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Study Group on Production Techniques in Wooden Houses under Conditions Prevailing in Developing Countries
Vienna, Austria, 17 - 21 November 1969

PRODUCTION OF JOINERY FOR TROPICAL COUNTRIES

by

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Addendum

ANNEX III

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PRODUCTION OF JOINERY FOR TROPICAL COUNTRIES 1/

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Contents

Bibliography:

1. F. E. Kelsey: Carpentry, Joinery and [illegible] Machinery, Macmillan, London 1954
2. Scharff Robert: Complete Book of [illegible], New York, McGraw-Hill 1956
3. Bois [illegible], Plaquette [illegible], Centre Technique Forestier [illegible]
4. F. H. Armstrong: Timber for [illegible], Bulletin No. [illegible], Department of Scientific and Industrial Research, London 1957
5. J. Eastwick-Field, J. Stillman: The Design and Practice of Joinery. Architectural Press, London 1958
6. W. R. Holtrop, H. [illegible]: Modern Machine Woodworking. Bruce Publ. Co. Milwaukee [illegible]
7. Bauer, Klifner, Mareš, [illegible]: Stavební truhlářství (The Joinery), Státni nakladatelství technické literatury, Praha [illegible]
8. Non-pressure Methods of Applying Wood Preservatives, Department of Scientific and Industrial Research, Report No. [illegible], London [illegible]
9. J. Bim: Manufacture of Doors and Windows, Background Paper No. 2, FAO Fellowship Study Tour of Woodworking Industries in Czechoslovakia, Published by State Forest Products Research Institute at [illegible] [illegible]
10. J. L. Feirer: Woodworking for Industry. Bennett, Peoria 1963
11. D. S. R. Leighton: International Marketing. McGraw-Hill, New York 1966
12. Timbers and Board Materials used in the Furniture Industries, Forest Product Research Laboratory, Princes Risborough 1966
13. W. J. Stanton: Fundamentals of Marketing. McGraw-Hill, New York 1967
14. Ensuring Good Service Life for Window Joinery, Technical Note No. [illegible], Ministry of Technology Forest Product Research Laboratory, Princes Risborough Aylesbury Bucks 1968
15. Australian Standards: AS [illegible]-1965, AS [illegible]-1966
    British Standards: [illegible]5-1954
    Indian Standards: IS 1141, IS 3629, IS 2338/I.,II., IS 3845, IS 2894, IS [illegible]83-1956, IS 287, IS 2366, IS 848-1957, IS 850-1957, IS 851-1957, IS 852-1957
16. Periodicals: Woodworking Industry, Wood, Bois et Forets des Tropiques, The Australian Timber Journal, Industrial Woodworking

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Study Group on Production Techniques in Wooden Houses under Conditions Prevailing in Developing Countries

Vienna, Austria, 17 - 21 November 1969

SUMMARY

PRODUCTION OF JOINERY FOR TROPICAL COUNTRIES 1/

by

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The report gives a general survey of the joinery industry with regard to tropical countries. Owing to an exceptional variety of products and sizes of production units, only the main features of various aspects are outlined, namely:

(1) the materials used in joinery production (solid timber, wood-based panels, glues and paints) with emphasis on the role of the climatic conditions influencing their selection and use in the tropical countries;

(2) the design problems, giving the general principles governing the construction, size and shape of the individual component parts and the design of joints to satisfy the expected functional and aesthetic requirements, in this connection, the advantages and potential implications of standardization upon joinery firms are mentioned;

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(3) the manufacturing processes, bringing together an overall view of various features to be considered in the machining of sections, assembling, preserving and finishing of joinery articles (shown on the example of the production of wooden framed doors);

(4) the choice of machinery with regard to the type of joinery firms prevailing in the tropical countries (stressing the implications of long-term product-market strategy of a firm influencing the selection of machinery and the importance of lay-out of machinery and materials handling);

(5) the marketing problems with brief references to marketing strategy as an important aspect influencing the choice of machinery, design of products, standardization, etc.; general notes about marketing concept and an overall survey of factors affecting price-setting decisions in a joinery firm;

(6) the vocational training, introducing the implications of the recent dynamic changes in the joinery trade (joinery firms are diverging into two major categories: small, general joinery shops and big, specialized mass-production factories) upon the structure of labour forces, skills required and occupational training.

In conclusion, the major problems concerning the prospects of the joinery trade in tropical countries are outlined, especially with regard to the expected developments in the future demand for joinery products, and the trends in prefabrication of joinery and industrialization of housing construction.

The report is complemented with two appendices - a list containing the characteristics of selected timbers, and a survey of fundamental machinery suitable for joinery production in tropical countries.

1. INTRODUCTION

In the present report, the authors shall attempt to give a general survey of the joinery industry with regard to the tropical countries. Since it is extremely difficult to include within the restricted limits of this paper all necessary details which could be of interest to all potential readers - architects, builders, joiners - we shall be able to outline only the main features of various aspects of this important branch of woodworking industries.

It is certainly not the intention to bring down a comprehensive list of all items produced by the joinery industry, with their almost infinite variety of design and construction. Practically all the woodwork which is exposed to view in a finished building - among others:

Windows, framed and flush doors, door frames,
built-in storage units, such as cupboards, wardrobes and kitchen units,
staircases,
shelving,
panelling, insulation board linings,
partitions,
components for industrialized buildings, such as wall pahels and curtain wall units, etc., etc. -
is involved into the term " joinery ".

The joinery industry is characterized with exceptionally wide limits as for the economic size of the production units.
Two extreme types of joinery works may be distinguished:

1) small joinery shops which carry out small scale traditional joinery of all types and sizes; their activity often extends to furniture and cabinet making; these shops have little production capacity and serve only the local and regional markets;
2) mass-production, specialized joinery firms which manufacture a limited range of products, e.g. only doors and windows of standard types and sizes; these firms generally supply the bulk of the joinery for the building industry;

because of the volume of work they are able to produce more efficiently and economically; on the other hand, however, they are to a certain extent more vulnerable as they require a nation-wide, or even international market.

Joinery firms fall between these two extremes, namely in the category of medium-size plants. But it seems reasonable to expect that the trends in the economic sizes of joinery firms will diverge to these two extreme types, since it is likely that the building market, especially low-cost housing programmes, might be more or less oriented to the highly standardized or very specialised joinery. The very small joinery shops which mostly produce non-standardized items will be less affected by big ones (than medium-size firms), since the demand for this type of joinery is not likely to disappear, as there will be always a certain market for individually designed joinery and for repair work - even if the differences in the price levels of standardized and non-standardized products will be undoubtedly substantially wider than under present conditions.

The main aim of these introductory lines is not, however, to analyse the prospects of the joinery industry - this matter will be treated in the last chapter of this report. First, within six chapters, the authors will try to bring together the presentation of the essential facts about:

- the materials used in the joinery production with an emphasis on the role of the climatic conditions influencing their selection in the tropical countries,
- the design problems,
- the manufacturing processes, stressing also the questions of the preservation and finishing, especially of external joinery,
- the choise of machinery with regard to the type of joinery firms prevailing in the tropical countries,
- the marketing problems: in view of the differences in the nature of markets, this chapter will be limited to a draft of general principles, and the vocational training.

2. MATERIALS

2.1. Solid timber

2.1.1. General characteristics

Considering the fact that tropical timbers are of different mechanical and physical properties and therefore also of different technical properties, it is necessary to select for every case the specific sort of timber, corresponding with its characteristics to the use and construction.

As for the selection for joinery, there are different timbers for the use in internal and external joinery. Mostly, timber for the external use are suitable for the internal wood construction too.

Generally, the characteristics of timbers for the internal and external joinery are.

1) medium up to high mechanical strength
2) easy to mechanical processing and working
3) ability to hold lacquers and paint
4) good appearance of unpainted timber
5) adhesive and bond strength
6) easy to dry and little working of parts when dried
7) sufficient resistance to biological factors (both fungal and insect)
8) resistance to weather effects
9) easy penetration of preservatives into the wood

The last three above mentioned properties are very important and nearly necessary for external joinery, where the products are exposed to disadvantageous weather effects and biological attacks.

The characteristics of timbers available for joinery including their technological properties are introduced in corresponding papers.

Timbers are to be selected on the basis of necessary properties; after their elementary mechanical processing - the qualitative selection is exercised - classification regarding defects, occuring in sawn timber and cut sizes.

2.1.2. Timber grading factors

Two main factors are considered in the grading of sawn timber:

1) Natural defects

2) Manufactured defects or defects caused by poor manufacture.

Combinations of the above factors considered with respect to the final use or purpose of sawn timber determine the classification of grade or quality of stock into which a board may fall.

Knots. Encased or loose knots are formed around dead or broken limbs. Intergrown knots or knots of which the annual growth rings are completely intergrown with those of the surrounding wood. When the limb is sawn at right angles, round knots are produced; when the cut is diagonal, an oval knot is produced. Pin knots are less than 1/2" in size. Small knots are 1/2" to 3/4". Medium knots are 3/4" to 1 1/2". Large knots are more than 1 1/2" in size.

Pitch pockets. An opening parallel to the annual rings of growth and usually containing pitch in either solid or liquid form is called a pitch pocket.

Checks. A lengthwise separation of the wood caused by shrinkage is called a check.

Splits. A tearing apart of the cells due to improper handling or storage is termed a split.

Heart shakes. A defect at the heart of a tree due to shrinkage in the live tree because of decay.

Wind shakes. Defects resulting from wrenching of the live tree by high wind causing the annual rings to separate.

Cross grain is grain not parallel to the length of a board. It may be either spiral, diagonal, or a combination of the two.

Crook. A board in which the edge is convex or concave.

Bow. A board in which the face is convex or concave.

Twist. A turning or winding of the edges of a board.

Warp is any deviation from a straight line, such as crook, bow, cup, or twist; usually a combination of two or more of these conditions.

Wane. Bark, or lack of wood or bark, on the edge of a board.
Decay. The desintegration of wood from any of number of causes.
Stain is discoloration caused by fungi or as the result of drying.
Worm holes. Holes caused by insect or beetles are called insects or worm holes.
Imperfect manufacture. Variations in sawing, torn grain, loosened grain, skip, mismatched material, machine turn, hit and miss surfacing and chipped grain are all classed under imperfect manufacture.

2.1.3. Moisture in wood and shrinkage

Sawn timber freshly cut from the log is said to be " green ", which means that it contains the natural moisture grown in the tree. Sawn timber that has attained a degree of dryness through the process of seasoning and has later been subjected to damp atmospheric conditions or rain and has absorbed moisture because of exposure is said to be " wet ".

Green wood contains water which saturates the fiber and fills the pores or cells. The point in the drying or wetting of wood at which the cell walls are saturated and the cell cavities are free from water is called the fiber saturation point.

Wood, like many other materials shrinks as it loses moisture. Shrinkage occurs when the moisture content is lowered beyond the fiber saturation point; for most woods this point is between 25% and 30% moisture content. Sawn timber containing 12% to 15% moisture will have shrunk about one half its total possible shrinkage. Wood shrinks most in the direction of the annual growth rings (tangentially). Only a small amount of shrinkage occurs along the grain (longitudinally).

2.1.4. Limits of the moisture content

It is essential that the timber should be well seasoned before use and should have attained a moisture content as near as possible to the value that will be attained in equilibrium with the average atmospheric conditions in service. The limits of the moisture content are not the minimum to which timber [illegible] should be seasoned, but are the maximum permissible for timber to be used for a particular store in any zone. For the particular use the Indian Standard [illegible] acceptable as it divided the country into four zones, according to the annual rainfall, or to the annual relative humidity of air.

Zone I [illegible] area, having an annual rainfall below 500 mm (or 20 in.), or average annual relative humidity less than 40 percent.

Zone II Moderately dry area, having an annual rainfall of [illegible] to 1,0[illegible] mm ([illegible] to [illegible] in.), or average annual relative humidity [illegible] - 50 per cent.

Zone III Moderately humid area, having an annual rainfall of 1000 to 18[illegible]5 mm (40 to [illegible] in.), or average annual relative humidity 60 - 67 per cent.

Zone IV Humid area, having an annual rainfall over 1875 mm (75 in.), or average annual relative humidity more than 67 per cent.

The maximum permissible limits of moisture content recommended for timber required for various wooden stores and uses in each of the four zones are given in the following table.

	Moisture content, per cent (max.)			
	Zone I	Zone II	Zone III	Zone IV
Doors and windows				
a) [illegible]0 mm and above in thickness	10	12	14	16
b) thinner than [illegible] mm	8	10	12	14
Fl[illegible]ring strips for general purposes	8	10	10	12
[illegible]ing strips for tea [illegible]	[illegible]	1[illegible]	14	16
[illegible]ure and cabinet making	10	12	14	1[illegible]

[illegible]imum permissible moisture content in all zones shall be 10%.

2.1.3. <u>Choice of species</u>

Selection of timber species for joinery is necessarily governed by the suitability of wood species for machine woodworking and availability in the quality required for joinery manufacture.

The specification of timber specified for use in joinery such as windows, window frames, doors, door jambs and door jamb linings, curtain walling has two grades - selected grade and standard grade.

<u>Selected grade</u> applies to joinery intended for use in interior and exterior situation and to be clear finished on some or all of the surfaces.

The pieces shall be of sound wood, without strong contrast in colour, and dressed straight. Species which have sapwood susceptible to insects attack shall not have sapwood on the exposed faces. The grain shall run generally straight. The slope of grain in pieces of cross-sectional area less than 4 sq.in. shall not exceed 1 in 10, and in pieces of cross-sectional area of 4 sq. in. or greater shall not exceed 1 in 12.

Exposed faces and edges shall be free from blemishes.

On concealed faces and edges the following shall be permitted:

1) Gum veins - not exceeding 1/8 inch wide, combined length not exceeding one-half the length of piece, and not more than one vein at any cross-section of less than 4 sq. in.
2) Gum pockets - pieces of an original nominal cross-sectional area of 12 sq. in. and greater only, and not more than one pocket up to 4 in. long by 1 in. by 3/8 inch per 2-ft length of the piece.
3) Knots - diameter not exceeding one-sixth the width of the face on which they occur, and not more than one knot in any 2-ft length of the piece.
4) Pinholes.
5) Other holes - not exceeding 1/2 inch diameter or width by 3 in. long, and not more than one hole in any 2-ft length of the piece.
6) Machinings defects - slight and not impairing the fixing of the piece.

<u>Standard grade</u> applies to joinery intended for use in interior [illegible] exterior situations. Although some blemishes are permitted, [illegible] be accepted for uses requiring a less exacting standard [illegible] finish than is provided for selected grade. The quality [illegible] for is [illegible] adequate for uses where the exposed [illegible] are to [illegible] finish.

[illegible] pieces shall [illegible] wood [illegible] straight. Species [illegible] have [illegible] shall not have [illegible] on the [illegible] faces. The grain shall run generally strai- [illegible] slope of grain in pieces of cross-sectional area less [illegible] in. shall not exceed 1 in [illegible], and in pieces of cross- [illegible] area of [illegible] in. or greater shall not exceed 1 in 12.

[illegible] faces and edges shall be free from blemishes, other than the following:

1) Tight gum veins - not exceeding [illegible] inch wide: individual lengths not exceeding 12 in; aggregate length of the veins in the piece not exceeding one-half the length of the piece: and not more than one vein at any cross-section of less than [illegible] sq. in.
2) Pinholes.
3) Knots, sound and tight - diameter not exceeding one-sixth the width of the face on which they occur, and not more than one knot in any [illegible]-ft length of the piece.

In addition to the blemishes allowed in concealed faces and edges shall be permitted to contain the following:

1) Gum pockets - in pieces of original nominal cross-sectional area of 12 sq. in. and greater only, and not more than one pocket up to [illegible] in. long by [illegible] in. by [illegible]/8 in. per 3-ft length of the piece.
2) Holes - not exceeding 1/2 inch in diameter or width by [illegible] in. long and not more than one hole in any 3-ft length of the piece.
3) Machining defects - not impairing the fixing of the piece.

2.2. Sheet materials

2.2.1. Plywood

2.2.1.1. Three ply and multiply

Three ply construction includes a " face ", a " back ", and a core or inner ply. Multiply includes a face and a back, usually with a core of three or more inner plies. With very few exception the grain of each veneer in the core runs at right angles to that of the veneers on either side of it.

The construction of plywoods may be balanced, with an odd number of veneers arranged symmetrically, or unbalanced. The tendency of the finished board to distort is reduced by adopting a balanced construction.

The construction may vary for a given panel thickness by the inclusion of veneers of various thicknesses. This will affect the strength properties as shown in the section on the structural use of plywood.

Plywood is assembled with veneers of one species, or a number of species. Sometimes it is desirable to reduce the weight of a panel by including a core of a species having a low density. Where possible combinations of veneer thickness and species should be chosen to give the finished board equal stiffness both parallel and perpendicular to the grain of the face veneer.

2.2.1.2 Blockboard

Blockboard consists of a core of wood made from strips up to 1" wide placed together, with or without glue between each strip, to form a slab which is sandwiched between outer veneers of 2 - 4.5 mm with their grain direction at right angles to the grain of the core. Finnish blockboards have double outer plies each side of the core totalling about 3 mm in thickness, but the grain of all veneers runs at right angles to the grain of the core. These types are usually crossgrain and generally known as three ply.

When the length exceeds the width, the blockboard should be 5 ply construction: a core of the same construction as that mentioned above, a veneer on each side of about 2 mm thickness running at right angles to the core, and an outer ply of about 1,5 mm running parallel to the core.

Boards where the strips have not been glued together to form a slab are sometimes known as stripboards.

2.2.1.3. Battenboard

This is a variation on blockboard construction in which the core is built up of strips usually not exceeding 3" wide.

2.2.1.4. Laminboard

The core is built up from strips of wood or veneers 3 mm to 7 mm wide, glued together face to face to form a slab. This is glued between outer veneers with the grain at right angles to that of the core strips, as in blockboard. It is heavier than blockboard since more glue and in some cases denser timbers are used in its construction, and its greater cost limits its use to high-class work.

All the above boards can be made lighter than the equivalent multiply of the same thickness, by using low-density species such as pine or obeche for the cores and less glue. They can be supplied in large sizes as [illegible] by up to 17'. They are used for large flat surfaces such as desk tops and cabinet doors in the furniture industry, where rigid panels are required.

2.2.1.5. Composite boards

Plywood with cores of insulating materials such as cork, asbestos fibre and foam rubber are generally made to order. They are used for cladding where heat insulation is important such as in cold storage rooms, and sometimes for sound damping in studios and telephone booths.

2.2.1.6. Metal and plastic faced plywood

Plywood of almost any thickness may be obtained faced with a number of metals-stanless or galvanised [illegible], copper, aluminium or with a decorative laminated plastic veneer. Such panels are used for counter-tops and wall [illegible] where surfaces are required to be decorative, hygienic and easy to clean. Sheets may be sealed at the edges and rendered waterproof and verminproof.

Plastic faced plywood with high abrasion resistance is also produced for use in concrete form work.

2.2.1.7. Decorative veneers

Decorative effects are obtained in a number of ways; by cutting veneers to reveal certain structural features: and from irregularities in growth and defects, colour variations and the arrangement and jointing of veneers.

Two important structural features, growth rings and rays (bands of tissue radiating from the centre of the tree to the bark), contribute to the figuring of veneers for this purpose and may dictate the method of cutting.

Slicing is a method used to produce decorative veneers for ultimate use in furniture, but not for standard plywood production. Peeling is the only true way of cutting tangentially to the growth rings and some hardwoods yield a more decorative figure from the rotary cutter than from any other method of conversion.

2.2.2. Particle board

Particle board or chipboard is a sheet material composed of small pieces of wood or other ligno-cellulosic materials agglomerated by use of an synthetic resin together with one or more of the following agents: heat, pressure, binding agents used etc.
On the density basis particle boards are divided in low density boards (0,2[illegible] - 0,40 g/cm^3), medium density (0,40 - 0,80 g/cm^3) and high density boards (0,80 - 1,20 g/cm^3).

Wood particles boards may be divided into four further categories:

- Single layer boards
- Sandwich boards
- Chipcores of the single layer type with the chips laying in the plane of the board
- Chipcores of the extruded type with the chips perpendicular to the plane of the board.

2.2.2.1. Single layer boards

Boards of this type have the same construction througout their thickness, and may be considered as either chipboards or chipcores according to their strength.

2.2.2.2. Sandwich boards

Boards of this type have three distinct layers. In the middle portion of the boards is a core consisting of large, coarse chips bound together with resin, and on either side of the core is a thin layer of finer chips, usually bound together with a higher percentage of resin.

2.2.2.3. Single layer chipboards

Various low density single layer chipcores may be made either from wood chips or other similar materials. One board now available is made from flax waste, such cores resemble single layer boards except that they are of lower strength and density and require the application of veneers to give them adequate bending strength.

2.2.2.4. Extruded chipcores

Although the term " extruded " refers to the method of manufacture, cores of this type have a distinctive layer formation which has an important effect on the physical and strength properties. If this board is to be used structurally, it must therefore be veneered or similarly treated.

Particle boards are used mainly as core stock for veneer and other overlaid furniture and as panel material. As panel material they are used for dry-wall and ceiling interiors, for flooring and roof. Particle board bonded with phenolic or melamine resins can be used under severe expositures even for exterior applications.

2.2.3. Fibre building boards

Fibreboard is a sheet material of widely varying densities manufactured from refined or partially refined wood fibres or other vegetable fibres. They are composed of single fibres or small fibre bundles and are formed from an interfelting of fibres which produce a mat with a characteristically natural bond.

2.2.3.1. Hardboards

Hardboards are homogeneous fibre building boards compressed to medium or high density.

- Standard hardboards have a density exceeding 50 lbs. per cubic foot. They have high structural strength and can be obtained in shades ranging from dark brown to almost cream. Their uses include wall and ceiling panelling, flush doors, kitchen cabinets, furniture and fitments etc.

- Tempered hardboards are standard hardboards which have been further treated in the course of manufacture to increase their strength and water resistance. They are sometimes called " ultra " or " super " hardboards as opposed to normal hardboards. Their use includes those for standard hardboards and in particular wherever moisture or abrasion resisting surfaces are required.

- Medium hardboards have a lower density than standard hardboards, that is, between [illegible] lbs. and 50 lbs. per cubic foot. By virtue of extra thickness they have higher qualities of stiffness and rigidity than the most commonly used thicknesses of standard hardboards, but do not have such a hard surface. They are widely used for wall and ceiling panelling, for chalk boards and pin up boards, as underlays to floor coverings etc.

- Perforated hardboards. Standard and tempered hardboards are available in perforated form, sometimes referred to as " pegboard ". Holes of various diameters and spacings are punched through the board. Perforated hardboard lend itself to a great number of uses, including interior decoration, vent covers, ventilation panels etc.

- Surfaced hardboards. These include enamelled, plastic-faced, veneered and moulded or embossed hardboards. Enamelled hardboards are produced in a wide range of colours, with either plain or tiled surfaces and as wood [illegible]. Common uses include wall linings, ceiling panels etc. Plastic-faced hardboards have a wide range of colour and surface finishes. Surfaces are resistant to heat, abrasion and acids. Veneered hardboard is an ideal material for the application of the whole range of natural wood veneers. Moulded or embossed hardboards have a pattern impressed into their surface during manufacture, the plates in the press being patterned instead of having a flat, plain surface. They are used for panelling, furniture etc.

2.2.3.2. Insulating fibre boards

Insulating fibre boards are again made from wood or other vegetable fibre, but the formed sheets do not go through presses so that the finished product, while rigid and self-supporting, is a light-weight, porous, low density board with very low thermal conductivity and good sound absorbing properties. They are used for wall and roof linings and ceilings in all types of buildings etc.

2.3 Glues

The bonding media used in the manufacture of joinery are of the utmost importance since, among other things, their properties determine the characteristics and end-usage of the final product.

For example, internal joinery or plywood used for internal application needs to be well bonded but does not necessarily in dry or moderately dry area require resistance to moisture or water. Conversely, used externally, exposed to all winds and weathers in moderately humid area or humid area, requires an adhesive capable of withstanding the full vagaries of the weather without fear of breakdown.

Depending upon their degree of resistance and their durability the adhesives most commonly used in joinery may be divided into the following groups:

2.3.1. Interior

2.3.1.1. Animal glues

Manufactured from hide, fleshings, bone and fish offal. Such glues provide an excellent bond under dry conditions of service. They are not water-resistant and if exposed to high relative humidities they are liable to destruction by micro-organisms (moulds and bacteria).

2.3.1.2 Blood albumen

These glues are prepared from fresh blood obtained from slaughtered animals or from dried soluble blood albumen. Such glues give a moderately strong bond with a high resistance to even boiling water. They are, however, liable to attack by micro-organisms which rapidly cause a breakdown of the glue line under damp conditions. Mixes containing paraformaldehyde are less rapidly attacked but are by no means immune to bacteria.

2.3.1.3. Casein

Casein glues consist of a mixture of the curds of milk, hydrated lime and certain other chemicals. Casein provides a strong bond in the dry state, but has only a short life when subjected to even moderately severe conditions of exposure. If exposed for long periods to wet or damp conditions, it is attacked and destroyed by micro-organisms (other chemicals are sometimes incorporated to increase its resistance to bacteriological attack). Exposure to chemical action is also likely to cause a breakdown in the glue line, but casein has good resistance to reasonably high temperatures under dry conditions.

2.3.2. Moisture resistant

2.3.2.1. Urea-formaldehyde (UF)

Urea resins are widely used in the manufacture and provide a high bonding strength in the dry state and even after prolonged soaking in water at normal temperatures, but they can withstand immersion in boiling water for very limited periods. They are suitable for use under most normal conditions but will break down under continuous exposure to extreme weather conditions. They are immune to micro-organism attack and possess a high resistance to acids and alkalis.

Urea resins are often extended by the addition of cereal flour or blood albumen, but this is accompanied by a reduction in the strength of the bond and in its resistance to micro-organism attack. Conversely, they can be fortified by the inclusion of other resins to increase their resistance to boiling water.

2.3.3. Boil resistant

2.3.3.1. Melamine-formaldehyde (MF)

This type of adhesive is comparatively new and few long term tests have been carried out to substantiate its properties. Its durability has been compared favourably with that of the phenol-formaldehyde resins and for this reason it has been combined with urea resins to increase their resistance to boiling water. Melamine resins can withstand immersion in boiling water and are immune to attack by micro-organisms. They have a greater heat resistance and are superior in both chemical and physical properties to UF resins, but their dry strength is no better.

2.5.4. Weather and boil proof

2.5.4.1. Phenol-formaldehyde (PF)

Phenolic resins have strength properties under all conditions of exposure. Long term weathering tests have indicated their ability to withstand the most severe conditions without deterioration. They are ideal adhesives for conditions of maximum durability and are immune from micro-organism attack. PF resins are very resistant to common solvents, wood preservatives, fire retardant chemicals and most acids.

2.5.4.2. Resorcinol-formaldehyde (RF)

RF resins are principally used as special purpose glues since they are more expensive than those hitherto mentioned and are therefore not normally employed in their natural state for the manufacture, but may be used as fortifiers. They are easy and pleasant to use and are capable of gluing substances other than wood. RF adhesives are boilproof, immune to micro-organism attack and have an excellent record for durability under the severest conditions of exposure.

Note

A fungicide can be mixed with adhesive to increase its resistance to micro-organisms. Casein is frequently mixed with blood albumen to increase its resistance to water, and is sometimes used as an extender to synthetic resin adhesives. The adhesives shall be mixed and applied strictly in accordance with the adhesive manufacturer's instructions.

2.4. Paints

Primer. Most paint manufacturers seem to agree that the best joinery primer is one based on white lead with a small proportion of red lead in a linseed oil medium. British Standard 2521 : 1966 suggests the following formulation:

Composition of paint:

Linseed oil	17 - 20 per cent
White spirit	4 per cent maximum
Pigment	remainder

Composition of pigment:

Genuine white lead	3 parts	96 per cent minimum
Genuine red lead	1 part	
Mineral suspending		4 per cent maximum

Shellac is a natural gum resin soluble in alcohol. The natural colour of prepared shellac is orange. White shellac is obtained by bleaching orange shellac. It is an excellent undercoat or sealer before using varnish, lacquer or paint.

Varnish consists of copal gums and linseed oil mixed with turpentine to brushing consistency. Most of the quick-drying types are based on synthetic gums. There are three types of varnish:

Oil varnish - contains drying oils that harden by oxidation.

Spirit varnish - contains no drying oils and hardens through the evaporation of alcohol or turpentine.

Japan varnish - it is made like an oil varnish but contains a much greater percentage of metallic driers.

Lacquers produce artistic and very attractive finishes that can be applied with great rapidity and dry with astonishing speed. Types of lacquers:

Clear gloss lacquer. A clean lacquer that dries with a glossy finish. It is thinned with lacquer thinner and is applied by spraying.

Clear flat lacquer. Same as above, except that it dries flat.

Lacquer enamel. Merely a coloured lacquer, which can give a flat, satin, or gloss finish etc.

Synthetics are medium, fast-drying materials, both clear and pigmented. All types of oil varnishes can be obtained in a synthetic-base materials to dry in 4 hours or less.

Enamel. A broad classification of free flowing pigmented varnishes, treated oils, or lacquers which usually dry to a hardgloss or semi-gloss finish. Enamel films are characterized by the absence of brush marks. Actually, the line of distinction between enamels and paints is very indefinite.

3. DESIGN PROBLEMS

Before starting production, the first step to be done is a thorough analysis of construction which will determine both what the article is to look like and how it is to be put together from separate component parts.

The methods of constructing joinery are based mainly on experience and practice handed down from craftsman to craftsmen, and there is very little scientific analysis (e.g. in timber engineering) to show where and how much material should be placed so as to provide the maximum of desired properties (which - by themselves - are frequently defined in a really vague manner). The construction of joinery is determined on the basis of certain constant considerations, amongst which are:

- functional requirements (e.g. the primary functions of a window are weather protection, thermal and sound insulation, etc.),
- characteristics of materials proposed to be used (movement of solid timber, little bending strength of particle boards, etc.),
- exposure to weather (influencing for instance the selection of constructional materials, glues, coatings, design of joints, etc.),
- size of articles (e.g. strength/thickness ratio of sections, etc.),
- finish (e.g. transparent finish implies the choise of first-quality timber, etc.),
- economy and quality (e.g. windows for low-cost housing will be painted, etc.),
- dimensional co-ordination with established building modules.

3.1. Design of sections

Parting from the general principles governing the construction of the given article, decision must be made on the size and shape of the individual component parts to be used. The potential variations are frequently numerous, since there are different ways how to satisfy the expected functional and aesthetic requirements (in preliminary sketching, functional aspects usually receive greater attention).

In determining the size of sections, such fundamental considerations as following must be included:

- mechanical and structural requirement,
- strength properties of particular species of wood, wood-based panels, and non-wooden materials (if any),
- performance characteristics of glues, screws, nails, hardware, etc..
- standard sizes of timber, wood-based panels and other sheet materials,
- space required by joints,
- space for housing hardware, etc.,

The shape of sections will depend mainly on the following factors:

- functional requirements,
- ease of machining,
- desire of particular appearance,
- economy (prevention of material wastage),
- junctions with other members,
- movement of solid timber,
- space for receiving and fastening hardware and fittings, etc.

3.2. Design of joints

Since the basic materials used for the production of joinery are limited in size and shape, almost all finished articles (with only very rare exceptions, e.g. shelves) must be composed of several basic elements, frequently made of different materials. This fact explains the reason for the importance of joints in the design and construction of joinery.

The types of joints to be selected for a specific situation are determined by the following main factors:

- materials to be used and their strength properties, especially their behaviour with regard to their changes in moisture content (see chapter 2.);

- methods of fastening: the designer may choose for joining the elements gluing, nails, screws, etc., or a combination of several methods;
- aesthetic aspects: generally, the joints should be visible as little as possible;
- required holding power: the strength of the individual pieces should be maintained as possible, and all stresses in the joint area avoided;
- resistance to the effects of weather: all joints in external joinery should be protected against rapid changes in moisture content;
- economic aspects: the joints shall be made easily, and with minimizing the consumption of material.

There are many types of joints in the construction of joinery, and practically each shop uses its specific modifications which are convenient to carry out with the equipment available. Among this variety, we may distinguish a limited range of types which are used most commonly:

- parallel grain joints or edge-to edge joints which are used primarily to join material to a required width (as in gluing shelves), e.g. tongued and grooved joint, loose tongued joint, square edge-to edge joint, etc.
- right-angle joints of square sections (as in the construction of a framed door or a window casement) in which the end of one member is fixed to the side of another member, e.g. tenon and mortise joint, comb joint, dowelled joint, etc.
- right-angle joints of flat sections (as for instance in the construction of a cabinet or a drawer) where the edge of one flat section is to be fastened to the face of another flat section, e.g. dowelled joint, dovetail joint, etc.
- end-to-end joints which are used to extend the length of flat section (scarf joints) or square section (finger joints).

[illegible] Standardization

The joinery industry - as an integral part of the building industry - has been always under a strong influence of architects who have a tendency to emphasize the individual approach, and underestimate the standardization considered as reducing the aesthetic value of architectural design. The increase of housing demand in the after-war period led to successive changes in opinions and thus, standardization (in the form of dimensional coordination of building components, mass-production of standard doors, windows, etc.) began to a considerable extent to the materialization of the building programmes.

From the vast range of aspects which are included in standardization of joinery, we shall attempt to indicate its potential implications upon the internal problems especially utilization of the fundamental factors of each firm's activity - materials, men, machines and space.

There is no doubt that the standardization (in a wide sense, namely with regard to production control) is one of the most efficient means for increasing productivity, even in small-scope joinery shop. The most remarkable advantages of standardization are likely to appear in the following ways:

1) Joinery is normally manufactured in ranges of designs each with many component parts. Through introduction of standardization, the number of different parts decreases, eliminating costly machine setting. Large numbers of identical parts and identical sub-assemblies can enable batch sizes to increase, to exceed their economic minimum and may also justify development of jigs and purchase of equipment to further simplify and accelerate production.

2) The majority of basic materials, such as sawn timber, plywood, particle boards, fiber boards, etc. are standardized to facilitate their distribution. When the dimensions of standard parts of joinery are related accurately to the size in which these materials are available, cutting plans and calculations can be simplified and rendered more economic.

3) Although prices fluctuate, standard parts and subassemblies enable accurate comparison or re-use of such cost constituents, as consumption of timber, operation times, machine rates, etc., facilitating thus considerably the estimating, costing and pricing activities.

4) It takes less time to train unskilled operators to produce standard parts and to assemble standard sub-assemblies and finished articles efficiently and uniformly than to train them to produce traditional joinery.

5) Needs of capital reduced in minimizing the necessary stock of basic materials, tools, hardware, etc. are the next, but not yet the last favourable impact of standardization upon joinery plant of any size.

4. MANUFACTURING PROCESSES

It is not the purpose of this chapter to explain in full details of the individual manufacturing processes used in the joinery industry, but rather to give an over-all view of various factors to be considered in the machining of sections, assembling, preserving and finishing joinery.

In view of the diversity of joinery articles with regard to their constructional complexity, it is proposed to show in the sub-chapters 4.1 and 4.2 the usual sequence of machining and assembly operations as they are followed in the production of wooden framed doors (as the description of the variety of even the most common machining and assembly operations used in a traditional joinery plant would by far exceed the limits of the present paper). The following sub-chapters 4.3 and 4.4 are treated in a much more general way as it corresponds to the nature of problems to be seen in this field in the tropical countries.

4.1. Machining of sections

4.1.1. Cross-cutting

The first operation in the preparation of sections is the cross-cutting of the material to approximate length with an allowance for trimming. This operation is generally carried out on a cross-cutting saw. There are two basically different types of cross-cutting saws: the stationary type where the timber is fed into the saw which remains fixed, and the movable type on which the saw blade moves into the material which remains stationary. This operation should be entrusted to an experienced operator, since he has to select the stock with care, cutting out loose knots and other defects and choosing suitable lengths to avoid undue waste.

4.1.2. Ripping

After the timber has been cut to length, it comes to the next operation which is ripping. The purpose is to cut the timber out of a wider stock to approximate width with an allowance made for planing and moulding (about 2 mm are allowed on each face of the member in excess of the required finished size).

The ripping of sections is usually carried out on a standard, hand-feed circular rip-saw. In the mass-production, this operation is generally performed on the multiple straight-line ripping saw in which the stock is fed automatically by and endless chain-feed mechanism.

4.1.3 Planing and moulding

The purpose is to machine the required section out of the stock, cut to length and roughly sawn to size. The sequence of operations involved differs according to the shape of the sections, the size of the batches and the available types and lay-out of machinery in the shop. In all cases, the first operation is to plane one smooth face which is carried out on a surface planer. When one surface has been planed, the timber is fed into the machine for second time to work an adjacent face which, when planed, will be square with the first surface. The stuff which has two faces planed at right angle is then passed through a thicknessing machine. The timber is fed through twice - once for width, and the second time for thickness, after which the section will be accurately rectangular. If any shape other than rectangular is required, the profile must be cut on a spindle moulder.

The above described sequence of operations is common in the individual production. The mass-production machining scheme is more simple. After one face has been surfaced, the timber is fed into four-sided planer and moulder which combines the funtions of planing, thicknessing and moulding. The timber is fed by a power-driven feed mechanism past cutters which work the four faces of the section in one pass through the machine.

4.1.4. Smoothing edge sides of members

Final sanding of internal edges of rails and stiles should preceed the assembly of doors, since afterwards, these faces would be inaccessible. This operation is accomplished on sanders with the flexible belt.

4.1.5. Scribing

The rails shall be end worked to the profile of stiles to ensure a close-fitting bevelled joint. This operation is carried out on a tenoner (or spindle moulder with a tenoring attachment). At the same machine, the stiles are cut to accurate height and their top ends rotated at the same time.

4.1.6 Boring dowel holes

The boring of holes for dowels is generally carried out on a special multiple boring machine to ensure the accurate spacing of holes which is absolutely necessary.

4.1.7. Plugging and patching

Defects arising from manufacture, knots and other defects shall be bored out and replaced with plugs of the same species well glued in the position. At the same time, the operator checks carefully all parts and patches minor defects with putty (doors are to be painted).

4.1.8 Preparing members for hardware

This part of the manufacturing process comprises several operations. According to the type of hardware, slots, holes and recesses to receive hinges, lock case, striking plates, etc. are accomplished on borers, mortisers, spindle moulders or routers. The preparatory work for installation of hardware can be carried out either before or after the assembly of doors. Owing to a much easer handling of separate members, it is more convenient to place this operation before assembly.

4.2. Assembly

In this sub-chapter, the sequence of operations in the production of framed doors will be further followed.

4.2.1 Proper assembly

This stage of the manufacturing process comprises several operations, accomplished largely by hand (as generally assembly operations in the production of practically all joinery items, even in large-size factories). First, dowels, spread with glue are driven into rails. Then, the moulded edges of stiles are cleaned up, rails with

-

glued dowels are connected to the stiles and panels inserted into the groves. The complete door, thus loosely assembled, is placed into a clamping device. The clamp (hand-operated or pneumatic) is used to tighten the scribed ends of rails against the edges of stiles and to bring the door into a truly rectangular shape.

4.2.2. Sizing

The assembled doors have to be sawn to accurate widths and heights and rebates have to be cut in the edges sides of stiles and top rails. This operation is accomplished on spindle moulders in smaller factories, whereas in mass-production, sizing can be more profitably performed on double-end tenoners.

4.2.3. Sanding and patching

The final sanding of doors is a highly important operation, not only from the standpoint of smoothing and cleaning them, but also from that of bringing all joints perfectly even. This operation is commonly performed on belt sanders or by passing doors through two- or three-drum sanders. After that, the doors are inspected, cleaned up and eventually occuring defects patched with putty.

4.2.4 Installation of hardware

The flaps of hinges are inserted into the slots mortised in hanging stiles and fastened. This operation should be performed very carefully - it is essential to see of the hinges are mounted in true alignment, ensuring thus the proper function of the door. The next operation is the fitting of the lock which is housed in the respective hole and secured firmly in right position with screws.

The manufacturing process is at its end - the doors are prepared for finishing or delivery to the building site.

The reader may be, perhaps, tired by all these details given above, the purpose of the long description of the manufacturing process was to show that even such a simple manufacturing of such article, as the framed door, necessitates in its production a great range of machinery and skills.

[illegible] Preservation

In considering the treatment of joinery timbers, particularly external joinery, the two main requirements are:

(a) that of water repellency to prevent, as far as possible, the absorption of water and thereby to improve the dimensional stability of wood at least to an acceptable degree, and

(b) that of straight forward preservation to prevent all forms of biological attack, e.g. wood-destroying fungi and insects and the prevention of termite attack in those areas where this constitutes a hazard.

[illegible] 1. Combined preservative water repellent

A considerable number of combined preservative water repellent oil-borne treatments are available to overcome these difficulties both for the pre-treatment and " in situ " treatment of joinery items. These are normally based on pentachlorophenol combined with a petroleum distillate and an aromatic co-solvent to attain the desired solubility for pentachlorophenol, coupled with anti-blooming agents and paraffin wax with or without various resins to give a degree of water repellency.

There are many variations in these formulations and a number of other chemicals are employed such as the organo-tin compounds (e.g. tributyltin oxide) as the preservative and silicone resins as the water repellent component. These formulations are usually supplied as proprietary products and the compositions are not normally freely published.

[illegible] 2. Waterborne [illegible]

In addition to these oil-borne formulations, some water-borne preservatives are also successfully applied to the joinery field. These include boron compounds applied by the dip-diffusion method (a type of treatment employed in New Zealand) and where effective preservation is the prime requirement, the copper/chrome/arsenate waterborne preservatives applied by vacuum/pressure impregnation are also widely used both in temperate and tropical areas.

The active chemicals employed, however, remain water soluble and the treated timber must be protected from the weather by either the design of the structure or by regular application of paint.

4.3.3. [illegible]

4.3.3.1 Preparation of timber for treatment

It is desirable that timber should be seasoned before treatment. If possible, the moisture content should be below about 25 to 30 per cent. Fairly good absorption and penetration can sometimes be obtained when partly seasoned material is treated, although on drying out later the timber is liable to split, which may result in exposing untreated surfaces to fungal or insect attack.

Before treatment the timber should be reasonably clean and free from dirt and surface water. As far as is possible, all cutting, boring, etc., should be done before treatment.

4.3.3.2. Brushing and spraying

Probably the best known and most widely used method of applying wood preservatives is by means of a brush. When applying a wood liquid by brush, it should be flooded over the surface and the timber allowed to absorb as much as possible. This technique differs from that used when applying oil paints. Paint is applied sparingly and worked well into the timber; with a preservative, brush work is not necessary except to ensure that the liquid [illegible] cracks and crevices. Two coats provide somewhat better protection than one, and the second application can be given as soon as the first has soaked into the wood.

Spraying [illegible] results in a [illegible] and effective covering of the timber than can be obtained by brushing, and there is more chance of the liquid penetrating into holes, cracks, etc. In all other respects it is comparable with brushing. A low-pressure coarse spray should be employed, similar to the type used in horticulture for spraying plants and trees.

With a permeable timber one [illegible] of preservative will cover about [illegible] sq. ft. of a [illegible] surface and about 400 sq. ft.

of a machined surface. With more resistant timber a coverage of 600 sq. ft. or more to one gallon may be obtained, the penetration generally being less than 1/30 inch. On well weathered external timbers, the coverage of preservative may be as low as 100 sq. ft. to one gallon.

[illegible] Dipping and steeping

The duration of immersion can range from a few seconds to days or weeks. The process is generally referred to as a dipping treatment when the timber is immersed for periods of up to a few minutes, and soaking or steeping treatment when immersion extends over several hours or days.

The degree of treatment obtained depends on the period of immersion, as well as on the particular liquid used and the species being treated. The results obtained by short-term dipping of 5 minutes or less, correspond to those obtained by brushing and spraying. Dip treatments are often used to give protection to window frames, doors and other joinery work.

By prolonging the duration of immersion, i.e. steeping the timber, the absorption and penetration are increased, but at very slow rate. A good standard of treatment can be obtained, however, with some permeable timbers by steeping for a few days. If a low-viscosity organic-solvent type is used a similar penetration can be obtained in about 24 hrs.

[illegible] Vacuum treatment

This treatment is carried out in a tank which is then hermetically closed. Over the sawn timber a vacuum is formed by the use of a pump, and after 10 minutes the preservative is let in, mainly of water repellent type. Then the vacuum is eliminated and the timber is exposed for 10 to 60 minutes to normal atmospheric pressure, depending on wood species treated.

If the treated joinery is not to be painted then somewhat higher retention of residual solvent can be tolerated and low pressure treatment up to about 50 p.s.i. is widely used in many tropical countries.

4.3.3.5. Pressure treatment

The consideration of full pressure treatment, employing pressure in the range 100 to 200 p.s.i. may conveniently be considered in two categories, first, oil-borne preservatives and secondly, waterborne preservatives

In a cylinder loaded with damp timber, first a vacuum is formed by a pump. Then the preservative is let in, and the pressure of 150 to 200 p.s.i. exerted. The time during which the timber is exposed to pressure and the retention of preservative depends on wood species. With joinery products this process is most suitable for flooring, joists, stairs, handrails and other wood products which are constantly exposed to weather or in contact with the ground.

4.4. Finishing of wood

Protection furnished by wood finishes is mainly a matter of retarding the absorption and subsequent drying out of moisture from the finished surface. Finishes as a rule do not protect wood from biological decay.

4.4.1. Preparing the surface

Sanding is the most important operation in preparing the wood for a finish. It must be done to remove tool marks and to smooth the surface so that the reflective properties of the finishing materials will accentuate the full beauty of the wood grain. Sanding can be done by hand or with a wide variety of power tools.

Patching. Holes, cracks, and other imperfections should be filled with stick shellac or wood plastic. Neither of these will take water stain or oil stain, and either must be the same colour as the final finish will be.

4.4.2. Applying finishes

Finishing materials may be applied by brush or with a spray gun. Brushing is the commonest and most economical method.

With paint varnish, and other brushing mediums, the quality of the brushed finish, as judged by durability and appearance, is equal and in some cases superior to the same finish applied by ... Application of paint, varnish, enamel, lacquer, and other finishes by means of a spray gun has many advantages. Speed of application, economy of time and labour, and simplicity of operation have made the spray gun a good tool for painter, finisher, or handy man.

1. .5. Painting

If the wood work is not already primed, a priming coat shall be applied. Primer mostly treated linseed oil shall be applied by brushing or dipping. Unless specified otherwise, all joinery work which is intended to be painted shall receive at least two priming coats.

Where wood is fairly uniform and not too absorbent white lead/linseed oil or white lead/titanium-zinc primers are satisfactory. Absorbent woods require a primer with a high binder ratio or " filling " primer such as calcium plumbate. Thixotropic paints are particularly suitable.

Stopping and filling should be done after priming. Stopping is made to the consistency of stiff paste and is used to fill holes and cracks, while the function of the filler is to level up slight irregularities of surfaces. Filler is usually applied with a putty knife and is subsequently rubbed down to a level surface with abrasive paper. The filler coat should be allowed to fully harden and flatten before subsequent coat is applied.

Undercoat shall be applied after the surface has been primed, stopped, filled and rubbed down to a smooth surface. Undercoat may be brushed or sprayed.

The application of finishing paint varies according to the type of paint employed. The finishing coat may be applied either with brush or sprayed.

4.4.4. Example of finishing

4.4.4.1. Finishing for windows

Conditions for painting:
Every painting work, especially applying the finishing coat, necessitates virtual cleanliness in preparatory work and application. Therefore, before applying any coat, the surface should be cleaned up and work should be carried out in a dry and dust-free shop.

Windows are painted with white external oil paint which is supplied ready-mixed. The priming coat (mostly treated linseed oil) is applied by brushing or dipping, all others coats usually by brushing. After each coating, the windows are allowed to dry stacked in racks for a required period and sanded carefully with sandpaper.

Procedure:

1. Priming coat. When primed by dipping, frames and sashes are submerged in the dipping vat by hand and a draining period is to be allowed so as all excess solution drains back into the vat.
2. Sanding and puttying (both operations are repeated twice).
3. First undercoat.
4. Second undercoat
5. Finishing coat.

4.4.4.2. Example of finishing procedure for doors

Procedure:

1. Priming coat (two parts treated linseed oil, one part white oil paint and adequate quantity of turpentine thinner) is applied by brushing.
2. Primed surface is sanded and two layers of thin oil putty is applied to the whole surface.
3. Doors, when dry enough, are sanded on overhead belt sanders; remaining defects are patched with putty.
4. One or two undercoats are then applied by brushing or spraying.
5. Undercoats are sanded with fine sandpaper. The surface of doors is checked and remaining defects are patched.

6. Final coat is applied first on one surface. The doors are allowed to dry for a fixed period; afterwards, the second surface is finished.

The operations of glazing will be accomplished before applying the finishing coat. The glazing is carried out with glazing beads and compound, the function of which is to prevent disagreeable vibration of panes.

[illegible] __Applying of enamels__

Enamels are the most commonly used paints for wood-finishing projects. When applying an enamel finish these steps should be followed:

1. Surface preparation - be sure the surface is clean and smooth.
2. Size all knots, pitchy spots, and very absorbent portion of the wood with half-strength white shellac.
3. Priming coat. There are a number of undercoats that may be used, although a specially prepared enamel undercoat sold for this purpose is best.
4. Puttying. All nail holes and defects in the wood should be filled with a prepared-lead and whiting oil putty leveled with the surface and allowed to dry.
5. All painted surfaces and putty should be lightly sanded with fine sandpaper.
6. Applying an undercoat similar to that used for priming preferably an enamel paint.
7. Sanding body coat.
8. Mix an enamel undercoat paint with an equal amount of enamel. Flow on with a brush or apply with a spray gun. Allow time for drying, then sand and dust.
9. Apply a full-strength coat of enamel, flowing the coating over the surface as smoothly as possible.
10. A gloss enamel should be rubbed like a coat of varnish using pumice stone and water.

[illegible]. CHOICE OF MACHINERY

The text of this chapter is divided in two parts. The first sub-chapter is devoted to a brief enumeration of factors to be considered when making decision concerning the purchase of new machinery. The second sub-chapter covers a very important factor influencing the efficiency of joinery plants, namely lay-out of machinery and materials handling.

[illegible].1. Main factors influencing the choice of machinery

The fundamental factors to be observed when selecting new machinery are the objectives of the long-term marketing strategy of the firm (i.e. the prospective product, mix - nature, volume, quality, etc. of products and range of markets served).
This principle may be illustrated on two examples:

- a joinery firm takes a decision to specialize in the production, for instance, of standard frames doors resulting in an output of large lots of the same articles; in such a case, it may be necessary to install special machinery and replan the lay-out into a throughout production line;
- the long-term policy of another joinery firm is reckoning with a diversified local demand, and, therefore, will stress the versatility of its equipment.

Besides implications given above, this product-market strategy will influence the selection of machinery with regard not only of its type and required performance, but also of its precision, cost, adequate degree of mechanization, etc. It is unnecessary to take note that the choice of new machinery must take into account the existing factory lay-out and space available, necessity and potentiality of linking new machines into production lines (in balancing the performance of adjacent machines), etc. No less important is the respect of sizes, versatility, etc. of basic materials (e.g. large standard sizes of sheet materials).

The situation of the decision-makers is often substantially complicated by imposed limitations, namely:

- lack of skilled workers for operation and maintenance,
- shortage of capital,
- lack of engineering experience,
- difficulties in ensuring necessary spare parts and more complex maintenance activities,
- relationship between wages and capital costs: unfavourable ration may direct decision to labour-intensive projects, etc.

6.2. Factory lay-out

With regard to the nature of the joinery production, where bulks of materials are moved through the shop - from handling of incoming timber up to delivery of finished articles - it is apparent that the effective utilization of basic resources of a firm, i.e. man, machines, materials and space is governed to a considerable extent by the level of lay-out of machinery and flow of timber through factory. The aim of planning the lay-out of a plant is to optimize the utilization of space available, so that materials can flow smoothly, machines can be operated efficiently and with safety, and men can work with a minimum of necessary physical effort. To achieve a smooth flow of materials, it is necessary to arrange the machines in relationship to each other so that they correspond to the sequence of machining operations, and to ensure that storage areas are of the correct size and strategically sited.

There is no doubt that the general rules of a rational planning of lay-out of machinery and materials handling apply, without exception, to joinery plants of all sizes. We could cite numerous examples of situations in which the production is adversely affected by poor lay-out (e.g. production time of skilled workers lost by handling operations, idle time of machinery caused by inadequate ... stocks, useless long distances travelled by timber through factory as a result of bad linking of machines, etc.

For selecting the materials handling methods, it is necessary to observe several general rules:

- Do not handle materials more than necessary, i.e. combine operations if possible or use methods which eliminate double handling,

- reduce handling to a minimum by arranging all operations to be accomplished in the correct sequence at adjacent machines,
- if materials must be laid aside after one operation, let their position render them readily available for the next operation,
- put materials on something that will simplify movement.

When analysing lay-out of machines and proper methods of materials handling, several fundamental questions must be considered at the beginning:
- nature of products to be made,
- their quantity and size of batches,
- suggested manufacturing process,
- machinery and sprace available (when replanning an existing plant), etc.

It is undoubtedly not easy to find an optimum solution which is to be looked for between the following three types of machinery lay-out:

- lay-out by product: the whole manufacturing process is broken down into a number of highly specialized and balanced operations, i.e. each operation takes the same time;

- lay-out by process: similar processes are grouped together into departments: the work is moved in batches from particular machines in one group to others in the next group;

- lay-out by workplace: all necessary equipment and manpower are grouped around a fixed position and all materials brought to this position: the material does not move until it has been turned into the finished product.

In many case, the optimum lay-out is found by combining any two, or even all three types of lay-out to varying degree.

6. MARKETING PROBLEMS

In the foregoing text, a brief reference was made to marketing strategy as an important factor influencing choise of machinery, design of products, standardization, etc. In this chapter, we shall attempt to bring together several general notes about marketing concept and pricing problems.

6.1. General marketing concept

Instead of stressing the significance of marketing approach for joinery firms, we shall cite as introduction to this sub-chapter the definition of the American Marketing Association saying that " marketing is the performance of business activities that direct the flow of goods and services from producer to consumer or user ".

Marketing as a business function has a decisive role in the long-term planning of any firm, irrespective of both the stage of economic development, and the industrial branch.

The marketing concept is based on the assumption that the satisfaction [illegible] justification of a firm's existence. Consequently, all fields of firm's activities must be devoted to, first, determining what the customer's wants are, and then, satisfying these wants while still making a reasonable profit.

Marketing considerations are thus the most critical factors in business planning and decision-making. Marketing processes begin long before the goods go into production - marketing decisions must be made regarding the questions of nature, quantity, quality of products, present and future customers, prices, etc. Just as marketing does not begin at the end of the production line, it does not, by far, end with the final sale. Thus, for instance, a product guarantee and servicing may be required after the sale is made.

The fundamental implications of the marketing concept can be summarized as follows:

- the entire system of business action should be market-oriented (i.e. customer's wants must be recognised and satisfied effectively),
- marketing is an integrated process (a problem lying in one segment of firm's activity must be constantly deliberated with regard to the effect of any change in this sector on other areas of marketing operations),
- marketing programming should be done with a maximum of effectiveness and a minimum of costs,
- to be successful, marketing must maximize profitable sales over the long run (customer must be satisfied in order to be willing to repeat his order),
- marketing is a dynamic process (marketing management consists in a never-ending process of recognising marketing problems, analysing them, and making decisions).

Marketing management must take into consideration a great variety of combinations of marketing elements (marketing mix) and adapt them properly to customer's wants, competition, social and legal controls, and other environmental forces.

The fundamental elements constituting the marketing mix are:

- product planning, i.e. products to be offered (qualities, design, etc.), market to sell (whom, where, when, and in what quantity), etc.,
- pricing comprising price policy (price level, use of price lists, etc.),
- channels of distribution,
- servicing, i.e. degree of services to be provided (transportation, assembly of joinery on site, etc.),
- sales promotion, advertising, etc.

Each element may contain several variables - a joinery firm may produce, for instance, a line of flush doors of standard sizes and sell them through a national wide wholesale chain with prices determined by price lists: on the other hand, its production programme may include also individually designed windows for a more restricted market with prices fixed in individual contracts. The marketing executive (or manager) of this firm must select the proper marketing mix - i.e. the combination of these variables based on long-ranged planning that promises to fit the economic situation of five or more years hence.

The marketing mix must be naturally formulated within certain limits of forces which constitute the firm's environment. Some of these forces are external factors (from the point of view of the firm not controllable), and others are internal factors (and thus essentially controllable).

The major external factors which influence business decision-making are:

- competition (size and strength of competitors, indirect competition, quality and prices of competing products, etc.),
- market demand (number of potential customers, their buying power, buying motives, living habits, etc.),
- legal and social forces (governmental regulations over products and pricing, governmental social policies influencing employment, housing programmes, etc.).

Under its control, management has the internal forces which may serve both as effective factors (nature of the products and other components of the marketing mix) in adjusting to the external environmental changes, and also as factors limiting the range of decisions. The limiting factors are the firm's resources, namely its production capacity, existing facilities and equipment, financial capability and experience of the personnel.

The effectiveness of the marketing plan may be measured by the ability with which the firm can:

- forecast the direction and intensity of changes of the external factors, and
- use its internal resources in adapting them successively to the changing environment.

7.2. Pricing and costing

Undoubtedly, one of the most important decisions which the management of a joinery firm must make is the setting of prices for the firm's products or services. The pricing decisions affect the entire enterprise and must be made with this fact in mind. Joinery trade is relatively very complicated in this respect, and it requires considerable experience and knowledge to carry out successfully the pricing, estimating and costing functions in a joinery firm, practically irrespectively of its size.

This sub-chapter will cover only overall problems affecting price-making decisions in a joinery enterprise. It is not intended to summarize price theories, and to give a comprehensive analysis of pricing policies, price-setting procedures and costing practice.

The setting of price for a product is basically determined by three considerations: the competitive characteristics of the industry, the characteristics of its customers, and the firm's own objectives and strategy. Not all pricing decisions have the same dimension. There may be great differences between the setting of price for a standard product and the pricing of a special order (the reader may be, once again, reminded the comparison of mass-produced standard flush doors and individually designed windows).

The most universally starting basis for pricing are costs (but it must be mentioned that cost are not the only basis for setting of price - prices could be substantially influenced, for instance, by competitive market decisions, etc.).

Cost concepts differ widely. A firm's accounting records describe what costs have been in the past, while the determination of price policy requires estimates of what costs will be in the future. Costing must provide management with answer on two fundamental questions about the article: How much should it cost ? and How much did it cost ? Comparisons of the actual (historical) costs should not only verify the accuracy of the original estimates but also indicate if a selling price is likely to be inadequate. In a multiproduct firm (which is the case of the majority of joinery enterprises), this requirement presents sometimes a very delicate problem, since not all costs are directly traceable to individual products (common costs, fixed costs), and any assignment of them to individual products may be considered as purely arbitrary.

Costing procedure should be a systematic recording of facts, which can be considered under two broad headings, namely direct costs (direct material and labour costs) and common costs (on-costs and overheads). The cost of materials will be transferred from timber sheets, cutting sheets and requisitions and posted to cost cards of individual products. The purchase prices must include the costs of storekeeping (by adding a percentage which should be sufficient to cover handling, drying and deterioration). Other addition of a certain percentage (which varies according to the type of material) have to cover the cutting waste. Direct labour costs are abstracted from the time sheets and transferred to the appropriate cost card.

The above mentioned items of manufacturing costs can be ascertained with reasonable accuracy, but the real problem are costs which cannot be traced directly to the product (included in classification of on-costs and overheads). On-costs and overheads are recouped as a percentage spreadover on all direct costs or alternatively as a percentage applied to direct labour costs. To calculate an on-cost or overhead percentage, all respective cost elements must be considered and priced on an annual basis and the total must be resolved into a percentage of the budgeted turnover or the anticipated annual labour value. The last question to be considered is the determination of the profit (generally a markup stated as a percentage of the total costs).

The fixing of selling prices must be always consulted and harmonized with the sales prospects and forms an inseparable part of all marketing decisions of the firm.

7. VOCATIONAL TRAINING.

The joinery industry [illegible] remain unaffected by dynamic changes occuring in the whole economy, but, wishing to keep pace with the rapid evolution of its environment, it must adapt itself to be able to [illegible] on the building market.

In this chapter, we will try to outline some implications of this situation upon the structure of needed workers, required skills and occupational training. With the development of mass-production methods, it is becoming apparent that the skills of the traditional craft workers are in many cases inadequate or superfluous to meet the needs of new technological processes. Although it is not reasonable to accept an opinion that it is a wastage of time and money to give to workers a general occupational training, it is, however, necessary to re-think the question of what direction vocational training should take and what qualifications would correspond to the future requirements.

As it was noted in the introductory chapter, the trend in the joinery trade is likely to diverge the joinery firms in two major categories:

- small, general joinery shops, and
- big, specialized, mass-production factories.

With the first type of joinery firms, the methods of production will require the traditional, broad, general occupational training and the share of unskilled workers will remain very limited. Although the work consists, in a great proportion, of hand operations, the necessity of increasing productivity will result in utilizing modern machines and tools. Consequently, the workers should be acquainted with a wide range of production methods and equipment and trained to carry out any operation at various stages of the manufacturing processes.

In the mass-production joinery factories, the work is divided into separate elements according to the different machines, and each worker performs repetitively his relatively small part of the manufacturing process. It is evident that in such a case the required qualifications differ considerably from those needed in the former type of joinery shops. The duration of training for performing simple technological operations can be substantially shortened, but on the other hand, an increasing number of workers who are occupied with maintenance and repair activities (necessitating conventional training in metal and electrotechnical trades) is absolutely indispensable.

Yet, even in the mass-production factories, very important advantages of general vocational training must be taken into account (especially when considering the available labour in the long run as one of the fundamental resources of the joinery firm):

- more flexibility and possibility of utilizing existing production capacity;
- easy adjustments of workers to different machines,
- relatively short periods and smaller costs of retraining in case of deeper changes in the manufacturing process,
- attitude of skilled workers to improvements of the working methods,
- greater personal satisfaction and higher relative wages (it is unreasonable to underestimate in the long term strategy the position of the joinery branch with regard to the relative level of average wages),
- possibility of recruitment of supervisory personnel among skilled workers,
- better attitude of workers towards safety problems, etc.

8. CONCLUSION

This paper was not intended to give an exhausting survey of the joinery production in the tropical countries, not even, it is [illegible] number of pages. The authors were merely attempting to give a general idea of several problems the manager of a joinery firm is daily confronted with.

In conclusion, it remains to mention the major problems concerning the prospects of the joinery trade in the tropical countries, especially the role of the joinery industry in the industrialization, the expected developments in future demand for joinery products and the trends in prefabrication of joinery and industrialization of housing construction.

a) Joinery industry and the industrialization in the tropical countries

Owing to its nature, the joinery industry is most suitable to take up an important place in the industrialization programmes in many tropical countries:

- generally small capital resources are sufficient to ensure the required labour-intensive investments,
- availability of timber in home forests represents an important advantage for the joinery industry and gives an incentive to the development of the primary forest industries,
- whereas there is frequently lack of workers with general technical training, the joinery industry has an advantage in developing from the traditional handicraft, etc.

b) Expected developments in the future demand for joinery

There are sufficient reasons for thinking that the demand for joinery products will increase considerably in the future:

- the number of dwellings should increase to meet the immense housing demand,
- with the growing standard of living, a tendency to use

more timber per dwelling (e.g. built-in storage furniture, kitchen units, etc.) will [illegible] the demand for joinery products,

- traditional builders will not be able to satisfy the whole demand for dwellings and the shortfall will be covered with prefabricated housing,
- government policy may be likely to encourage (e.g. by direct supports, changes in building regulations, etc.) building systems which could increase the volume and quality of housing construction, etc.

c) Joinery industry and industrialization of housing construction

The industrialization of housing construction offers several important advantages enabling to presume the increase in percentage of industrialized dwellings over traditional, as for instance:

- the time spent on the building site can be limited to a few days, and consequently associated site costs can be reduced to a minimum,
- quality of dwellings can be improved by precision drawings and manufacture,
- the overall building weight is reduced and all current wet processes are replaced by dry construction, etc.

It is difficult to forecast the development in the prefabrication of housing components and complete housing systems in the tropical countries. At the beginning, it is likely to expect a tendency to go further in the standardization and prefabrication (i.e. painting and glazing) of such items as windows and doors. The future steps may be to proceed from prefabricated window frames to wall panels and finally to systems of components which could be used within fully industrialized units or within rationalized traditional houses.

Summing up, it can be anticipated that a growth of demand for joinery products may be considered as incontestable in the majority of the tropical countries. Besides, new markets and new technological developments may incite, in the future, and even more rapid progress of the joinery trade than can be foresseen at the present time.

9. APPENDIXES

9.1. Selection of timbers suitable for joinery

(See the following tables)

Timbers used for external and internal joinery

Countries: Brazil, Paraguay

/Sources of Supply/

International nomenclature /designation/ of timber	National name /local/ "	Production	Appearance	Uses	Properties
AMARANTE	Braz. Braz. Guarabu Pau Roxo Ipé Roxo	current	hard fine straight	external joinery parquets	[illegible] easy to work heartwood [illegible] [illegible] durable
AMARELO	Braz. Pau Cetim	-	hard enough	external joinery	
AMENDOIM	Braz. Amendoim Par. [illegible]	current	long grain	joinery beams	easy to work hard enough
ANDIROBA	Braz. Andiroba Par. Andiroba	current	hard enough straight" fine "	internal external joinery	breaking dries at a moderate rate [illegible] not durable
ARARIBA	Braz. Arariba Par.	considerable	straight regular hard	external joinery	easy to work very resistant checking fine surface
BALATA ROUGE	Braz. Maçaranduba	current	straight fine very hard	external joinery	easy to work durable

BALSAMO	Braz. Oleo vermelho Par. Incienso	-	fine enough hard enough	joinery	easy to work [illegible] durable
CANELA	Braz. Louro branco Inamui Preto Canelo	current	straight fine enough	joinery	easy to work
CATUCAÉM	Braz. Catucaém Carvalho	-	straight hard	joinery	uneasy to work hard checking
COEUR DEHORS	Braz. Sucupira	current	hard irregular	external joinery	uneasy to work smooth resistant
ESPAVEL	Braz. Caju	considerable	light weight resin	joinery	
GUARANTÁ	Braz. Guaranta		fine hard irregular	external joinery	easy to work resistant hard
GUAYABI	Braz. Guayaba	current	straight very fine hard		easy to work resistant smooth
IBIRÁ PYTÁ	Par. Ibira pyta	current	long grain hard heavy	joinery	easy to work fine finish durable checking

IPÉ	Braz. Pau d'Arco Par. Ipe	current	fine enough very hard wood veining greasy (fatty)	internal joinery external beams	uneasy to work very strong [illegible] checking good finish
[illegible]	Braz. [illegible]	middle	[illegible] light wood veining	external internal joinery	easy [illegible] resistant not checking
[illegible] BRASIL	Braz. Jacaranda	very current	fine enough hard	joinery	easy to work [illegible]
[illegible]	Par. [illegible] Braz. [illegible]	current	straight fine enough hard enough	joinery	easy to work not checking fine finish
AU [illegible]	Braz. Pau Ferreira	local	hard [illegible] grain	external joinery beams	uneasy to work very hard fine finish
PAU [illegible]	Braz. Pau Perola	considerable	very hard irregular	external joinery beams	uneasy to work durable good finish
PEROBA JA[illegible]	Braz. Peroba de Campos Ipé peroba Peroba branca	large	straight enough	joinery parquets	durable enough checking

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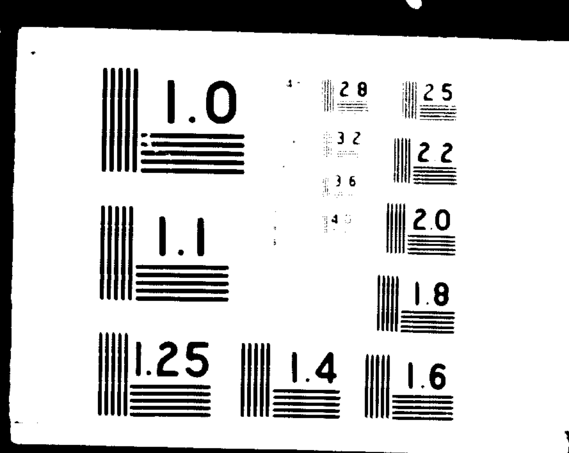

cont. 4.

PEROBA ROSE	Braz. Amarello	large	straight very irregular hard, fine	external joinery beams	durable enough /checking/ splitting
TATAJUBA	Braz. Tayuva Par. Tatagva	current	very hard irregular	joinery	easy to work uneasy to cut very resistant
TREBOL	Braz. Trebol Par. Trebol azul Trebol amarillo	current	fine hard irregular wood-veining	internal external joinery beams	easy to work hard most resistant
URUNDAY	Braz. Urunday Par. Urunday para Gracile	current	straight fine hard	joinery	good finish durable splitting
WACAPOU	Braz. Acapu, Sapupira	current	straight hard irregular	external joinery parquets	easy to work splitting good finish

Timber used for joinery/

Countries: Congo /Kinshasa/, Ivory Coast, Kenya, Nigeria

International nomenclature /designation/ of timber	Regional name /Local/ "	Production	Appearance	Uses	Properties
ACAJOU D'AFRIQUE	I.C. Acajou-Bassam Nig. Lagos Mahogany	large	middle-fine handsome	joinery	easy to work fine finish best timber
AZOBÉ	Nig. Ekki Cgo. Bonkolé	large	very hard very heavy	joinery parquet:	[illegible] [illegible] good resistance
BILINGA	I.C. Badi Nig. Opepe	middle	fine enough hard " sap-wood bad oils, resin	external joinery	[illegible] cracks good to work [illegible] strength good finish durable
DOUSSIÉ	I.C. Azodau, Lingué, Nig. Anyan, Aligna, [illegible] Cgo. Bolengu, Sifu sifu	considerable	homogenous irregular hard, heavy resin [illegible]	external joinery	dries slowly without difficulties easy to work [illegible] not easy to nail, easy to glue and paint
EYONG	I.C. Bi Nig. Okoko, Aye	sufficiant	heavy enough hard	joinery	[illegible] must be protected after cutting easy to work

FRAMIRÉ	I.C. Framiré Nig. Idigbo	middle	fine enough middle hard	joinery parquets	easy to work durable [illegible] and paint sapwood attacked excellent timber
IROKO	I.C. Iroko, Odoum Nig. Rokko Cgo. Kambala	considerable	hard enough heavy waxes	external internal joinery parquets	easy to cut and work resistant fine finish
KOKRODUA	I.C. Asamela Cgo. [illegible]	middle	straight fine hard enough	joinery fine parquets	[illegible] fine finish
LANDA	I.C. Dabé Cgo. Mukienzo	middle	homogenous fine hard enough	external and internal joinery	easy to work
LIMBA	I.C. Fraké Nig. Afara Cgo. Limba	large	different density a hardness	joinery	easy to work excellent timber
MAKORÉ	I.C. Makoré	considerable	straight very fine hard enough	external and internal joinery	easy to work [illegible] resistant good finish and gluing properties
MOABI	Cgo. Dimpampi	small	straight homogenous fine, hard heavy	joinery parquets	splitting [illegible] fine finish

cont. 3.

MUKULUNGU	Cgo. Mukulungu	middle	straight enough hard	joinery	not easy to work good finish good resistance not easy to cut
NIANGON	I.C. Niangon	considerable	hard enough fine irregular	joinery external and internal	excellent timber well resistant easy to work
NIOVÉ	Cgo. Kamashi Susamenga Ngube	small	fine enough straight hard	external and internal joinery	good resistance splitting good finish
OKURO	Nig. Okuro Cgo. Kassa-Kassa	regular	straight grain	joinery	easy to work not durable
PADOUK	Cgo. Kisésé E. Afr. Mwangura	small till middle	straight grain fine enough hard	external joinery	very good resistance easy to glue and paint
RIKIO	I.C. Rikio Cgo. Bosengo	considerable		external joinery	good finish shrinkage
SAPELLI	I.C. Aboudikro Nig. Sapele Cgo. Lifaki E. Afr. Miovu	large	fine enough regular hard enough	special joinery	easy to work easy to glue and paint splitting
SIPO	I.C. Mebrou Cgo. Kalungy E. Afr. Mfumbi	considerable	fine enough	external joinery	good to work lacquer and paint

SOUGUÉ	I.C.Sougué Cgo. Fembe	considerable	hard dip grain		
TCHITOLA	Nig. Lolagbola	small	straight grain resinous soft enough	joinery	easy to work protect after cutting
TIAMA	I.C.Tiama Nig.Gédu- -Nohor Cgo.Kalungi Lifaki E.Afr.Mukusu	middle	fine enough hard "	external and internal joinery	easy to work easy to glue and paint insect resistant
TOLA	Nig. Agba	middle	fine enough soft " little resinous	external joinery	easy to work durable
WENGÉ	Cgo.Wengé E.Afr.Panga- panga	small	straight fine enough very hard darkens on exposure to air	fine joinery	easy to work very durable strong working easy to dry

Timbers used for joinery

Countries: Phillippines, Malaysia

International nomenclature /designation/ of timber	Regional name /Local/ "	Production	Appearance	Uses	Properties
BANG-LANG	Malays. Mabek Jungor Philip. Pemeba	-	fine enough hard	joinery beams parquets	easy to work very resistant dries slowly easy to bend
BINTANGOR	Malays. Bintangor	-	hard enough	joinery beams	easy to work checking twisting
CAOI	Malays. Katia	-	hard enough	joinery beams parquets	
CHENGAL	Malays. Chengal	marked	fine enough	joinery	very durable standard in Malaysia
MERONGGANG	Malays. Meronggang	small	straight	joinery	easy to cut easy to dry low durability
MALDU	Malays. Merawa	-	fine straight enough hard	joinery beams roof trusses	easy to work durable
KAMIHANG	Malays. Mampadon Tempol	-	fine enough hard enough	joinery flooring	easy to work easy to dry low durability

cont. 2.

KASAI	Philip. Kalugai Malays. Kasai	-		joinery roof trusses beams	
KELAT	Malays. Kelat	-	hard fine	joinery beams roof trusses	-
KELEDANG	Malays. Keledang Lakooch	local	irregular hard enough	joinery beams	easy to work
KRABAK	Malays. Mersawa Philip. Palosapis	small	hard enough	joinery	easy to work resinous dries slowly little durability, checking
KRA-THON	Malays. Sentul	-	fine enough straight "	joinery	easy to work easy to paint easy to plane, smooth
ENGKHLANG	Philip. Lumbayau Malays. Chumprak	large	straight enough hard enough	joinery flooring	easy to work resistant little resinous holds nails
MERANTI DARK RED	Philip. Bataan Malays. Nemesu	sufficiant	straight resin	joinery	no knots little checking more resistant than red light meranti

MERANTI LIGHT RED	Philip. Almon Malays. Light Red Melanti	large		joinery	easy to painting dry [illegible]
MERANTI WHITE	Malays.White Meranti Pleng Meranti Pipit		hard enough	joinery	easy to cut resinous [illegible]
MERAWAN	Malays. Merawan Philip. Manggacha- pui	-	homogenous hard enough straight	joinery roof trusses beams flooring	easy to work very resistant [illegible]
PULAI	Malays. Pulai	-	-	joinery	-
RAMIN	Malays. Melawis	large	straight fine hard enough	joinery	easy to cut good finish [illegible] [illegible] [illegible] blue staining
RESAK	Malays. Resak Philip. Narig	-	fine hard	joinery roof trusses beams	timber of good quality resistant dries slowly

SAL	Malays. Thitya	–	hard	joinery roof trusses beams	timber of good quality durable easy to work good finish
WHITE SERAYA	Malays. Gerutu Philip. Bagtikan	sufficient	hard enough	joinery flooring	easy to work [illegible]
SUREN	Philip. Calantas	–	straight enough	joinery	easy to work good surface dries slowly checking
THITKA	Malays. Melunak	sufficient	fire enough hard enough	joinery flooring	easy to work holds nails
YANG	Philip. Apitong Malays. Keruing	large	hard enough straight	joinery roof trusses beams flooring	easy to work [illegible] easy resinous durable

[illegible] Examples of machines suitable for joinery production

[illegible] to meet the requirements of the *outline* of this [illegible] the basic technical data [illegible] the fundamental [illegible] machinery - the authors have been confronted with [illegible] difficulties. The matter is rather complicated in [illegible] of the fact that there exists a great number of manufacturing firms and a still greater variety of types of each individual kind of machine (with very wide limits of their [illegible]formance).

To avoid these difficulties, we decided to execute the [illegible] by presenting the standard joinery machines which can be found in the small up to medium-size plants in our country. [illegible] no case, we are intending to make publicity to their manufacturers, we are simply regarding them as a suitable [illegible] machinery (with regard to the characteristics of these [illegible]ines) for the considered type of joinery production units [illegible] tropical countries

[illegible] Sawing machines

[illegible] line edging and ripping saw KOH-A

[illegible] is designed for accurate edging and ripping work. [illegible] blade is mounted on the motor shaft suspended over the [illegible]. The speed and accuracy of work are ensured by chain feed [illegible] and overhead pressure rollers.

[illegible] diameter of saw	350 mm
[illegible] diameter of saw	250 mm
[illegible] width between fence and saw	450 mm
[illegible] height of cut	100 mm
[illegible] length of cut	250 mm
[illegible] of table: width x length	950 x 1600 mm
[illegible] rates of feed	from 6 to 40 m.p.m.
[illegible] of saw spindle	2800 r.p.m.
[illegible] required	15 kW

Multiple straight-line edging and ripping saw KRN

The machine is designed to perform mass-production edging and ripping. The saw spindle is housed in a heavy casting suspended over the table. The chain feed and overhead pressure rollers ensure perfect straight-line travel of timber and accuracy of [illegible].

maximum diameter of saw (for multiple ripping)	350 mm
minimum diameter of saw (for multiple ripping)	250 mm
maximum height of cut	100 mm
maximum width between centre of feeding chain and fence	600 mm
maximum distance between outside saws	220 mm
twelve standard rates of feed	from 4,5 to 50 m.p.m.
speed of saw spindle	4000 r.p.m.
power of saw motor	28 kW
power of feed motor	2,2 kW

Parallel cross-cutting RPK 50

The machine is suitable for rough cross-cut'ing of boards. The saw unit is mounted on a counterbalanced device which makes it easy to operate the machine.

maximum diameter of saw	500 mm
maximum depth of cut	130 mm
maximum width of cut	700 mm
speed of motor	2800 r.p.m.
power of motor	5,5 kW

Universal radial saw [illegible]

The saw unit rotates horizontally through 180° and tilts to any angle; the arm swings 45° either way. Consequently, the saw can be arranged to an almost unlimited variety of operations: precision cross-cutting, mitring, bevel, ripping, etc..

maximum diameter of saw	[illegible] mm
maximum depth of cut	[illegible] mm
maximum width of cross-cut	500 mm

-

[illegible] of motor	[illegible] r.p.m.
Power of motor	[illegible] kW

[illegible] 2400

[illegible] are two tilting saw units mounted on an overhead beam. [illegible] has a metal under-carriage: its rollers run [illegible] on rails ensuring straight travel.

[illegible] travel of table	[illegible] mm
[illegible] width [illegible]	1[illegible] mm
[illegible] of cut	[illegible] mm
[illegible] height of cut	1[illegible] mm
[illegible] of saw	400 mm
Speed of saws	[illegible] r.p.m.
Power required	3 kW

Band saw [illegible]

The machine serves for a large variety of ripping and cross-cutting work, and curved-line cutting as well.

Diameter of saw wheels	800 mm
Width of saw wheels	[illegible] mm
Size of table (tilting 45°)	[illegible] mm
Maximum depth of cut under saw guide	560 mm
Maximum width from saw to frame	7[illegible] mm
Speed of saw wheels	[illegible] r.p.m.
Power of motor	[illegible] kW

[illegible] Planing and moulding machines

Surface planer [illegible]

This machine is suitable for surfacing and accurate jointing of any class of timber. Cutterblock is of four-knife circular type.

Surfacing capacity	[illegible] mm
Maximum depth of cut	[illegible] mm
Diameter of cutting circle	1[illegible] mm
Speed of cutterblock	[illegible] r.p.m.
Overall length of table	2500 mm
Power required	[illegible] kW

Thicknesser [illegible]

The machine is designed to plane timber to required thickness. Cutterblock is of four-knife circular type; feed is by two [illegible] feed rollers, the infeed one being grooved for grip.

Thicknessing capacity	[illegible] x [illegible] mm
maximum depth of cut	[illegible] mm
diameter of cutting circle	[illegible] mm
speed of cutterblock	4200 r.p.m.
four feeding speeds	from [illegible] to [illegible] m.p.m.
length of the pressing table	115[illegible] mm
power of motor	11 kW

Four-side planer [illegible]

The feed mechanism comprises three top and three bottom driven rollers. The two front top feed rollers are of sectional type, and will feed several pieces of varying thicknesses at the same time. Cutterblocks are of four-knife circular type.

planing capacity	[illegible] x [illegible] mm
diameter of cutting circle	[illegible] mm
six rates of feed	from [illegible] to [illegible] m.p.m.
speed of cutterblocks	[illegible] r.p.m.
power required	13 + [illegible] kW

Four-side planer and moulder [illegible]

The machine is designed for the mass-production moulding of timber to any desired section. The feed is ensured by means of chain mechanism and feed and pressure rollers. Cutterheads are of square type.

maximum size of timber	1[illegible] x 1[illegible] mm
maximum diameter of cutting circle	[illegible] mm
speed of cutterheads	[illegible] r.p.m.
six rates of feed	from [illegible],5 to [illegible] m.p.m.
power of cutterheads motors	5,15 + [illegible] + [illegible],4 kW
power of feed motor	[illegible] kW

[illegible]

The most common operations that the machine can perform are moulding of straight and curved parts, rebating, recessing, tenoning, etc.

Size of table	1000 x 1000 mm
Standard spindle speeds	3000, 4500 and 6000 r.p.m.
Table of tenoning attachment	500 x 1000 mm
Power of motor	4 kW

[illegible]

In the manufacture of doors and windows, the machine is used especially for cutting recesses, mortises etc.

Size of table	600 x 600 mm
Distance between centre of spindle and frame	400 mm
Speed of motor	1750 r.p.m.
Power of motor	1,5 kW

[illegible] BORING AND MORTISING MACHINES

Horizontal boring and mortising machine [illegible]

The machine is designed for all kinds of mortising operations. The movements of the boring spindle and the work table are controlled by means of two levers.

Maximum size of mortise, width x length	40 x 250 mm
depth	150 mm
Size of table	500 x 900 mm
Speed of boring spindle	4500 r.p.m.
Power of motor	1,5 kW

[illegible] knot boring machine [illegible]

The machine is designed especially for boring out knots and other defects in timber and for cutting plugs for insertion into the bored holes. The spindle is fed down and retracted by means of a lever.

- - -

maximum diameter of holes	60 mm
maximum depth of boring	70 mm
size of table	420 x 600 mm
speeds of boring spindles	2000, 2[illegible]0, [illegible]000 r.p.m.
power required	[illegible] kW

Chain mortiser [illegible]

The machine is intended to perform all kinds of mortising work. It is operated by a hand lever.

width of mortise	[illegible] - 25 mm
maximum length of mortise	[illegible]0 mm
maximum depth of mortise	175 mm
power required	2 kW

Multi-spindle horizontal dowel borer

The machine is designed to perform accurate boring of dowel holes in door parts. Each of four drill units has its independent motor and can be adjusted to any position along the machine bed.

maximum depth of drilling	1[illegible] mm
maximum distance of outside holes	[illegible] mm
maximum number of dowel holes	11
	(1 x 4 + 1 + 1 + 2 x 2)
power required	2 x 1,5 + [illegible] + 1,[illegible] kW

Multiple slot mortising [illegible]

The machine is designed to mortise two, possibly three narrow slots for hinges in window and door parts. The mortising units can be adjusted in any required spacing along the table.

Size of table	[illegible] x [illegible] mm
minimum distance between adjacent slots	3[illegible] mm
maximum depth of slots	6[illegible] mm
maximum length of slots	1[illegible] mm
power required	[illegible] x 1,1 + [illegible],4 kW
speed of motors	14[illegible] r.p.m.

[illegible].4. Sanding machines

[illegible] sander [illegible]

[illegible] is used in mass production for sanding of flat surfaces. [illegible] the drums perform also an assillating axial [illegible]. The [illegible] of the feeding endless rubber band is infi[illegible] variable.

[illegible] capacity (width x height)	1000 x 1000 mm
[illegible] of sanding drums	250 mm
[illegible] of 1st [illegible]	[illegible]00 r.p.m.
[illegible] of the 2nd sanding drum	[illegible]
[illegible] variable speed of feed	from [illegible] to 1[illegible],5 [illegible]
Power required	15 + 1,5 kW

[illegible]-drum sander [illegible]

Sanding capacity (width x height)	1600 x 100 mm
[illegible] of sanding drums	[illegible]22 mm
[illegible] of the 1st and the 2nd sanding drum	1470 r.p.m.
[illegible] of the 3rd sanding drum	1570 r.p.m.
[illegible] rates of feed	from 5 to 12 m.p.m.
[illegible] required	12 + 12 + 2,2 kW

[illegible] belt sander [illegible]

The movements of the table and the pressure-pad are easily [illegible] operated.

Size of table	[illegible]00 X [illegible]00 mm
Width of sanding belt	1[illegible] mm
Peripheral speed of sanding belt	2[illegible] m.p.s.
Power of motor	[illegible]

[illegible] disc sander [illegible]

The machine is used especially for sanding square or bevelled [illegible] of timber. [illegible] table of the sander cants [illegible]° [illegible] the horizontal. The fences are slidable across the entire width of the table.

[illegible]	[illegible]00 mm
[illegible] tables	[illegible] mm
[illegible] of motor	[illegible]
[illegible]	[illegible] r.p.m.

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