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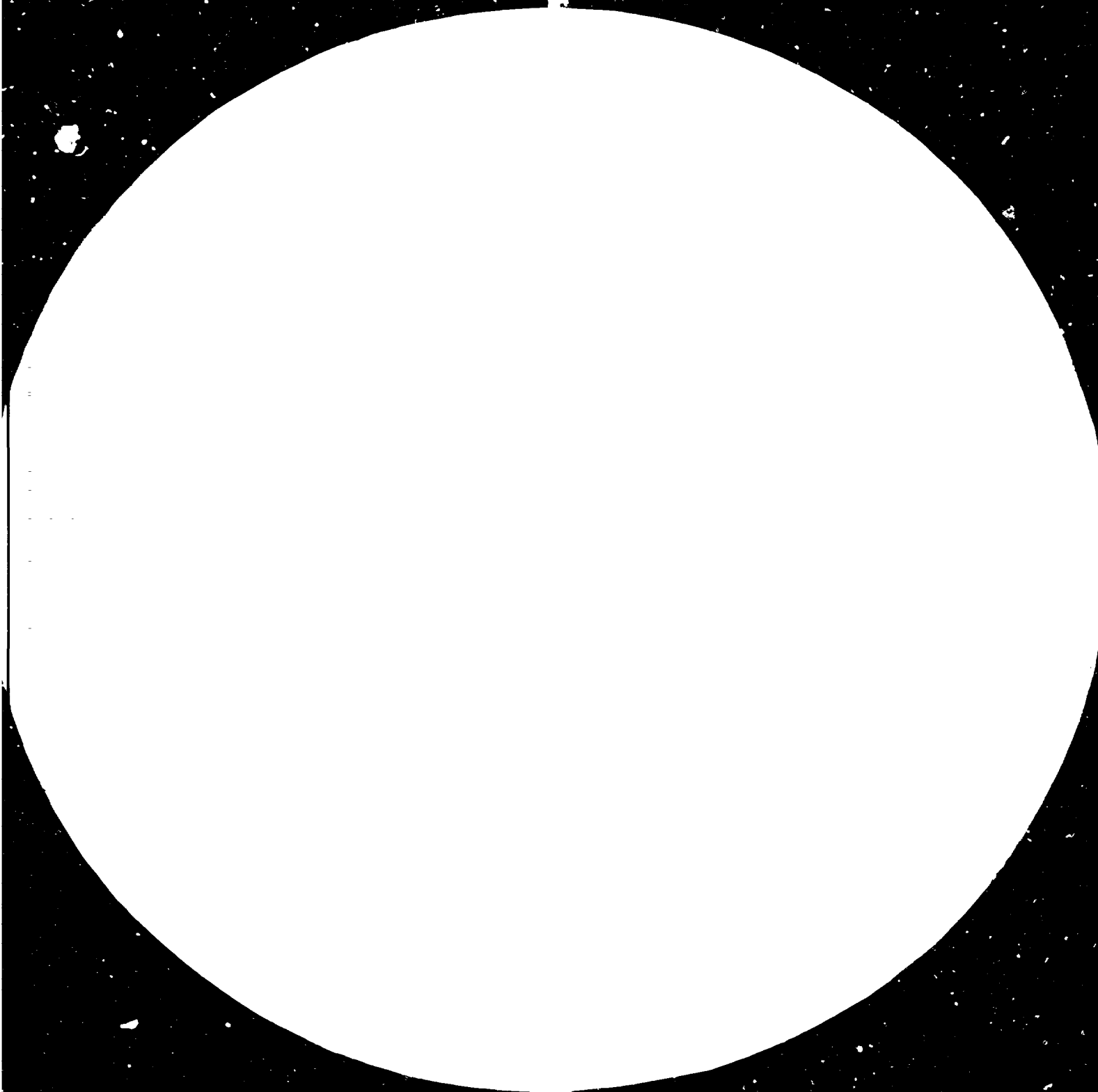
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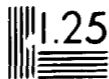
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EVALUATION OF TECHNOLOGICAL OPTIONS
IN THE PRODUCTION OF FURNITURE AND JOINERY 1/

by

Viktor Arh^{2/}

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2/ General Manager, Assistant for Production, MEBLO. Industry of furniture and furnishing accessories, Nova Gorica.

1. SOME DATA WHICH MAY HELP WITH DECISION TAKING IN THE DEVELOPMENT PROCESS OF FURNITURE AND JOINERY INDUSTRIES:

The production of furniture and joinery is a labour intensive sector, i.e. a great many people may be employed and a relatively high revenue per person employed may be achieved with comparatively small investments.

Development of the Yugoslav wood industry through the number of persons employed (in 000)

	1952	1955	1960	1965	1970	1974	1977
Industry	615	780	1134	1380	1486	1799	2060
Wood processing industry	119	130	152	134	131	159	174
Percentage	19,3	16,7	13,4	9,7	8,8	8,8	8,4

Regardless of the fact that this sector is one of those characteristic for developing countries, it remains an important development factor also once the country become developed. Some data on the European furniture industry are given on page 3.

The furniture and joinery industry offers potential opportunities for development of other industries as a direct consumer of its products, namely: the hardware fittings industry (assembly fittings, visible furniture fittings, screws, etc.); the chemical industry (adhesives, lacquers, etc.); the tools industry, and the machine industry.

The furniture and joinery industry is normally not concentrated only in one city or region, but it is usually spread over the whole country. There are smaller factories which do not need greater concentration of energy, infrastructure and labour. This offers the possibility of a more even development of the entire country.

Some data of the European furniture industry in 1978

Country	Popula- tion (1000)	Number of workers employed in furni- ture in- dustry	Number of factories (+10 wor- kers)	Value of production (£ m)	Exports 000 £ FOB	Imports 000 £ FOB
Fed. Rep. Germany	61.200	127.000	1.363 (+20)	5.422	860.570	583.740
Belgium	9.950	21.000	566 (+5)	598	232.400	205.500
Denmark	5.090	10.000	378 (1977)	331	151.470	68.960
Spain	37.100	75.000	1.680	533	67.000	15.890
France	53.200	80.000 (1976)	1.164 (1976)	1.273	223.910	438.740
Great Britain	56.000	70.000	1.400	1.209	235.500	194.700
Italy	56.800	85.000	3.950	2.149	656.960	32.320
Norway	4.100	8.000 (1976)	188 (1976)	181 (1976)	29.780	79.800
Netherlands	13.900	16.000	453	460	140.360	459.660
Sweden	8.300	13.000	310 (1977)	442	167.150	104.170
Switzerland	6.200	3.000	78	103	56.230	179.120
Yugoslavia	22.000	70.000	202	515	84.000	1.530

The products of the furniture and joinery industry are very important for the development of a country. They are present everywhere, namely in construction as well as in furnishing of projects (hotels, airport buildings, government buildings, schools, nurseries, etc.) and once the industry has been established, there is no need to import such products.

Both furniture as well as joinery appear in the international exchange of goods, and as such, provide the country with foreign currency which can be spent for other needs.

In the developed countries, furniture is becoming an article of fashion and as such a consumer's article. Therefore, there is no danger that this industry would suffer a decline once a country becomes developed. It will prosper as long as it follows the fashion, i.e. it satisfies the needs of the local and foreign market.

The furniture and joinery industry should be promoted in the regions rich in forest resources and where the primary wood processing industry has already been developed (production of sawnwood, veneers and woodbased panels), so that the natural resources (wood) is given maximum value added. In Yugoslavia, there are some areas rich in forests which have started the development of the furniture and joinery industries quite late due to the lack of economic resources (capital and infrastructure). On the other hand there are areas not rich in forest resources which have developed their furniture and joinery industry. In such cases, problems of supply of the raw materials arise quickly.

Constant changes of technology in the factories of the secondary woodworking industry should be counted upon (change of machinery, machinery layout, investments in complementary machines) and therefore the micro-infrastructure (production hall and installations) should be designed in such a way that changes can be made with the lowest possible cost. Such planning is possible in this industrial branch while it is quite impossible for other branches.

3. BASIC CONDITIONS FOR THE DEVELOPMENT OF THE FURNITURE AND JOINERY INDUSTRIES

As mentioned in the preceding chapter, both furniture and joinery are essential for a country's development. The decision to start the development of this sector in a country should be based on certain natural resources, tradition or some other factors. Only the following will be covered here: natural resources, wood, tradition in furniture manufacture, and infrastructure.

1) Natural resources - wood

This is one of the most important factors in deciding on the development of the furniture and joinery industries. In spite of the fact that the basic raw material (wood in the form of logs) is not directly used by these industries, it represents the basic condition for development of primary wood processing industry whose products (sawn wood, veneers, different woodbased panels) are used as basic materials in these industries. If the primary wood processing industry is quite developed in a country, imports of semi-finished wood products will be smaller. But if this type of industry is not developed at all its development should, whenever the wood raw material exists, be developed concurrently, with these industries. First of all production of sawnwood should be started, then production of veneers, plywood and blockboard and only later on production of particle board and fibreboard.

Regardless of the level of development of the primary wood processing industry, the supply of timber of various species and characteristics are essential for the development of the furniture and joinery industries. This has been pointed out only because the species of wood and their characteristics may be decisive in the choice of technology (for example for exterior joinery only wood species resistant to atmospheric conditions should be used).

2) Tradition in furniture manufacture

This is the next important factor in taking a decision. The number of skilled workers (joiners) in a country is an indication of tradition in furniture manufacture and the level of development of this craft. It will not be an exaggeration to say that the skilled labour (joiners) are as important as wood natural resources for the development of these industries. An example from Europe may be given. Italy is the second biggest furniture producer in Europe, but its wood natural resources are quite poor. The development of its furniture industry is based on tradition in furniture manufacture, i.e. on skilled labour. Another example to illustrate the importance of skilled labour is that of the development of "Meblo" which has grown up from private

joiners workshops, practically without machines, only with hand tools in possession of the individual craftsmen. A joiner's school was founded at the same time as the firm "Meblo". It has now grown and provides various additional types of training for workers from the woodworking branch.

In Yugoslavia, there are many examples where training of labour in woodworking has been done in parallel with the development of the furniture and joinery industries.

3) Infrastructure

This is the third condition for the development of the furniture and joinery industries. It comprises rail and road transport networks, electricity and water.

The above factors should be studied in depth before projecting furniture and joinery industries in a country. Much data is available in the existing literature and different dissertations, but projecting without prior inspection of the site is not recommended.

4. BASIC DIRECTIVES FOR THE CLASSIFICATION OF TECHNOLOGIES IN THE FURNITURE AND JOINERY INDUSTRIES

A technological analysis should first be made to find out whether the basic conditions exist for the development of these industries.

Technology is not meant to be used as a means in itself but for the production of products such as windows, doors, indoor furniture (bedrooms, kitchens, dining rooms, living rooms, etc.), furniture for furnishing of projects (hotels, government buildings, schools, nurseries, hospitals, etc.). The choice of technology depends on the production programmes.

1) Production programmes

Normally, any developing country has a pressing need for a very large production programme for its development requirements. It often wants to incorporate all these needs in a bigger or smaller factory. A conflict

soon arises on the choice of technology, since as a rule, the larger the production programme is, the simpler is the technology to be introduced (machinery, transport means).

As the country providing the help to the developing country is itself more developed and its technology more mechanized and automated than the one foreseen in the factories in the developing countries, the experts specializing in these countries for operational management of the newly built factory notice it. These experts are usually not told they will meet an essentially simpler technology than in their country nor are they told that such a technology is conditioned by the production programme. It must be pointed out there is a very close connection between the range of the production programme and the choice of technology.

2) Capacities

From the point of view of the choice of technology, the capacities of individual production programmes are as important as their range. It is relatively easy to find out the theoretical needs for individual production programmes as there are certain practical standards available. The next question is how to match the capacities throughout the whole country. The following points may be of some help in this respect: availability of woodbased raw material; number of inhabitants in each area; location of primary wood processing industries; and local development tendencies.

Through practice, it can be said that the furniture and joinery industries are usually quite evenly spread in all areas of any country where there are either wood raw materials, tradition in manufacturing of finished wood products or sufficient manpower.

I am convinced that there is no use in building giant furniture and joinery factories; on the contrary, several smaller factories in those areas having at least one of the above three conditions would be much more profitable. In studying the capacities of furniture factories in European

countries with 200 to 4000 furniture factories per country, it has been found that about 80 percent of these factories employ only about 50 workers. In Yugoslavia there is practically no factory employing fewer than 100 workers. There are quite a lot of groups of woodworking enterprises, but about 100 employees is optimal for a specialized factory.

Finally, it can be stated that there is no general recipe for determining optimal capacity of a factory but there is no problem to determine the optimal capacity for each case separately if minimal data is available.

3) Classification of technologies

A fundamental classification of technologies in the furniture and joinery industries can be made regardless of the above problems. The elementary way in which the furniture and joinery industries have developed has its origin in the craft-joiner universal workshops where a product is manufactured by one worker from the beginning to the end by means of most elementary machines and devices (especially hand tools) and by application of skills acquired through training and practice. However, some countries may skip a certain development phase. In other words, the creation of universal joiner workshops for all types of furniture (i.e. having a large production programme) could be started, but it should be taken into consideration that technology (machinery, equipment, transport means) could only be very simple, the productivity would be low and all manpower must be skilled.

This phase in the industrial development of this sector can be skipped and this type of work taken over by craftsmen. In case there are no such craftsmen, this simple production may serve as a starting point for an industry which has been specializing before, or for creating from scratch specialized factories with specialized technology. Universal workshops for finished wooden products are welcome in all development phases and they always justify their creation.

The first division of work and division of programmes and technologies arising thereof can be as follows: (a) production of building furniture; (b) production of interior furniture; and, (c) in certain cases, also production of kitchen furniture.

These technologies differ so much from one another that this division is justified from the technological, economic and labour point of view. Greater specialization and division of work is possible but might not be suitable in the initial development phase.

5.

PRODUCTION HALLS, BUILDING PROJECTS AND INSTALLATIONS IN FURNITURE AND JOINERY PLANTS:

Nowadays, the production halls with their installations represent about 50 percent of the funds invested. This means that special attention should be paid to their design, layout and installations. Besides, the depreciation of the production halls is essentially slower (in about 50 years) than that of the technology (machinery and equipment) which are depreciated much more quickly (up to 10 years).

In the early phase of development in Yugoslavia, factories were of wood construction (since at the time there was no other material available) and therefore with smaller spans (resulting in a greater number of supports) which made the layout of the equipment a task more difficult task and the utilization of the space available less efficient. On the sides of the main production hall, there were many additional buildings built for parallel activities (machine workshops, electric workshops, tool maintenance shop, etc.) which greatly hindered expansion of capacities because of high costs of relocating these departments. Nowadays buildings have developed to the extent that it is not a problem any more to build production halls with spans without supports of 16 to 32m. This gives unlimited possibilities for obtaining the optimal plant layout in furniture and joinery plants. All the auxiliary process installations (water electricity, compressed air, dust and waste removal) are placed under the ceiling so that the relocation of machinery and equipment and the installation of additional units is possible at any moment. That is the reason why a certain reserve should be taken into account in

designing the layout of the installations so that machinery and equipment can be added at minimal costs. The parallel activities referred to above are carried out in the production hall separated by temporary partitions which can be removed if needed.

6), CHOICE OF MACHINERY AND EQUIPMENT PLANT LAYOUT AND INTERNAL TRANSPORT IN THE PRODUCTION HALLS:

The choice of machinery and equipment and internal transport depends on the production programme chosen, the capacities foreseen, and the qualifications of the productive labour. As it was said in the preceding chapters, the factors given are established for each developing country separately.

Regardless of the above-mentioned considerations there are the following possibilities with respect to choice of machinery:

- (a) Universal machines (one machine capable of making different operations). These machines are recommended for the prototype workshop.
- (b) Individual machines for one operation (sawing, planing, boring, milling, sanding, glueing, etc.). Such machinery are suitable for factories with large production programmes and are very convenient for developing countries where the furniture and joinery industries have not yet been developed.
- (c) Production lines (a series of machines performing several operations without interruption): These lines are usually used in furniture and joinery plants in developed countries where division of labour is very advanced. They offer great possibilities for mass production of a very limited production programme when the competition is very steady. These are suited for conditions of high productivity and when the labour force is able to manage such advanced machinery.

This type of machinery is not recommended for developing countries. Some exceptions may be made for individual specific operations, but they should be introduced in developing countries only after careful study by the responsible persons familiar with the local conditions.

The above-mentioned machinery for individual operations can be operated:

- manually with relatively low productivity and precision, with no additional investments;
- automatically, using pneumatic devices and low cost automation, in which case the productivity and the precision are increased with relatively low investments;
- using numerically controlled devices. In this case both the productivity and the precision, but the investments are greatly increased;

The decision of what to automate can be taken after considering the improvements that automation will bring about in the following fields:

- product quality;
- productivity (labour utilization and its skills);
- raw material utilization (reduction of rejects and waste);

Furthermore, it must be realized that adding low cost automation to an existing piece of equipment often delays the need for investing in additional equipment.

The decision of when to automate is based on the following simple consideration: the cost of the investment and the additional cost of operating the machine after the addition of the automation should be less than

cost of labor and raw material saved $\frac{1}{2}$.

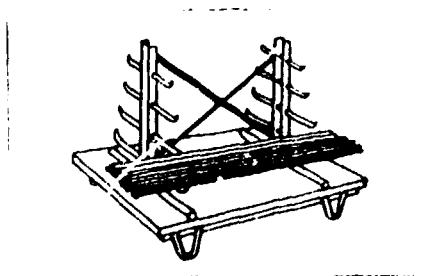
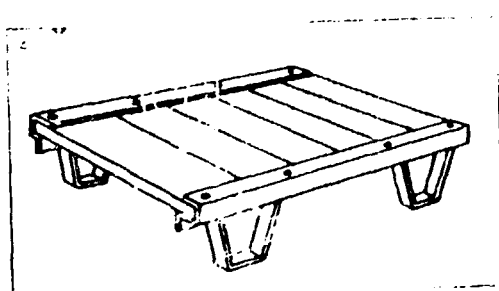
As far as automation equipment for machinery is concerned, the same recommendations are valid for it as for machinery.

3) The choice of internal transport depends on the choice of machinery and its layout in the production halls. In general, the following possibilities exist for internal transport:

- hand carrying (only in individual production, sample workshop);
- hand transport by pallets and hand carts;
- hand transport on rollers;
- electric conveyor belts;
- fork-lifts.

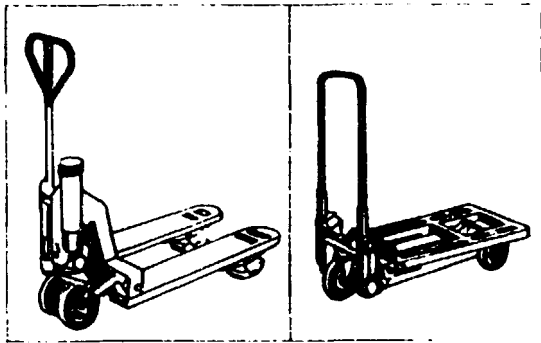
All these means of transport mentioned are usually used in furniture and joinery plants in developed countries and they should also be used in similar factories in developing countries. The choice of internal transport systems depends on the quantities and weight of the materials to be transported.

Pallets for hand-transport

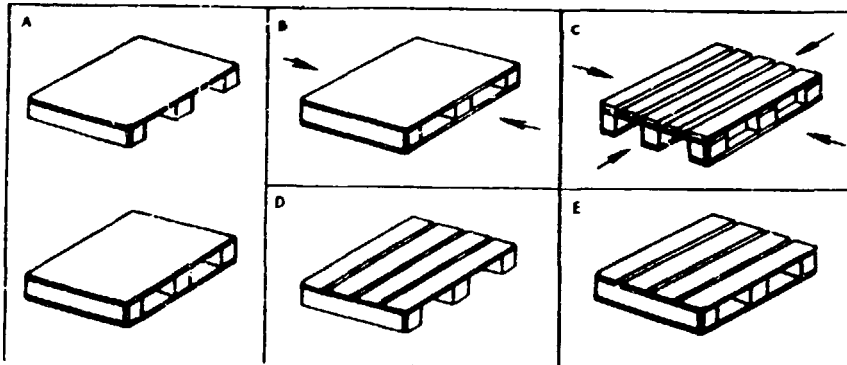


1/ For further consideration on this matter, the reader is referred to the UNIDO publication "Low Cost Automation for the Furniture and Joinery Industry" (UNIDO document ID/154 Rev.1), United Nations, New York, 1982.

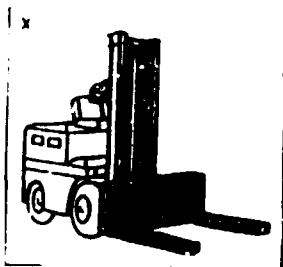
Hand-carts for transport of pallets



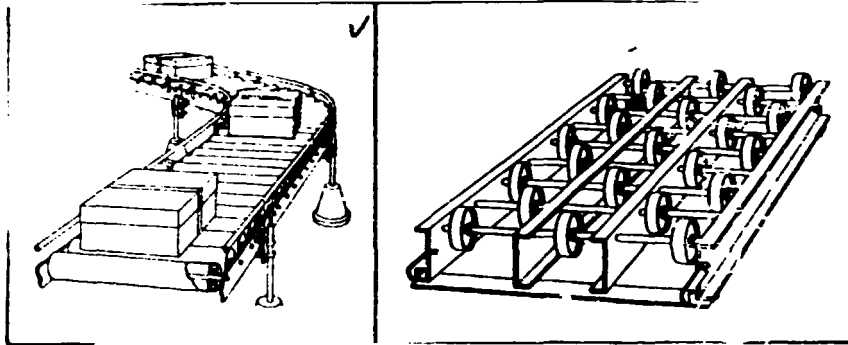
Pallets for transport by fork-lifts



Fork-lift for transport of pallets



Roller transport



4) The layout of the machines in the production hall depends on:

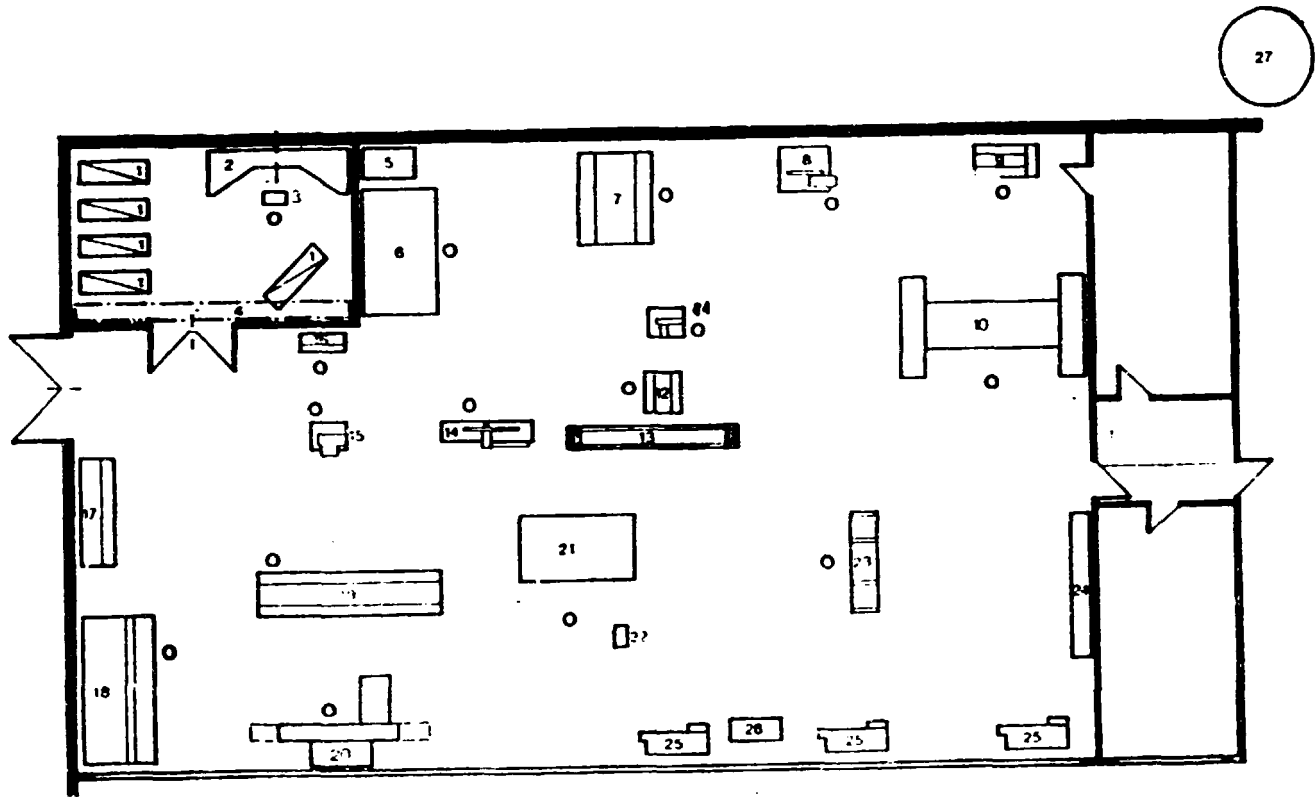
- type of machines;
- range of the production programme;
- conditions required by the process (temperature, protection against fire, noise, etc.)

The alternatives in planning the layout of the machines are as follows:

- layout of all machines in one place (small craft workshops with individual production);
- layout of machines per groups of operations in successive phases of work in separate areas (veneer cutting and assembling, sawing of boards, solid wood processing, veneer workshop, lacquer spraying, assembly, packing etc.)
- layout of machines into the production lines in separate or one large location.

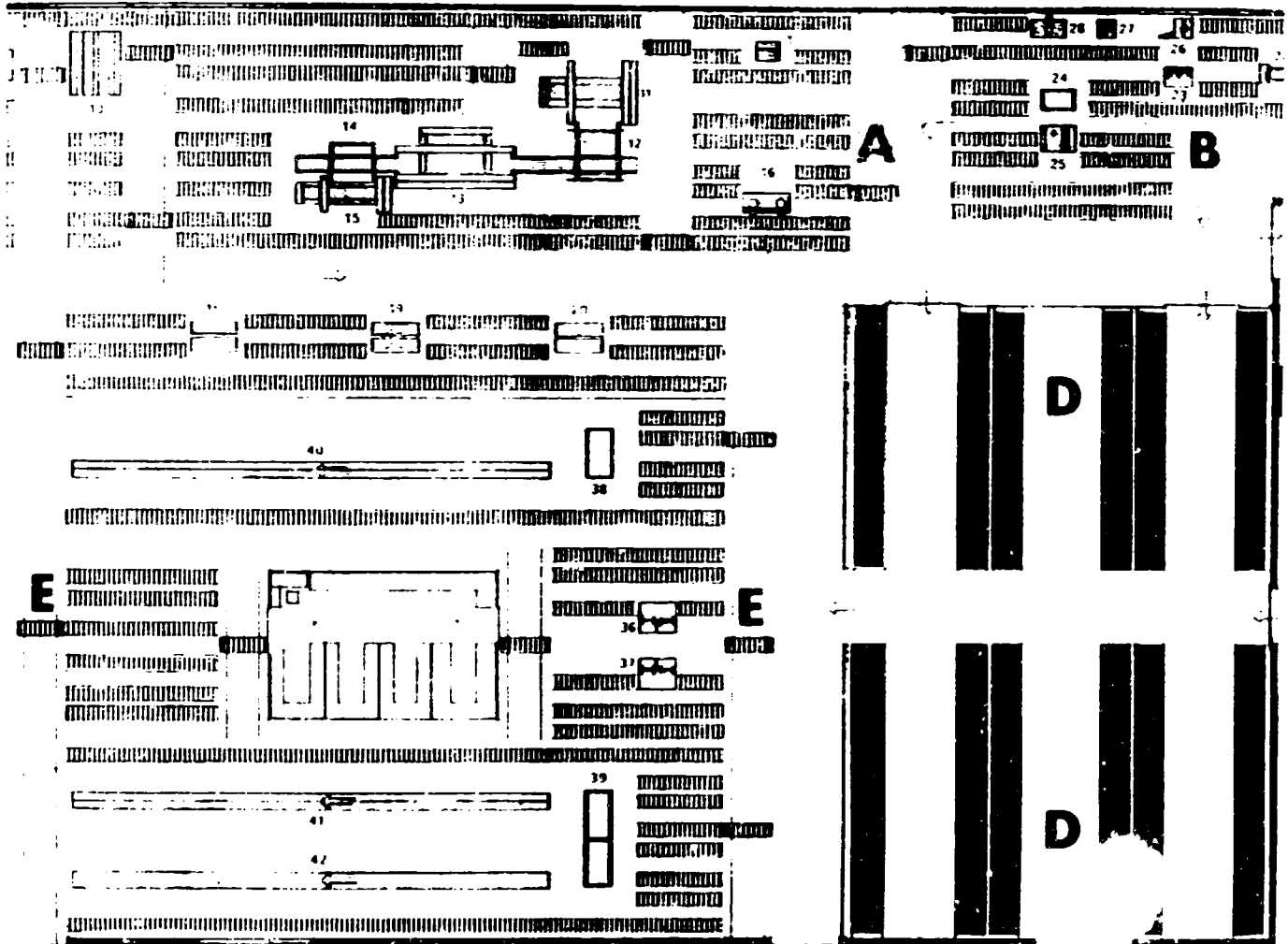
Nowadays, a combination of the third and fourth variant is used in woodworking industries producing finished products. I suggest the same combination should be introduced in the developing countries.

Machine layout in a workshop:



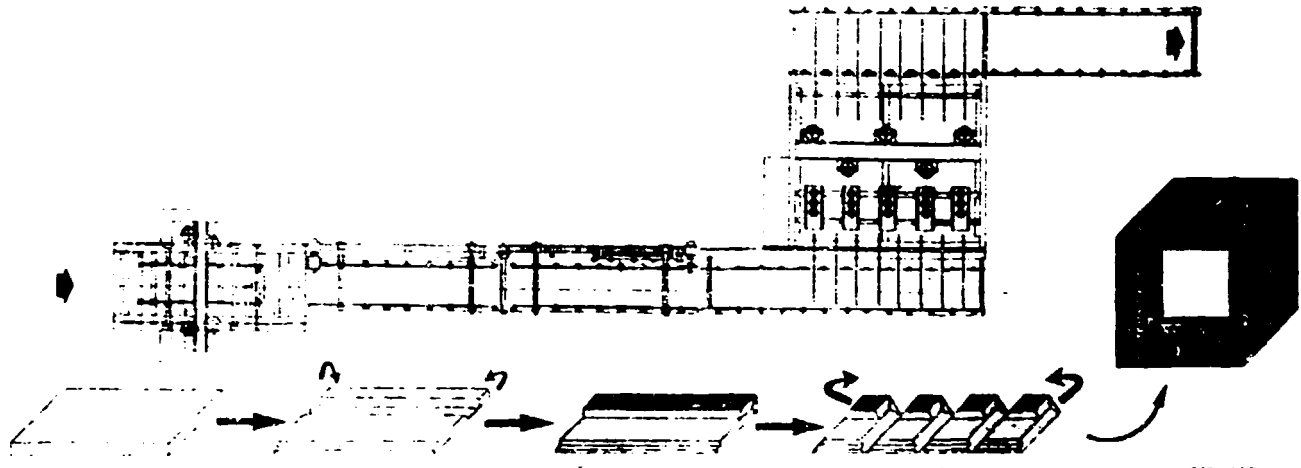
- LEGEND** 1. Cart, 2. spraying booth, 3. turning table, 4. ventilation duct, 5. compressors, 6. narrow band sander, 7. contact sander, 8. spindle moulder, 9. dowel boring machine, 10. double blade circular saw, 11. table circular saw, 12. thicknesser-planer, 13. roller table, 14. jointer, 15. bandsaw, 16. band sander, 17. stand for panels, 18. veneer clipper, 19. edge banding machine, 20. single blade circular saw, 21. hydraulic press, 22. roller glue applicator, 23. frame press, 24. work tables for manual work, 25. planers, 26. transport carts, 27. dust extraction silo.

Plant Layout: Machine layout, machine lines, and interior transport arrangements.



Legend: A. Machine processing of panel surfaces; B. Machine processing of solid elements; D. Intermediate storage place; E. Assembly area.

Machine line for the production of carcasses through V-grooving and folding:



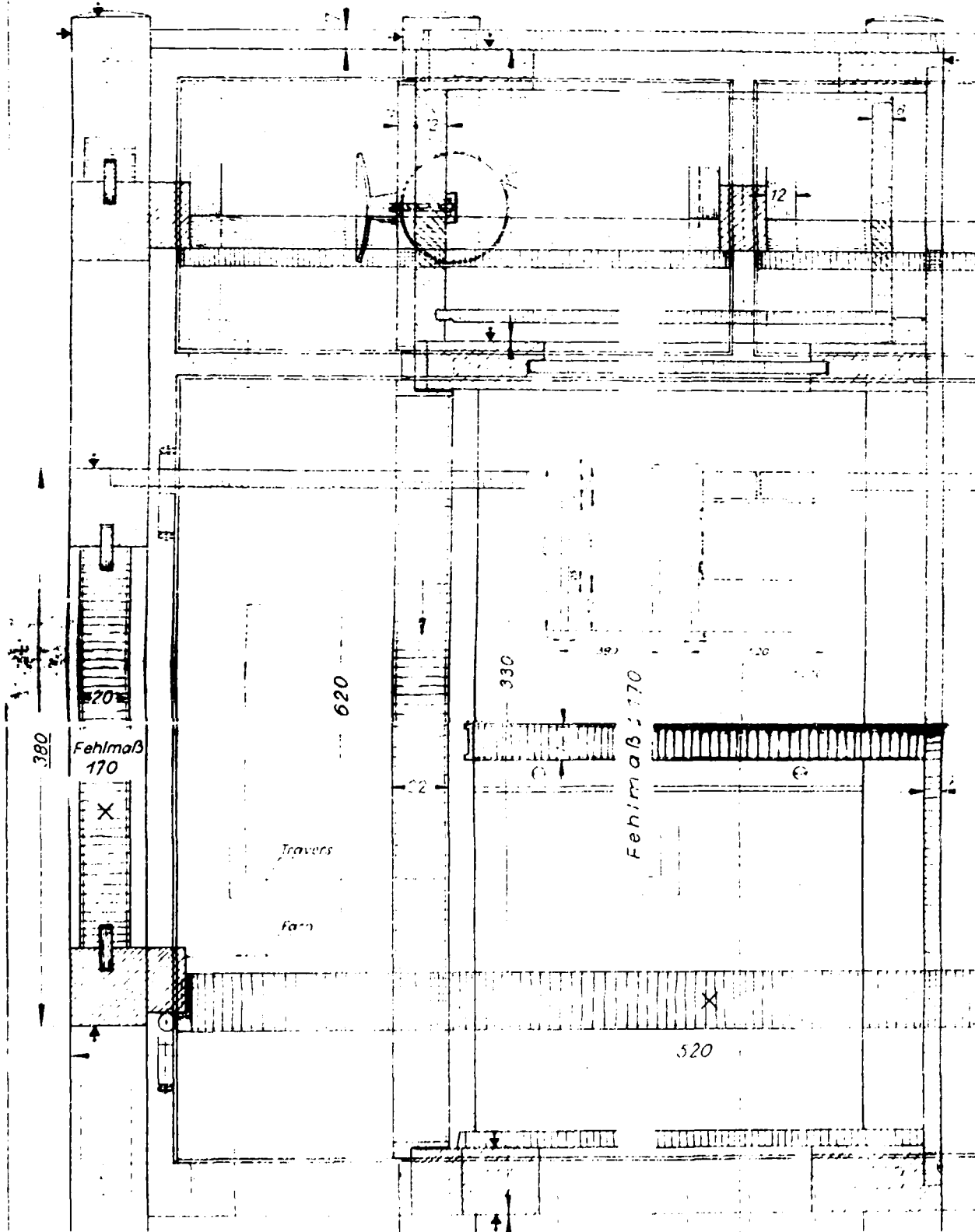
7) TECHNICAL DOCUMENTATION IN FURNTIURE AND JOINERY INDUSTRIES

Technical documentation comprises the preparation of all documents needed for any start of production and subsequent normal operation. This documentation comprises drawings of products (some examples are given on the following pages), material lists, calculations, etc. and should also cover the training of workers in this field.

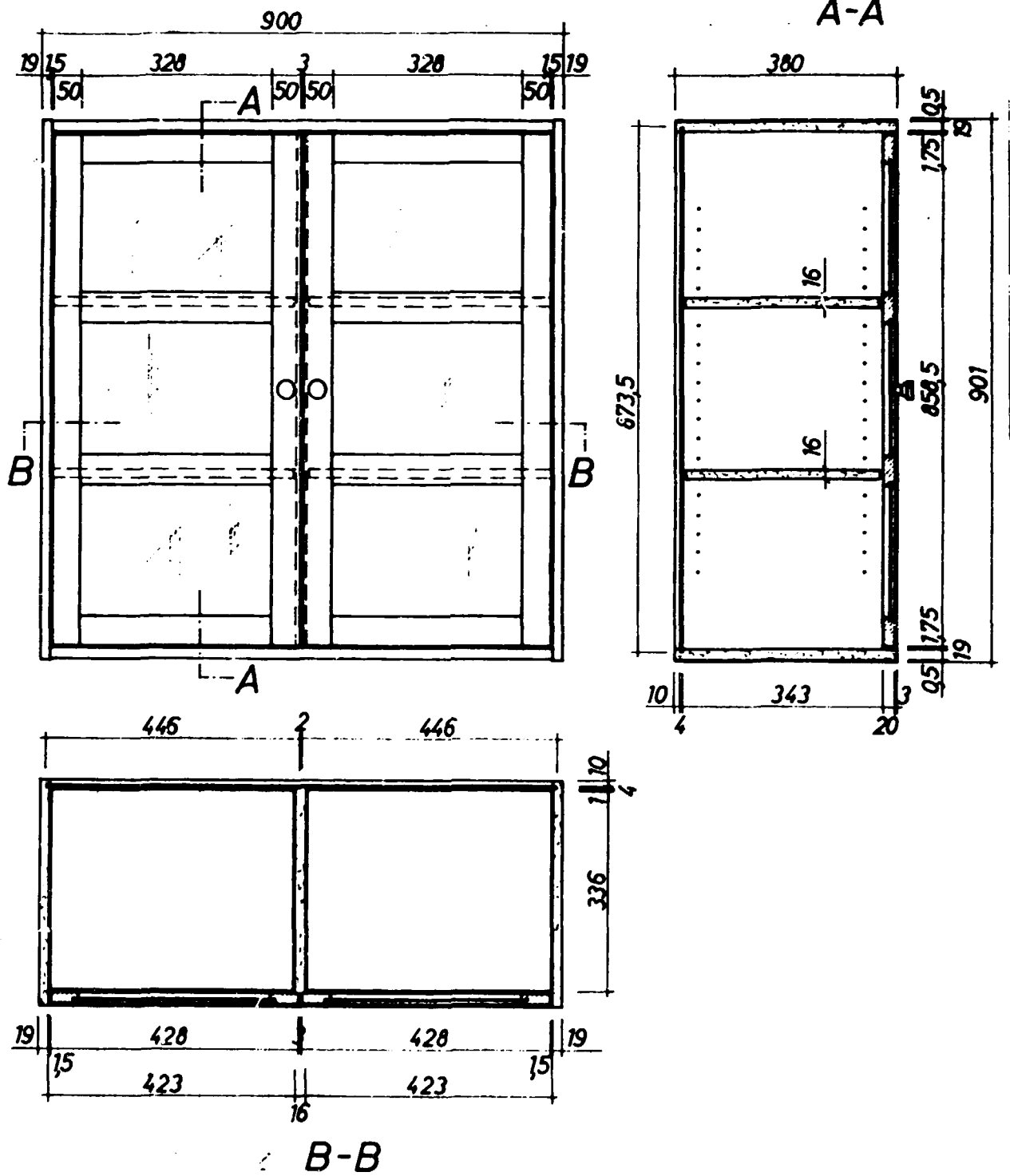
Technical documentation has developed in its own way, and depends on the technology chosen. The technical labour engaged in preparation of the documentation has to acquire detailed knowledge of the product, raw materials, standards (if applicable), design, etc. Usually skilled joiners are the most suitable for such work. In case their knowledge is not sufficient they can very quickly be trained through specialized courses.

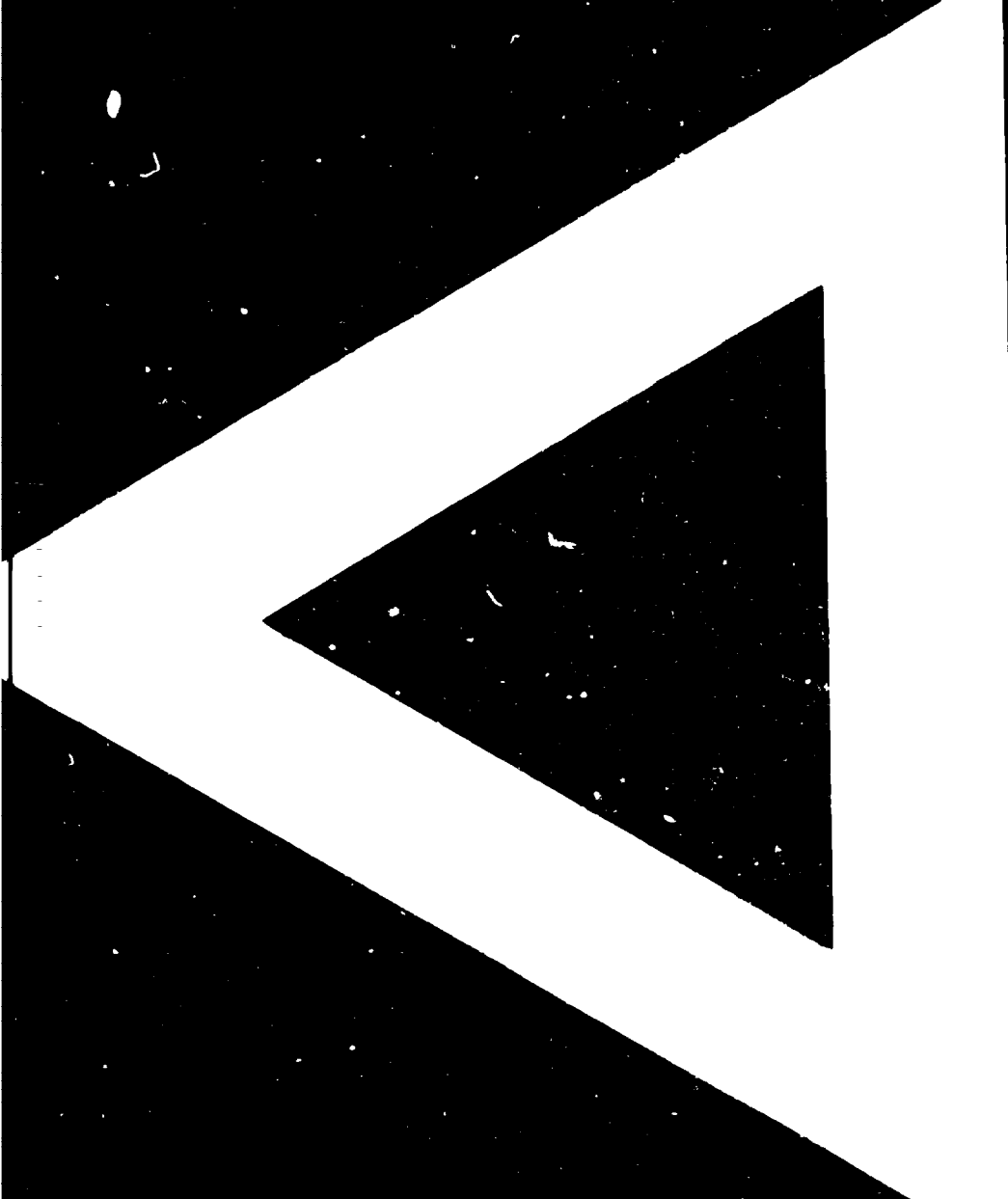
Together with the preparation of the technical documentation, referred to above, documents determining the sequence of operations of work, technological procedures, standard times, etc. should be elaborated. Labour skills can be upgraded by providing additional training to skilled joiners in these fields.

Technical drawing for traditional artisanal production.



Technical drawing for serial production.





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