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JOINERY PRODUCTION IN DEVELOPING COUNTRIES

AN ANALYSIS OF ALTERNATIVES 1/

by

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INTRODUCTION

The classification of joinery does not lend itself to unambiguous definition. The traditional definition says that "Joinery is an assembly of wood components designed and manufactured for incorporation in a building structure from which it shall receive support but no load". This leaves the border-line with carpentry somewhat uncertain, and excludes the limited uses of specialised joinery, such as window walling, which has been specifically designed to accept structural loading in addition to satisfying another functional need.

In the context of this paper the quoted definition has been adopted, and is illustrated by the following list of products.

Doors: external and internal, flush and other.
Windows: simple and specialised, fixed and opening.
Stairs: open and closed, straight and geometrical.
Shutters and balustrades.
Partitioning: bench framing.
Wall panels, door frames.
Built-in storage units, work-tops, etc;

Where costs are quoted they must be regarded as indicative only, but providing an order of magnitude. Though the level of costs will differ widely from country to country, within any one country their inter-relationship is likely to be reasonably uniform.

I. MARKET ASSESSMENT

Before any industrial investment can be initiated a very clear picture has to be obtained of the whole character of the potential market. Though there may be some element of social or political stimulus, such as the provision of employment or the improvement of living standards, an enterprise must expect to stand or fall by its ability to earn a proper return on the capital invested

In developing countries market assessment is often more difficult through the lack of published records and statistics, and some of these may first have to be gathered from a wide range of sources which are uncertain in their accuracy. Though intuitive assumptions may sometimes have to replace detailed analysis, yet this is preferable to omitting consideration of any factors

The demand for joinery is closely associated with the state of the construction industry in new work, alterations, and maintenance. Information will be needed on the current and future programmes of the public and private sectors, with particular emphasis on the character of the main constituents. A heavy road programme contributes nothing to joinery demand, whilst schools, hospitals and houses will provide extensive requirements

Income levels and living standards will have an important effect on the design and quality of joinery products and on the balance between functional efficiency and aesthetics. Front entrance doors, for example illustrate this point, for they can vary from the simplest closure of an opening to an elaborate, highly finished, and expensive design, in reflection of the owner's financial status

There will certainly exist some system of controls upon planning, development, and building design, both centrally and locally Mandatory regulations need examination for any special requirements affecting joinery

The topography of the country should be examined for any substantial regional variations affecting climate Population distribution and the existing pattern of industries, communications and transport facilities by road, rail, and water must be established. Energy resources for local or centralised power generation, and the distribution system for the latter will also have an important bearing on factory location

The existing educational system, including craft training, must be considered for its adequacy as a source of industrial operatives, supervisors, and management. This is not alone the concern of a joinery industry as such, since it could not flourish without the aid of electricians, engineers and a dozen other skills

Having reached favourable conclusions on the existence of a home market for joinery, attention should be given to export possibilities as a secondary outlet for basically the same products. There may be other developing countries with similar needs and easy access, or industrialised countries with high cost levels and open to cheaper imports. Excessive dependence on export markets, however, must be avoided, if the potential danger of importing an external recession is to be mitigated.

Other issues which must be faced in deciding how and whether the potential market can be profitably supplied are examined in succeeding chapters.

II. MATERIAL AVAILABILITY

It is a basic assumption that timber of species suitable for joinery manufacture are freely available, whether currently harvested or not, on a scale sufficient to satisfy domestic demand and at best to provide an export potential. Since the species may cover a wide range it will be necessary to consider them in some detail to ensure suitability for particular products.

Firstly, the volume availability of each species on an annual basis, within specified supply areas, must be checked together with any special difficulties of extraction from forest areas and of conversion. Continuity of supplies is very important.

The form of delivery must be known. If only logs can be supplied, the joinery factory would be faced with the installation of a log bandmill and edgers to break them down to lumber. This is regarded as outside the scope of this paper (though not beyond the possibilities of a large factory), and it will, therefore, be assumed that lumber can be purchased. It should not be excluded that the supply of dimension stock could be negotiated with great savings in the waste factor. It is also important to know the Commercial grading rules to be applied, and the condition at the time of delivery i.e. kiln dried to specified moisture content, shipping dry, or green.

From published data the physical characteristics of practically all species can be found. The particular features which concern suitability for joinery include the following,

Ease of kilning without degrade.
Machineability.
Stability and moisture movement.
Strength.
Acceptance of nailing, screwing and glueing.
Reaction to surface finishes.
Durability under all service conditions.
Permeability to preservatives if non-durable.

For many joinery products the use of wood-based panel products is requisite, notably plywood, particle board and hardboard. There may also be needs for other sheet materials such as asbestos-cement, plaster-board and laminated plastics. The source and availability of all these should be checked.

Finally, supply sources must be established for ancillary materials and components, adhesives, fixings, ironmongery and joinery furniture, primers and finishes. Some may have to be imported but the channels used must be known.

III. PRODUCT DESIGN

There will be strong national prejudices in favour of traditional designs in terms of appearance, methods of use, and functional efficiency. Some may have sound support for reasons of climate, others may exist for lack of pressures for change, but all are likely to be based on the use of local materials and hand tools. So long as small-quantity purpose-made products are envisaged as the factory output, then designs will be dictated by these factors. However, once it is the intention to produce in greater volume then fresh considerations arise.

A first requirement will be a degree of standardisation, both in dimensions and in details. Such standards may exist locally and should be examined for adoption, but the probability is that in a developing country changes in traditional building designs will be widespread, and it will be an opportunity to update standards with a strict regard for dimensional co-ordination. Excessive variety must be avoided from the outset.

During the process of Market Assessment much information should have been gathered from informed and popular sources on the prejudices and preferences of the people who use joinery in their normal life. It is best to advance slowly with changes, and not to stimulate sales resistance with pronounced novelty. Every change should have its supporting arguments in improved quality, performance or cost.

Above all, new designs should be fully tested and proven, if possible by independent agencies, before marketing and thus reduce the chance of failure and complaint. Further-more all new designs should be carefully considered with regard to ease of manufacture on the installed machinery.

IV. SIZES OF ALTERNATIVE ENTERPRISES

Joinery factories are not simply different in size, expanded from a basic model. At various levels however, there are important changes in their equipment, processes, objectives and management. Separation into categories is a necessarily arbitrary choice but the generally accepted basis is that of the number of employees within the factory complex.

For the purposes of this paper a selection has been made of three categories falling into the following general classification.

Small, employing 10 to 50 workers, producing purpose-made joinery to customers designs, combining handcrafts with the simpler types of machines, in relatively small order quantities.

Medium, employing 50 to 200 workers, mainly engaged on batch production of fair quantities of a wide range of joinery, with the use of modern machinery and limited handwork, but not making for stock.

Large, employing 200 to 1000 workers, making only a limited range of standard stock products in high volume, with sophisticated and specialised machinery, and modern controls.

For each of these typical factories their needs will be separately examined. Although some of these needs will be simply a matter of size, others will be concerned with differences of character. Particularly it should be noted that whereas a small factory may be readily expanded to the medium class, if the floor area can be made available, a switch to specialisation is likely to require substantially different equipment and involve a start de novo.

V. PRODUCT CHOICE

For the Small Factory the choice of product lies with the customer rather than with management. Fundamentally it must live by the servicing of local demand for every sort of joinery. It is unlikely to have the degree of repetition to justify the holding of manufactured stocks. The objective therefore, must be flexibility in meeting needs as they arise.

In a Medium Factory there will be a more selective approach to the meeting of demand from a wider geographical area than that available to the Small Factory. Some joinery products will be more economic to produce than others. There may be gaps in the market served by the Large Factory, which might be reluctant to make non-standard products even if potential, but non-recurrent orders are of fair size. The drawing office will aquire a valuable expertise in detailing and the solution of problems of functional efficiency that will attract a steady clientele. Here again flexibility is essential but it must be subject to strong management control.

The case of the Large Factory is very different. The products to be made must be chosen before the Factory is designed or even located, for success will be determined by making the right choice as much as by the skills of creating the production facilities.

Reference has been made under "Market Assessment" to some of the fields to be explored, it being assumed that in a Developing Country national distribution will be the objective, unless there are very substantial physical barriers to this. In some cases also national boundaries may be easy to cross to allow for participation in export markets of similar character. The dangers, however, of heavy reliance upon distant export markets cannot be too strongly emphasised, because they are subject to political, industrial, financial and regulatory influences of an unforeseen character which can have devastating effect on the exporter who lacks a firm home market basis.

There will be the need to determine the parameters of the market chosen, in terms of variety of product, dimensions and quality levels to ensure that the benefits of volume production of high demand items are not dissipated by the higher costs of complementary low demand items.

Finally the continuity of demand over future years, the inevitable changes that will follow research, development, and alterations in living standards and tastes, must be considered in relation to the consequential changes that will be necessary and feasible in production processes.

VI. FACTORIES AND THEIR EQUIPMENT

Some of the facilities required by a joinery factory are common to all sizes and vary only in degree. They fall into the following sectors. The costs include the appropriate equipment of buildings.

STORAGE BUILDINGS

In most climates fully enclosed ventilated buildings should be provided to keep lumber and ancillary materials in good condition. Medium and large factories will also need similar storage for finished products. Handling equipment for loading and unloading must be provided. A minimum floor to ceiling height of 6m is recommended.

Needs.		
	Small - 250m^2	Cost £ 6.000
	Medium - 1000m^2	.. £ 25.000
	Large - 4000m^2	.. £100.000

OFFICES, SANITARY AND SOCIAL FACILITIES

The nature and extent of these will be much affected by regulations, climate and living standards. Single storey offices in particular can be readily expanded as needs increase, but the other facilities less easily.

Needs		
	Small - 200m^2	Cost £ 20.000
	Medium - 600m^2	.. £ 50.000
	Large - 1000m^2	.. £ 75.000

KILN DRYING FACILITIES

Small factories may be expected to satisfy their need for dry lumber partly by holding stickered stock in for air-drying and partly by purchasing material already kiln-dried by the supplying sawmill. Medium factories, however, must provide themselves with kiln batteries on the right scale to ensure proper control of moisture content in their products, according to the ambient conditions they may be subjected to in service, and a sufficient buffer stock for production.

Steam can be obtained from boilers fuelled by wood-waste produced by the factory or from other sources, supplemented by oil fuel if economic. Batch kilns of 20/25m^3 capacity are likely to be most suitable, but a Large Factory using a standardised raw material might find a continuous kiln better.

Needs			
	Small - Nil		
	Medium - 4 chamber battery	Cost	£25.000
	Large - 10 chamber battery	Cost	£60.000

PRESERVATION TREATMENT PLANT

Unless any factory can assure itself of a continuous supply of naturally durable species of lumber, or unless its products are unlikely to meet exposure hazards in service, it must be equipped with a suitable impregnation plant. The choice will generally be of an oil-borne formulation, in view of the redrying of lumber requisite for water-borne preservatives before use in joinery. If hardwoods are the principal raw material it will almost certainly be necessary to install cylinders, pumps and control gear to withstand high pressure as well as low vacuum, so that any species resistant to impregnation may be treated to a proper level of retention.

Needs		
Small -	Cost	£20.000
Medium -	..	£30.000
Large -	..	£40.000

WOOD-WASTE DISPOSAL

Advance claculations will be desirable to determine the probable volume of wood-waste in the form of sawdust, chips, edgings and end trimmings as a daily output from any factory. The use of dumps and uncontrolled burning are becoming socially unacceptable.

One outlet is as boiler fuel to raise steam for kilns or perhaps other uses. If there is an excess volume the solid residues can be chipped in a hogger and combined with the sawdust and planer chips for disposal to an external board factory.

The extraction system is dealt with as factory equipment, but additionally it will be necessary to have outside of the plant cyclones, bins and redelivery gear to deal with residues in the manner finally determined.

Needs		
Small -	Cost	£ 3.000
Medium -	..	£ 8.000
Large -	..	£20.000

POWER

It is assumed that ample power supplies are available at economic prices. Indeed such supplies may be a determining factor in the location of a factory. The alternative of factory generators driven by natural gas or diesel engines is only worth consideration if such fuel supplies are locally available at favourable prices.

There may be capital costs to meet for connection to an electricity grid for feed cables and transformers, and it is important to know that reserves of power supply are available if needed.

Needs	Small	-	100	K.V.A.	Cost £ 2.000
	Medium	-	500	..	.. £ 5.000
	Large	-	1000	..	.. £10.000

LAND AND DEVELOPMENT

It is not feasible to suggest capital costs for the required land area for any project, nor for its reclamation, filling, levelling, service roads etc; Appropriate areas would be preferably leased.

Needs	Small	-	2.000 m^2
	Medium	-	10.000 m^2
	Large	-	20.000 m^2 (plus)

PRODUCTION BUILDINGS

Permanent production buildings should be planned for operational flexibility and, s far as possible, for incorporation in any future expansion plans without excessive modification. They should be single storey and of 6m minimum height from floor to ceiling or eaves. This will allow space for overhead suspended lifting and conveyor gear, exhaust piping, lighting, and mezzanine floors where needed.

Portal frame buildings of 20m clear span are both suitable and economic in cost, and may be constructed of timber, steel or precast concrete, according to availability. Trunk distribution systems for electric power and compressed air should be installed, as well as lighting.

Needs	Small	-	1.000 m^2
	Medium	-	4.000 m^2
	Large	-	6.000 m^2

PRODUCTION MACHINERY

In principle, sophistication of equipment is accompanied by increased investment cost and higher output per employee. Its feasibility increases with the size of the factory on an exponential

basis. It follows naturally that the three illustrative factory sizes should reflect this in the equipment of each.

Small. By reason of the great variety of work likely to be undertaken there will be considerable reliance upon the skills of bench craftsmen. The installed machinery should be chosen to relieve the craftsmen of the heavy and simple work operations, and so to use their abilities more effectively.

Machines will include circular saws, single block planers, spindle moulders, mortisers, single-end tenoners, bandsaw, router, belt-sander and the necessary tool room equipment for cutter and saw maintenance.

Note that multi-head moulders and double-end tenorers, which are of much higher cost and capacity are excluded. Waste removal would be by sweep-up to central points for exhausting to bins. Work benches, hand tools and assembly equipment, also electric bench tools (but not compressed air tools) are provided.

Cost £30.000

Medium. The greater size of enterprise justifies the installation of faster feed, more powerful, and more elaborate machinery to boost output. The degree of component completion will tend to reduce the amount of skilled benchwork and call for more simple assembly operations by semi-skilled labour. Longer production runs and less variety are a corollary, with higher back-up skills in tool-room and machine setting.

Machines will include circular saws, band resaws, straight line edger, panel saw, multi head moulders, spindle moulders, overhand and panel planers, routers, single and double-tenoners, single and gang mortisers, belt and drum sanders, powered cramping tables and a veneering press, electrostatic spray equipment, and comprehensive tool room equipment for saw sharpening, cutter grinding, tool setting and general mill maintenance.

An air compressor will be needed for machine pressure, assembly tools and spray work. There will be a comprehensive exhaust system for sawdust, chips and sander dust with segregation, as desirable, in the bins. A hogger may be needed for solid residues.

Cost £130.000

Large. By definition this is a specialist producer. National sales coverage means high volume and low costs (relative to the product). Low costs will only be achieved by concentration on standardised design in limited variety, and this will call for specialised machinery. For the purposes of this paper a door factory has been chosen, of which the products would be both panelled and flush doors, involving at least two seperate production lines.

Machines will include cross-cut saws both single and multi, band resaws, straight line edgers, multi-rip and panel saws, multi-head moulders, routers, double-end tenoners, gang mortisers, gang-borers, glue spreaders, powered cramping tables, H.F. glue setting equipment, powered presses, roller sanders, large recessors, lock mortiser and borer, etc;

There must be a tool room equipped not just for machine servicing but for a full electrical and engineering back-up, since line failures and delays are a costly combination.

An air compressor of high capacity will be needed for both machines and assembly tools, and a segregated exhaust system for all waste.

An important cost item will be lift tables and the transfer tables between machines, reducing the labour element and speeding the work-flow, but increasing the operational complexity.

Further, there can be involved the installation of elaborate and expensive machine lines such as finger-jointing, curtain-coating, or even grain printing according to the needs of the product. These have not been included in the cost figure because they will arise in specific rather than general cases.

Cost £280.000

VII INVESTMENT COSTS AND TRADING FINANCE

The various capital expenditures associated with the sectors described in the previous chapter are brought together in the following table.

Items	Small	Medium	Large
Land and development	N/A	N/A	N/A
Production buildings	40.000	150.000	200.000
Production machinery	30.000	130.000	280.000
Storage buildings	6.000	25.000	100.000
Offices, sanitary and social	20.000	50.000	75.000
Kiln drying facilities	Nil	25.000	60.000
Preservation plant	20.000	30.000	40.000
Waste disposal plant	3.000	8.000	20.000
Power distribution	2.000	5.000	10.000
Total	121.000	423.000	785.000

Trading finance will be dependent upon the value of stocks of raw materials, work in progress and finished products, and the amount of credit given less that received. Both will be related to the level of sales. Much will depend on commercial practices in the region concerned, but a desirable provision in the permanent capital would be about equivalent to two months average sales. There will still be a requirement for temporary finance to support stock holdings and book debts, perhaps bank overdrafts, in addition to the permanent capital.

It is impossible to state, with any degree of accuracy, the level of potential output from each factory, measured in value terms. Raw material costs can vary by a factor of two or more, according to their nature and source, and while labour costs may reflect the level of skills they do not operate on a proportionate basis. That said, the following figures give an indication of annual output values within wide brackets.

Small - £ 250.000 to £ 300.000 p.a.

Medium - £ 850.000 to £1.000.000 p.a.

Large - £1.500.000 plus.

On these figures coupled with the cost of fixed assets the appropriate investment in the form of permanent capital would be,

Small	-	£ 175.000
Medium	-	£ 600.000
Large	-	£1.200.000

The target return on these investments should be at least 20% (preferably 25%) to match the commercial risks of a new enterprise in an unestablished market.

VIII MANNING AND TRAINING

In the early years of the new enterprise it may be necessary to employ expatriate managers, down to supervisor level, for lack of comparable knowledge and skills available by local recruitment. The long term objective, however, is likely to be the almost exclusive employment of nationals. To this end the problems of training must be faced from the start.

There may be local institutions of higher education teaching professional, commercial, or technological skills. From these should be sought the future managers, who can be integrated into the management team gradually while learning the proper application of their knowledge.

More likely will be the existence of technical schools teaching a variety of trade skills. These should be encouraged to widen their scope, if necessary, to train the future skilled operatives of the factory.

In addition to these sources there will be a need for training within the factory. The Small Factory may be able to limit itself to an apprenticeship system based on learning on the job. The Medium Factory can manage by setting up training groups for specific operations involving limited skills. The Large Factory, however, looking to the future, must establish a separate training section to ensure adequate replacements for the normal labour turnover, as well as its expansion. It cannot afford to slow its production lines for lack of the right operatives.

It must not be forgotten that every factory must provide, on a single or multi-functional basis, the services of buying, selling, estimating, costing, planning, work-study, book-keeping, designing, and all the other operations that do not function on the factory floor.

IX PRODUCTION CHARACTERISTICS

The sequence of operations in a joinery factory is always basically the same, from the smallest handcraft shop to the largest producers. The differences are mainly the reduction in manual handling, the higher feed speeds of the machines, greater consistency of dimensional tolerances and quality controls, and breaking down operative responsibilities into smaller sectors. This is all brought about by the substitution of machines for labour.

A simple rule of thumb equates a level of new investment in machinery with four or five times the annual cost of labour it replaces. It is not normally as easy a calculation as that, since there may be other factors involved, but it provides a rough and ready standard of first judgement.

The Small Factory will undoubtedly have a forklift truck to handle inward and outward loads, but within the factory itself there will be no more than a system of stillages and manually operated lift trucks, and perhaps a few idle-roller lines.

The Medium Factory will have lift and roller tables for its faster machines and perhaps some demountable conveyor belt units. If the lay-out is suitable, limited use can be made of lateral transfer machines. In general, because of the need for manufacturing flexibility, floor space between machines must be kept unobstructed. Stillages and trucks will be used, but in this case electric battery operated.

The Large Factory limits its product range and is able to adopt the line system of production which for much of its length allows the piece parts to move from process to process without manual intervention. The machines themselves become more complex by the combination of several operations within a single machine, such as the lipping of flush doors.

The investment cost of both transfer systems and multi-purpose machines is high in comparison with a series of machines of a simpler character independently mounted and fed by stillage units and hand. Every installation requires special planning to suit precisely the identified need.

The potential rise in productivity is high, but is accompanied by consequential changes in both labour and methods. Provision must be made for breakdowns or blockages that will happen in any high cost and complex machinery. In a line or transfer system this will mean a complete halt to production unless units can be quickly replaced by spares in reserve, or by-pass arrangements exist for temporary operation. Regular maintainance schedules must be laid down and adhered to, and tool-room staff must be ready at

all times to carry out emergency repairs. Machine attendants must be trained to spot incipient changes in routine machine behaviour that may be leading to trouble.

Dimensional accuracy can and must be maintained at a high level in component production to ensure ease of assembly, and is as important as quality control of materials and finishes. Extensive use should be made of multi-knife profile cutters and check-gauges to keep within specified tolerances.

These factors call for tight management in work-study and costing, control over stock levels and availability, and a smooth outflow of products to consumer or warehousing centres.

X PROCESS SELECTION

The options for choice of processes in making a range of joinery are few in relation to particular products, for which long experience has determined the best machines for each, but do exist for combinations which may thereby justify the installation of higher capacity machines to handle them

There are only five basic operations involved in the machine production of joinery

Linear sawing and machinery

Transverse sawing and machinery

Side grain joint recessing e.g. mortising or boring

Frame assembly

Panel application

Surface finishing e.g. sanding or coating.

The real alternatives lie in the degree of sophistication, continuity, and cost of the appropriate machines to carry out the basic operations accurately and efficiently This can be illustrated by the production methods applicable to panelled and flush doors, which by reason of their essentially different construction call for totally separate machine sequences, though each category could be made by a craftsman at his bench in the traditional way were this not hopelessly uneconomic. In each case it is assumed that the timber has been processed by sawing to the required dimensions ready for onward manufacture.

Panelled door production options

(a) Straighten, plane and profile the stiles, rails and finished sizes on surfacer, thicknesser, and spindle

Cut, haunch, relish and scribe tenons of rails and muntins on spindle

Drive mortices through stiles, and rails receiving muntins, on chisel mortisers

Machine solid panels on spindle, (board panels will be simply cut to size)

Assemble components on bench, frame up, glue and wedge joints, cramp up, hand-sand and finish

Production time - 4 to 6 man hours according to the door specification with minimum machine investment

(b) Straighten frame-components on surfacer, machine to finished sizes and profiles on four-cutter

Form tenons on single-end tenoner.

Cut mortices on chain mortiser.

Prepare panels as (a).

Assemble components on powered cramping stand, glue and wedge joints, cramp up.

Finish on belt sander.

Production time - 1 to 1½ man hours for minimum 10 doors of one size and design - investment minimum for Medium Factory.

(c) Straighten and machine to finished sizes and profiles on six-cutter.

Form tenons on double-end tenoners.

Cut mortices on multiple chain mortiser.

Prepare panels on double-end tenoner.

Assemble, glue and cramp as (b)

Finish on two drum sander

Production time - ½ to 1 man hour for minimum 50 doors of one size and design - investment average for a well equipped Medium Factory

(d) Straighten and machine as (c) in separate batches for each length.
Automatic transfer to double-end tenoner in single lengths.
Automatic transfer to side or end dowel-borer in single lengths.
Transfer to glued dowel insertion, panel emplacement, and cramp-up
Mechanised circuit for glue set-off, perhaps with continuous oven.
Transfer to multiple sanders and finish.
Production time - 0.15 to 0.2 man hours - investment normal for a specialist Large Factory

Production capacity - 200,000 doors per annum - per line per shift.

Flush door production options

(a) Plane core material to finished size on surfacer and thicknesser.
Cross-cut to exact lengths on small cross-cut saw.
Trim facings of plywood or hardboard to exact sizes
Place one face down in bench jig and brush glue on areas to receive core.
Position core stiles, rails and lock block on first face.
Staple or pin core to hold position.

Brush glue on back of other facing panel and apply to top of core
Remove complete assembly to press, and set off glue.
After setting add lipping (if required), pinned and glued.
Production time - 1 to 2 man hours.

(b) Thickness core stock to finished size in four cutter
Pass directly to multiple rip-saw to produce core members of dimensions and finish suitable for gluing
Crosscut to required lengths
Trim face boards to exact size in double panel saw.
Jig assemble on roller line the timber core and add the paper, plastic or veneer, expanded support filling (or wood 'egg box' slatting, rolls, etc.)
Feed face boards through glue spreader, reversing every other board, on to static assembly jig, add complete core, then second face
Transfer to press line for hot or cold setting in presses of appropriate type.
Transfer to lipping line, part trimming cutters to ensure door width accuracy and gluing surfaces, automatic placing of lipping strips after glue applicators, through H.F. field on to sanding and buffing line, then to take-off point for warehouse

If additional finishing by lacquers or primers there would be a continuation line through curtain coaters, drying ovens, sanders and buffers, involving two passages by every door to complete one face per circuit

Production time - [illegible] man hours per door

Production capacity - [illegible] doors per annum - per line - per shift

Note that there is no satisfactory intermediate size production unit between hand production and fully mechanised. This is due to the quantity of specialised machines and equipment necessary for fluid flow production at economic cost.

[illegible]

The complexity of planning, building and operating a large, and necessarily specialist, factory will be obvious from the very brief outline above. In contrast with the problems of smaller industries there is need for technology stretching much beyond the normal understandable confines of the timber industry. There may, therefore, be a case for seeking the advice of independent specialist sources or even the negotiation of a "turnkey" contract, which would cover everything from site preparation to the start of full production.

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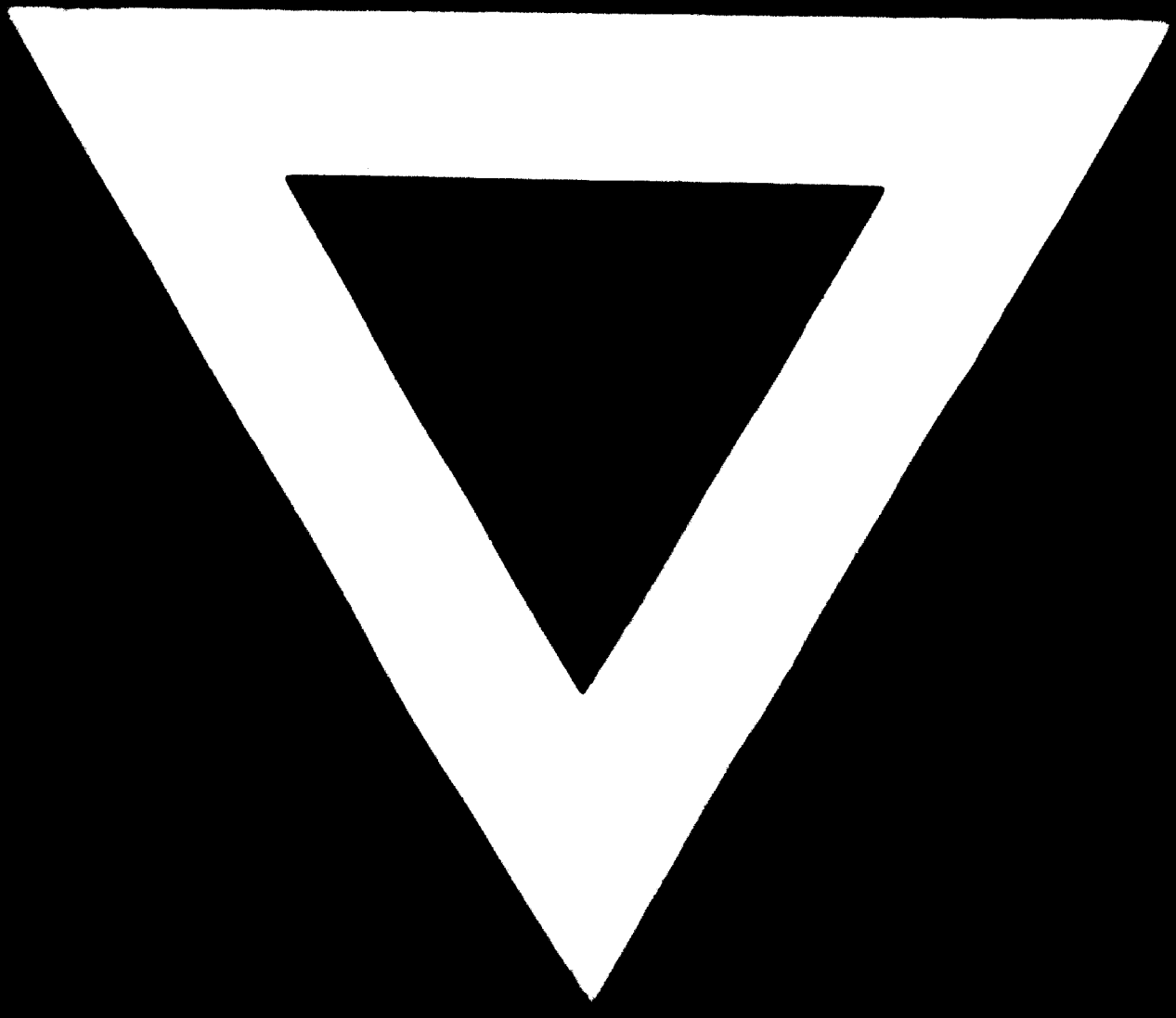

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