of glue

- pressing requirements and tools (amount of pressure and length of time)

- heating requirements (pressing temperature and length of time)
- atmospheric humidity conditions
- state of dryness (or wetness) of wooden parts to be glued together

(d) Demonstration of gluing operations

- UF type glue
- PVA type glue
- Animal glue

(e) Safety Guidelines during gluing operations

(f) Gluing operations performed by each student

(g) Proper care of gluing tools after use

* EXERCISE No. IW-3.19

(2) SANDING OPERATIONS ---------- (15 hrs.)

(a) Types of Industrial Abrasives commercially available

- paper-back sanding sheets
- cloth-back sanding sheets
- paper-back sanding belts (production abrasive paper)
- cloth-back sanding belts (for profiled edges)

(b) Size and Type of Abrasives Grits

- size (in the 0-system; in the multi-digit system; equivalent ratings in the two systems)
- type (carborundum, silicon oxide, emery, ground glass, etc.)

(c) Recommended use (or Application) of each type of Sanding Abrasive

- machine sanding, rough
- machine sanding, fine
- hand sanding and sanding blocks
- profiled edge sanding

(d) Demonstration of Sanding Operations

- stroke sanding
- hand sanding (with sanding blocks)
- hand sanding (with portable sanding machine)

(e) Safety Guidelines on sanding operations

(f) Sanding operations performed by each student

(g) Proper care and storage of sanding machine, belts or sheets after use

* EXERCISE No. IW-3.20

(3) FINISHING OPERATIONS ---------- (21 hrs.)

(a) Principal Functions of Finish Coatings on Woodworks products

- to provide protection to the wood while the furniture or joinery product is in use
- to add to the beauty of the furniture or joinery product

(b) Types and uses of different finish coatings

- shellac (low grade wooden products)
- varnish
- lacquer (clear or colored)
- enamel (colored)
- polymers (polyurethane, polyester, etc.)

(c) Gloss levels of industrial finishes

- dull (matte)
- semi-gloss (satin sheen)
- glossy
- high gloss

(d) Surface preparation needed to attain a successful finish

- properly sanded
- free from oily or greasy spots
- adequately seasoned (dried) wood
- well puttied or filled drill holes and other surface imperfections

(e) Typical properties (or characteristics) of a desirable industrial finish system

- good adhesion to wooden surface
- good adhesion between coats of the finishing system
- good scratch (or mar) resistance

- good dent (or impact) resistance
- desired color (or shade)
- low drift or change in color (usually fading) during long period when painted (or varnished) product is in use
- good resistance to alcoholic liquids (especially for bar and counter tops)
- reasonable cost of the finishing system

(f) Recommended Sequence of Finishing Operations

(i) Clear Finish

- wood staining, if desirable
- wash coat (if wood is stained)
- scuff sanding
- filling
- sealer coat application (one cross-coat)
- hand sanding
- top coat application, as many coats as required

Note: (a) It is understood that each coat is sufficiently dried before the next operation is started.

(b) At least three layers of top coat are required if the finished surface is going to be rubbed (or sanded).

(ii) Colored (Opaque) Finish

- puttying surface defects
- application of primer coat (more coats are required by coarse wood surfaces)
- sanding
- application of top coats
- polishing (or buffing), if required

(g) Demonstration of Finishing Systems

- shellac
- varnish
- lacquer system (clear)
- enamel system (colored)

(h) General Guidelines in finishing operations and areas

- work area: cleanliness, tidiness and good organization

- materials storage areas: fire safety precautions; covered cans (or containers) of finishing materials; ample ventilation
- disposition of industrial waste from the finishing area after work hours

(i) Finishing operations performed by each student

* EXERCISE No. IW-3.21

C. ASSEMBLING OPERATIONS ---------- 9 hrs.

(1) Hardware and fastener items for furniture and joinery products

- for solid wood type of construction
- for wood-panel-based construction

(2) Machining for woodworks hardware and fasteners

- hinge seats (butterfly hinge, piano hinge, invisible hinge, etc.)
- lock seats
- pilot holes for wood screws or C.W. nails (2" and larger)
- others

(3) Dowel type of furniture construction

(4) Demonstration of furniture and joinery products hardware and fasteners and their corresponding machining requirements

(5) General guidelines on machining for hardware and fasteners

D. CLASS PROJECT ---------- 30 hrs.

The class is divided into groups of five (5) or less students. Each group is assigned to produce two units each of the same furniture or joinery product, under the guidance of the teacher. Production operations shall be carried out according to a definite plan of action developed by the members of each group and approved by the teacher.

This exercise will illustrate the machining precision required of wooden components to attain full interchangeability of the components.

Suggested Project Items :

(1) Elementary School Desk, with seat for two (2) pupils

(2) Class Seats for High School Students (with writing extension arm)

(3) Kitchen (or Laboratory) Stool

(4) Other furniture and joinery items of simple design

** CLASS PROJECT No. A-1

SUMMARY OF WOODWORKING III

PROGRAM OF ACTIVITIES

Quarter	Topic Coverage	No. of Class Hours
First	Exposition to and Familiarization with the Basic Concepts of Carpentry, its Required Materials and Hand Tools (Currently Implemented)	120 hours
Second	Development of Skills in Carpentry and Joinery (Currently Implemented)	120 hours
Third	Introduction to Industrial Woodworking Concepts and Operations, its Required Machinery, Tools, Systems and Techniques (New Syllabus)	120 hours
	A. Orientation and Familiarization with Concepts and Factory Operations	(6 hours)
	B. Introduction to Precision Machining	(24 hours)
	C. Familiarization with the Design and Operations of Basic Woodworking Machines	(90 hours)
Fourth	Familiarization with Woodworking Machines and other Basic Industrial Woodworking Operations (New Syllabus)	120 hours
	A. Familiarization with the Design and Operations of Basic Woodworking Machines (continuation)	(30 hours)
	B. Familiarization with other Woodworking Operations	(51 hours)
	(1) Gluing Operations (2) Sanding Operations (3) Finishing Operations	
	C. Assembling Operations, Hardwares and Fasteners for Furniture and Joinery Products	(9 hours)
	D. Class Project	(30 hours)

IV YEAR

OBJECTIVES:

(a) To familiarize the students with some of the major non-production activities in woodworking factories and learn the basic concepts involved in the various systems and techniques supporting industrial scale of production operations; and

(b) To develop fully the students' potential for industrial woodworking operations and identify the particular operational skills in which each student excels and for which he stands the best chance of being hired in industry.

First Quarter ---------- 120 hrs.

A. WOODWORKS MILLWRIGHT OPERATIONS, ITS REQUIRED MACHINES AND TOOLS AND BASIC TECHNIQUES ---------- 75 hrs.

(1) CIRCULAR SAW FILING/GRINDING OPERATIONS----(21 hrs.)

- circular saw filing machine, its principal parts and operations; and the required tools and accessories
- circular saw blades, types and uses
- saw kerf, different types of saw tooth set (spring set, swage, etc.) and carbide tipped sawblades
- demonstration of circular saw filing operations
- demonstration of circular saw grinding operations (if available)
- safety guidelines during saw filing/grinding activities
- circular saw filing/grinding exercise performed by each student
- proper care of saw filing/grinding machine and tools after use

* EXERCISE No. IW-4.1

(2) BANDSAW FILING OPERATIONS ----------(21 hrs.)

- bandsaw filing machines, its principal parts and operations; and the required tools and accessories
- bandsaw blades, types and pitch of saw teeth, width of blade and saw kerf
- demonstration of bandsaw filing operations
- safety guidelines during bandsaw filing activities

- bandsaw filing exercise performed by each student
- proper care of saw filing machine and tools after use

* EXERCISE No. IW-4.2

(3) KNIFE GRINDING OPERATIONS ----------(18 hrs.)

Plain knives (planer, jointer and shaper) grinding operations

- knife grinding machine, its principal parts and use, and the required tools and accessories
- plain knives (thick or thin), their cutting vs. grinding angles - straight grinding and profile grinding
- demonstration of knife grinding and honing operations
- safety guidelines during knife grinding activities
- straight and profiled knife grinding exercises performed by each student
- proper care of grinding machine and tools after use

* EXERCISE No. IW-4.3

(4) SPECIAL MACHINE SET-UP ACTIVITIES ---------(15 hrs.)

- the need for machining jigs in production operations using some basic woodworking machines
- machine set-up activities for: box planing, miter cut sawing, shaping, routing, mortising, etc.
- demonstration of setting-up techniques on the table saw, planer/thicknesser, shaper, router, mortiser, etc.
- safety guidelines on machine set-up activities
- machine setting-up exercises performed by each student
- proper care of machining jigs after use

*EXERCISE No. IW-4.4

B. FULL SIZING AND TECHNICAL DRAFTING ACTIVITIES FOR INDUSTRIAL WOODWORKING OPERATIONS ---------- 45 hrs.

(1) STANDARD SIZES AND DIMENSIONS FOR SOME BASIC FURNITURE AND JOINERY PRODUCTS

- chairs and seats
- dining tables
- beds (single or double)

- kitchen stools
- window frame (single or double)
- doors (single or double, flush or panel, etc.)
- other basic woodworks products

(2) FULL-SIZING

- the need for full-size drawings of some components of woodworks products
- basic full-sizing concepts and techniques
- drafting supplies and tools for woodworks technical drawing and full-sizing

(3) Demonstration of full-sizing and technical drawings activities for woodworks products and components

(4) Full-sizing and technical drawing activities performed by each student

(5) Proper care and storage of drafting tools and materials

* EXERCISE No. IW-4.5

Second Quarter ---------- 120 hrs.

Note: It is suggested that the teacher take up the two major topics in daily sessions during this Quarter. In this manner, half of each day's session will be used for activities in preparation for the class projects and the other half will be devoted to lectures and illustrations to orient the students to general practices and procedures in industrial plants.

A. PREPARATION FOR CLASS PROJECTS FOR THE SCHOOL YEAR ------ 60 hrs.

(1) Briefing on class projects and formation of production teams composed of five or less students, and selection of Team Leaders --- (3 hrs.)

(2) Discussion among Team Leaders and teacher, then selection of joinery product(s)to be manufactured as class projects for the Third Quarter ---------- (6 hrs.)

Each production team is expected to select a joinery product different from those selected by the other teams in the class. The joinery product selected may be any of the following

- window frame, with jambs
- flush door, with jambs

- raised panel door, with jambs
- divider
- other joinery products

(3) Discussion among Team Leaders and teacher, then selection of furniture products to be manufactured as class projects for the Fourth Quarter ---------- (6 hrs.)

Each production team is expected to select a furniture product different from those selected by the other teams in the class. The furniture products selected may be any of the following:

- dining table, with chairs
- laboratory table, with stools
- living room set (1 sofa, 2 chairs and 1 coffee table)
- bookshelves for the library
- classroom cabinet
- teacher's desk and chair
- other furniture items

(4) Formulation of plans and schedule of activities and materials for the project ---------- (45 hrs.)

- preparation of working and full-size drawings
- preparation of list of wooden and other materials, hardware, woodscrews and nails needed for the project
- preparation of list of production operations (in the proper order or sequence) needed to produce the selected joinery or furniture product
- preparation of assignment for each team member
- preparation of forms needed to report on materials and labour used to complete the project
- preparation of cost estimates

B. INTRODUCTION TO GENERAL PRACTICES AND PROCEDURES IN INDUSTRIAL PLANTS ---------- 60 hrs.

(1) Labour grades in industrial operations --- (6 hrs.)

(a) Industry pays workers on the basis of skills and experience required by the job. Thus, the higher the skills required by the job, the higher the labour grade rating (and better

pay rate), for the job. Similarly, a graduate engineer will not receive an engineer's pay rate if he is only hired to operate a simple machine. The engineer, thus hired, will receive a machine operator's pay rate.

(b) Labour skills levels and general specifications

- UNSKILLED: - no training or experience required

  Examples : plant janitor, factory helper, material handler, etc.

- SEMI-SKILLED: - very short training period required; previous industrial experience an advantage but not a strict requirement; etc.

  Examples : hand sander, production helper (outfeed helper, catcher), assembler, operator of simple machine, filling line crew, etc.

- SKILLED: - definite length of training period required; some industrial experience in same job line necessary; educational level specified; etc.

  Examples : operator of basic production machines, sprayer (finishing operations), touch-up and repairman (finishing operations), saw-filer/knife grinder, etc.

- HIGHLY-SKILLED: - longer period of training; wider industrial experience in same job line and specific educational level required.

  Examples : woodworking millwright, finishing technician, etc.

(2) Labour usage and product costs ---------- (9 hrs.)

- work done by one man in one hour is called a "man-hour"
- productivity = output ÷ labour usage; that is, man-hours used for each unit product (or component) produced
- reporting labour usage: regular labour usage summary reports, labour tickets, time cards, etc.
- responsibility of worker regarding labour usage correctly charged to the correct product or project
- example of reporting labour usage in woodworking operations

* EXERCISE No. IW-4.6

(3) Other concerns of an industrial worker --- (9 hrs.)

- usage of materials (type of material and quantity used) correctly charged to the corresponding product or project

- avoidance of excessive material wastage
- methods of reporting materials usage
- maintaining desired quality level of product by following correctly factory procedures and observing closely characteristic of his operation's output
- keeping his machine (and/or tools) in good operating condition by: avoiding abuse of the machine (and/or tools); immediately reporting abnormal functioning of the machine and following factory procedures on machining operations

(4) Calculation of product cost ---------- (15 hrs.)

(a) Cost elements

- materials cost
- labour cost
- overhead cost

(b) Cost of materials include

- lumber
- plywood
- hardwood, woodscrews and nails
- all finishing materials (lacquer, woodfiller, etc.)

All these items are directly applied to and/or can be identifed in the complete finished product.

(c) Cost of labour includes

- salaries/wages of workers directly used in the actual production of the product

(d) Overhead cost includes

- salaries of company officials
- taxes and licenses
- labour not directly used in the manufacture of the product such as salaries of mechanics and electricians, janitors, office clerks, quality control inspectors
- all other costs which do not fall under materials or labour costs

(e) Total Product Cost = Cost of Materials + Cost of Labour + Overhead Costs

(f) Unit Product Cost = Total Product Cost ÷ Number or Products Manufactured

(g) Other cost information relevant to the course objective.

(5) Industrial worker's rights under the National Labour Code ---------- (15 hrs.)

- tenure of work
- right to join trade and labour unions
- sick and vacation leaves
- Social Security System membership
- thirteenth month pay
- other benefits

(6) The Woodworking Industry of the country ---------- (6 hrs.)

(a) Main products of the woodworks industry

- wooden and rattan furniture for the domestic market
- wooden and rattan furniture (and components for the expoert market
- joinery (windows, doors, dividers, banisters, stairs, etc.) for the domestic market

(b) Major woodworking centres of the country

(c) National Manufacturers and exporters' associations.

- promotion of woodwork products for export
- development of designs of woodwork products using local materials
- modernization of woodworking plants in the country
- technical and training seminars on the manufacture of furniture and joinery products

(d) Wood species commonly used for woodwork products

- for furniture (and components) products:

- for joinery products.

(e) Major labour problems of the industry

- lack of adequately trained skilled and highly skilled workers
- lack of properly trained furniture designers and full-sizers

(f) Other information about the industry

Third Quarter ---------- 120 hrs.

The principal objective of this portion of the course is to fully develop the student's potentials for possible work in the joinery factories (or shops) of the country.

The class is divided into production teams composed of five or less students (as programmed in the Second Quarter). Actual production activities will be allowed to start only after the teacher is convinced that all preparatory work has been completed, as programmed in the Second Quarter. Production operations should be conducted according to the schedule agreed upon during the Second Quarter and using the techniques and knowledge acquired by the student since the Third Year of the course, i.e., according to actual industrial practice.

The teacher, considering the needs of the school and the availability of funds, will decide how many units of each joinery product will be assigned to each team.

The last week of the Third Quarter should be devoted to calculation of actual costs, discussion of the problems encountered during the period alloted to production activities and suggest solutions to the problems. The class discussions should also include recommendations on how to improve the course - making it more meaningful to the student.

** CLASS PROJECT A-2

Fourth Quarter ---------- 120 hrs.

The principal objective of this portion of the course is to fully develop the student's potentials for possible work in the furniture factories (or shops) of the country.

The class is divided into production teams composed of five or less students (as programmed in the Second Quarter). Actual production activities will be allowed to start only after the teacher is convinced that all preparatory work has been completed, as programmed in the Second Quarter. Production operations should be conducted according to the schedule agreed upon during the Second Quarter and using the techniques and knowledge acquired by the student since the Third Year of the course, i.e., according to actual industrial practice.

The teacher, considering the needs of the school and the availability of funds, will decide how many units of each furniture product will be assigned to each team.

The last week of the Fourth Quarter should be devoted to calculation of actual costs, discussion of the problems encountered during the period alloted to production activities and suggest solutions to the problems. The class discussions should also include recommendations on how to improve the course - making it more meaningful to the student.

** CLASS PROJECT A-3

SUMMARY OF WOODWORKING IV

PROGRAM OF ACTIVITIES

Quarter	Topic Coverage	No. of Class Hours
First	Introduction to Industrial Woodworking Concepts and Operations, Its Required Machinery, Tools, Systems and Techniques (continuation of previous year's work, New Syllabus)	120 hours
	A. Woodworks Millwright Operations, Its Required Machines and Tools and Basic Techniques	(75 hours)
	B. Full-Sizing and Technical Drafting Activities for Industrial Woodworking Operations	(45 hours)
Second	Class Projects and Common Industry Practices	120 hours
	A. Preparation for Class Projects for the School Year	(60 hours)
	B. Introduction to General Practices and Procedures in Industrial Plants	(60 hours)
Third	Class Project, Joinery Product	120 hours
	A. Shopwork	(105 hours)
	B. Performance Evaluation and Costing of Project	(15 hours)
Fourth	Class Project, Furniture Product	120 hours
	A. Shopwork	(105 hours)
	B. Performance Evaluation and Costing of Project	(15 hours)

ANNEX VIII-B

BASIC INDUSTRIAL WOODWORKING COURSE PROJECT

MACHINERY/EQUIPMENT LIST

Note: (1) Each machine should be provided with a set of standard tools, electrical switchgear; and a brochure on operating and maintenance procedures.

(2) All electric motors and switchgears should be provided for a power supply of 440/220 volts, 50 or 60 hertz, 3-phase.

(3) Each machine supplier should be requested to furnish a list of recommended spare parts for the machine, good for one year's operations. This list will be used as the basis for ordering the first batch of spare parts to be delivered together with the machinery.

I. FIRST PHASE REQUIREMENTS

A. Production Machinery :

(1) One Unit - CROSS-CUT SAW, Manually Operated, Pendulum or Sliding Type

Maximum Workpiece Capacity	: 420 mm Wide; 80 mm Thick
Circular Sawblade	: 355 mm Ø; 25 mm Bore; 3600 RPM
Power	: 2.2 kw, electric motor

(2) One Unit - TILTING ARBOR SAW, Variable Speed, with Sliding Table and Extended Arm Attachment

Maximum Depth of Cut	: 140 mm
Circular Sawblade	: 400 mm Ø; 38 mm Bore; 3200 to 6000 RPM
Max. Sliding Table Stroke	: 2700 mm
Power	: 4 kw, electric motor

(3) One Unit - HAND PLANER/JOINTER

Maximum Workpiece Capacity	: 300 mm Wide
Work Table Dimensions	: 2000 mm Long; 330 mm Width
Rebating Capacity	: 19 mm
Cutterblock Speed	: 5000 to 5500 RPM
Power	: 4 kw, electric motor

(4) One Unit - PLANER/THICKNESSER, Single Cutterhead

Workpiece Capacity	: 500 mm Wide; 235 mm Thick
Cutterblock Speed	: 4500 to 5000 RPM
Feed Speed	: 7.5 to 15 meters per minute
Power	: 4 kw, electric motor

(5) One Unit - VERTICAL SPINDLE MOULDER (SHAPER), Single Spindle

Cutterhead	: Cutting Circle - 150 mm : Bore - 25.4 mm Ø : Speed - 3000 to 8000 RPM
Maximum Workpiece Capacity	: 100 mm Thick
Work Table Dimensions	: 650 mm x 1000 mm
Power	: 4 kw, electric motor

(6) One Unit - DOVETAILING MACHINE (8 Spindles)

Maximum Workpiece Size	: 200 mm Wide; 9 to 25 mm Thick
Dovetail Spindle Pitch	: 25 mm
Spindles	: 8 pieces
Spindle Speed	: 6000 to 6500 RPM
Power	: 1,5 kw, electric motor

(7) One Unit - CHISEL MORTIZING MACHINE

Drill Speed	: 2800 RPM
Traverse	: 240 mm Length; 80 mm Front to Rear
Depth	: 240 mm
Max. Workpiece Cross-Section	: 150 mm x 240 mm
Head Stock Traverse	: 250 mm
Working Head Stock Traverse	: 100 mm
Power	: 0.55 kw, electric motor

(8) One Unit - STROKE SANDER, Single Belt

Sanding Table Size	: 800 mm x 2500 mm
Sanding Belt	: 6680 mm to 6920 mm Length 100 mm to 150 mm Wide
Pulley Speed	: 1500 RPM
Power	: 5 kw, electric motor

(9) One Unit - BANDSAW, 1/2" Sawblade

(10) One Unit - DRILL PRESS, 3/4" Chuck Capacity

(11) One Unit - WOOD LATHE, 1000 mm x 75 mm Workpiece Capacity

(12) One Unit - SPRAY BOOTH, Dry Type with Exhaust Fan and Air Baffles, 3000 mm Width, 2000 mm Depth and 2440 Height, 0.75 kw , electric motor

(13) Two Sets - SPRAY GUN with Cup (1 quart capacity) attachment, and AIR HOSE

(14) One Unit - PANEL PRESS (Hydraulic Type), designed and fabricated, using wooden member, bolts/nuts and hydraulic jacks (10 tons), to accommodate 1220 mm Wide x 2440 mm Long x 1000 mm Diameter workpiece(s)

B. Supporting Equipment and Tools :

(1) One Unit - COMBINATION BANDSAW and CIRCULAR SAWBLADES FILING (OR GRINDING) MACHINE

Sawblade Capacity : Bandsaw Blade - up to 1" Wide, Variable circumference

Circular Sawblade - up to 400 mm Diameter

Complete with electric motor and two (2) sets of steel files (and grinding stones, if required) as recommended by the machinery supplier.

(2) One Unit - STRAIGHT KNIFE GRINDER

Knife Size Capacity : Up to 75 mm Wide and 550 mm Long

Complete with electric motor, adjustable knife holder, and at least two (2) sets of grinding stones (for rough grinding, fine grinding and honing) as recommended by the machinery supplier.

(3) One Set - CENTRALIZED SAWDUST, WOOD SHAVINGS and CHIPS COLLECTING SYSTEM (Including Air-Dust Separator and Sawdust Incinerator)

Designed, fabricated and installed on the basis of wood waste volume to be generated by the machinery/equipment in Phase I plus 50% capacity for future expansion of the operation.

(4) One Unit - AIR COMPRESSOR

(5) One Unit - COMBINATION AIR FILTER and AIR PRESSURE REGULATOR, 40 CFM Capacity

(6) One Set - HAND TOOLS (Metric System) for maintenance work (screw drivers, portable electric drill, spanners, wrenches, etc.) as recommended by the Workshop Supervisor

(7) One Set - HAND TOOLS (English System) for maintenance work (screw drivers, portable electric drill, spanners, wrenches, etc.) as recommended by the Workshop Supervisor

(8) One Unit - ELECTRIC ARC WELDING MACHINE, complete with welding cable and electrode holder and other standard accessories

(9) One Unit - OXY-ACETYLENE WELDING EQUIPMENT, complete with pressure gauges, welding mask, etc.

(10) One Unit - SAW-TOOTH SETTING TOOL

(11) One Unit - BENCH GRINDER, 0.55 kw motor with standard size grinding stones (coarse and fine)

II. MACHINERY/EQUIPMENT LIST SUGGESTED FOR FURTURE EXPANSION

A. One Unit - STRAIGHT LINE RIP SAW, with Variable Chain Feed System

Maximum Workpiece Capacity	:	100 mm Thick
Circular Sawblade	:	250 mm to 355 mm Diameter 38 mm Bore, 3600 RPM
Chain Speed	:	20/30/40 meters per minute
Power	:	for Saw Spindle - 11 kw for Feed System - 1.5 kw

B. One Unit - RADIAL ARM SAW, Manually Operated

Maximum Workpiece Capacity	:	420 mm Wide; 80 mm Thick
Circular Sawblade	:	355 mm Diameter; 38 mm Bore 3600 RPM

C. One Unit - HEAVY DUTY ROUTER

Spindle Speed	:	10,000 to 20,000 RPM
Throat	:	500 mm to 750 mm
Max. Vertical Stroke of Spindle	:	100 mm
Max. Vertical Stroke of Table	:	200 mm
Power	:	2.2/3.3 kw, electric motor

D. One Unit - CORNER LOCKING MACHINE

Maximum Workpiece Size	:	330 mm Wide; 125 mm Length
Tenon Depth	:	38 mm
Cutter: Maximum Diameter	:	180 mm
Speed	:	3600 RPM
Work Table	:	Automatic Vertical Stroke, 8 strokes per minute
Power	:	2.2 kw, electric motor

E. One Unit - EDGE SANDING MACHINE

Sanding Belt Dimension	:	100 mm Wide; 3000 mm Circumference
Sanding Belt Speed	:	12 to 25 meters per second
Power	:	1.4 to 2.3 kw, electric motor

F. One Unit - HEAVY DUTY ROUTER

Spindle Speed	:	20,000 RPM
Maximum Router Bit Size	:	12 mm (1/2") Diameter
Max. Distance from Collet to Table	:	210 mm (8-1/4")
Max. Distance from Spindle to Frame	:	690 mm (27")
Work Table, Tilting	:	500 mm x 800 mm (18-3/4" x 31-1/2"); 45° maximum tilt
Power	:	2P - 1.5 kw (2 hp)

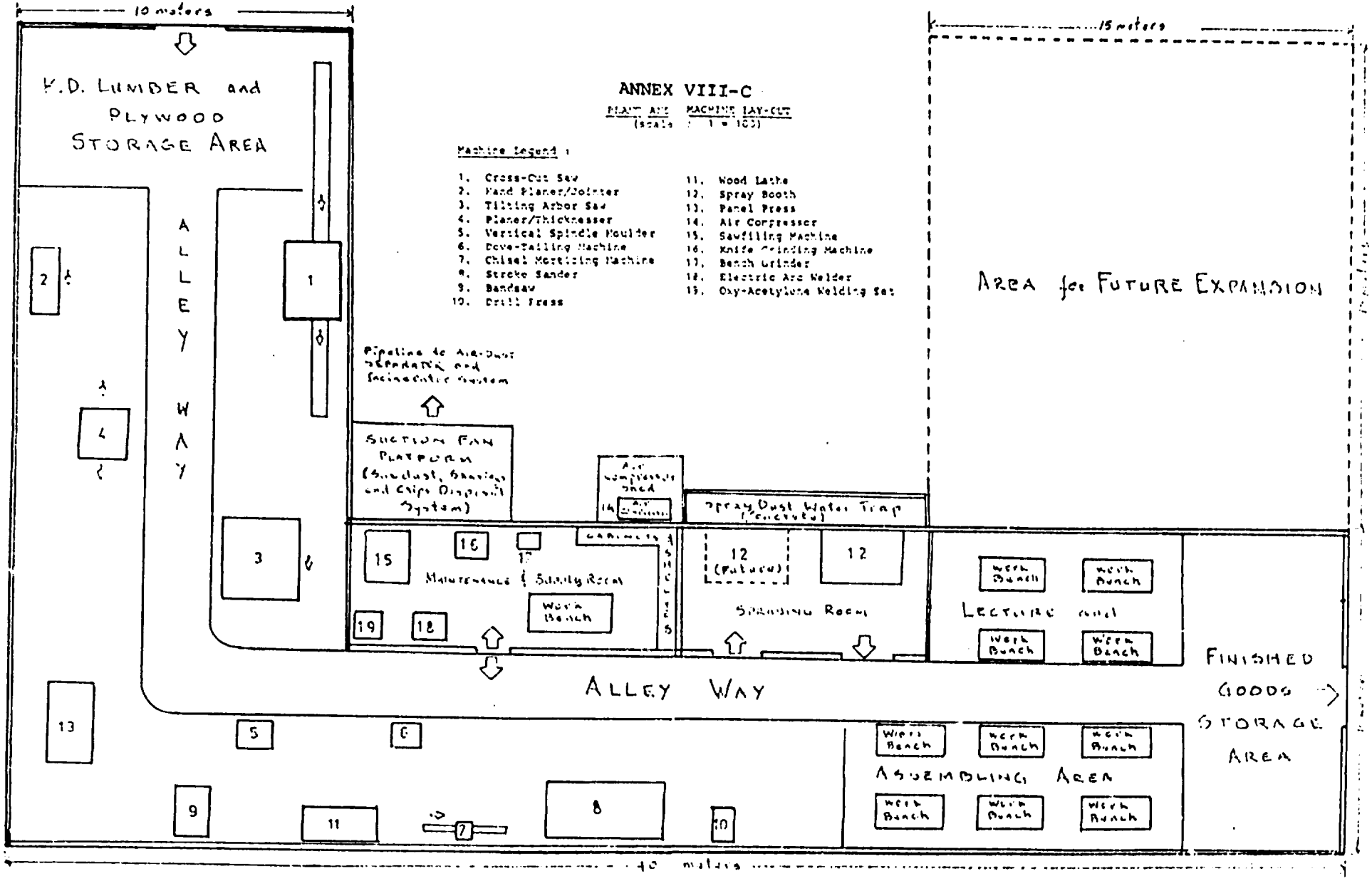
G. One Unit - SPRAY BOOTH, Dry Type with Exhaust Fan and Air Baffles, 3000 mm Width, 2000 mm Depth and 2440 Height, 0.75 kw, electric motor

H. Two Sets - SPRAY GUN with Cup (1 quart capacity) attachment, and AIR HOSE

I. One Unit - COMBINATION AIR FILTER and AIR PRESSURE REGULATOR, 40 CFM Capacity

ANNEX VIII-C

PLANT AND MACHINE LAY-OUT
(Scale : 1 = 100)



Machine Legend :

1. Cross-Cut Saw
2. Hand Planer/Jointer
3. Tilting Arbor Saw
4. Planer/Thicknesser
5. Vertical Spindle Moulder
6. Dove-Tailing Machine
7. Chisel Mortising Machine
8. Stroke Sander
9. Bandsaw
10. Drill Press
11. Wood Lathe
12. Spray Booth
13. Panel Press
14. Air Compressor
15. Sawfiling Machine
16. Knife Grinding Machine
17. Bench Grinder
18. Electric Arc Welder
19. Oxy-Acetylene Welding Set

ANNEX VIII-D

EXERCISES IN INDUSTRIAL WOODWORKING COURSE

INDUSTRIAL WOODWORKING III

EXERCISE No. IW-3.1

A. Title : FAMILIARIZATION WITH THE METRIC AND ENGLISH SYSTEMS OF MEASUREMENT

B. Objective : To familiarize the students with the metric and English systems of measurement and teach them how to convert metric measurements to English measurements, and vice-versa.

C. Tool/Machinery/Equipment:

(1) Steel tape (2 or 3 meters long), with both metric and English systems of gradation

(2) Standard Wooden folding meter (1-1/2 or 2 meters long)

(3) Ordinary 12" (30 cm.) ruler

D. Material : One piece of wooden slat for each group in the class, 12 mm (1/2") thick x 50 mm (2") wide x 300 mm (12") long

E. Procedure :

(1) At any point on the edge of the wooden slat mark point "A". Farther along the length of the slat mark point "B" any distance from "A".

(2) Each member of the group is required to take the following measurements in the English system, using each of the measuring tools available: (a) thickness of the slat; (b) width of the slat; (c) length of the slat; and (d) distance between the points "A" and "B".

(3) The same measurements are again taken, but this time in the metric system.

(4) The students are then required to convert the English measurements into metric measurements by multiplying each English system dimension by the factor 2.54. The computed results thus obtained are then compared with the dimensions taken in Step (3) above.

F. Remarks : The teacher should point out to the students the corresponding accuracies of their own measurements, as compared to the calculated conversions from the English to metric systems of measurement. Seatwork problems in converting metric measurements into English measurements should add to the measuring skills of the students.

EXERCISE No. IW-3.2

A. Title : THE VERNIER CALLIPER

B. Objective : To familiarize the students with the effective use and proper care of a vernier calliper

C. Tools/Machinery/Equipment :

(1) Vernier calliper

(2) Steel tape (2 or 3 meters long)

(3) Ordinary 12" (30 cm.) ruler

D. Material : One wooden slat with the same measurements as in Exercise No. IW-3.1 for each group in the class.

E. Procedure :

(1) Each student measures the thickness, width, length, and the distance between the points "A" and "B" on the wooden slat, using a vernier calliper as demonstrated by the teacher.

(2) The English measurements are then converted to metric measurements using the factor 2.54 as learned in Exercise No. IW-3.1.

F. Remarks : The teacher should point out to the students the accuracy within which a vernier calliper could be used to take either "outside" or "inside" dimensions. Another exercise maybe introduced, provided there is still time available, making use of the vernier calliper to measure the inside dimensions. The procedure will be as in paragraph (E) above.

EXERCISE No. IW-3.3

A. Title : THE MICROMETER CALLIPER

B. Objective : To familiarize and teach the students on the proper use and care of a micrometer calliper

C. Tools/Machinery/Equipment :

(1) A Micrometer calliper with Vernier scale

(2) Steel tape (2 or 3 meters long)

D. Material : One-inch flat washer; 1" diameter water pipe, galvanized, about 7 to 8" long and the wooden slat used in previous exercises.

E. Procedure :

(1) The "outside" diameter of the flat washer is measured with the use of micrometer calliper.

(2) The diameter of the hole at the center of the flat washer is measured with the aid of the micrometer calliper. This dimension is called "inside" dimension with respect to a calliper.

(3) The actual thickness of the wall of a water pipe is determined by taking the "inside" and "outside" dimensions of the pipe. The actual thickness is the difference between the two dimensions.

(4) The thickness of the wooden slat is determined with the aid of a micrometer calliper.

F. Remarks : Further exercises in determining "inside" and "outside" dimensions, using a micrometer calliper might be added to this exercise, in case the teacher feels that the students need additional exercises. The thickness of the wooden slat as measured by the micrometer calliper should be compared to the thickness measurements of the same slat taken during Exercises No. IW-3.1 and IW-3.2.

EXERCISE No. IW-3.4

A. Title : TRY-SQUARES AND THEIR USES

B. Objective : To familiarize and teach the students on the proper use of try-squares.

C. Tools/Machinery/Equipment :

(1) 90° (Right Angle) Try-square

(2) Bevelling (Adjustable) try-square

(3) Ordinary protractor (180 degrees)

D. Materials :

(1) A piece of 2" x 4" lumber, S4S

(2) A piece of 3/4" thick plywood panel with at least one edge bevelled

(3) A piece of 3/4" plywood panel with straight square edges

E. Procedure :

(1) The 90° try-square is set on the edge of the plywood panel and a line is drawn on the face of the panel. The try-square position is then reversed keeping the leading edge on the line previously drawn. Another line is drawn on the leading edge and the position of the two lines are checked. Any deviation between the two lines

indicate that the try-square is not square (i.e., is not 90°). If the second line falls exactly all its length on the first line drawn on the panel then the try-square is said to be true or 90°

(2) The angle of the bevelled edge on the plywood panel is measured by setting the bevelling try-square on the bevelled edge, adjusting the movable arm to fit the bevelled edge of the panel perfectly. The angle of the bevel is then measured with the aid of the protractor (i.e., if the bevelling try-square is not equipped with a protractor).

F. Remarks : The students should be given more exercises with both the 90° and the bevelling try-squares should the teacher find that the students need them.

EXERCISE No. IW-3.5

A. Title : PRODUCTION GAUGES

B. Objective : To familiarize the students with the use of a production gauge and make some simple gauges.

C. Tools/Machinery/Equipment :

(1) A production gauge used to check either the thickness or width of a piece of wooden furniture or joinery product component.

(2) Steel tape (2 or 3 meters long)

(3) Vernier Calliper

(4) Micrometer Calliper

(5) Try-Squares

D. Materials : Pieces of gauge 24, plain GI sheet

E. Procedure :

(1) The teacher indicates to each group of students the part of the production gauge whose dimensions they will measure. The dimension is measured with a simple calliper or a micrometer calliper or a steel tape.

(2) Each student is given a dimension for which a production gauge is to be made. The dimension is laid on a piece of plain GI sheet and the necessary gap to measure the dimension is cut with the aid of a tin snip. The accuracy of the dimension is then checked with the aid of a micrometer calliper.

F. Remarks : It is suggested that gauges to be used in the production of class projects be assigned to the student groups for fabrication as a part of this exercise.

EXERCISE No. IW-3.6

A. Title : WORKING DRAWINGS FOR MACHINING OPERATIONS

B. Objective : To impart to the students the technique of reading (or interpreting) working drawings for machining operations and make them realize the importance of the drawings in industrial production operations.

C. Tools/Machinery/Equipment :

(1) Samples of working drawings for machining operations

(2) Drafting scale

(3) Steel tape (2 or 3 meters long)

D. Materials : Machined furniture or joinery component which are represented by the working drawing samples.

E. Procedure :

(1) The important features of the working drawings are studied and listed by the students.

(2) Wherever indicated, the student will list machining tolerances, machining allowances and other operational instructions as depicted in the working drawing. (Note: If not indicated on drawings, the teacher should give the standard tolerances, and machining allowances used in industry.)

(3) The student will check the wooden component against the dimension given in the working drawing.

F. Remarks : The teacher may devise other exercises on this topic. The major aim of this exercise, however, should be to train the students to read the working drawing.

EXERCISE No. IW-3.7

A. Title : THE CROSS-CUT SAW

B. Objective : To familiarize and teach the students on the operations and proper care of the cross-cut saw.

C. Tools/Machinery/Equipment :

(1) Cross-cut saw

(2) Production gauges

(3) Steel tape (2 or 3 meters long)

(4) Working drawings of furniture or joinery product component parts

D. Materials : Pieces of lumber (of different sizes) which will be cut into components for class projects to be fabricated in the future.

E. Procedure :

(1) Each group is assigned a number of working drawings for component parts of furniture or joinery products to be manufactured in the future.

(2) The members of the group list the names of the component parts, their corresponding widths, thicknesses, and their calculated rough lengths to be cut on the cross-cut saw.

(3) The group then prepares the pieces of lumber needed to make the component parts.

(4) The cross-cut saw is set up to cut the desired lengths.

(5) The pieces of lumber are cut to the desired rough lengths and stored for future use after they have been checked with a production gauge.

F. Remarks : Other cutting assignments maybe given to the groups should it happen that there is still available time within the period assigned to take up studies on the cross-cut saw.

EXERCISE No. IW-3.8

A. Title : TILTING ARBOR SAW

B. Objective : To familiarize the students with, and teach them the operating procedures for a tilting arbor saw.

C. Tools/Machinery/Equipment :

(1) Tilting arbor saw

(2) Production gauges

(3) Steel tape (2 or 3 meters long)

(4) Working drawings of furniture or joinery product component parts

D. Materials : Pieces of lumber (of different sizes) which will be cut into components for class projects to be fabricated in the future.

E. Procedure :

(1) Each group is assigned a number of working drawings for component parts of furniture or joinery products to be manufactured in the future.

(2) The members of the group list the names of the component parts, their corresponding widths, thicknesses, and their calculated rough lengths to be cut on the tilting arbor saw.

(3) The group then prepares the pieces of lumber needed to make the component parts.

(4) The tilting arbor saw is set up to cut the desired lengths.

(5) The pieces of lumber are cut to the desired rough lengths and stored for future use after they have been checked with a production gauge.

F. Remarks : Other cutting assignments may be given to the groups should it happen that there is still available time within the period assigned to take up studies on the tilting arbor saw.

EXERCISE No. IW-3.9

A. Title : THE HAND PLANER/JOINTER

B. Objective : To familiarize and teach the students on the proper care and operating procedures for the hand planer/jointer.

C. Tools/Machinery/Equipment :

(1) Hand planer/jointer

(2) 90° try-square

D. Material : Pieces of lumber which have been cut in the preceding exercises to be fabricated into component parts of the furniture or joinery product assigned as class project. These pieces of wood should be segregated into those which are reasonably straight and another group composed of pieces of lumber which are bent or have significant curves along the length, or are cupped or warped.

E. Procedure :

(1) Two adjacent surfaces of the pieces of lumber which are reasonably straight are machined on the hand planer/jointer to obtain two faces which are smooth and square (90° to each other).

(2) The squareness of the two adjacent surfaces which were just machined is then checked with the aid of a 90° try square.

(3) Machining and checking operations are repeated until a perfect 90° angle is obtained between the two machined surfaces.

(4) The procedure is repeated this time for all of pieces of lumber which were grouped as those which are bent, warped or cupped or having significant curves.

F. Remarks : The teacher is reminded to point out to the students the result of improper machining on the hand planer/jointer operations. The teacher is also cautioned to keep close watch on the students using this machine as the operator is directly exposed to the cutterhead during operations.

EXERICSE No. IW-3.10

A. Title : THE PLANER-THICKNESSER

B. Objective : To familiarize the students with and teach them the proper care and operations of the planer-thicknesser.

C. Tools/Machinery/Equipment :

(1) Planer-thicknesser

(2) Production gauges for specific dimensions of component parts of the furniture or joinery products assigned as class projects.

(3) 90° try-square

D. Material : The pieces of lumber which have been machined under Exercise No. IW-3.9 and other pieces of lumber which are allocated for other purposes whether or not for class projects.

E. Procedure :

(1) The planer-thicknesser is set to admit the thickness of the pieces of lumber to be planed to the desired thicknesses. The machine is also set at the lowest feed speed obtainable from the machine.

(2) Two (2) pieces of lumber are machined at each speed setting. The planed surfaces are checked for smoothness and dimensions.

(3) The feed speed is then adjusted to the next higher level and procedures (1) and (2) are repeated.

(4) The same procedure is repeated using higher levels of feed speeds until the fastest feed speed obtainable from the machine is reached.

(5) The smoothness of the surfaces thus machined at different feed speeds are then compared.

(6) Procedures (1) to (5) are then repeated for all the other surfaces to be machined.

F. Remarks : The teacher should point out to the students the effects of higher feed speed on the smoothness of the surface. If time is still available, the teacher should demonstrate to the students how to machine tapered square legs for tables and other pieces of furniture using the "box planing" technique on the planer-thicknesser.

EXERCISE No. IW-3.11

A. Title : THE VERTICAL SPINDLE MOULDER (SHAPER)

B. Objective : To familiarize the students with, and teach them the proper care and operations of the vertical spindle moulder (shaper).

C. Tools/Machinery/Equipment :

(1) Vertical Spindle Moulder (Shaper)

(2) Production gauges for specific dimensions and edge profile of components parts of furniture or joinery product assigned as class projects.

(3) 90° try-square

D. Material : The pieces of lumber which have been machined under Exercises IW-3.9 and 3.10 which need to be machined on the shaper.

E. Procedure :

(1) The vertical spindle moulder (shaper) is set to machine the pieces of lumber to the desired edge profile, or squareness (in the case of a straight edged piece), using a shaping jig in one case and using the cutterhead collar (without a shaping jig) in the other case.

(2) The accuracy of the edge profile is then checked with the aid of a production gauge for correctness of shape and dimension of the profiled segments. In the case of straight edged pieces, the squareness of the edge with the other faces is checked with the aid of a try-square.

F. Remarks : The teacher should emphasize the safety guidelines on the use of the machine. As in the hand planing/jointing operation, operator's hands are directly exposed to the shaper's cutterhead.

Likewise, the safety procedures on starting the operation of the shaper should be followed very strictly.

EXERCISE No. IW-3.12

A. Title : THE DOVETAILING MACHINE

B. Objective : To familiarize the students with and teach them the proper operations and care of the dovetailing machine.

C. Tools/Machinery/Equipment :

(1) Dovetailing machine

(2) Steel tape (2 or 3 meters long)

(3) Production gauges

D. Material : Wooden blanks for drawer sides, drawer backs and drawer fronts, which are to be dovetailed. (Note: The thickness and width of the drawer components should conform to the requirements of furniture items under manufacture.)

E. Procedure :

(1) The machine is set to take in the thickness and width of the wooden blanks for drawer sides, backs and fronts.

(2) The machine is run to cut dovetails on the desired ends of the blanks.

(3) The dovetailed ends are checked with the dovetailing production gauge.

(4) One set of drawer side front and back are temporarily assembled and the "outside" and "inside" dimensions of the resulting box frame are checked with the steel tape.

F. Remarks : The teacher should emphasize the high level of precision required in dovetailing operations. The teacher should also point out the possible negative results arising from faulty feeding of the drawer components into the machine, so that the devetailed pieces will not match each other properly.

EXERCISE No. IW-3.13

A. Title : THE CHISEL MORTIZING MACHINE

B. Objective : To familiarize the students with and teach them the proper care and operations of the chisel mortizing machine.

C. Tools/Machinery/Equipment :

(1) Chisel mortizing machine

(2) Steel tape (2 or 3 meters long)

D. Material : All component parts which were machined in previous exercises and which need mortises to be machined for joining purposes.

E. Procedure :

(1) The chisel mortizing machine is set to machine mortises at the proper location on each piece of surface lumber.

(2) Mortises are then machined on the pieces of lumber.

(3) The depth, length and width of the mortises are checked with the use of the corresponding production gauges.

(4) The distances between the mortises on the same piece of lumber are checked with the aid of a steel tape.

F. Remarks : The teacher should emphasize the high level of precision required in this machining operation. The size of the mortise should be checked also with a piece of lumber whose end has been tenoned to the desired size (to match the mortise done on this machine).

EXERCISE No. IW-3.14

A. Title : THE STROKE SANDER, MACHINE SANDING OPERATION

B. Objective : To familiarize the students with and teach them the proper technique of sanding on the stroke sander and the proper care of the machine and sanding belt after use.

C. Tools/Machinery/Equipment :

(1) Stroke sander (single belt)

(2) At least two (2) grits of sanding belt, one coarse (180 Grit), the other finer (220 Grit).

D. Material : Plywood panels cut to size and pieces of lumber which were machined and surfaced during previous exercises, all intended to be component parts of furniture or joinery products which have been assigned as class projects.

E. Procedure :

(1) The coarser sanding belt (180 grit) is mounted on the sander's pulleys. The pulleys are then adjusted to give the desired tension on the sanding belt.

(2) The sander table is then adjusted to fit the first material to be sanded.

(3) After all lumber pieces have been sanded, the sanding belt is changed to the finer grit (220 grit), observing the proper procedures for mounting the sanding belt on the sander pulleys.

(4) The sander table is again adjusted, this time to fit the plywood panels to be sanded.

(5) All plywood panels are then sanded according to the procedures given by the teacher during the previous demonstration of the exercise.

F. Remarks : The teacher should point out to the students the difference in the smoothness of the surfaces sanded by the different grits of the sanding belt. He should also emphasize the principal objective in sanding operations, i.e., to prepare the wooden surfaces for finishing operations by making them not too rough nor too fine for the finish coatings.

EXERCISE No. IW-3.15

A. Title : THE NARROW BLADE BANDSAW

B. Objective : To familiarize the students with and teach them the proper operating procedure and care of the bandsaw.

C. Tools/Machinery/Equipment :

(1) Narrow blade bandsaw

(2) Production pattern for specific components of furniture and joinery products.

(3) Production gauges for specific components of furniture and joinery products.

(4) Steel tape (2 or 3 meters long)

D. Materials :

(1) Pieces of plywood panels, previously cut to desired sizes, to be bandsawn to the desired shape as components of furniture and joinery products.

(2) Pieces of lumber which are to be bandsawn into shapes and sizes required for specific components of furniture and joinery products.

E. Procedure :

(1) The bandsaw blade is set properly on the bandsaw pulleys, observing proper procedures to obtain the desired tension on the bandsaw blade.

(2) The bandsaw blade guide fixture is set up at a desirable distance from the bandsaw table for the thickness of the wooden pieces which have to be cut.

(3) The plywood panels are the first pieces cut to the desired shape or form.

(4) The bandsaw blade guide fixture is then reset to match the thickness of the next lumber pieces which have to be cut to the desired shape.

(5) The lumber pieces are then bandsawn into the desired shape and size.

F. Remarks : The teacher should warn the students of the bad effects of a poorly set or faulty bandsaw blade tension. The teacher should also be very strict on the observance of proper safety practices in connection with the operation of the bandsaw, again because the operator is exposed directly to the bandsaw blade.

EXERCISE No. IW-3.16

A. Title : THE DRILL PRESS AND BORING OPERATIONS

B. Objective : To familiarize the students with the proper operations and care of the drill press.

C. Tools/Machinery/Equipment :

(1) Drill press

(2) Production gauges for drilling holes

(3) Center punch and ball peen hammer

(4) Steel tape (2 or 3 meters long)

D. Material : Components for furniture and joinery products which were previously machined, and are ready for drilling operations.

E. Procedure :

(1) The proper size drill bit is installed in the drill chuck.

(2) Hole centers are located on the lumber pieces with the use of a center punch.

(3) The desired depth of the holes is set by installing a "drilling stopper" on the bit.

(4) The holes are drilled as per specifications.

(5) The locations, depth and diameter of the holes thus drilled, are checked with the aid of production drilling gauges.

F. Remarks : The teacher should emphasize the strict compliance with safety guidelines on drilling operations because, again in this case, the operator is exposed directly to the drill bit.

EXERCISE No. IW-3.17

A. Title : TURNING OPERATIONS ON THE SIMPLE WOOD LATHE

B. Objective : To familiarize the students with the proper operations and care of the wood lathe.

C. Tools/Machinery/Equipment :

(1) Simple wood lathe

(2) Steel tape (2 or 3 meters long)

(3) Simple caliper

(4) Production patterns for the specific profiles of the items

D. Material : Pre-cut lumber pieces which are to be turned into component parts of furniture products.

E. Procedure :

(1) The end chucks of the wood lathe are set to take in the lumber piece to be turned.

(2) The set of knives which are required by the specific profile to be turned are set on the turning tray in the proper order of use.

(3) The wood piece is marked into segments according to the lengths of each profiled pattern to be turned.

(4) The machine is started to produce the desired profile on the wood piece.

(5) The turned item is then checked for correctness of profile dimensions with the aid of the corresponding production pattern.

F. Remarks : The teacher should emphasize to the students the advantage of using sharp tools.
The students should also be cautioned to observe strictly the safety guidelines for turning operations, to prevent wood splinters or slivers getting into operator's eyes.

EXERCISE Nos. IW-3.18 & IW-3.19

A. Title : BUILDING UP PANELS ON THE HYDRAULIC PRESS, AND OTHER GLUING OPERATIONS

B. Objective : To familiarize the students with and teach them the techniques of building up panels with the aid of the hydraulic press.

C. Tools/Machinery/Equipment :

(1) Hydraulic press

(2) Glue mixing container

(3) Paint brush

(4) Water container

(5) Bar clamps

D. Material : Plywood panels cut to desired sizes; glue material (UF and PVA type); S4S lumber cut to desired widths and lengths; thin strips of surface lumber to be glued to the edges of built-up panels.

E. Procedure :

(1) Built-up Panels

(a) The components of the built-up panel are checked to match one another.

(b) Glue is applied on the plywood panels with the aid of a paint brush.

(c) The panels are then set on the pressing fixtures, being aligned together to form straight edges all around the panels.

(d) The pressing platforms are closed to press the glued panels together until the desired pressing pressure is attained.

(e) The panels are then clamped to the pressing fixtures with the aid of retaining bars.

(f) The clamped panels are then unloaded off the pressing platform and moved to the waiting area for overnight drying and storage.

(g) In the meantime, all glue squeeze-out on the edges of the built-up panel are wiped clean with the aid of a wet piece of rag.

(h) The retaining bars are loosened and the built-up panels are released after overnight drying.

(2) Edge Gluing

(a) Glue is applied to the edging strips and the edges of the built-up panels to form a complete solid wood edging around the built-up panel.

(b) The assembled edgings are then clamped to the built-up panels with the aid of bar clamps and allowed to stand under pressure for at least overnight.

(c) The glue squeeze-out on the edges of the panel are wiped off with a wet piece of rag.

(d) The bar clamps are released after overnight drying.

F. Remarks : The teacher should point out to the students the need for organization and cleanliness during the pressing operations. The most important feature of the operations is the attainment of the correct pressing pressure, followed by wiping off the glue squeeze-out after the panels or edgings have been clamped together.

EXERCISE No. IW-3.20

A. Title : HAND SANDING OPERATIONS

B. Objective : To familiarize the students with, and teach them the techniques of hand sanding furniture and joinery components in preparation for finishing operations.

C. Tools/Machinery/Equipment :

(1) Sanding blocks for straight edges and profiled edges

(2) Small sheets of sanding paper cut to fit the sanding blocks, (200-240 grit) may be used.

D. Material : Machined furniture and joinery components, built-up panels with edgings and such other components of the furniture and joinery products assigned as class projects.

E. Procedure : The machined wooden components and built-up panels are sanded with the proper grit and type of sandpaper for plain surface sanding or cloth back abrasive, for profiled surface sanding. Whenever required, built-up panels may be sanded on the stroke sander.

F. Remarks : The teacher should point out to the students the texture of the panel or wooden surface which have been properly sanded and is ready for finishing operations. The teacher should also remind the students of the safety guidelines for sanding operations in order to avoid inhaling sanding dust.

EXERCISE No. IW-3.21

A. Title : APPLICATION OF FINISH COATING SYSTEMS

B. Objective : To familiarize the students with and teach them the proper technique of applying systems of coating materials (paints and varnishes) on wooden surfaces.

C. Tools/Machinery/Equipment :

(1) Spray gun and air supply system

(2) Paint brushes, different sizes

(3) Spraying stand and spraying fixtures

(4) Spray booth with air exhaust system

D. Material : Sufficient number of step panels (1/4" x 6" x 12" plywood pieces); complete system of materials for lacquer coating system (wood stain, wood filler, sanding sealer, clear lacquer top coat, lacquer thinner); system of materials for shellac (shellac flakes, denatured alcohol, wood stain); 1" wide gummed tape.

E. Procedure :

(1) Preparation of Step Panels for Lacquer System

(a) The 6" x 12" plywood panels are cleaned and sanded properly.

(b) A 2" wide strip at one end is taped off.

(c) The panel is then sprayed with wood stain of the desired color and tone.

(d) The stain is allowed to dry.

(e) A 1" wide strip next to the strip covered in the previous operations is also covered with tape.

(f) Wash coat is then sprayed on the rest of the panel and allowed to dry.

(g) The same application and drying and taping procedures are repeated for the succeeding coats of the finish system until all the component materials of the system have been applied to the step panel.

(h) The tapes are removed after sufficient drying (at least overnight) of the finish coatings.

(2) Step Panel for Shellac System

(a) The 6" x 12" plywood panels are inspected, cleaned and sanded properly.

(b) A 2" strip at one end of the panel is covered with gummed tape.

(c) The rest of the panel is then sprayed with the desired wood stain and allowed to dry.

(d) A 1" strip of the panel next to the 2" strip covered in the preceding operation is also covered with the tape and the rest of the panel is sprayed with shellac solution up to a certain thickness.

(e) The tapes are stripped when the shellac coating is sufficiently dried.

(3) Finish Coating for Funiture and Joinery Component Parts

The procedure implemented in part (1) of this exercise is repeated on the components (solid wood or built-up panels) of furniture and joinery items which have been assigned as class projects. This time, however, the tape is not used to block off any portion of the wooden pieces to be finished.

F. Remarks : The teacher should emphasize to the students the importance of maintaining a very orderly, neat and clean finishing area. The teacher should also point out to the students the safety guidelines as far as finishing operations is concerned, particularly the fire hazard situations commonly encountered in finishing areas and operations.

INDUSTRIAL WOODWORKING IV

EXERCISE No. IW-4.1

A. Title : CIRCULAR SAW FILING (OR GRINDING) OPERATIONS

B. Objective : To familiarize the students with and teach them the proper techniques of filing (or grinding) circular sawblades.

C. Tools/Machinery/Equipment :

(1) Circular saw filing (or grinding) machine

(2) Steel file

(3) Saw-tooth setting tool

D. Material : Dull circular sawblades of different type and sizes.

E. Procedure :

(1) The sawblade is checked for leveling and tension. Required adjustments in leveling and tension are done before the sawblade is mounted on the sawfiling (or grinding) machine.

(2) The circular sawblade is properly mounted on the sawfiling (or grinding) machine and adjustments on the tooth feed and filing speed are set to the desired levels.

(3) The sawfiling (or grinding) machine is started and run for a short time (not more than 2 minutes) and some more adjustments are done, if required.

(4) The sawfiling (or grainding) machine is left in operation until all the teeth on the circular sawblade are properly filed (or ground).

(5) The sawfiling (or grinding) machine is stopped and the sawblade is taken off from the machine.

(6) The sawblade is then given the desired set using the saw-tooth setting tool.

F. Remarks : The teacher should emphasize the importance of each step in the sawfiling operations. The standard safety precautions should also be observed strictly to prevent any accident happening during the sawfiling exercises.

EXERCISE No. IW-4.2

A. Title : BANDSAW BLADE FILING (OR GRINDING) OPERATIONS

B. Objective : To familiarize the students with and teach them the proper techniques of filing (or grinding) bandsaw blades.

C. Tools/Machinery/Equipment :

(1) Bandsaw blade filing (or grinding) machine

(2) Steel file (or grinding wheels)

(3) Saw-tooth setting tool

D. Material : Dull bandsaw blades

E. Procedure :

(1) The bandsaw blade is checked for leveling and tension. Required adjustments in leveling and tension are done before the the bandsaw blade is mounted on the bandsaw blade filing (or grinding) machine.

(2) The bandsaw blade is properly mounted on the bandsaw filing (or grinding) machine and adjustments on the tooth feed and filing speed are set to the desired levels.

(3) The bandsaw blade filing (or grinding) machine is started and run for a short time (not more than 2 minutes) and some more adjustments are done, if required.

(4) The bandsaw blade filing (or grainding) machine is left in operation until all the teeth on the bandsaw blade are properly filed (or ground).

(5) The bandsaw blade filing (or grinding) machine is stopped and the bandsaw blade is taken off from the machine.

(6) The bandsaw blade is then given the desired set using the saw-tooth setting tool.

F. Remarks : The teacher should emphasize the importance of each step in saw-filing (or grinding) operations. Required safety precautions should also be taken to prevent any accident happening during the sawfiling operations.

EXERCISE No. IW-4.3

A. Title : KNIFE GRINDING OPERATIONS

B. Objective : To familiarize the students with , and teach them proper techniques of knife grinding operations, both for plain straight knives and profiled knives.

C. Tools/Machinery/Equipment :

(1) Knife grinding machine

(2) Grinding stones of different grit (or fineness) as recommended by the supplier.

(3) Honing stone

D. Material : Dull planer knives or shaper knives (plain or profiled)

E. Procedure :

(1) The dull knives are checked for "nicks" or "edge cracks". Corresponding grinding marks are made on the knives based on the extent of defects detected on the knives.

(2) A knife is then installed on the knife holder fixture of the grinding machine.

(3) The machine is set to the correct depth of grinding by raising or lowering the knife holder as desired.

(4) The grinding wheel motor is then started.

(5) Periodic checks on the grinding operations are done to ensure that the knife is not heated excessively thus making it unsatisfactory for long periods of use.

(6) The grinding wheel is stopped as soon as the desired grinding depth and sharpness is achieved and the knife is unloaded from the knife holder fixture.

(7) The knife edge is made smooth is made smooth using a hosing stone.

F. Remarks : The teacher should emphasize to the students the need for caution and slowness of bite in order not to heat the knife excessively. A separate exercise may be done on profiled knives. This, however, has to be done on a free hand basis, using the bench grinder and on an improvised knife holding device.

EXERCISE No. IW-4.4

A. Title : JIGS FOR MACHINING OPERATIONS IN WOODWORK PLANTS

B. Objective : To familiarize the student with and teach them the proper techniques of improvising machining jigs for selected basic woodworking machines.

C. Tools/Machinery/Equipment :

Sheet metal working and woodworking tools and equipment as required by the fabrication activities.

D. Material : Pieces of lumber, sheet metal (18 to 24 gauge), flat iron bar, bolts and nuts, nails and wood screws, as required.

E. Procedure :

(1) Each group is assigned a basic woodworking machine and a specific component part of either a furniture or joinery product which is expected to be processed on the machine assigned to the group.

(2) The group is expected to design and fabricate a machining jig which will help speed up the machining of the assigned component part on the assigned machine.

F. Remarks : The teacher should follow closely and encourage ideas brought up by the students in their effort to devise a machining jig according to their specific assignments. The teacher should also provide guiding suggestions so that this project can be finished within the alloted length of time.

EXERCISE No. IW-4.5

A. Title : FULL-SIZING AND TECHNICAL DRAFTING FOR INDUSTRIAL WOODWORKS OPERATIONS

B. Objective : To familiarize the students with and teach them the proper techniques in full-sizing and technical drafting for components of furniture or joinery products which are to be manufactured on an industrial scale.

C. Tools/Machinery/Equipment :

Drafting tools and equipment

D. Materials : Samples of woodworks or joinery products preferrably knock-down; drafting (or full-sizing) paper

E. Procedure :

(1) Each group is assigned a piece of furniture or joinery product for full-sizing and/or technical drafting activities.

(2) Each student member of the group is assigned to prepare a technical working drawing or full size drawing, whichever is required, of one component part of the product assigned to his group.

(3) The steps in preparing the drawings, as discussed during the lecture portion of this session, should be followed strictly. All drawings must be approved by the teacher before they are accepted for actual use in the fabrication of the respective component parts.

F. Remarks : The teacher should encourage full discussions on the merit or demerit of the drawings presented by the students. He should point out the mistakes commonly commited by the students, and the corresponding methods of avoiding them in the future. Any drawing which does not technically represent the component part to be manufactured should be reworked before the student assigned to prepare that drawing is allowed to go ahead with his part in the class project.

EXERCISE No. IW-4.6

A. Title : LABOUR USAGE AND PRODUCT COST

B. Objective : To acquaint the students with and teach them the proper procedure in calculating product cost.

C. Tools/Machinery/Equipment :

(1) paper and pencil

(2) calculator (if available)

D. Material : Simulated reports on labour and materials used in the fabrication of certain components of wooden furniture or joinery products.

E. Procedure :

(1) Each group in the class is assigned a piece of furniture or joinery product for costing purposes.

(2) The group is provided with the necessary data on labour, material, machine hours, and other basic cost elements required by the exercise.

(3) The corresponding cost of the product is obtained by using the costing technique discussed in previous sessions of the class.

F. Remarks : The teacher should emphasize the importance of accurate costing technique. The students should also be encouraged to discuss the mistakes they commited during costing exercises.

ANNEX VIII-E

CLASS PROJECTS IN INDUSTRIAL WOODWORKING COURSE

I. INDUSTRIAL WOODWORKING III

A. CLASS PROJECT A-1 : BASIC INDUSTRIAL PRODUCTION

(1) Objective :

To illustrate the machining precision required of wooden components of furniture or joinery products which will allow them to be interchanged from one unit to another, without the necessity of adjustments to fit the other component parts.

(2) Suggested Item for Assignment as Class Projects :

(a) Elementary school desk, with seat for two pupils

(b) Class seat for high school student with writing extension arm

(c) Kitchen or laboratory stool

(d) Other furniture and joinery items of simple design

(3) Procedure :

(a) Only one type of furniture or joinery product, as chosen by the teacher, will be produced by all the groups composing the class.

(b) Each group will produce two (2) units of the same product, observing the steps discussed during the previous sessions of the class.

(c) As soon as all the groups have completed machining operations and the parts are ready for assembling, the teacher will require each group to exchange at least one (1) unit of each principal component part with another group. Then and only then will final assembling be allowed to commence.

(d) More or less, the steps to be followed are as follows :

i - a material list should be prepared to include all materials, with estimated quantities, required to produce the assigned class project.

ii - working drawings should be prepared for each of the component parts of the class project. All the groups in the class will cooperate in preparing the working drawings, each group preparing the drawings for at least one (1) component part. The completed working drawings will then be checked by the teacher, and discussed by the whole class before actual production operation is started.

iii - a list of machining operations, together with the corresponding machining jigs needed to produce the component parts, should be prepared by each group of the class.

iv - machining operations will be performed according to the list of operations prepared by the student, and approved by the teacher.

v - a class session will be alloted to discuss the problems, the significant portions of the exercise, and the corresponding solutions improvised by the groups in order to solve the problems that developed during the exercise.

II. INDUSTRIAL WOODWORKING IV

A. CLASS PROJECT A-2 : PRODUCTION OF A JOINERY PRODUCT

(1) Objective :

To fully develop the students' potential for possible work in joinery factories (or shops) in the country by requiring them to produce standard joinery items on an industrial scale.

(2) Suggested Items for Assignment as Class Projects :

(a) Window frame with jambs

(b) Flush door with door jambs

(c) Movable room divider

(d) Railings and bannisters for stairs

(e) Any other joinery product which could be conveniently manufactured using the available stock of raw materials.

(3) Procedure :

(a) Each group is assigned a different type of joinery product.

(b) At least two (2) units of the joinery product should be produced by each group. The final number of units to be produced by each group will be determined by the teacher.

(c) A complete list of materials, with corresponding quantities, should prepared by each group, to meet the material requirements of the product that the group is assigned to produce.

(d) Each group shall prepare a list of operations which are required to machine the component parts of the product according to specifications.

(e) Actual production operations will be started only after the teacher has approved the list of materials and the list of operations prepared by the students. These lists will be used by the teacher as the basis for preparing a schedule of machine usage so that each group will have access to the required machine at the time they need the machine.

(f) In case machining jigs will be required, the group needing the machining jig will have to design and fabricate the jig, if they are not already available.

(g) After all the assigned projects have been completed, the groups will be required to prepare actual cost calculations of the joinery product they produced.

(h) At least one (1) class session (3 hours) should be devoted to discussion of problems encountered during the exercise, and the solutions devised by the students to solve these problems.

(4) Remarks :

The teacher, assisted by the shop technician, should make himself available at all times during the course of this exercise. He should also be very strict in observing and enforcing safety regulations as discussed in previous sessions of this course.

B. CLASS PROJECT A-3 : PRODUCTION OF A FURNITURE PRODUCT

(1) Objective :

To fully develop the students' potential for possible work in furniture factories (or shops) in the country by requiring them to produce standard furniture items on an industrial scale.

(2) Suggested Items for Assignment as Class Projects :

(a) Dining table and chair set for four (4)

(b) Teacher's desk with teacher's chair

(c) Buffet cabinet

(d) Living room set consisting of one (1) sofa, two (2) end chairs and one (1) coffee table

(e) Any other furniture items which could be conveniently produced from the available stock of raw materials.

(3) Procedure :

(a) Each group is assigned to produce a different type of furniture product.

(b) At least two (2) units of the furniture product should be produced by each group. The final number of units to be produced by each group will be determined by the teacher.

(c) A complete list of materials, with corresponding quantities, should be prepared by each group, to cover the requirement for the product that the group is assigned to produce.

(d) Each group shall prepare a list of operations which are required to machine the component parts of the product according to specifications.

(e) Actual production operations will be started only after the teacher has approved the list of materials and the list of operations prepared by the students. These lists will be used by the teacher as the basis for preparing a schedule of machine usage so that each group will have access to the required machine at the time they need the machine.

(f) In case machining jigs will be required, the group needing the machining jig will have to design and fabricate the jig, if they are not already available.

(g) After all the assigned projects have been completed, the groups will be required to prepare actual cost calculations of the furniture product they produced.

(h) At least one (1) class session (3 hours) should be devoted to discussion of problems encountered during the exercise, and the solutions devised by the students to solve these problems.

(4) Remarks :

The teacher, assisted by the shop technician, should make himself available at all times during the course of this exercise. He should also be very strict in observing and enforcing safety regulations as discussed in previous sessions of this exercise.

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