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It is, therefore, advisable to have a storage of panel materials of standard sizes and withdraw daily from this storage the quantity needed to meet the production schedules.

Thus, the panel sizing preparation section must be equipped as follows:
- a fork-lift will handle the panels, to be cut to size, from the general store and store them ahead of the panel sizing saw, over a scissor lift bench to facilitate the machine's loading operation;
- a panel saw of suitable cutting capacity, to cut sheets according to required sizes;
- a router to carry out rough cut-out operations on those sheets which will be used as skins for those panels which will be used in turn as doors with glass openings;
- a buffer storage, between the sheeting materials section and pressing section, where will be stocked all sized sheets and all under cut panels reclaimed during the rough cut-out operation, ready for the pressing operation.

2.205 - HONEYCOMB CORE PREPARATION

The panal sandwich core, as mentioned previously, may be either of cardboard (more commonly called "honeycomb") or strips of wood, plywood or fibreboard.

However, in modern door manufacturing practice the "honeycomb" is the most widely used because of its relatively low cost compared with other types of core materials, because of its better flexibility and practical application and because it is readily available commercially.

Owing to the honeycomb's ability to adapt itself to any geometrical form and to undergo, within certain limits, a fair amount of deformation under pressure which allows to compensate for the eventual slight variations to which the panel sandwich may often be subject, because of the impossibility to control the inner frame components thickness, the honeycomb core preparation section requires the installation of only a bend saw to cut to size the honeycomb which is to be used as core for cut-out doors.

2.206 - VENEER PREPARATION

This manufacturing step applies only to the production of luxury doors. It implies:

- the construction within the plant of a veneers storage with controlled temperature and moisture, in order to avoid that variable room conditions cause excessive dehydration of the rare wood veneers, thus impairing their good quality;
- the installation of a veneer jointer which will enable to joint the veneer for matching a pattern which will give the door skins and panels the appearance of a homogeneous massive wood board with all its grain patterns oriented in a natural fashion;
- the installation of a veneer thread splicer to enable the veneer previously jointer to be spliced both lenghtwise and crosswise;
- a control bench with an illuminated glazed glass top to check the good quality of the veneer joints.

.207 PANEL TO BE THE ASSEMBLY

At this stage, having available all the elements which go to make up the panel sandwich, that is to say: inner frame complete lock and hinge blocks, honeycomb panels, panels for skins cut-out and veneer sheets, it is possible to start the sandwich forming operation by means of hot pressing.

This step involves the following sequence:
- withdrawal of skin panels from storage ahead of pressing line, previously stored face up and face down alternately;
- feeding of two panels simultaneously through to roll glue-spreader for spreading urea based glue (Kaurit) on two opposite faces of panels and discharged of same over disc conveyor along pressing line;
- withdrawal of first panel from disc conveyor and positioning of same onto sandwich forming bench;
- withdrawal of internal frame from nearby storage and overlaying of same over first skin panel spreaded with glue lying on sandwich forming bench;
- withdrawal of honeycomb from nearby storage and positioning of same into internal frame lying on sandwich forming bench, above first glue spreaded skin panel, and eventual fastening of honeycomb to frame by means of staples;
- withdrawal of second panel from edge knife conveyor and positioning of same over internal frame;
- feeding of sandwich into hot platen press and start of work sequence just described for making ready next sandwich;
- discharge of pressed panels, at the end of pressing cycle, and storage of same for a lapse of time sufficient to guarantee its complete cooling down and equilibrium with room moisture conditions.

2.208 DOOR PANEL CALIBRATING

All sandwich panels, be they used as plain or as luxury doors, must be thickness-sanded in order to ensure their constant thickness throughout the production runs and to get their faces perfectly smooth throughout, within acceptable tolerence limits.

For this reason each and every panel is passed through a wide belt contact sander, which may be of the single overhead belt type only, or a top-and-bottom belt type one - the former type or sander, naturally, involves two machining steps, one for each face of the panel. Each panel, after the thickness sanding operation, is checked up to ascertain that its faces be well finished and do not show any streaking, chatter marks, trailing marks, sandtoughs or other surface defects.

Having completed the thickness-sanding operation, all panels to be used as plain doors are stored prior to undergo sizing and/or rebating, whilst all panels to be used as luxury doors are moved to the pre-press storage to undergo the veneering operation.

Next to the check-up point at the calibrating station, it is advisable to set up a "doctor" section where all surface defects previously mentioned are patched-up in order to cut down to as low as possible manufacturing costs due to eventual work rejects.

Generally, this "doctor" section is equipped with a work bench (complete with: a pot of filler, a spatula, a splicing knife, glue, household hot pressing iron), and a belt sander.

2.209 FACE VENEERING AND LAMINATING SECTION

Where production runs are relatively low, the veneering and laminating department may be equipped with and a panel laminating press ; while, where relatively high production runs are involved, it is always convenient to install this department in line of the calibrating department.

At this stage both the skins veneering and the pocket panels laminating and veneering operations are carried out on luxury flush doors.

Veneering of the sandwich skins, previously thickness sanded, involves the following work sequence:

- feeding of sanded sandwich through roll glue-spreader for spreading urea based glue (Kaurit) on both faces and discharge of sandwich over disc conveyor along the pressing line;

- withdrawal of first sheet of veneer from bridge-type deposit, located overhaed of the press preparation bench, and laying it over the same bench;
- placing of glue spreaded sandwich over the firat sheet of veneer;
- withdrawal of second sheet of veneer from overhead bridge-type deposit and laying it on top of the other face of the glue spreaded sandwich;
- feeding of veneered sandwich into hot press and start work sequence all over again for each successive aandwich;
- unloading of veneered sandwich, after completion of press cycle and storing to allow complete curing and cooling of panels.

The laminating and veneering of pockets for luxury flush doors is carried out in much the same way as for the sandwich panels veneering, that is to say:
- glue spreading over the pocket faces which have to be laminated and veneered;
- laying-on of veneer sheets on the outside faces of pockets;
- 4-layer hot preaaing and curing;
- storage.

2.10 - DOOR SIZING AND EDGE BANDING

The panel sandwichee eanded and veneered, as they come out of the preee, are not yet accurate in aiee as they have protruden excees skine. It is therefore neceeeary to trim and aize the rough door panele. The trimming and aizing operation is done on eingle ended or double ended automatic machines which do not require highly akilled manpower to control the quality of the work in that, once they have been tooled-up and set-up theee machines need only faeding and out-feeding.

Plain doors are only eized and rebated on a work station compoeed of:
- firat automatic double end eieing machine to trim and rebate the doors on the atile edge.
- automatic panel turner to turn the doors by 90° to machine the rail edge in the eecond double end tenoner;
- eecond automatic double end aieing machine to trim and rebate the doore at the rail edge.

Luxury doors, beeides the aieing and rebating operations, will be edge banded by top quality lipping or veneer bands along the atile edge. For this type of door should be installed a work line composed of:

- first automatic double end sizing machine to trim and/or rebate the doors on long sides;
- link conveyor between first double end sizing machine and edge banding machine in line;
- double side edge banding machine for application, on long sides of doors, of high grade wood lippings and machining of rebates or, alternatively, a specially built double side edge banding machine for application of high grade veneer bands on rebated doors;
- automatic panel turner to feed the doors into the second double end sizing machine in line;
- second automatic double end sizing machine to trim the doors on rail edges and to machine top rail.

First grade flush doors to be fitted with overlapping lippings, applies the same work sequence as for plain doors, but the overlapping lips are glued onto the doors edges, after the trimming operation, in special cramps and after the surface finish operation.

2.211 FINAL SIZING OF GLAZING CUT OUTS

Attention is brought to that step of the production cycle in which was mentioned about the need to carry-out the rough cutting-out operation on panel skins to be used for the manufacture of cut-out doors.

However, in that stage it was a rough cut-out without any reference edge. Consequently, during the pressing and sizing operations some inaccuracy of the cut-out arises.

It is, therefore, necessary to correct all geometric deviations at this stage as the door after trimming and rebating has an accurate size thus the cut-out can be centred in relation to the doors circumference edge accuracy.

This accurate machining or centering operation of the door cut-out is done on automatic router, which may be either of the type using a template copying device, or a numerical controlled operation.

2.212 FINISH SANDING, SURFACE AND EDGE COATING OPERATIONS

This step of the manufacturing cycle is treated in full as a separate topic, therefore, in the present context only a broad outline of the work sequence involved will be given:
- fine sanding of edges and surfaces;
- edges and surfaces staining coat;
- curing of staining coat;
- denibbing of edges and surfaces stain coated;
- base-coating of edges and surfaces;
- curing of basecoat;
- top coating of edges and surfaces with transparent or pigmented coating materials;
- curing of top coat.

2.213 - ASSEMBLY OF HARDWARE, MOULDINGS AND CUT-OUT PANELS

At this stage, the door is practically complete and needs only to be fitted with hinges, lock, glass mouldings or cut-out panels and, in the case of doors with overlapping lippings, fitting of lippings all round.

All the above described operations may be carried out either on a transfer line or singly at separate work centres. If the final assembly operations are carried out on a transfer line, provision must be made that each work station along the line be stocked, with the hardware and fittings proper to that station's operations while, on the other hand, if the assembly operations are carried out at separate work centres all hardware and fittings proper to each work centre may be stored nearby each machine or work bench.

It is a fact, however, that in spite of their diminished flexibility the in-line operations are to be preferred to their counterparts because they enable to achieve a considerable saving in material handling in buffer storages, in labour and supervision and, last but not least, they guarantee a better product quality.

Whether the one or the other be adopted, however, the work sequence does not change and is as follows:
- machining of lock housing and handle bores on lock mortising machine;
- assembly of hinges on hinge driving machine.

These two operations may be performed simultaneously by using a combination lock mortising and boring/hinge driving machine.

- assembly of lock;
- fitting of glass fixing mouldings or cut-out panels;

- packing: either by shrink foil wrapping or by corrugated cardboard; this latter method is to be preferred to the former in that it offers better protection against impacts and during stacking, while the P.V.C. foil packing implies also the installation of very costly and un- reliable equipment performance

3 EXTERIOR DOORS

3.1 - SPECIFICATIONS

The door for exteriors differs from that for interiors in that, it must satisfy functional specifications completely different. While on the one hand both types of doors must satisfy the requirements of easy handling, allow or not allow air getting through with the possibility of graduating its flow, allow people and things to get through; on the other hand, the door for exteriors must also protect the house from outside agents; thus, it must avoid water getting through, resist to the distructive action of atmospheric agents and it must have burgler proof characteristics.

From this is drawn the conclusion that the door for exteriors must be built with more stable and solid materials, although this should take nothing to its functional characteristics of easy handling.

Granted this, the door for exteriors may be classified into two types:

- doubly reinforced door with the interior face sheeting made of panel sandwich;
- door sheethed with hard wood matchboard tongued and groove, and matched to form a wide board; or with interior face sheething laminated with plywood.

3.2 - MANUFACTURING PROCESS

As the manufacturing cycle for the inside face of the door of type (1) is analogous to that for the panel sandwich previously described in section (2) of doors for interiors; only a description of the work sequence inherent to the outside hardboard shingles will be given in this context with a description, as the case arises, of those complementary steps which serve to complete the anufacturing cycle.

3.201 - TIMBER DRYING

See work cycle 2.201.

3.202 CROSS CUTTING AND MULTIPLE RIPPING OF BOARDS

Compare 2.2.0 relating to panel sandwich inside framing.
Further, add:

3.203 - CROSS CUTTING AND MULTIPLE RIPPING OF MATCH WATER-DRIPS AND STOCK FRAME

- cut to length boards at the swing cut-off saw
- rip boards into dimensioned stock at the multiple rip saw to obtain rough sawn match board stock, water drips, rails and stiles for frames.

3.204 STOCK SELECTION

After step 3.303, all components are sorted out prior to further machining. All slats and boards having knots, deformations and defects of any kind which might influence the appearance and good quality of the doors, undergo some defect removing operations such as knot boring and plugging by means of appropriate machine (knot borer and plugger) and edge and surface straightening at the surface planer.

3.205 STOCK STRAIGHTENING

It is done at the surface planer and at the thickness planer.

3.206 MATCH PROFILING

Both edges of the match board stock are machined according to the type of match profile required
to tongued and groove shiplap or rebated pattern.

3.207 - INSIDE PROFILING OF RAILS AND STILES

The rails and stiles of the master frame are machined at the spindle moulder.

3.208 - END TRIMMING AND TENONING

All matchboards, , stiles and rails are end trimmed and tenoned at the combination trimming saw moulder.

3.209- WATER DRIPS MACHINING

At the spindle moulder.

The machining steps 3.205to 3.208 described above may be best and most efficiently done on a machining line made up of the following units:

- four side moulder in line with a 90° angle transfer unit equipped with push feeding arm which automatically feeds the work pieces into a double end automatic tenoning machine. This machining line not only guarantees the product's quality, but results also in a great saving of labour.

3.210- PREPARATION OF PANEL SANDWICH FOR INTERIOR FACE SHEETHING

See manufacturing cycle for interior doors - step 2.202 (I to X).

3.211 MATCHING OF EXTERIOR FACE SHEETHING

All boards are now matched so as to form a full size board, by gluing and pressing them in special cramps then allowed to cure before undergoing the next manufacturing stage.

3.212 - DOOR CALIBRATING

After glue curing, the matched face is calibrated either through a belt sander or through an automatic wide belt contact sander, depending on the quantity of doors to be produced.

3.213 ASSEMBLY OF MATCHBOARD TO DOOR

The assembly operation is generally carried out on a cold press in order to avoid deformation of the two components.

The work sequence is then as follows:

- spreading of glue over the contact face of the interior sandwich half, either manually or by roll glue spreading machine;
- overlaying of sandwich half just glue spreaded onto matched panel resting on press charging table;
- feeding of door through cold press platens: the press may be either single or multi-daylight pressuniversal or automatic depending on the production quantities required. Hence, unloading of laminated door at completion of press cycle time and storage of doors to allow complete glue hardening.

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PRODUCTION OF DOORS, WINDOWS AND FRAMES*

by

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3.214 - ASSEMBLY OF DOOR WITH MATCHBOARD PANELS

For exterior door made up of matchboard panels or with inside face of plywood, after step 3.208 comes the final assembly stage or just assembly.

The assembly operation is done on manual or oilpneumatic cramps after spreading of glue on the various components by means of gun spreaders or brushes.

It is assumed that all components such as stiles, top, bottom and middle rails, matchboard panels have been stored nearby the cramps after the previous manufacturing steps.

Each component, after being spread with glue, is properly placed on the cramps work tops, then the clamps are tightened and the frame is left under pressure for a few minutes; hence, the clamps are loosened, the door is unloaded and stored for a sufficient time to allow glue curing prior to the next work step.

3.215 CALIBRATING OF THE DOOR

See step 2.2[illegible], , which applies for both type (1) and type (2) doors.

3.216 - SIZING AND REBATING

The work sequence for both doors of type (1) and type (2) is the same as step 3.[illegible] by fitting an extra machining head on the automatic double end sizing machine, it is possible to machine the groove into which is fitted the water drip element.

3.217 - SURFACE AND EDGE SANDING AND FINISHING

See step 3.212

3.218 ASSEMBLY OF HARDWARE, TRIMS AND WATER DRIPS

The work sequence is identical to that described under step 3.213

4 - WINDOWS - LOUVRE DOORS AND ROLLER BLINDS

4.1 - TERMINOLOGY

Generally speaking, the window is composed of the following elements:

I-A - sash frame which fastens the window to the building structure and receives the sash or sashes.

II-A - sashes within the sash frame fulfills the conditions of articulation allowing air, light, people and things to pass through.

III-A - fastening element (hinges, sliding support, etc.) which enables the moving sash to open or shut.

IV-A - locking elements (handles, tie rods, latches, etc.) which locks the moving sash in shut position

V-A - shading elements (louvre boards and roller blind slats etc.) which intercepts light with possibility of graduating it, protects the window from agents and increases its thermal insulation. As regards the moving sash , the window may be classed according to the type of closures, thus the following relationships hold:

VI - rotational relation, where the moving sash components, during motion, describe a cylindircal path. In this class belong windows with one, two, three or more wings, horizontal and vertical centre hung windows, windows and tilting windows.

VII - sliding relation, where the moving sash components, during motion, are parallel . Hence, in this class windows with vertical and horizontal sliding wings are grouped.

VIII - mix relation, in which a moving frame component, during motion, describes a plan, the other components describe a cylindrical path. In this class belong the balanced vasistas windows, folding windows and bellow windows.

In the present context only those windows belonging into the class with rotational relation will be treated, in that their manufacturing cycle can be considered, broadly speaking, to be common to all classes of windows.

4.2 - MANUFACTURING PROCESS

There is a strict analogy in the manufacturing process of windows, louvre-doors and roller blinds which makes it worthwhile to group all three product int similar work process.

4.201 KILN DRYING

This step is the subject of another specific topic (q.v.)

4.202 CROSS CUTTING AND MULTIPLE RIPPING OF BOARDS

- kiln dried boards are withdrawn from the stacks, then
- the boards are cut to lengths, appropriate the rails and stiles of the sashes and the wings, to the water drips, the tie rod cover strips on to the roller blind mouldings at the swing cut-off saw;
- the sawn boards are ripped at the multiple rip saw, fitted with return bench for eventual re-machining of the boards portions exceeding the ripping capacity of the multiple rip saw;
- the ripped stock is then removed of defects, such as knots, at the combination knot boring and plugging machine.

4.203 - COMPONENT MOULDING AND TENONING

- moulding of components at the spindle moulder;
- machining of male-and-female tenons at the combined trimming and tenoning machine.

The two operations described above may be performed on an automatic machining line made up of: four side moulder in line with a 90° feeding unit and an automatic double end tenoner; this line will result in a great saving of manpower and floor space.

- end chanfering of louver boards at the chamfering machine;
- end trimming of tie rod cover strips and water drips at the double cut-off saw and eventual mitre-cuts on water drips.

4.204 - SLOT MORTISING OF LOUVER DOOR STILES

- machining of louver board stiles at the pneumatic slot mortising machine.

4.205 ASSEMBLY OF "BORE IN" HINGES ON SASHES

Hinge driving on sash frame stiles at the automatic hinge driving machine. This operation must be performed prior to assembly of sash frames otherwise problems of machine setting and frames handling might arise if the sash frames were assembled before the hinge assembly operation, especially if many-winged windows were to be produced whose sash frames are very cumbersome.

4.206 - ASSEMBLY OF SASH AND WINDOW FRAMES

- glue spreading on male and female tenons, of sash and window frame components by guns & brush glue batching equipment by means of automatic glue brushing machine;
- matching of frame's stiles and rails on the manual or hydraulic operated frame cramps.

- releasing of cramp's pressure, unloading and storage of assembled frames to allow complete glue hardening.

4.207 - ASSEMBLY OF LOUVER DOOR FRAMES

- glue spreading on male and female tenons (see step 4.206
- matching of stiles, rails and louvers slats on flat cramp, manually or hydraulically operated, and clamps tightening or pistons closing-in;
- releasing of cramp's pressure and unloading and storage, of jalousies frames (see operation 4.206.

4.208 CALIBRATING OF SASHES

Only the sashes are calibrated, thus:

- calibrating of sashes either by means of manually operated belt sanders or by means of automatic wide belt sanders. For high production runs two automatic wide belt sanders are used in line, linked by a work-piece turning device and a surface control station, or, alternatively, an automatic wide belt bottom sander and a surface control station.

4.209 SIZING AND REBATING

Only the sashes are sized and rebated. It is possible to tool-up machines capable of performing in one pass such machining operations as glass rebates locking rod groove, water drip housing and latches housing (on louvre doors).

When small production runs are considered only one machine will do and the work is passed through to the machine twice; along stiles and rails. In case of higher production runs, it is advisable to install a machining line which links an automatic double end sizing machine, a workpiece turner, and another automatic double end sizing machine.

Thus the work sequence is as follows:
- sizing, rebating, machining of locking rod groove and latch housing, on the rail edge when passing the first automatic double end sizing machine properly tooled-up. In the case of louvre doors, the sizing and rebating operations are performed;
- turning of the wing and feeding into second sizing machine in line, by means of automatic work turning device;
- sizing, rebating and machining of glass way and water drip housing groove on rails while passing the second automatic double end sizing machine in line with workpiece turner. In the case of louvre doors, sizing and rebating operations are performed only;
- storage of sized sashes in buffer storage.

4.210 PRE-ASSEMBLY

By the term pre-assembly is meant the assembly of such fittings as water drips, locking rods, cover strips for locking rods and lean-on external strips (if any).

These pre-assembly operations usually are done with power driven portable tools such as nailing guns, screwdrivers, drills, etc. on suitable workbenches.

4.211 SURFACE AND EDGE FINISHING

This step is treated in a specific paper (q.v.).

4.212 HARDWARE ASSEMBLY

As described previously in the door manufacturing process the assembly of hardware may be done either on single machines, or on a specialized assembly line built-up of a suitable number of work stations according to the production capacity.

The work sequence is as follows:

- drilling of water drining holes on sash by means of portable power or pneumatic drills;
- setting of eye-bolts on sash for engagement of locking rod, by means of driving machine or portable tools, depending on the type of locking rod adopted;
- setting of hinges on sashes by automatic hinge driving machine or by combined automatic or manual hinge boring and driving machine, depending on the type of fastening element used; for example, on the louver doors the fastening element is mostly of the wedge-type. This requires a hinge slotting and driving machine suited for the job, be it semi-automatic or fully automatic;
- assembly of latches, forks and locking rod on louver doors on the workbenches with portable power tools or hand tools;
- assembly of packing strips, if any, on the windows and louver doors sashes and sashes at the workbenches or work stations;
- testing of fastening and locking elements at the workbenches or work stations in order to ensure perfect fit of sashes frames and sashes;
- packaging of finished windows: all handles or protruding hardware are not assembled but are enclosed with the windows for ease of packaging and mounted on site; packaging of windows is not necessary, however if it is required, it should be done with corrugated cardboard boxes for the reasons already explained in the door manufacturing process.

5 - FRAMES AND INTERIOR TRIM

5.1 - TERMINOLOGY

In the door and window manufacturing field, the term interior trim plies all those decorative mouldings which enhance the quality of the products (door , casings decorative trim and glazing mouldings , skirting board) and those which impart the products a greater structural function (casings and top glazed frame for doors).

Usually, mouldings are made of selected exhotic woods such as African walnut, mahogany, ramin, yellowtone, etc., because these woods have good appearance and are easily machinable.

5.2 - MANUFACTURING PROCESS

As the machines to produce lippings, decorative parts, glass holding strips, skirting board and casements have specifications such as to enable the machining of any type of mouldings, it is convenient to treat the subject in a broad sense.

5.21 - KILN TIMBER

See manufacturing cycles for doors and windows.

5.22 - CROSS CUTTING AND MULTIPLE RIPPING OF BOARDS

- cut out defects and cross-cut at the swing cut-off saw;
- machine cross-cut boards into slats at the multiple rip saw and recycling, if needed, of unripped portions of boards in excess of multiple rip saw capacity.

5.23 - SHAPING AND CUTTING TO LENGTH

- shaping of moulds at the spindle-moulder (for low production quantities) or at the four side multi-spindle moulding machine (for high production quantities);
- end tenoning of casings and jambs and heads at the combination circular saw-spindle moulder (for low production quantities) or at the automatic double end tenoner (for high production quantities)

- mitre-cutting of decorative moulds and glazing mouldings at the single or double head mitre saw.

5.24- SANDING AND FINISHING

The sanding and finishing process is the subject of a specific topic (q.v.)

5.25 ASSEMBLY

The assembly step applies only for decorative mouldings, glazing mouldings and casings, because the casings and the skirting boards are usually supplied to a customer in running meters for easier mounting at the building site.

Thus, the decorative mouldings and the glazing mouldings are assembled and nailed to the products by portable pneumatic nailing guns glued the door panels at the assembly work benches.

As regards the casings whose jambs and heads are generally constructed in a knock-down form, the following assembly operations are carried out:
- hinge driving, on the door supporting jamb, by means of automatic hinge boring and driving machine;
- machining of latch/counterplate housing, on jamb opposite the hinged jamb, by means of lock mortiser and fitting of lock counterplate by means of screws;
- drilling of holes for bolts and bushes, for jambs and heads assembly, at the bush drilling-driving machine or by use of drill and hammer at the assembly benches.

5.26 - PACKAGING

By means of corrugated carton prior to shipping out.

6 - CONCLUSIONS

The choice of machines and, at the same time, the ratio of their utilization with respect to the required productivity is of vital importance in a firm's costs structure and efficiency.

Keeping into consideration the interdependance existing between a firm and its productive capacity it must be realized that, provided the machines utilization remains constant, the exploitation of a production unit is as much greater as greater is the productive capacity of that unit. For example, consider a unit that must produce doors, windows and mouldings. The use of machines and semi-automatic machining lines for this unit is economically valid for production quantities not exceeding 40.000 unit/year.

Beyond this level, it is necessary to realize a jump in quality and go on to machines and machining lines highly automated. In fact if, on the one hand, for production quantities below 40.000 units/year is sufficient the installation of single machines of the traditional and semi-automatic type such as band saws, circular saws, spindle moulders, double end sizing machines, sanding machines, etc. employing more skilled labour in number relatively higher with reepect to the production quantities; on the other hand, for production quantities greater than 40.000 units/year a firm oriented towards the installation of single machines would no longer be competitive, because productivity would fall to levels economically unacceptable, in that, remaining unchanged the capital investment on machines, would increase the building investments, the administration and the direct labour costs.

That is why it is justified a choice on automatic machines and machining lines which, besides diminuishing the ratio cu.mt./man/unit produced and hence the building expenses, has the adavantage of employing less skilled labour and less manpower expenditure.

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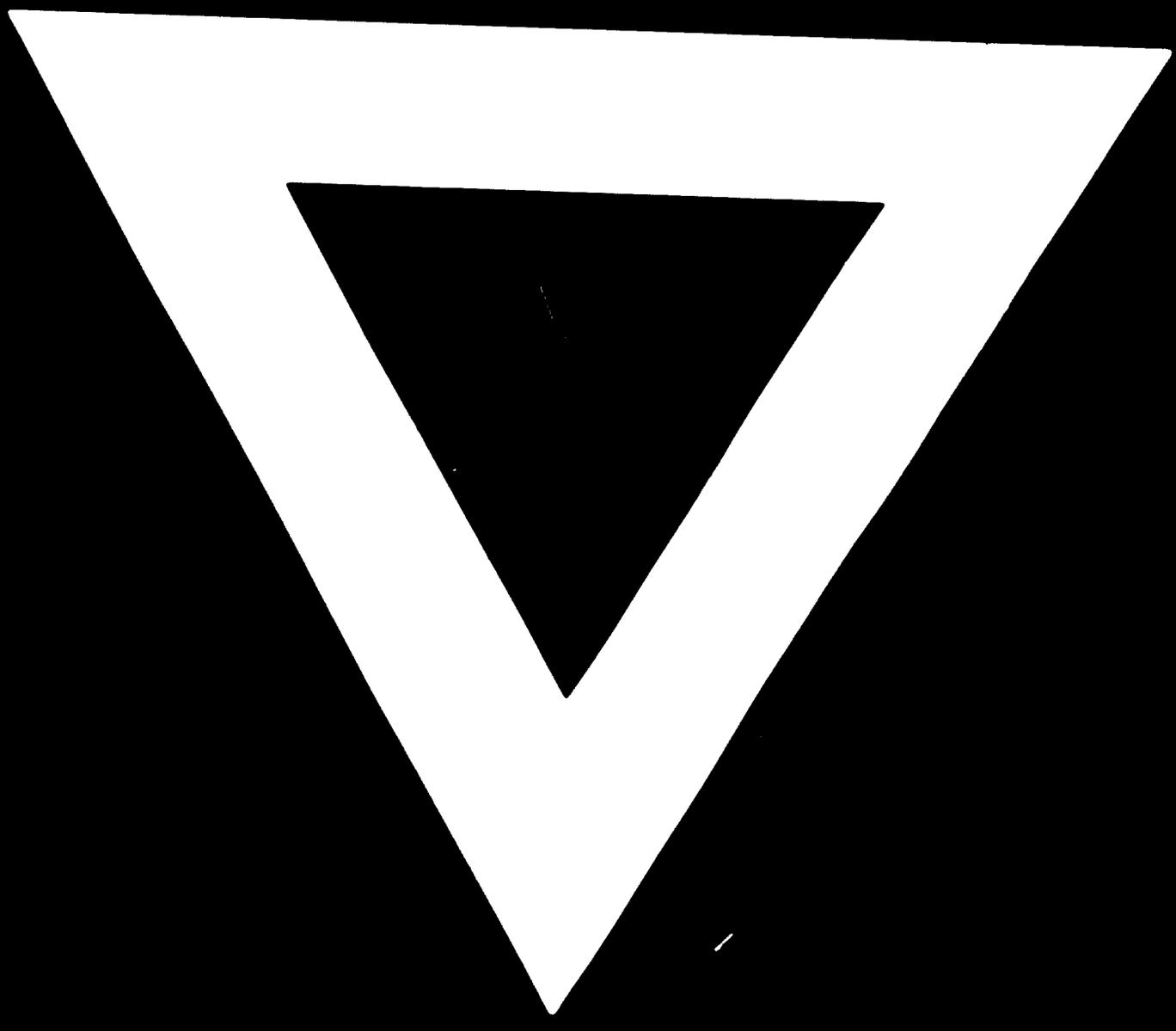


78.10.31

CONTENTS

1 - INTRODUCTION

Broadly speaking, the production of interior and exterior wooden shutters, in developing countries, plays a predominant role and represents quite an economical effort.

No doubt, this is due to the vast programs of investiment that are being undertaken and developed by these countries in the public housing field. Hence, then, the need to produce locally the most important completing elements such as doors and windows.

Such products, which will necessarly have diversified specifications fromone country to another, nevertheless must satisfy common specifications, such as good protection against local atmospheric agents (high humidity, wide thermal ranges, dust, etc.), and the need to be manufactured in the most simple and functional way.

It is thus obvious that the kind of product to be manufactured determines a choise of machines particularly suited for the manufacture of such products; from this appears clear the need to study simple models, with good mechanical specifications, easy to manufacture and to assemble, in order to reduce the financial investment, as far as the machineries are concerned, and in order to curtail the expenses both during the assembly stages and for the ordinary unkeeping.

It is indispensable to account for the raw matarerials to be employed, and for the ancillary materials which, unfortunately, sometime cannot be purchased locally, in order to cut down to a minimum the importing of such materials which will have to be replaced by others manufactured locally, or even produced within the firm's premises itself.

It will be seen later on which of these materials may be replaced by alternative solutions. It is certain, however, that it shall be necessary to forecast and care for all production requirements by ensuring a stock of raw and ancillary materials, having specifications as far as possible constant through time, so as to avoid technological changes in the manufacturing processes, and consequently, the cropping up of technical production problems which will generally lead to increases in manufacturing costs.

Further, it is appropriate to underline, at this point, the importance which the daily production output plays upon the choice of manpower, machineries, auxiliary plant services and material handling equipment.

Clearly, a diversified and low volume production requires the recruitment of particularly skilled labour, since the various manufacturing operations and their good quality depend on the skill of the workers, rather than on the machines.

On the other hand, in those plants producing on a large scale basis, it is obvious that the manual skill is needed only in some specific manufacturing operations which do not require a particular skill of the worker.

With this in mind, will be examined the specifications of each products, the manufacturing cycle on large scale production of each of them, the machinery and equipment needed for their manufacture, by-passing the timber drying and finishing steps which are treated in other specific papers.

2 - DOORS FOR INTERIORS

2.1 - SPECIFICATIONS OF FLUSH DOORS

Generally speaking, the door for interiors consists in a panel "sandwich" or "book" built-up by a solid wood frame and reinforcing blocks for lock and hinges, by a honeycomb core, which may be of cardboard, wood or fibreboard, and by two skins which may be of plywood or chipboard or even fibreboard panel.

The skins of the sandwich may be either flush or with glass openings, laminated with high quality veneer sheets or simply paint coated. The sandwich edges may be rebated or flush, depending on the standard requirements in different countries.

Naturally, all the combined features which may be given to the outer appearance of the sandwich, in order to impart the door different finish and quality, do not modify its basic structure.

Provided certain conditions of accurate preparation of its components be satisfied, the manufacture of the sandwich is simple; failure to comply with such conditions may lead to poor results which in turn may give rise to a lot of problems in the succeeding manufacturing stages, particularly during the finishing stage.

As far as the finish and the outer appearance of the panel sandwich are concerned, provided the above said conditions relative to the basic structure remain unchanged, the door for interiors may be classed into two main types:

2.1.1 - STANDARD FLUSH DOORS (SECOND GRADE)

This type of door, which in turn may be lipped or rebated, flush or with glass opening, is made by using relatively cheap materials, that is to say, the lips or rebates are machined directly off the same wood which acts as the sandwich frame; the chipboard, fibreboard or plywood skins are not veneered but are paint finished directly on, following the thickness sanding operation. The hardware used is generally of plain quality, even though its service performance is good.

2.1.2 - VENEERED FLUSH DOORS (FIRST GRADE)

This type of door, like the previous one, may be lipped or rebated flush or with glass opening. It is made with good quality materials, that is to say, the lips or rebates are machined directly off the sandwich frame, the edge banded with high quality veneer strips, or obtained after lamination of good quality wood strips on the edges; prior to laminating, the sandwich skins with

high quality veneer sheet (such as mohogany, "aniegrè", etc.) the raw skins are perfectly thickness sanded; hence, after veneering, they are lacquer coated in semi-glass or satin finish.

Particular care is given to door with under-cut or applicated on panels, instead of glass openings, so as to obtain the effect of a continuous whole sheet of veneered skin taken from the same matrix as the sandwich. The hardware used is of top quality.

To the luxury door family belong, also, those panels whose skins have been upgraded by the surface printing process of by melamine or plastics overlays (P.V.C., formica, etc.); however, this type of panel will not be treated here, as its application in present door manufacturing practice is little or not at all adopted.

2.2 - MANUFACTURING PROCESS

The manufacturing process for the two types of doors just described is almost the same; in fact, the luxury door differs from the plain door's manufacturing process in that, as it will be seen further on, it implies the installation of a few more machines.

Thus the working steps are as follows:

2.201- TIMBER DRYING

The drying process of timber board to be used as internal framing for the panel sandwich, and the choice on the type of drying equipment are the subjects of another specific topic; therefore, this step will not be treated in the present context.

2.202 - CROSS CUTTING AND MULTIPLE RIPPING OF BOARDS

It is clear that, in order to obtain both the core frame of the panel sandwich and the hinge lock blocks, the dried boards must be cut and ripped into slats of suitable dimensions.

To speed-up the production rate, particularly when the daily doors output is relatively high, it is suggested the following work sequence:

- trim off defect board ends at the swing cut-off saw;
- cross cut boards to correct lengths at the swing cut-off saw, in order to obtain from each board lengths equal to the stiles, hinge and lock blocks forming the panel sandwich core frame, allowing a certain amount of excess wood for the successive trimming operations of the panel sandwich;
- machine the cross-cut boards into slats of correct cross sections at multiple rip saw recycling, if needed the unripped portions of boards (this is the case of boards whose widths exceed the ripping capacity of a multiple rip saw).

Very often happens that, during the drying stage the timber undergoes twisting effects thus making it practically impossible to machine the boards directly, either on the swing cut-off saw or on the multiple rip saw. To avoid costly rejects, it is good practice to complement the cross cutting and ripping section with a planer, a thichnesser and a band saw.

Further, owing to the high production output that can generally be achieved during this step and owing, also, to the risk of deformations to which are subject the slats, it is advisable to step-up a buffer storage between this step and the succeeding one, having a storing capacity equivalent to at least a two day production run. This not only will allow better balancing of the production departments concerned, but will also enable further relieving of the wood internal stresses.

2.203 - DOOR FRAMES ASSEMBLY

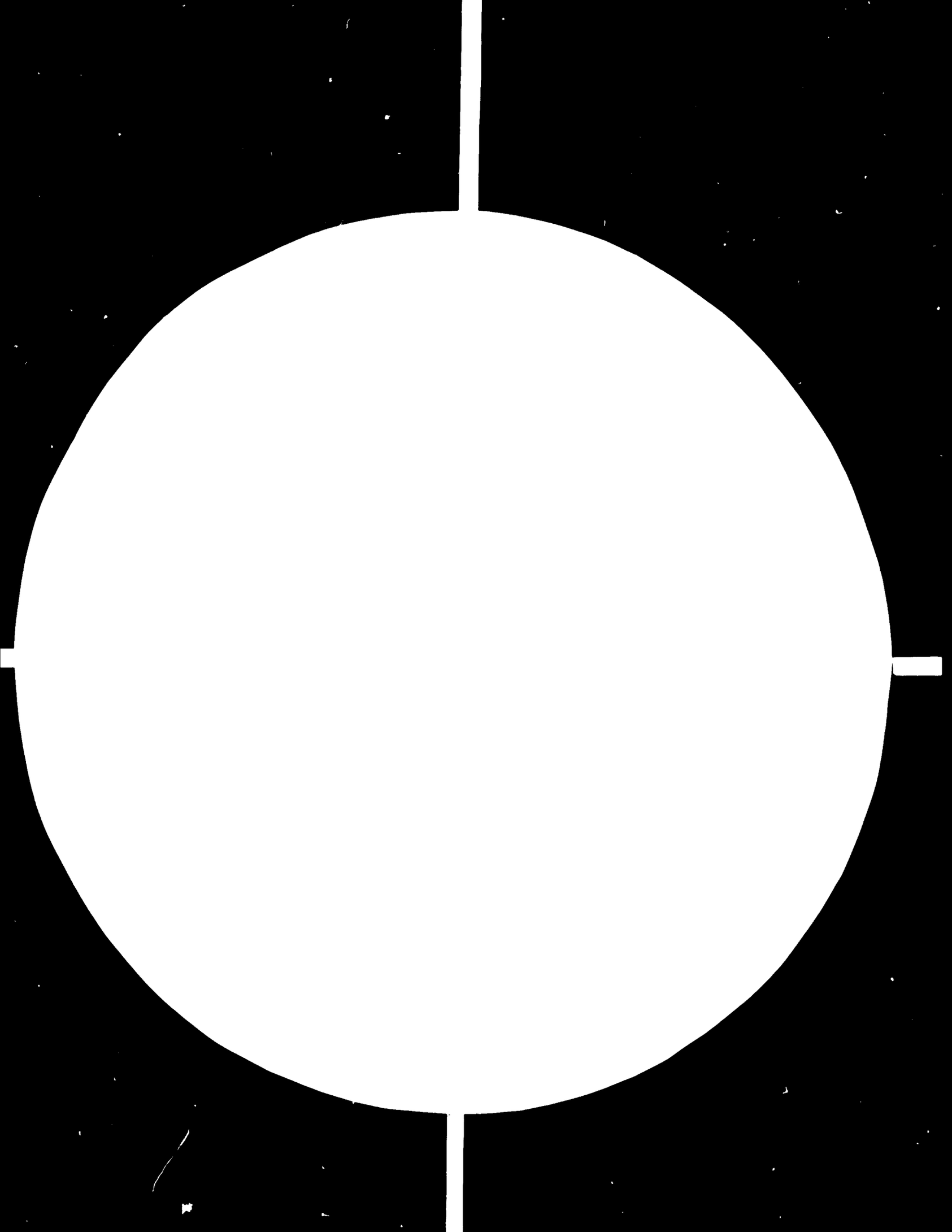
The panel sandwich internal framing and the lock and hinge blocks, in order to form a whole body with the panel sandwich during the pressing stage, must be fastened together. The fastening may be achieved in several ways, but the method most widely used is that employing steel or aluminium staples which are shot-in by means of portable or automatic stapling machines.

After the frame components, and the hinge and lock blocks have been laid-out on assembly benches, equipped with special templates, or simply rested one against the other, relying upon the workers skill to obtain a good matching.

It often happens that, the internal frame's rails and stiles, during the ripping operation, undergo twisting and wraping effects which might impair the frame's, hence the panel's geometry; in order to overcome this setback, it is good practice to install a saw, which may be either a bandsaw or a gang circular saw depending on the production requirements, that will enable to make small stress relieving cuts on the rails and stiles which will ensure a greater control of the frame's geometry.

2.204 - PANEL SIZING SECTION

By sheeting materials, are meant the plywood, chipboard and fibreboard panels which will make-up the door skins after the pressing operation. It is clear that, owing to a plant's flexibility to produce doors of different dimensions, it is not advisable to purchase these materials pre-sized because this would imply, also, relatively high storekeeping costs.



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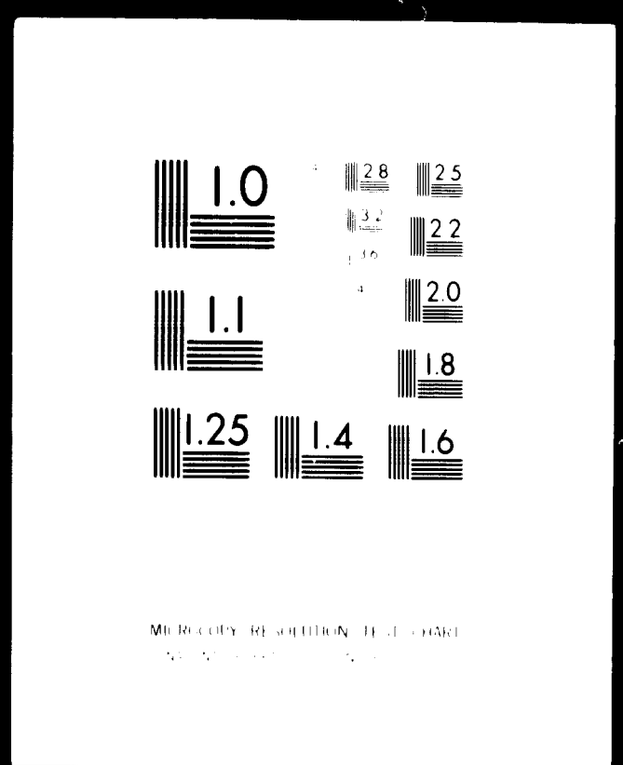

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2.207 Panel to frame assembly

At this stage, having available all the elements which go to make up the panel core that is to say: inner frame complete lock and hinge blocks, honeycomb panels, panels for skins cut-out and veneer sheets, it is possible to start the sandwich forming operation by means of hot pressing.

This step involves the following sequence:

- withdrawal of skin panels from storage ahead of pressing line previously stored face up and face down alternately;
- feeding of two panels simultaneously through to roll glue-spreader for spreading urea based glue (Kaurit) on two opposite faces of panels and discharge of same over disc conveyor along pressing line;
- withdrawal of first panel from disc conveyor and positioning of same on to core forming bench;
- withdrawal of internal frame from nearby storage and overlaying of same over first skin panel spreaded with glue lying on the core forming bench;
- withdrawal of honeycomb from nearby storage and positioning of same into internal frame lying the core forming bench, above first glue spreaded skin panel, and eventual fastening of honeycomb to frame by means of staples;
- withdrawal of second panel from edge knife conveyor and positioning of some over internal frame;
- feeding of core into hot platen press and start of work sequence just described for making ready next core;
- discharge of pressed panels, at the end of pressing cycle, and storage of same for a lapse of time sufficient to guarantee their complete cooling down and equilibrium with room moisture conditions.

2.208 Door panel calibrating

All core panels, be they used as plain or luxury doors, must be thickness-sanded in order to ensure their constant thickness throughout the production runs and to get their faces perfectly smooth throughout, within acceptable tolerence limits.

For this reason each and every panel is passed through a wide belt contact sander, which may be of the single overhead belt type only, or a top-and-bottom belt type - the former type of sander, naturally,

involves two machining steps, one for each face of the panel. Each panel, after the thickness sanding operation, is checked to ascertain that its faces are well finished and do not show any streaking, chatter marks, trailing marks, sandtoughs or other surface defects.

Having completed the thickness-sanding operation, all panels to be used as plain doors are stored prior to undergoing sizing and/or rebating, whilst all panels to be used as for first grade doors are moved to the pre-press storage to undergo the veneering operation.

Next to the check-up point at the calibrating station, it is advisable to set up a "dootor" section where all surface defects previosuly mentioned are patched-up in order to cut down on manufacturing costs due to eventual work rejects.

Generally, this "doctor" section is equipped with a work bench (complete with: a pot of filler, a spatula, a splicing knife, glue, household hot pressing iron), and a belt sander.

2.209 Face veneering and laminating section

Where production runs are relatively low, the veneering and laminating department may be equipped with a panel laminating press; while, where relatively high production runs are involved, it is always wise to install this department in line with the calibrating department.

At this stage both the skin veneering and pocket panel laminating and veneering operations are carried out on first class doors.

Veneering of the core skins, previously thickness sanded, involves the following work sequence:

- feeding of sanded sandwich through roll glue-spreader for spreading urea based glue (Kaurit) on both faces and discharge of sandwich over the disc conveyor along the pressing line;
- withdrawal of first sheet of veneer from bridge-type deposit, located overhead of the press preparation benoh, and laying it over the same bench;
- placing of glue spreaded core over the first sheet of veneer;
- withdrawal of second sheet of veneer from overhead bridge-type deposit and laying it on top of the other face of the glue spreaded sandwich.

- feeding of veneered core into hot press and start work sequence all over again for each successive core;
- unloading of veneered sandwich, after completion of press cycle and storing to allow complete curing and cooling of panels.

The laminating and veneering of pockets for first grade doors is carried out in much the same way as for the sandwich panel veneering, that is to say:

- glue spreading over the pocket faces which have to be laminated and veneered;
- laying-on of veneer sheets on the outside faces of pockets;
- 4-layer hot pressing and curing;
- storage.

2.10 Door sizing and edge banding

The panel cores, sanded and veneered, as they come out of the press, are not yet accurate in size as they have protruden excess skins. It is therefore, necessary to trim and size the rough door panels. The trimming and sizing operation is done on single or double ended automatic machines which do not require highly skilled manpower to control the quality of the work in that, once they have been tooled-up and set-up these machines need only feeding and out-feeding.

Plain doors are only sized and rebated at a work station composed of:

- first automatic double end sizing machine to trim and rebate the doors on the stile edge.
- automatic panel turner to turn the doors by 90^{o} to machine the rail edge in the second double end tenoner;
- second automatic double end sizing machine to trim and rebate the doors at the rail edge.

First grade doors, besides the sizing and rebating operations, will be edge banded by top quality lipping or veneer bands along the stile edge. For this type of door there should be installed a work line composed of:

- first automatic double end sizing machine to trim and/or rebate the doors on long sides;
- link conveyor between first double end sizing machine and edge banding machine in line;

- double side edge banding machine for application, on long sides of doors, of high grade wood lippings and machining of rebates or, alternatively, a specially built double side edge banding machine for application of high grade veneer bands on rebated doors;
- automatic panel turner to feed the doors into the second double end sizing machine in line;
- second automatic double end sizing machine to trim the doors on rail edges and to machine top rail.

First grade flush doors to be fitted with overlapping lippings, requires the same work sequence as for plain doors, but the overlapping lips are glued onto the doors edges, after the trimming operation, in special clamps and after the surface finish operation.

2.211 Final sizing of glazing cut outs

Attention is brought to that step of the production cycle wherein it was mentioned about the need to carry-out the rough cutting-out operation on panel skins to be used for the manufacture of cut-out doors.

However, in that stage it was a rough cut-out without any reference edge. Consequently, during the pressing and sizing operations some inaccuracy of the cut-out arises.

It is, therefore, necessary to correct all geometric deviations at this stage as the door, after trimming and rebating has an accurate size thus the cut-out can be centred in relation to the doors circumference edge accuracy.

This acourate machining or centering operation of the door cut-out is done on an automatic router, which may be either of the type using a template oopying device, or a numerical controlled operation.

2.212 Finish sanding, surface and edge coating operations

This step of the manufacturing cycle is treated in full as a separate topic, therefore, in the present context only a broad outline of the work sequence involved will be given:

- fine sanding of edges and surfaces;
- edges and surfaces staining coat;
- curing of staining coat;
- denibbing of edges and surfaces stain coated;
- base-coating of edges and surfaces;

- curing of base coat;
- top coating of edges and surfaces with transparent or pigmented coating materials;
- curing of top coat.

2.213 Assembly of hardware, mouldings and cut-out panels

At this stage, the door is practically complete and needs only to be fitted with hinges, lock, glass mouldings or cut-out panels and, in the case of doors with overlapping lippings, fitting of the lippings all around.

All the above described operations may be carried out either on a transfer line or singly at separate work centres. If the final assembly operations are carried out on a transfer line, provision must be made that each work station along the line be stocked with the hardware and fittings essential to that station's operations while, on the other hand, if the assembly operations are carried out at separate work centres all hardware and fittings essential to each work centre may be stored nearby each machine or work bench.

It is a fact, however, that in spite of their diminished flexibility the in-line operations are to be preferred to their counterparts because they allow for achieving a considerable saving in material handling in buffer storages, in labour and supervision and, last but not least, they guarantee a better product quality.

Whether one or the other be adopted, the work sequence does not change and is as follows:

- machining of lock housing and handle bores on lock mortising machine;
- assembly of hinges on hinge driving machine.

These two operations may be performed simultaneously by using a combination lock mortising and boring/hinge driving machine.

- assembly of lock;
- fitting of glass fixing mouldings or cut-out panels;
- packing: either by shrink foil wrapping or corrugated cardboard; this latter method is to be preferred to the former in that it offers better protection against impact and during stacking, while the PVC foil packing implies the installation of very costly and unreliable equipment performance.

3. EXTERIOR DOORS

3.1 Specifications

The exterior type door differs from that for interiors in that, it must satisfy functional specifications completely different. While on the one hand both types of doors must satisfy the requirements of easy handling, allow or not allow air getting through with the possibility of graduating its flow, allow people and objects to pass through; on the other hand, the door for exteriors must also protect the house from outside agents; thus, it must avoid water getting through, resist to the distructive action of atmospheric agents besides having burgler proof characteristics.

From this is drawn the conclusion that the exterior type door must be built with more stable and solid materials, although this should take nothing from functional characteristics of easy handling.

Granted this, the door for exteriors may be classified into two types:

- doubly reinforced door with the interior face sheeting made of panel sandwich;
- door with hard-wood matchboard tongued and grooved, sheeting and matched to form a wide board; or with interior face sheeting laminated with plywood.

3.2 Manufacturing process

As the manufacturing cycle for the inside face of the door of type (1) is analogous to that for the panel sandwich previously described in section (2) of doors for interiors; only a description of the work sequence inherent to the outside hardboard shingles will be given in this context with a description, as the case arises, of those complementary steps which serve to complete the manufacturing cycle.

3.201 Timber drying

See work cycle 2.201.

3.202 Cross cutting and multiple ripping of boards

Refer to para. 2.202 relating to panel core inside framing.

3.203 Cross cutting and multiple ripping of match, water-drips and stock frame

- cut to length boards at the swing out-off saw
- rip boards into dimensioned stock at the multiple rip saw to obtain rough sawn match board stock, water drips, rails and stiles for frames.

3.204 Stock selection

After step 3.203 all components are sorted out prior to further machining. All slats and boards having knots, deformations and defects of any kind which might influence the appearance and good quality of the doors, undergo some defect removing operations such as knot boring and plugging by means of appropriate machines (knot borer and plugger) and edge and surface straightening at the surface planer.

3.205 Stock straightening

It is done at the surface planer and at the thickness planer.

3.206 Match profiling

Both edges of the match board stock are machined according to the type of match profile required. Tongue and groove shiplap or rebated pattern.

3.207 Inside profiling of rails and stiles

The rails and stiles of the master frame are machined at the spindle moulder.

3.208 End trimming and tennoning

All matchboards, stiles and rails are end trimmed and tenoned at the combination trimming saw-moulder.

3.209 Water drips machining

At the spindle moulder.

The machining steps 3.205 to 3.208 described above may be best and most efficiently done on a machining line made up of the following units:

- four side moulder in line with a 90° angle transfer unit equipped with push feeding arm which automatically feeds the work piece into a double end automatic tenoning machine. This machining line not only guarantees the product's quality, but results also in a great saving of labour.

3.210 Preparation of pane core for interior face sheeting

Refer to para. 2.203 for manufacturing cycle of interior doors.

3.211 Matching of exterior face sheeting

All boards are now matched so as to form a full size board, by gluing and pressing them in special clamps which are then allowed to cure before undergoing the next manufacturing stage.

3.212 Door calibrating

After glue curing, the matched face is calibrated either through a belt sander or through an automatic wide belt contact sander, depending on the quantity of doors to be produced.

3.213 Panel to frame operation

The operation is generally carried out on a cold press in order to avoid deformation of the two components.

The work sequence is as follows:

- spreading of glue over the contact face of the interior half, either manually or by roll glue spreading machine;
- over laying of half just glue spreaded onto matched panel resting on press charging table;
- feeding of doors through cold press platens: the press may be either single or multi-daylight universal or automatic depending on the production quantities required. This is followed by unloading of the doors at completion of press cycle time and their storage to allow for complete glue hardening.

3.214 Assembly of doors with matchboard panels

For exterior doors made up of matchboard panels or inside faces of plywood, after step 3.208 comes the final assembly stage.

The operation is done with manual or oil pneumatic clamps after spreading of glue on the various components by means of gun spreaders or brushes.

It is assumed that all components such as stiles, top, bottom and middle rails and matchboard panels have been stored nearby the clamps after the previous manufacturing steps.

Each component, after being spread with glue, is carefully placed on the clamps work tops, then the clamps are tightened and the frame is left under pressure for a few minutes; hence, the clamps are loosened, the door is unloaded and stored for a sufficient time to allow glue curing prior to the next work step.

3.215 Calibrating of the door

See step 2.208 which applies for both type (1) and type (2) doors.

3.216 Sizing and rebating

The work sequence for both doors of type (1) and type (2) is the same as para. 3.210. By fitting an extra machining head on the automatic double end sizing machine, it is possible to machine the groove into which is fitted the water drip element.

3.217 Surface and edge sanding and finishing

Refer to para. 3.212

3.218 Assembly of hardware, trims and water drips

The work sequence is identical to that described under para. 3.213.

4. WINDOWS - LOUVRE DOORS AND ROLLER BLINDS

4.1 Terminology

Generally speaking, the window is composed of the following elements:

I-A - sash frame which fastens the window to the building structure and receives the sash or sahes.

II-A - sashes within the sash frame fulfills the oonditions of articulation allowing air, light, people and objects to pass through.

III-A - fastening element (hinges, sliding support, etc.) which enables the moving sash to open or close.

IV-A - locking elements (handles, tie rods, latches, etc.) which locks the moving sash in closed position.

V-A - shading elements: (louvre boards and roller blind slats, etc.) which intercepts light with possibility of graduating it, protects the window from agents and increases its thermal insulation. As regards the moving sash, the window may be classed according to the type of closure, thus the following relationships hold:

VI - rotational relation, where the moving sash components, during motion, describe a cylindrical pat. To this class belong windows with one, two, three or more wings, horizontal and vertical centre hung windows, and tilting windows.

VII - sliding relation, where the moving sash components, during motion are parallel. Hence, in this class windows with vertical and horizontal sliding wings are grouped.

VIII - mix relation, in which a moving frame component, during motion, describes a plan, while the other components describe a cylindrical path. To this class belong the balanced vasistas windows, folding windows and bellow windows.

In the present context only those windows belonging into the class with rotational relation will be treated, in that their manufacturing cycle can be considered to be common to all classes of windows.

4.2 - Manufacturing process

There is a strict analogy in the manufacturing process of windows, louvre-doors and roller blinds which makes it worthwhile to group all three products in a similar work process.

4.201 Kiln drying

This item is the subject of another specific topic it will, therefore, not be commented on in this report.

4.202 Cross cutting and multiple ripping of boards

Kiln dried boards are removed from the stacks, then cut to appropriate lengths for the various components pertaining to windows, louvre doors and roller blinds, at the swing out-off saw.

The sawn boards are ripped at the multiple rip saw, fitted with return bench for eventual re-machining of the board portions exceeding the ripping capacity of the multiple rip saw.

The ripped stock is then removed of defects, such as knots, at the combination knot boring and plugging machine.

4.203 Component moulding and tenoning

- moulding of components at the spindle moulder;
- machining of male and female tenons at the combined trimming and tenoning machine.

The two operations described above may be performed on an automatic machining line consisting of a moulder in line with a 90° feeding unit and an automatic double end tenoner. This line will result in a great saving of manpower and floor space.

- end ohanfering of louvre boards at the chamfering machine;
- end trimming of tie rod cover strips and water drips at the double cut-off saw and eventual mitre-cuts on water drips.

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PRODUCTION OF DOORS, WINDOWS AND FRAMES*

by

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4.204 Slot mortising of louvre door stiles

- machining of louvre board stiles at the pneumatic slot mortising machine.

4.205 Assembly of "bore in" hinges on sashes

Hinge driving on sash stiles at the automatic hinge driving machine. This operation must be performed prior to assembly of sash frames otherwise problems of machine setting and frame handling might arise if the sash frames were assembled before the hinge assembly operation, especially if many-winged windows were to be produced for which sash frames are very cumbersome.

4.206 Assembly of sash and window frames

- glue spreading on male and female tenons, of sash and window frame components by gun and brush glue batching equipment by means of automatic glue brushing machine;
- matching of frame stiles and rails on the manual or hydraulic operated frame clamps;
- releasing of clamp pressure, unloading and storage of assembled frames to allow complete glue hardening.

4.207 Assembly of louvre door frames

- glue spreading on male and female tenons (see para. 4.206).
- matching of stiles, rails and louvre slats manually or hydraulically with clamps tightening or pistons closing-in;
- releasing of clamp pressure, unloading and storage of jalousies frames (see para. 4.206).

4.208 Calibrating of sashes

- calibrating of sashes either by means of manually operated belt sanders or automatic wide belt sanders. For high production runs two automatic wide belt sanders are used in line, linked by a work-piece turning device and a surface control station, or, alternatively an automatic wide belt bottom sander and a surface control station.

4.209 Sizing and rebating

Only the sashes are sized and rebated. It is possible to tool-up machines capable of performing in one pass such machining operations as glass rebates looking rod groove, water drip housing and latches housing (on louvre doors).

When small production runs are required only one machine is needed and the work whioh is passed through to the machine twice; along stiles and rails. In case of large production runs, it is advisable to install a machining line which links an automatic double end sizing machine, a workpiece turner, and another automatic double end sizing maohine.

Thus the work sequenoe is as follows:

- sizing, rebating, machining of locking rod groove and latch housing, on the rail edge when passing the first automatic double end sizing machine properly tooled-up. In the case of louvre doors, the sizing and rebating operations are performed;
- turning of the wing and feeding into second sizing maohine in line, by means of an automatic work turning device;
- sizing, rebating and machining of glass way and water drip housing groove on rails while passing the second automatic double end sizing machine in line with workpieoe turner. In the case of louvre doors, sizing and rebating operations are performed only;
- storage of sized sashes in buffer storage.

4.210 Pre-assembly

By the term pre-assembly is meant the assembly of suoh fittings as water drips, locking rods, oover strips for locking rods and lean-on external strips (if any).

These pre-assembly operations usually are done with power riven portable tools such as nailing guns, screw drivers, drills, etc. on suitable work benches.

4.211 Surfaoe and edge finishing

This item is covered in another paper for presentation at the oourse and will, therefore, not be disoussed herein.

4.212 Hardware assembly

As desoribed previously in the door manufacturing process, the assembly of hardware may be done either on single machines, or on a specialized assembly line consisting of a suitable number of work stations in aooordance with produotion requirements.

The work sequence is as follows:

- drilling of water draining holes on sash by means of portable water or pneumatic drills;
- setting of eye-bolts on sash for engagement of locking rod, by means of driving machine or portable tools, depending on the type of locking rod adopted;
- setting of hinges on sashes by automatic hinge driving machine, or by combined automatic or manual hinge boring and driving machine, depending on the type of fastening element used; for example, on the louvre doors the fastening element is usually of the wedge-type. This requires a hinge slotting and driving machine, be it semi-automatic or fully automatic;
- assembly of latches, forks and locking rod on louvre doors on the work benches with portable power tools or hand tools;
- assembly of packing strips, if any, on the windows and louvre door sashes and sashes at the work benches or work stations;
- testing of fastening and locking elements at the work benches or work stations in order to ensure perfect fit of frames and sashes;
- packaging of finished windows: all handles or protruding hardware are not assembled but are enclosed with the windows for ease of packaging and mounting on site; packaging of windows is not necessary, however, if it is required, it should be done with corrugated cardboard boxes for the reasons already explained in the door manufacturing process.

5. FRAMES AND INTERIOR TRIM

5.1 Terminology

In the door and window manufacturing field, the term interior trim implies all those decorative mouldings which enhance the quality of the product as well as those which give the product a greater structural function.

Usually, mouldings are made of selected exotic woods such as African walnut, mahogany, ramin, etc., because these woods provide an attractive appearance.

5.2 Manufacturing process

As the machines which produce lippings, decorative parts, glass holding strips, skirting board and oasements have specifications which allows for the machining of any type of mouldings, it is unnecessary to detail their functions in this report.

5.21 Kiln timber

See manufacturing cycles for doors and windows.

5.22 Cross cutting and multiple ripping of boards

- cut out defects and cross-cut at the swing cut-off saw;
- machine cross-cut boards into slats at the multiple rip saw and recycling, if needed, of unripped portions of boards in excess of multiple rip saw capacity.

5.23 Shaping and cutting to length

- shaping of moulds at the spindle-moulder in the case of requirements for low production or at the four side multi-spindle moulding machine where high production is needed;
- end tenoning of casings jambs and heads at the combination cicular saw-spindle moulder (for low production) or at the automatic double end tenoner (for high production);
- mitre-cutting of decorative moulds and glazing mouldings at the single of double head mitre saw.

5.24 Sanding and finishing

The sanding and finishing process is covered in another paper for presentation at the oourse and will, therefore, not be discussed herein.

5.25 Assembly

The assembly step applies only for decorative mouldings and glazing mouldings because the casings and the skirting boards are normally supplied to a customer in running meters.

Thus, the deoorative mouldings and the glazing mouldings are assembled and nailed to the products by portable pneumatic nailing guns.

As regards the casings, the jambs and heads of which are normally produoed in knooked-down form, the following assembly operations should be followed:

- hinge driving, on the door supporting jamb, by means of automatic hinge boring and driving machine;

- machining of latch counterplate housing, on jamb opposite the hinged jamb, by means of lock mortiser and fitting of lock counter-plate by means of screws;
- drilling of holes for bolts and bushes, for jambs and heads assembly, at the bush drilling-driving machine or by use of drill and hammer at the assembly benches.

5.26 Packaging

By means of corrugated carton prior to shipping out.

6. CONCLUSIONS

The ohoioe of plant machinery and, at the same time, ratic of its utilization with relation to required production is of prime importanoe to a oompany's cost structure and efficiency. In other words where a oompany plans a set production figure and providing the equipments' utilization remains constant the exploitation of a produotion unit is no greater than that unit's designed capacity, which means that each piece of equipment must be carefully selected so that it may cope with the planned production of the over all operation. Take, for example, a unit whioh is required to produce doors, windows and mouldings, the makeup of whioh consists of a variety of machines, including some automatio lines. Such a unit is only economically valid where an annual production of up to 40,000 units is visualized. Beyond this level it is essential for management to consider the pros and cons relative to providing more sophisticated equipment to avoid any bottle-necks throughout the operation.

Because of the importanoe of adhering to careful planning during the early stages of setting up a plant a company needs to examine all situations, suoh as availability of power, water, local man-power, both skilled and unskilled, transportation systems, materials, shipping, the latter particularly where export markets are involved. To sum it all up and ensure that an operation is going to prove viable it is important that proper planning be oarried out, keeping in mind that while initially a certain production figure is being antioipated this oan change, hopefully upwards, in a very few years henoe.

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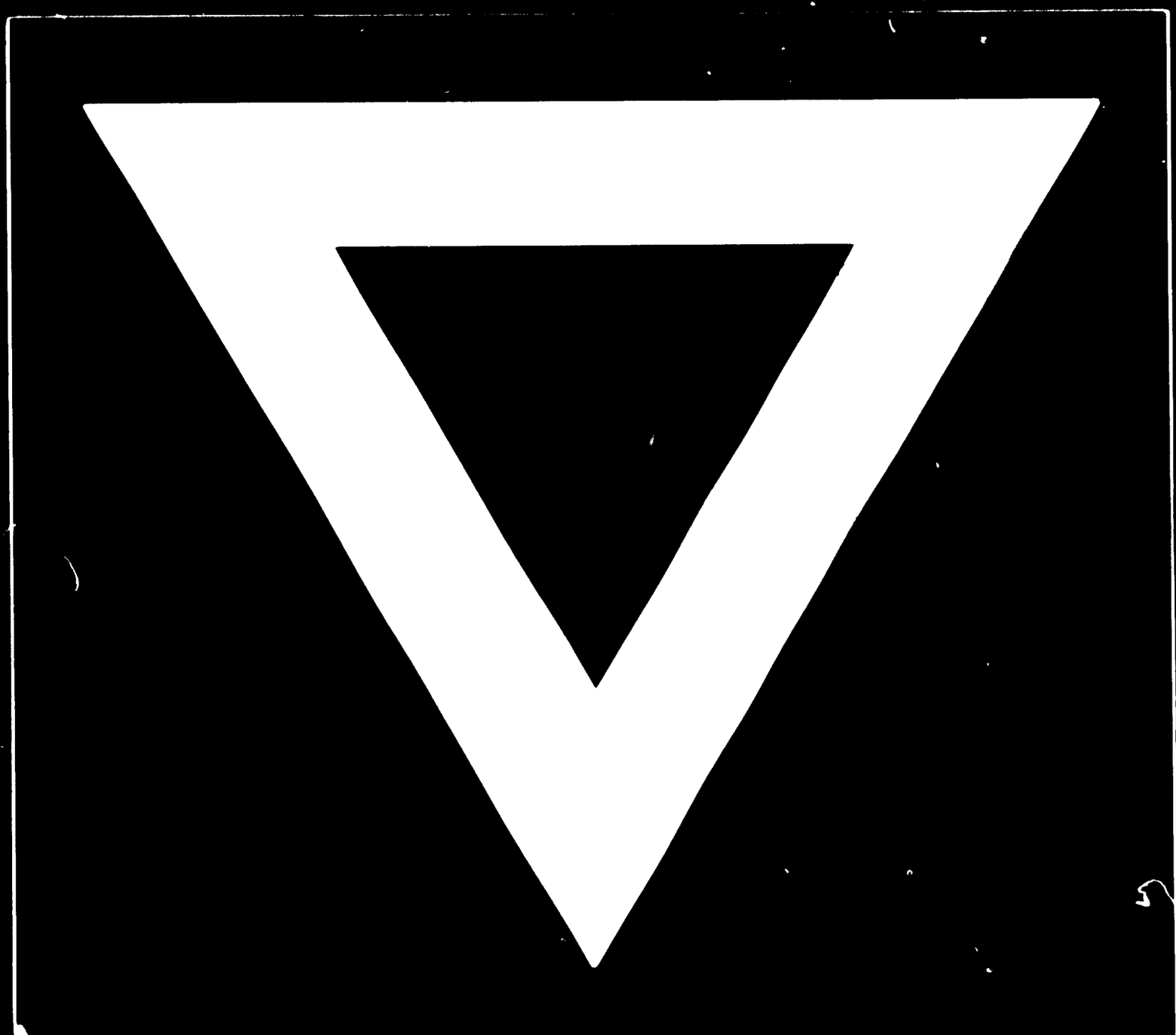

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CONTENTS

1. INTRODUCTION

The production of interior and exterior wooden shutters, in developing countries, plays a major role besides contributing in a large way to the economy of those countries.

No doubt, this is due to the vast programmes of investments that are being undertaken and developed by these countries in the housing field. Hence, the need to produce locally more important elements, such as doors and windows.

These products, which will necessarily have diversified specifications from one country to another, nevertheless must meet common specifications, such as protection against local atmospheric agents (high humidity, wide thermal ranges, dust, etc.), and the need to be manufactured in the most simple and functional way.

It is, therefore, obvious that the kind of product to be manufactured determines a choice of machines particularly suited for the manufacture of it. From this it appears clear there is the need to study simple models, with good mechanical specifications, easy to manufacture and assemble, in order to reduce the capital investment, as far as the machinery is concerned, as well as to curtail expenses during the assembly stage and also for ordinary maintenance.

It is very necessary to explore the availability of raw materials which are to be used, and anciallary materials which, unfortunately, sometimes cannot be purchased locally, in order to reduce the importation of those materials which should eventually be replaced by others to be manufactured locally, or even produced within the company's premises.

It will be noted later on which of these materials may be replaced by alternative solutions. It is certain, however, that it shall be necessary to forecast and care for all production requirements by ensuring a stock of raw and anciallary materials, having specifications as far as possible constant through time, so as to avoid technological changes in the manufacturing processes, and consequently, the cropping up of technical production problems which could lead to increased manufacturing costs.

Further, it is appropriate to underline, at this point, the importance which the daily production output plays upon the choice of manpower, machinery, auxiliary plant services and material handling equipment.

Clearly, a diversified and low volume production requires the recruitment of particularly skilled labour, since the various manufacturing operations and their good quality depend on the skill of the workers, rather than on the machines.

On the other hand, in those plants producing on a large scale basis, it is obvious that the manual skill is needed only in some specific manufacturing operations which do not require a particular skill of the worker.

With this in mind, will be examined the specifications of each product, the manufacturing cycle for large scale production of each of them, the machinery and equipment needed for their manufacture, by-passing the timber drying and finishing steps which are treated in other specific papers.

2. DOORS FOR INTERIORS

2.1 Specifications of push doors

The interior type door consists of a panel "core" or "book" built-up by a solid wood frame and reinforcing blocks for lock and hinges, by a honeycomb core, which may be of cardboard, wood or fibreboard, and by two skins which may be of plywood or particle board or even fibreboard panel.

The skins of the core may be either flush or with glass openings, laminated with high quality veneer sheets or simply paint coated. The core edges may be rebated or flush, depending on the standard requirements in different countries.

Naturally, all the combined features which may be given to the outer appearance of the core, in order to impart the door is different finish and quality, do not modify its basic structure.

Provided certain conditions of accurate preparation of its components are satisfied, the manufacture of the sandwich is simple. Failure to comply with such conditions may lead to poor results which in turn may give rise to a lot of problems in the succeeding manufacturing stages, particularly during finishing.

As far as the finish and outer appearance of the panel sandwich is concerned, provided the aforesaid conditions relative to the basic structure remain unchanged, the door for interiors may be classified into two types:

2.1.1 - Standard flush doors (second grade)

This type of door, which in turn may be rebated or lipped flush or with glass opening, is made by using relatively cheap materials, that is to say, the lips or rebates are machined directly of the same wood which acts as the core frame; the particle board, fibreboard or plywood skins are not veneered but are paint finished immediately, following the thickness sanding operation. The hardware used is generally of plain quality, even though its service performance is good.

2.1.2 - Veneered flush doors (first grade)

This type of door, like the previous one, may be rebated or lipped flush or with glass opening. It is made with good quality materials, that is to say, the lips or rebates are machined directly off the core frame, then edge banded with high quality veneer strips, or obtained after lamination of good quality wood strips on the edges. Prior to laminating, the core skins with high quality veneer sheet (such as mohogany, "aniegrè", etc.) the raw skins are thickness sanded; hence, after veneering, they are lacquer coated in semi-gloss or satin finish.

Particular care is given to doors with under-cut or applicated on panels, instead of glass openings, so as to obtain the effect of a continuous sheet of veneered skin taken from the same matrix as the sandwich. The hardware used is of top quality.

The first grade doors cover those panels also on which the skins have been upgraded by surface printing or by melamine or plastic overlays (PVC, formica, etc.); however, this type of panel will not be treated here, as its application in the present door manufacturing business is negligible.

2.2 - Manufacturing process

The manufacturing process for the two types of doors just described is almost the same; in fact, the first grade door differs from standard door's manufacturing process in that, as it will be seen further on, it implies the installation of a few more machines.

Thus the working steps are as follows:

2.201 - Timber drying

The drying process of timber boards to be used as internal framing for the panel core, and the choice on the type of drying equipment are the subjects of another specific topic; therefore, this subject step will not be discussed in this report.

2.202 - Cross cutting and multiple ripping of boards

It is clear that, in order to obtain both the core frame of the panel core and the hinge lock blocks, the dried boards must be cut and ripped into slats of suitable dimensions.

To speed-up the production rate, particularly when the daily door output is relatively high, it is suggested that the following work sequence be applied:

- trim off defect board ends at the swing cut-off saw;
- cross cut boards to correct lengths at the swing cut-off saw, in order to obtain from each board lengths equal to the stiles, hinge and lock blocks forming the panel core frame, allowing a certain amount of excess wood for the successive trimming operations of the panel sandwich;
- machine the cross-cut boards into slats of correct cross sections at the multiple recycling rip saw and if needed the unripped portions of boards.

Very often happens that, during the drying stage the timber undergoes twisting effects thus making it practically impossible to machine the boards correctly, either on the swing cut-off or on the multiple rip saw. To avoid costly rejects, it is good practice to complement the cross cutting and ripping section with a planer, a thicknesser and a band saw.

Further, because of the high production output that can generally be achieved during this step and owing to the risk of deformations to which are subject the slats, it is advisable to step-up a buffer storage between this step and the succeeding one, having a storing capacity equivalent to at least a two day production run. This not only will allow better balancing of the production departments concerned but will also enable further relieving of the wood internal stresses.

2.203 - Door frame assembly

The panel core internal framing and the lock and hinge blocks, in order to form a whole body with the panel oore during the pressing stage, must be fastened together. The fastening may be achieved in several ways, but the method most widely used is that employing steel or aluminium staples which are shot-in by means of portable or automatic stappling machines.

After the frame components and lock blocks have been laid-out on assembly benches, equipped with special templates, or simply rested one against the other, relying upon the workers skill to obtain a good matching.

It often happens that, the internal frame's rails and stiles, during the ripping operation, undergo twisting and warping effects which might impair the frames, hence the panel's geometry; in order to overcome this setback, it is good practioe to install a saw, which may be either a bandsaw or gang oircular saw depending on the produotion requirements, that will enable to make small stress so that small stress relieving cuts may be made on the rails and stiles whioh will ensure greater control of the frame's geometry.

2.204 - Panel sizing section

By sheeting materials, are meant the plywood, particle board fibre-board panels whioh will make-up the door skins after the pressing operation. It is clear that, owing to a plant's flexibility to produce doors of different dimensions, it is not advisable to purchase these materials pre-sised beoause this would imply relatively high store-keeping costs.

It is, therefore, advisable to have a storage of panel materials of standard sizes and withdraw daily from this storage the quantity needed to meet the production sohedules.

Thus, the panel sizing preparation seotion must be equipped as follows:

- a fork-lift truok whioh will handle the panels, to be cut to size, from the general store and store them ahead of the panel sizing saw, over a soissor lift benoh to facilitate the maohine's loading operation;
- a panel saw of suitable cutting capacity, to out sheets according to required sizes;

- a router to carry out rough cut-out operations on those sheets which will be used as skins for those panels which will be used in turn as doors with glass openings;
- a buffer storage, between the sheeting materials section and pressing section, where will be stocked all sized sheets and all under cut panels reclaimed during the rough cut-out operation, ready for the pressing operation.

2.205 Honeycomb core preparation

The panel core, as mentioned previously, may be either of cardboard (more commonly called "honeycomb") or strips of wood, plywood or fibreboard.

However, in modern door manufacturing practices the "honeycomb" is the most widely used because of its relatively low cost compared with other types of core materials, because of its better flexibility and practical application and because it is readly available commercially.

Owing to the honeycomb's ability to adapt itself to any geometrical form and to undergo, within certain limits, a fair amount of deformation under pressure which allows to compensate for the eventual slight variations to which the panel core may often be subject, because of the impossibility to control the inner frame component thickness, the honeycomb core preparation section requires the installation of only a band saw to cut to size the honeyoomb which is to be used as core for cut-out doors.

2.206 Veneer preparation

This manufacturing step applies only to the production of first grade doors. It implies:

- the construction within the plant of a veneer stock storage with controlled temperature and moisture, in order to avoid variable room conditions whioh cause excessive dehydration of the rare wood veneers, thus impairing their good quality;
- the installation of a veneer jointer which will enable jointing the veneer for matching a pattern to give the door skins and panels the appearance of a homogeneous massive wood board with all its grain patterns oriented in a natural fashion;
- the installation of a veneer thread splicer to enable the veneer previously jointed to be spliced both lengthwise and crosswise;
- a control bench with an illuminated glazed glass top to check the quality of the veneer joints.