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ASSISTANCE IN THE ESTABLISHMENT  
OF A PILOT FURNITURE PLANT

DP/DRK/86/011

THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

Technical report: Training manual on furniture products:  
their design, construction and quality standards\*

Prepared for the Government of the Democratic People's Republic of Korea  
by the United Nations Industrial Development Organization,  
acting as executing agency for the United Nations Development Programme

Based on the work of Radmilo Malis  
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\* This document has not been edited

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## PREFACE

This training manual is one of a series prepared by a UNIDO Furniture Production Expert, Radmilo Malis, while serving as Chief Technical Adviser of a UNDP financed and UNIDO executed project in the People's Democratic Republic of Korea, to assist in the establishment of a Pilot Furniture Plant in Pyongyang (Project DP/DRK/86/011).

This manual deals with furniture products: their design, construction and quality standards.

The manuals were written to achieve two major goals, first: to give trainees a broader view of an industrial system and second: to serve as a practical guide to machine operators and assemblers, thus enabling them to better perform their duties.

A particular attention has been devoted to materials and their proper utilization, to the design and quality of products, to the organization of the work areas and to safety measures.

The description of the machines is based on those bought for the Pilot Furniture Plant.

These manuals have been written in such a way that they can also apply to other similar factories.

The entire scope of the training envisaged to be given, with the intended audience for each topic is given in Annex I.

The syllabus, namely the topics, the duration of lectures (theory) and practical work and the level of competence attained after completion of the course on this topic is given in Annex II.

1. Introduction

The purpose of this training course is to acquaint the trainees with the products to be produced in the Pilot Furniture Plant. Workers should be informed about the products manufactured in the plant (at a level that they understand), the complete system of the product line, its design features, construction details and quality requirements. Apart from theoretical training, illustrated by drawings, the prototypes of new products will be used as a training aid which can be compared to the drawings.

2. General information about furniture production

In mechanical wood processing, there are two basic groups of production: primary and secondary wood processing. These groups are distinguished by the type of raw material, the form of the product, and the characteristics of the technological processes (Fig. 1).

In the primary wood processing industry, logs and other forestry products are the raw materials which are used to produce sawnwood, veneer, wood-based panels and other semi-manufactured products. In the secondary wood processing industry, the raw material used is sawnwood, veneer, wood-based panels, metal, plastic and textile. The secondary wood processing industry manufactures products for end users, such as furniture, joinery, sporting goods, etc. Furniture is its most important production group.

There are various classifications of furniture products, based on the final use: these can be categorized as follows:

- Sitting furniture,
- Dining furniture,
- Bedroom furniture,
- Kitchen furniture,
- Office furniture,
- School furniture,
- Restaurant furniture,
- Special furnishing products, etc.

Depending on the raw material used, furniture can be categorized as follows:

- Solid wood,
- Veneered panels,
- Upholstered,
- Metal, etc.

Depending on the type of construction, it can be classified as:

- Case furniture,
- Frame furniture,
- Upholstered furniture,
- Metal furniture, etc.

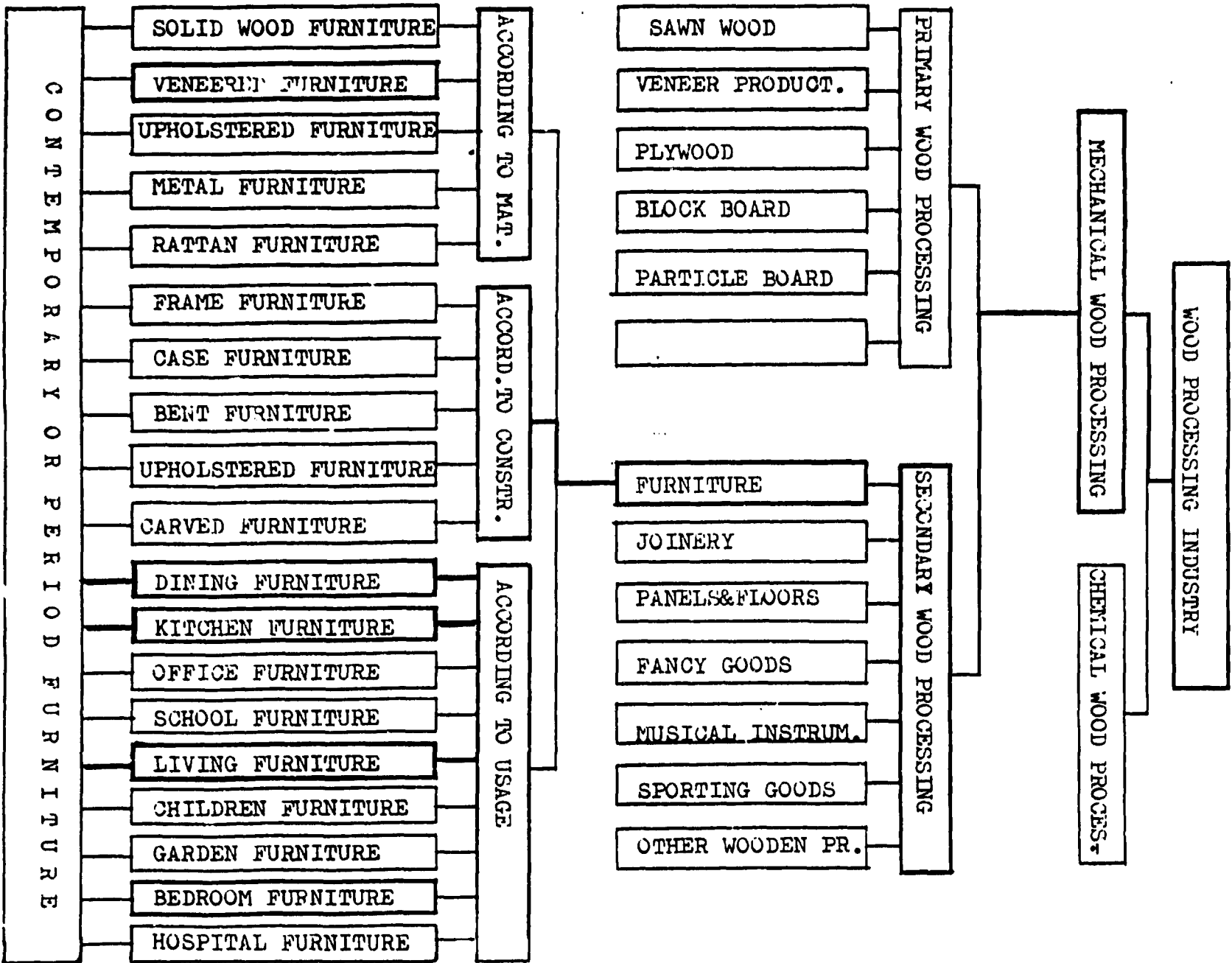


Fig. 1: Classification of wood processing

Two major design groups are distinguished, namely period and contemporary furniture. There are many styles of period furniture. These are influenced by historical period, with specific characteristics and decorations, reflecting cultural and economic features of their period and country of origin. Contemporary (modern) furniture tends to be comfortable, practical, easy to produce and maintain, and of a lower cost, i.e. the majority of the population can buy it. It can be produced either as a definite product, or based on interchangeable parts which are adaptable to various needs and types of furniture. The traditions and customs of the country also have an influence on the consumption of furniture.

3. Importance of product development in furniture production.

It is most important to draw up a programme in order to achieve a successful production. This programme predetermines the raw materials used, the technology to choose, the customers the products will be sold to, the organization of production, the productivity, the quality of the products and the factory layout. Factories cannot wait for a customer to come and order a product which will fit his individual needs or desires. This was possible at the time of artisanal production, but furniture was very expensive and accessible only to a privileged few. Today, furniture is produced industrially, with expensive equipment, industrial methods and an organized production. Production in factories are intended for the working people to meet the needs of their modern lives. Product development is not easy. A market survey on the needs and desires of the future customers must be done prior to production, the basic rule being that a factory should not sell what it produces, but should produce what it can sell. The management of a factory is fully responsible for the new product's development and should set clear definitions for a category of product and the criteria for its acceptance. Many factors have to be analyzed in order to define an appropriate range of products which will satisfy the customers and meet the factory's objectives. Product development is the permanent task of a team of designers, marketing people and production technicians. The team's work will result in new products that will improve the production and the plant's profits. About three quarters of all cost savings are achieved at the product development stage. Unfortunately, most production people do not think along these lines, so that all their efforts are concentrated on improving the production process with no input in the direction of product development. The more attention is paid to product development, the less problems the factory will face during production.

4. Strategic approach to product development

Manufacturers have to reexamine their product strategy from time to time. A strategic approach to product development is a fundamental decision, which should determine the type and quality of products to be developed. Many facts must be taken into consideration, eg. market requirements, production possibilities, materials available, skill and experience of the staff, etc. Some of the requirements are contradictory and a compromise might be the solution. The strategic key points concerning product development are: specialization, diversification, cooperation and the balance that exists between them. The best choice is to develop specialized production, and to cooperate with other factories to diversify production.

In order to deal with product development, the stages of the product life cycle and the different stages of product development must be understood. (See fig. 2 for the product life cycle and fig. 3 for the product development stages.)

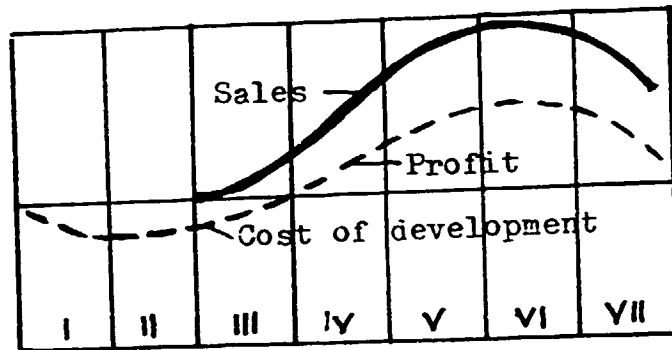


Fig.2 (a) Product life cycle  
I= Market research  
II= Product development  
III= Introduction into market  
IV= Growth of sales  
V= Product maturity  
VI= Market saturation  
VII= Sales decline

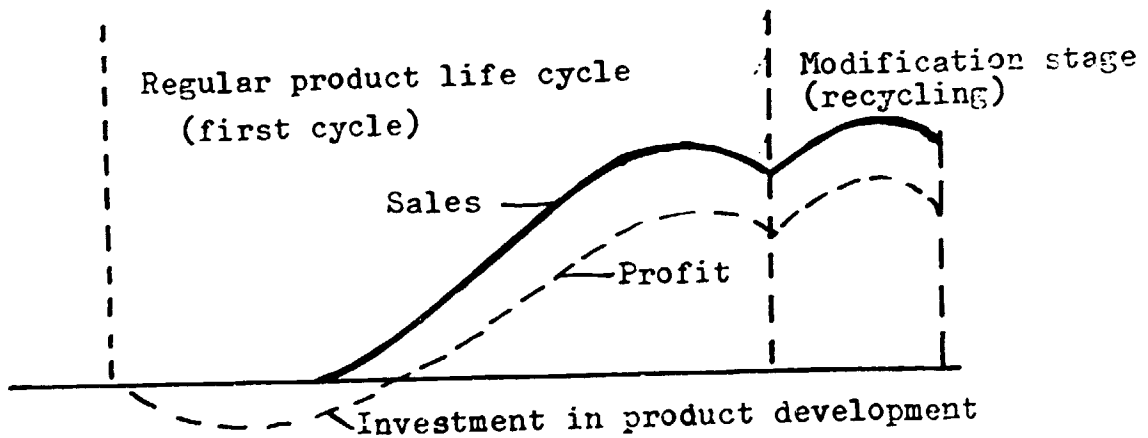


Fig. 2 (b): Product modification.



Number of alternatives

Development process

Main requirements and criteria

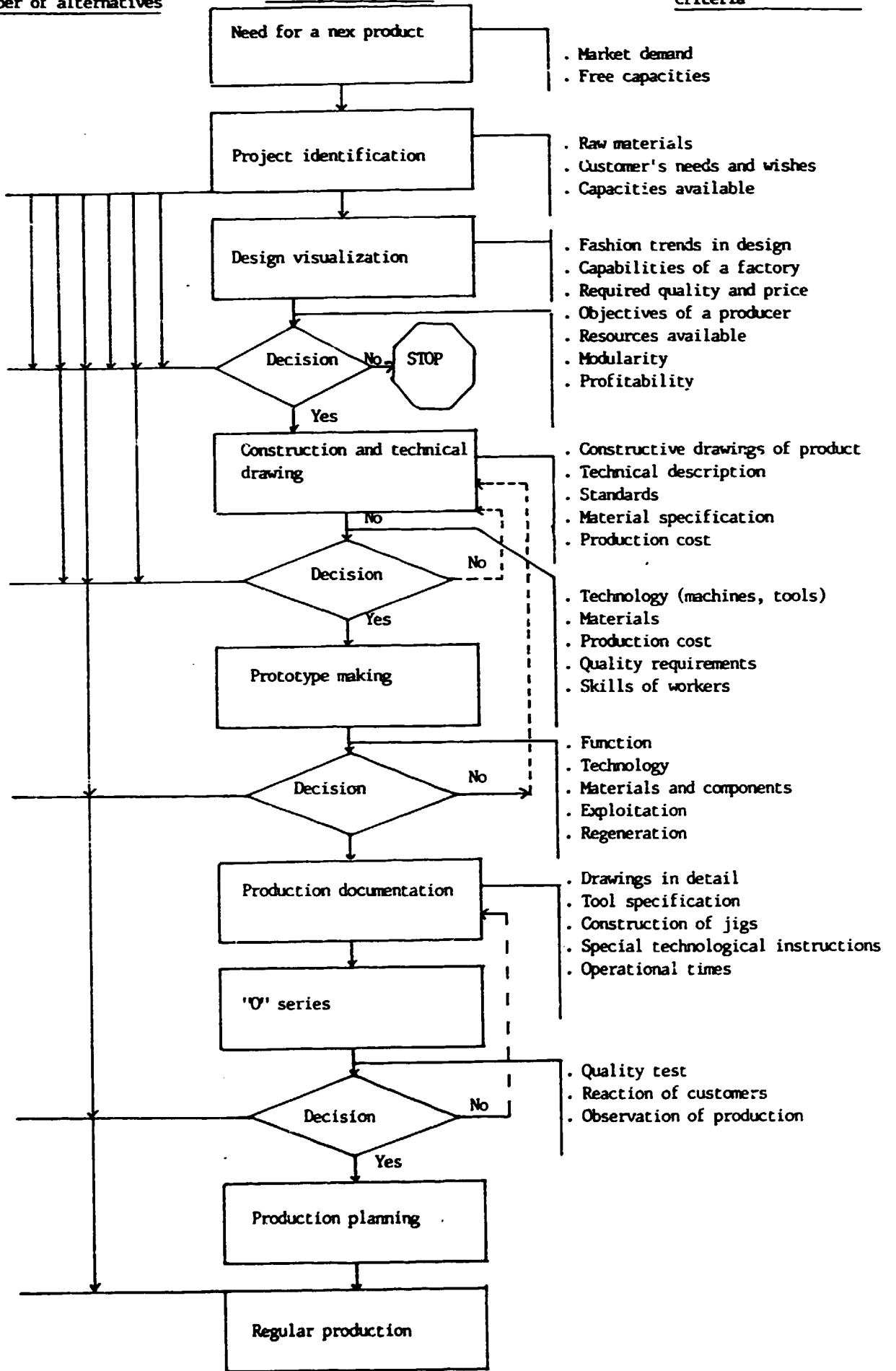


Fig. 3: Scheme of product development procedures

The product life cycle consists of seven stages, as follows: market research, technical development of the product, introduction on the market, growth of sales, product maturity, market saturation and sales decline. These stages are unavoidable, regardless of whether they are recognized or not. Knowledge about this cycle is useful in planning product development. Thus, it can be understood that the factory cannot rely on its current products for satisfactory results over longer periods of time.

In studying the product development stages, it can be realized that product development is a very complex task which must consider many factors and conditions and meet certain criteria set for a new product. Two important facts must be understood, the first being that product development starts with a large number of ideas from which one or more are taken up, and the second being that each stage of product development ends with a decision, whether the product is satisfactory or not. All in all, product development is highly specialized work and must be carried out by well trained and experienced personnel.

#### 5. Design of furniture products

Furniture design is a creative activity which will - if well designed - improve lifestyle. The designer must get a written brief which serves as an orientation guide expressing a product's development policy. For example: "Design a modular system of case furniture for living rooms, dining rooms, bedrooms and other household needs, made of veneered particle boards and suitable for the manufacture process of the Pilot Furniture Plant. The products designed should be of good quality with a medium price range." The designer should visualize his ideas in drawings and axonometric pictures. Details of particular interest can be shown in a 1:1 scale and in all three orthogonal projections. The designer must be aware of the production flow in the factory and how his ideas are going to be produced. He must know the capacity of the equipment installed, and must also be aware of bottlenecks and other problems which can be expected.

From the products proposed by the designer, only those which follow the company's policy can be accepted. The company should have available the materials and equipment to produce it, and the cost calculation must ensure profitability. This is due to the fact that design has the strongest influence on the economics of furniture production. Modern serial production techniques must usually also meet the following criteria:

- The product must be suited to the plant's manufacturing process and permit efficient use of the equipment installed.
- No manual work and hand fitting should be foreseen in the assembly phase.
- Surface finishing should be done before assembling.
- Parts should be interchangeable.
- Dimensions, joints, metal fittings, etc. should be standardized as far as possible.
- Profiles, roundings, borings, etc. should be standardized to suit the existing machines and tools at the factory.
- The dimensions of a product must result in a minimum of waste.

The designer must also consider the purpose of the product, its function, its durability, the possibility of cleaning it, etc. He must also pay attention to the subjective design factors, eg.: form, comfort, size, weight, style, mobility, etc.

The designer must determine the division of space and areas, the proportion, ornaments, colour and other important details of a product. Production design factors are limited by law, standards, patents and government regulations. The number of components used is a design factor, which would increase the cost of production if it is too high. Both designer and producer should examine the product from the customer's point of view. (Some examples of design proposed for the Pilot Furniture Plant by Mrs. Galicic, design experts are shown in figs. 4, 5 and 6.)

#### 6. Standardization and interchangeable parts.

Standardization is a very important product development and design factor. It rationalizes production and simplifies organization. Standardization minimizes the number of different furniture parts and sizes to the most rational and reasonable number. It also relates to materials, joints, tools, jigs, documents, quality, terminology, etc., and contributes to and increase in productivity, a better quality and more economic results.

A danger of excessive uniformity always exists. It can be eliminated by creating a modular system of products and extending a product line using interchangeable parts. Interchangeable parts are product details which fit various pieces of the same modular system. It is not only the parts, but also sub-assembly and assembly groups which can be interchangeable. The basic prerequisite is a very high accuracy of processing and using appropriate controlling instruments and gauges. Standardization helps in product development, work preparation, material supply and manufacturing. Standardized furniture parts, or assembly groups can be used for many products at any point in time without repeating the constructive or the preparatory work.

#### 7. Construction of case furniture

A rational technological process and maximal utilization of materials should be established in a factory. Adequate methods of joining the parts of a product, positioning them, taking care about strengths (both product and parts), function, economy, production possibilities and specific characteristics of wood as a raw material should be established. The main element in case furniture is a box to which are added frames, flat elements or a combination of frames and flat elements. Joining the flat parts into a case depends on the material used, the end purpose intended for the product, the technological possibilities, etc. (Some carpentry joints for case construction are shown in fig. 7).

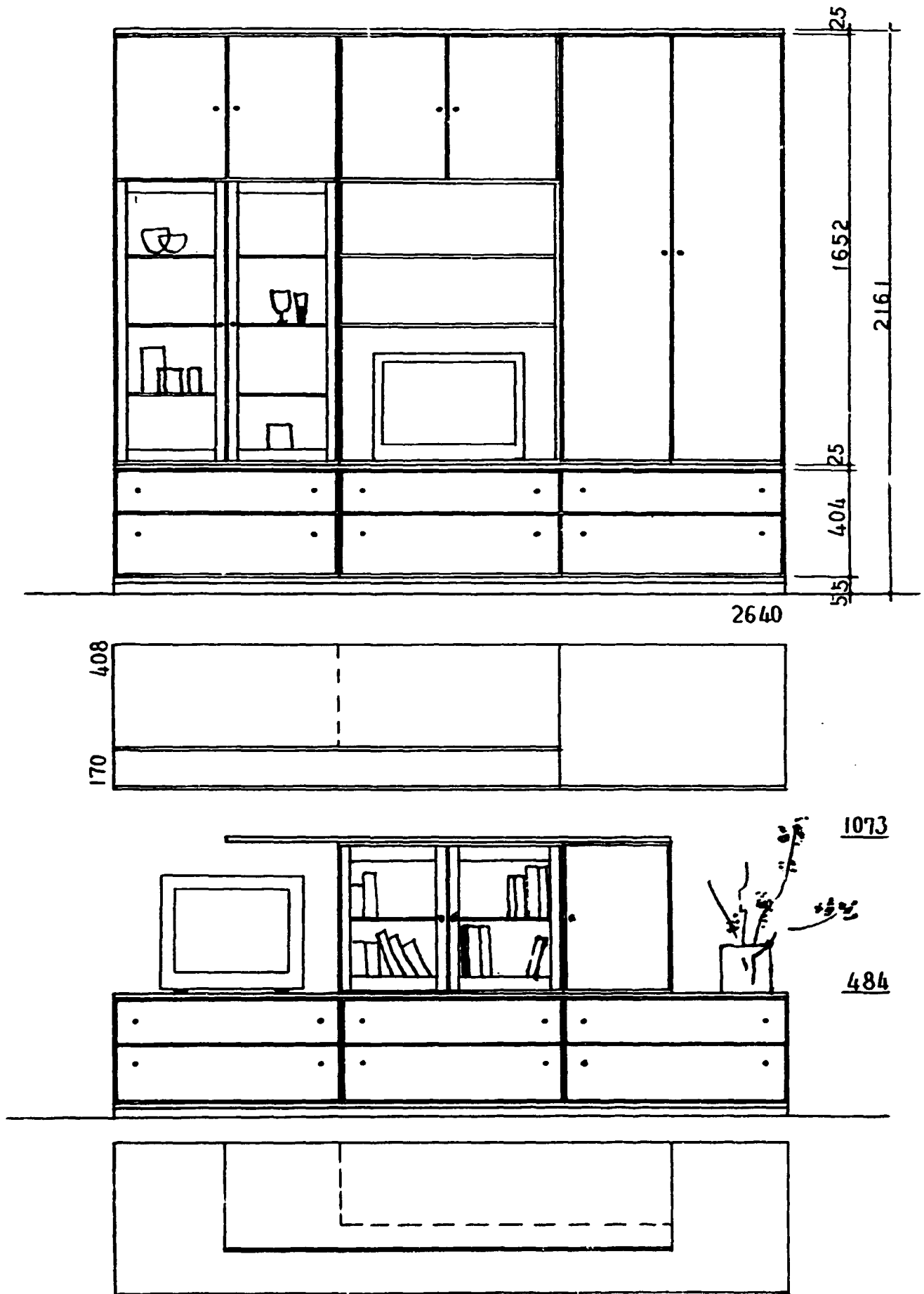


Fig. 4: Example of a case furniture designed by Mrs. N. Galicic.

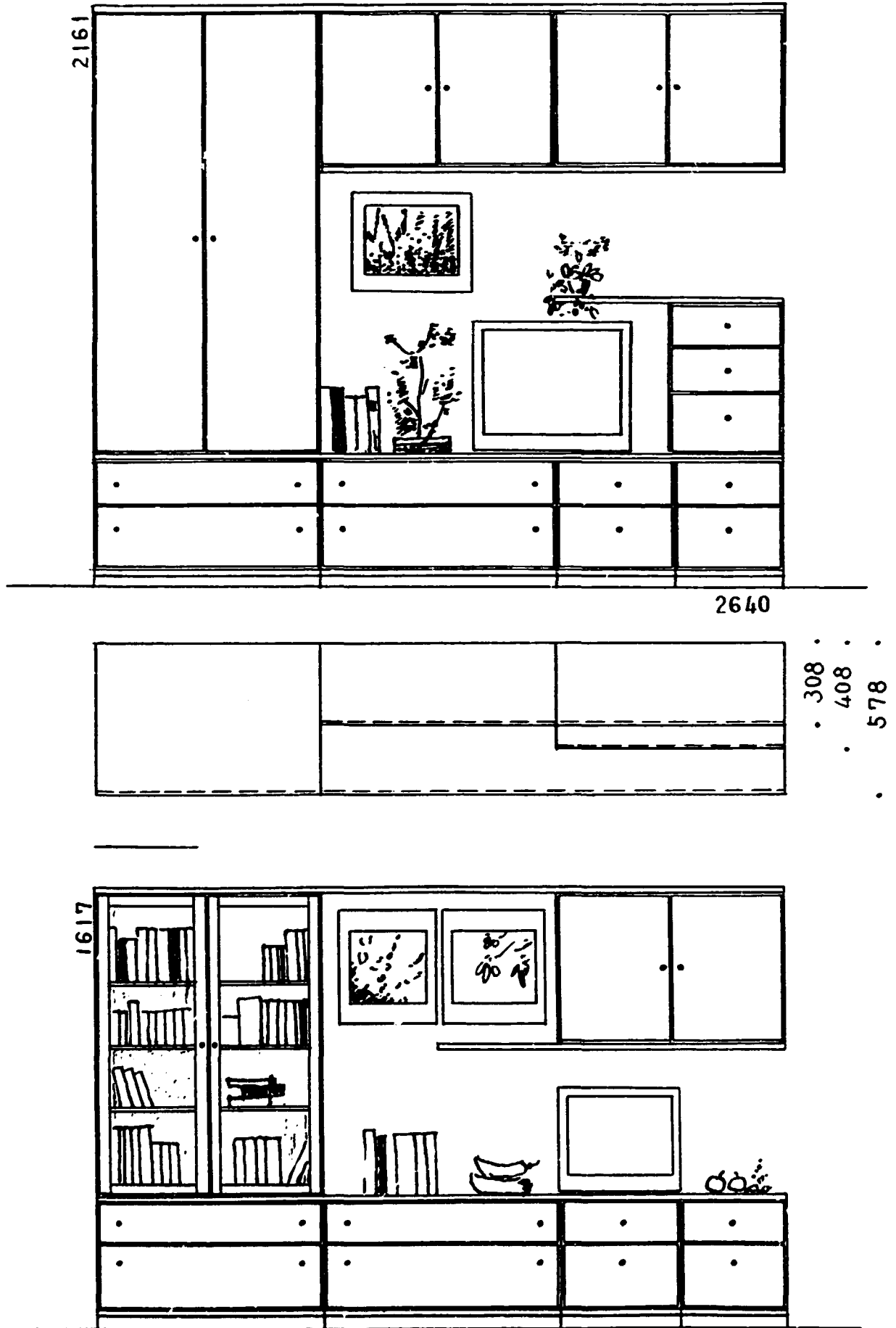


Fig. 5: Example of a case furniture designed by Mrs. N. Galicic.

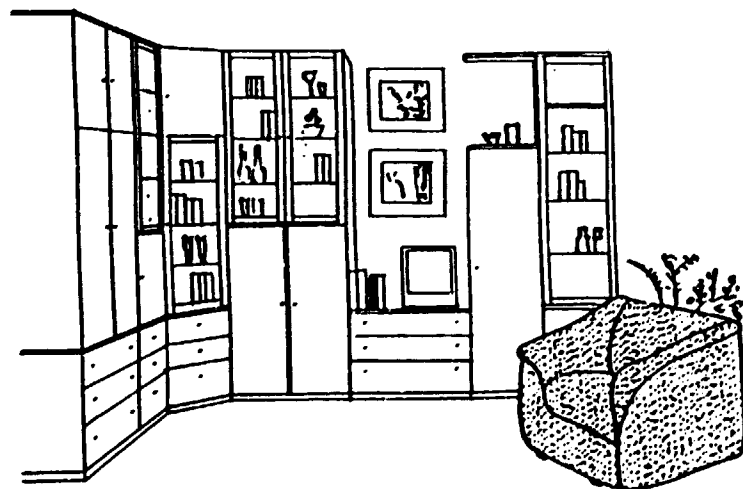
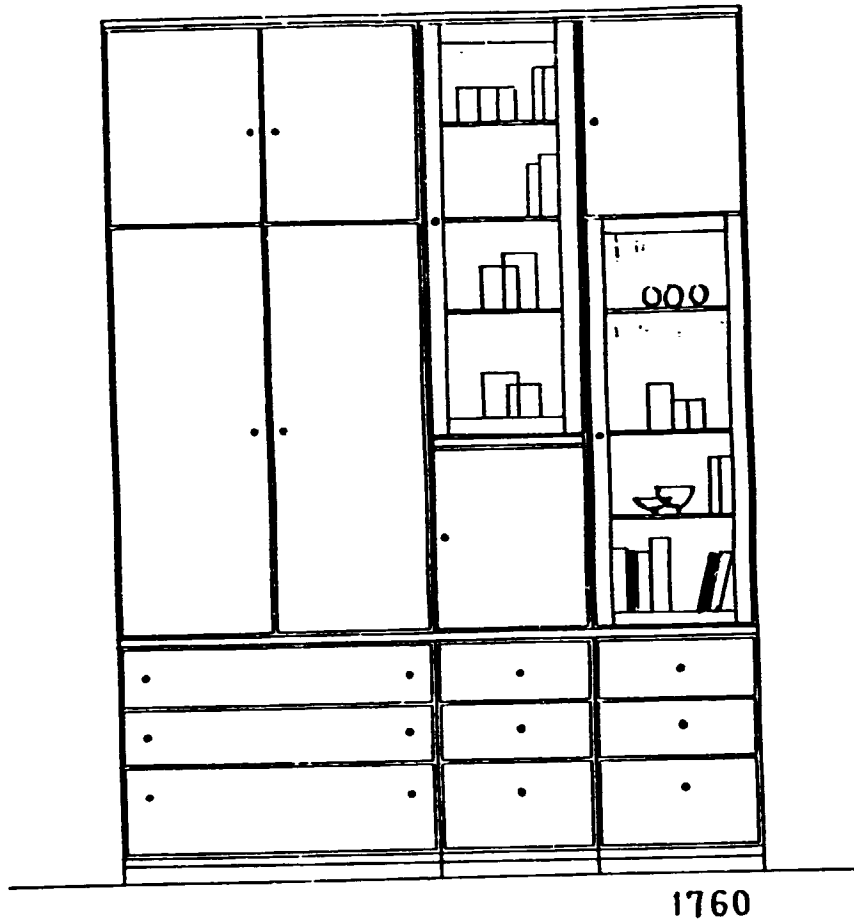
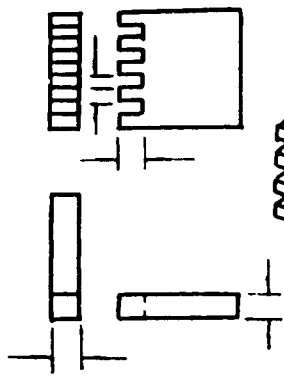
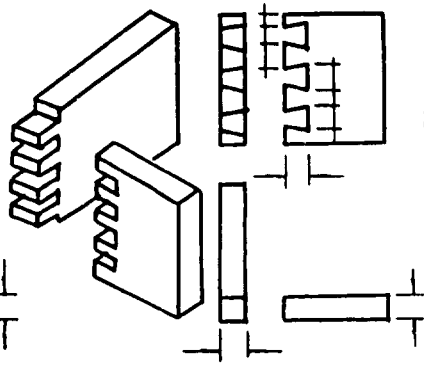


Fig. 6: Example of a case furniture designed by Mrs. N. Galicic.

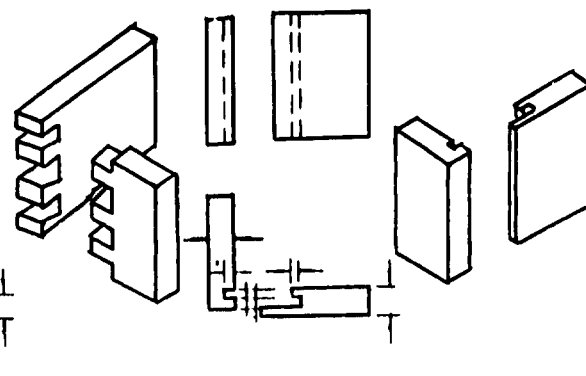
Fig. 7: Carpentry joints for case construction.



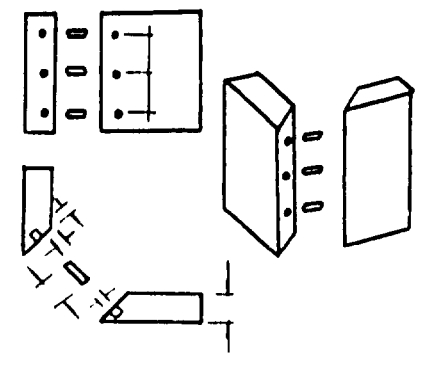
Corner lock joint



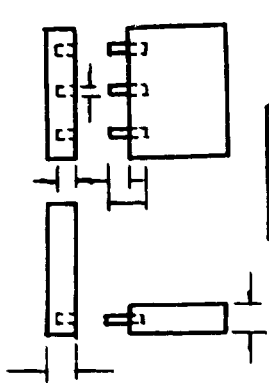
Open corner dove joint



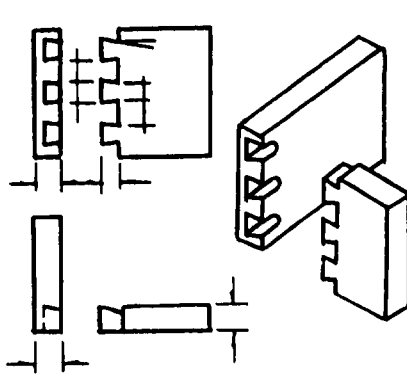
Corner double tongue and groove joint



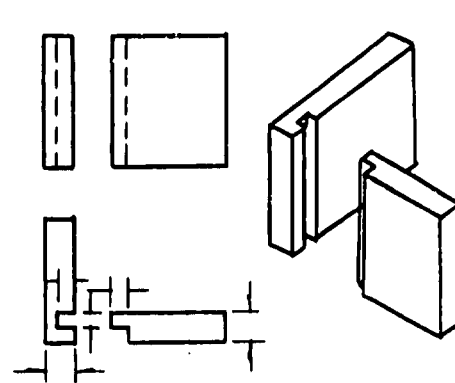
Mitre joint with dowels



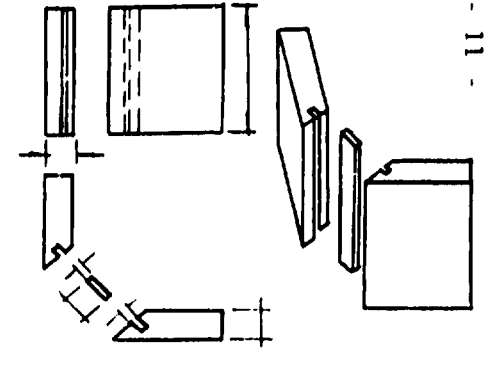
Corner dowel joint



Corner hidden dove joint



Corner tongue and groove joint



Mitre joint





In traditional furniture production, mostly fixed joints are used. In modern production, knock-down construction using separable joining components is preferred. The product scheme must first of all be drawn (see fig. 8). It is actually a division of the product into assembly groups and elementary parts. The constructor must adapt the design to the existing technology, thus ensuring a proper functioning of the different parts of the product. To assure adequate strength of the product, dimensions and directions of constructive elements must correspond to the maximum load during use. The furniture constructor must respect some basic rules, which are:

- He must construct his furniture taking into account unavoidable changes of dimensions caused by changes of moisture content. This should not affect the form and strength of the product.
- The details of a product must be constructed to minimize dimensional changes.
- The design of a product must allow the construction of all its joints on the machines available.
- The details of the furniture piece must be constructed based on nominal sizes of the material used.
- The design and construction of furniture must satisfy technical, sanitary, hygienic and aesthetic criteria.

There are several groups of joints:

- Glued joints used only in order to get a bigger size or to stiffen constructive elements.
- Carpentry joints are most often used for connecting furniture parts. To these joints (combed joints, dovetail joints, house joints, mortise and tenon joints, lock joints, mitre joints, etc.) glue is usually added to strengthen the construction.
- Screwed joints are used to fix fittings, for assembling knock-down construction and to put together other different parts such as backs, sliding rails, etc.
- Metal connections are used to assemble knock-down furniture.
- Nail and staple connections are used only for fixing concealed parts of constructions, eg. backs of case furniture or wooden constructions of upholstered furniture.

It is strongly recommended to use joints which allow surface finishing of individual parts and assembling them after finishing. Manual work for hand fitting during assembling must also be eliminated. Construction drawings must show the product as a whole in all orthogonal projections, with measures, joints and other details. Single assembly groups or important constructive elements can be shown separately. A construction drawing must contain:

- The specification of all parts with their dimensions, type of material used and the number of pieces used for the product.
- The technical description of the construction, thus avoiding ambiguity.

Designing appropriate construction methods is a major responsibility since production cost depends on it to a great extent. (An example of case furniture construction is shown in fig. 9.)

## 8. Preparation of drawings

In order to prepare tools and jigs, and in order to set the machines for production, all details should be drawn in the three basic projections (in some cases two are enough) showing profiles, joints and other dimensions and characteristics. Since detailed drawings influence the choice of machines, tools, jigs and method of processing, personnel producing such work documents must be familiar with the technology used. The same people should be in charge of producing the jigs. In order to make detailed drawings, it is helpful to standardize joints and tolerances. Dowel joints, which are mainly used in case furniture production have many advantages, which are:

- simple and accurate machining with multi-spindle boring machine;
- easy assembly;
- a curtain coating machine can be used for surface finishing;
- consumption of material is reduced;
- the dowel is the best suited joint for particle board constructions.

Details of a dowel corner joint with its recommended dimensions are shown in fig. 10.

There are two principal types of drawings in the furniture industry: full-scale drawings and drawing to scale. Full scale drawings (1:1) are not suited to modern serial production because the dimensions are not indicated in the drawing and the accuracy of production is poor. They are useful, however, in presenting the dimensions of curved details, profiles, etc.

A drawing to scale is made to a given scale, eg. 1:5, 1:10, and details are shown 1:1. Each original part should be drawn on a separate standard sheet (A4 size), which is easily filed and copied. The dimensional figures on the drawings are decisive, and, in the case of alterations, only the figures need to be changed. Standardized joint types and profiles may be indicated on the drawings by standard codes or appropriate abbreviations and symbols. An example of a detailed drawing is shown in fig. 11.

An assembly drawing of the complete product is made to show the positions of parts and assembly groups. The single parts can be marked by standard codes. It is necessary to indicate the quality of the material and the processing requirements in such a drawing. In case preassembled constructions are machined, eg. frames, the work drawing should show only those elements which will be processed, while the elements which will be made after the preassembly should be shown on the working drawing of the subassembly construction.

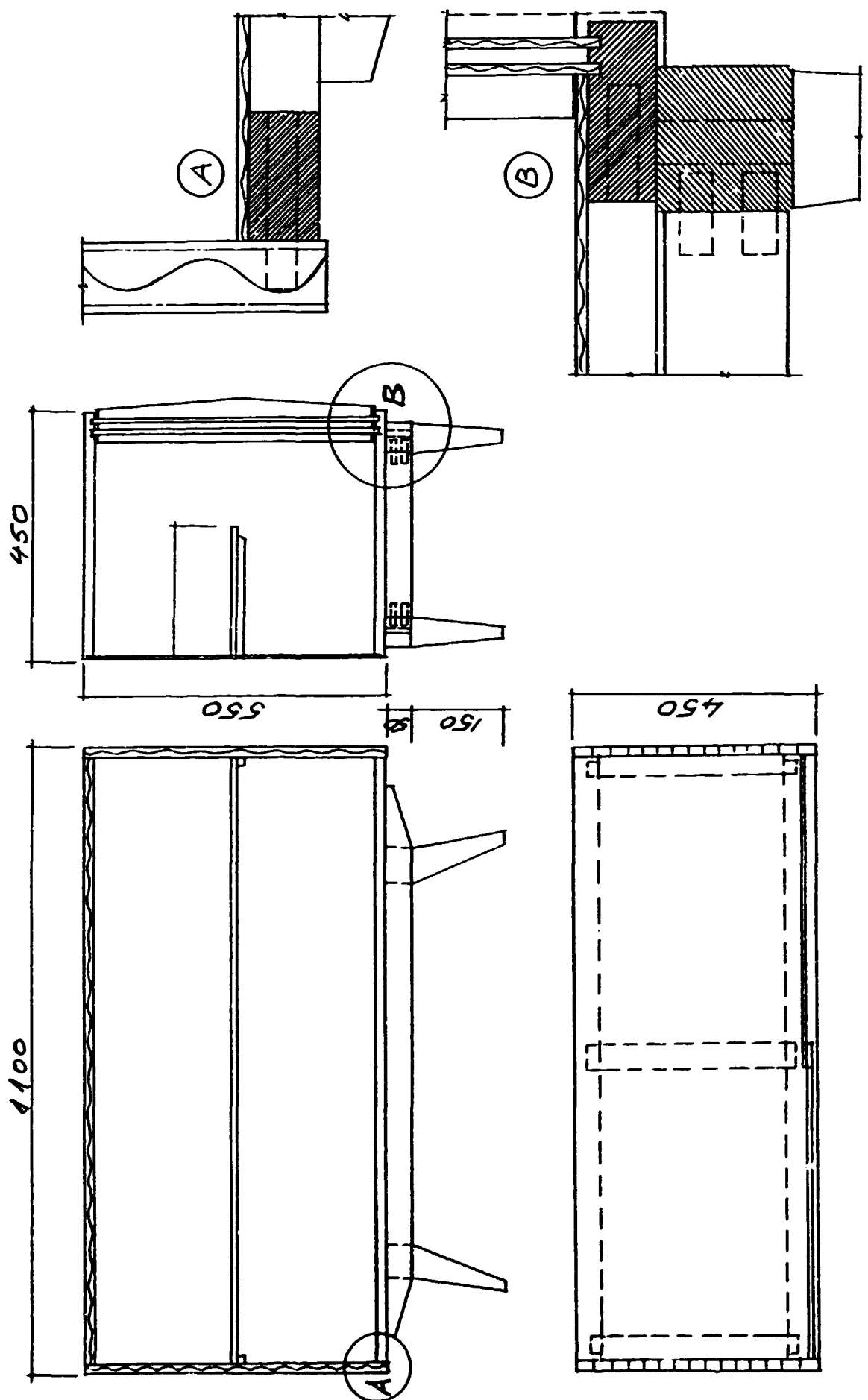
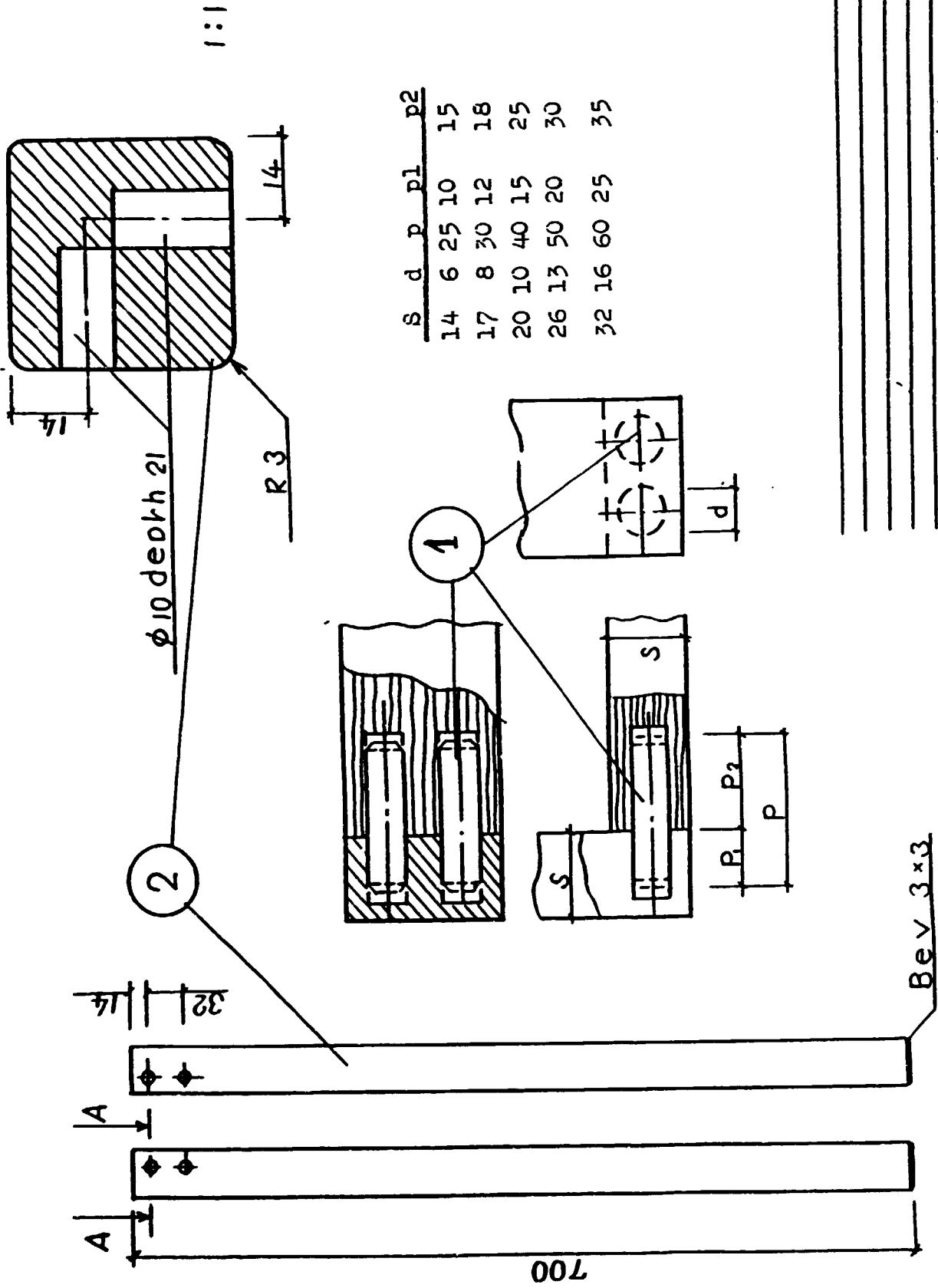


Fig. 9: An example of case furniture construction.

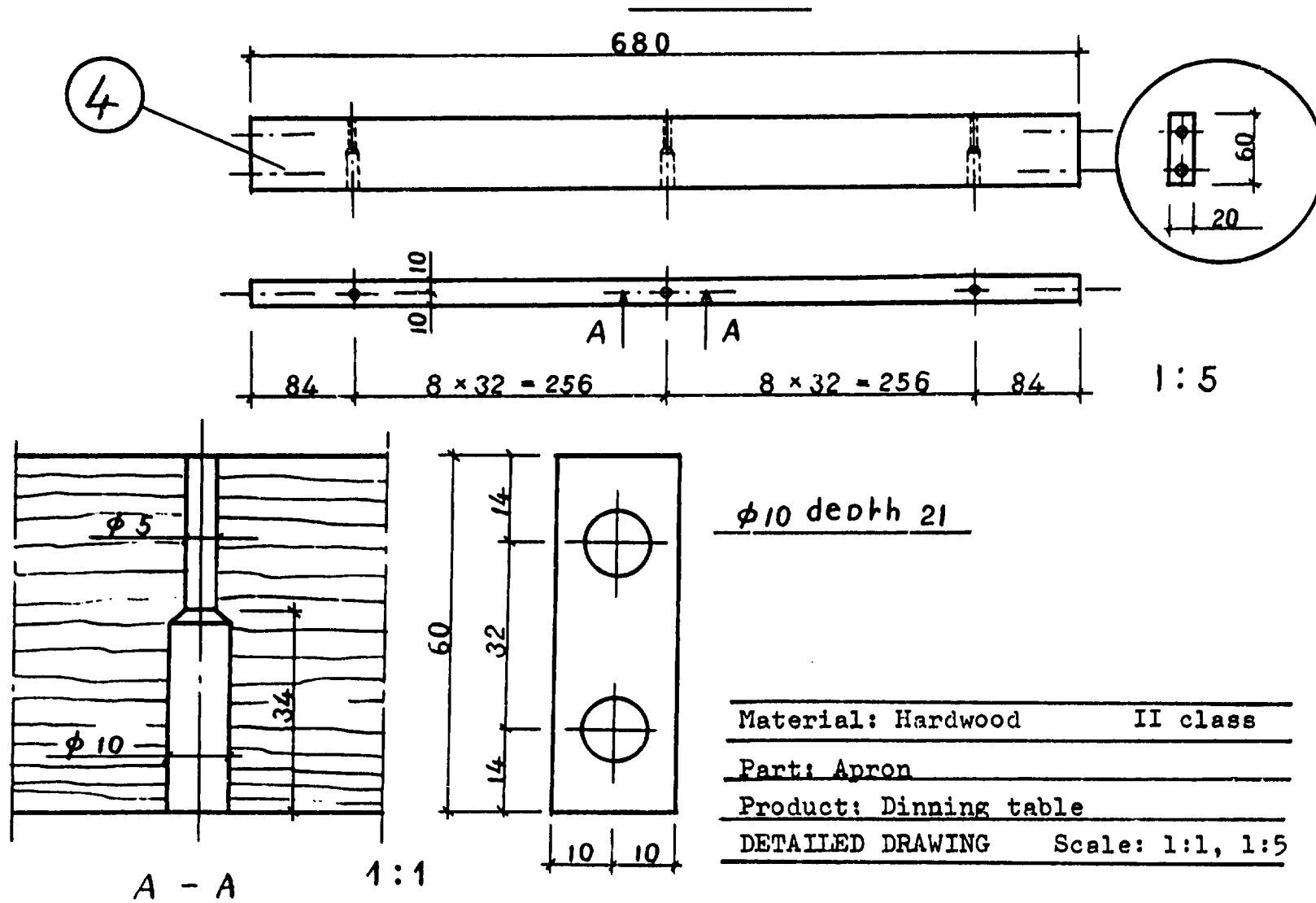


s	d	p	p1	p2
14	6	25	10	15
17	8	30	12	18
20	10	40	15	25
26	13	50	20	30
32	16	60	25	35

- (2) Dowel leg and apron joint
- (1) Dowel corner joint

Fig. 10: Dowel corner joint.

Fig. 11: Example of a detailed drawing.



9. Fixed and knock-down constructions

Fixed furniture is produced using inseparable constructive joints and glue for the assembly. Assembling is done in the factory and the product is delivered completely assembled.

Since furniture, especially case furniture, is bulky, transport costs and thus the price of furniture are high. New developments rationalized furniture production by offering various separable metal and plastic jointers which allow the customer to assemble the furniture at home. Knock-down furniture production is now prevailing, especially for case furniture. Before shipping knock-down furniture, hardware and fittings are mounted, but only those, which do not make packaging difficult. Special attention should be paid to the packaging of knock-down furniture, including all parts necessary and preventing their movement in the package. A list of all parts and components and a well illustrated assembly instruction sheet, easy to understand by the customer should be included in the package. Some manufacturers include a simple assembly tool, such as a screw driver, as well as instructions for the proper use and maintenance of the furniture.

In knock-down furniture production, special attention must be paid to work precision and to the control of quality. The controllers must select packages, open them randomly and assemble the furniture in order to check the completeness of the package and the accuracy of work.

Knock down furniture production allows long distance transportation and facilitates the international trade of furniture.

10. Furniture quality standards and their use in production

The proposal of internal standards for furniture quality will be used for this training course. It is a part (Annex I) of the quality control training manual prepared for the Pilot Furniture Plant in May 1988. Since machine operators and assemblers must also control quality, it is recommended that they learn the quality criteria of the products they will manufacture.

ANNEX I

TRAINING PROGRAMME FOR FURNITURE MANUFACTURING

1. Introduction

This training programme is designed to accomplish the objective and outputs foreseen in the project "Assistance in the Establishment of a Pilot Furniture Plant" (DP/DRK/86/011).

Referring to the project document, the immediate objective is to "train wood technicians and machine operators in the efficient operation of all the machinery and maintenance of tools, so as to manufacture furniture of medium quality", and also to "train managerial staff in overall management techniques including introduction to the marketing of furniture products".

This objective will be achieved through the accomplishment of outputs Nos. 6, 8 and 10.

Output No. 6 states: "20 wood machinists, 10 assemblers and four team leaders trained in the efficient use of the available manufacturing equipment, able to manufacture furniture of medium quality acceptable for export."

Output No. 8 states: "Two wood technicians trained to design and make the required production fixtures aimed at attaining accurate machining of components parts."

And output No. 10 states: "Design of overall factory organization, with established work preparation, cost accounting and management procedures, with managerial staff trained in (a) factory management based on modern industrial production methods and in (b) the basic elements of marketing."

The planned activities of the quoted outputs are:

For output No. 6:

- 6.1 Prepare a training programme for furniture manufacturing.
- 6.2 Prepare a training manual for each of the major production operations.
- 6.3 Train 20 machine operators, 10 assemblers and four team leaders to manufacture furniture of acceptable quality.

For output No. 8:

- 8.1 Train two wood technicians to design, produce and maintain jigs and other furniture production fixtures.

For output No. 10:

- 10.3 Train factory management in modern industrial production methods.
- 10.4 Acquaint the managerial staff with the basic elements of export marketing.

Training labourers is an integral part of production in modern industrial enterprises. Technical and technological developments are offering, practically on a daily basis new products and methods which make human work easier, safer and more productive. To follow such advances, people working in industry have to learn and to train in order to acquire new knowledge and skills necessary for the handling of modern equipment and processes.

In developing countries, such training has a decisive importance for the fuller utilization of new production techniques and for mastering new technological processes. To avoid unnecessary mistakes and to gain indispensable skills, training courses are the most rational mode, because people can learn, in a short time, the best ways of performing their production duties.

## 2. Training programme for the Pilot Furniture Plant

This training programme is designed to meet the specific requirements of the Pilot Furniture Plant. The main topics covered in the programme are:

1. Wood, affiliated products and other materials used in the production of case furniture;
2. Furniture products: design, construction and quality standards;
3. Production organization and work preparation;
4. Panel sizing;
5. Veneer trimming and joining;
6. Veneering;
7. Processing of veneered furniture parts: trimming, tenoning edge banding and drilling;
8. Moulding and routing;
9. Sanding;
10. Finishing;
11. Preassembling, assembling and packaging;
12. Tools, jigs and measuring instruments;
13. Quality control;
14. Safety measures in the furniture production;
15. Management based on modern industrial production methods;
16. Basic elements of marketing.

The main goals of this training are to enable workers, not only to learn how to perform their jobs, but also to understand the industrial production system as a whole.

Courses numbers 1, 2, 3, 12, 13 and 14 are foreseen to be attended by all workers to be trained, while the other courses are intended only for the workers who will perform the respective production operations.

All these courses are independent from one another, but in their totality they represent an integral training programme for the production of casegoods furniture in a medium size factory.

## 3. Methodology of training

There is an old Chinese wisdom which says "What I hear I will forget, what I see I will remember, and what I have done I will know." The



output of this training should be knowledge learned by workers who will increase their ability for effective production. To achieve this, the training method will rest on three steps as follows:

1. Explain (to hear),
2. Demonstrate (to see), and
3. Try (to do).

Short manuals, written in a simple language, understandable to the workers, will be prepared for each course, translated into Korean and distributed to the trainees. All graphs, tables and formulae will be adjusted to the level of understanding of the people to be trained.

Theoretical teaching will take place in a classroom and its duration will be adapted to the minimum of theory which has to be known for a certain job. This part of the teaching will be performed by the expert (CTA) and the Chief of the Technical Department in the Pyongyang Wood Processing Complex (PWPC).

The practical part of the training will be organized at work areas for the respective work operations. For that purpose, the work areas must be organized correctly, including production documents, materials, tools, jigs, gauges, pallets, protective devices and everything that is necessary for productive, safe and good quality work. The expert will explain and show how to check a machine, tools, jigs and, in the case of wrong adjustments, how to correct them and prepare the equipment for correct use. The expert will show the correct way of performing operations and continue to supervise these operations until he concludes that proper work is fully accepted and that the quality of production is satisfactory.

The Chief of the Technical Department and other engineers who have undertaken training abroad will also collaborate in performing this practical training. Some practical experience of the trainees will help in the practical part of training.

Course No. 12 (tools, jigs and measuring instruments) should be conducted by the Tool Maintenance Expert.

Course No. 13 (Quality control). The manual prepared during the CTA's first mission can be used.

Courses Nos. 15 and 16 ("Management based on the modern industrial production methods" and "Basic elements of marketing") are foreseen for the managerial staff and will be conducted in a way to initiate discussion and an active participation of the trainees.

#### 4. Selection of trainees

The persons to be trained will be selected by the counterpart, according to their duties and to the topics of the training programme. Besides workers who will directly perform particular production operations, all other people concerned with certain aspects of the production, such as foremen, members of the management, maintenance personnel etc. could be included in the training.

It is recommended that in selecting the trainees attention should be paid that their physical and psychological abilities be in accordance with the requirements of the pertinent jobs.

The list of trainees is an integral part of the training programme, and it determines the number of copies of the training manuals to be prepared and distributed for every course.

5. Training programme

TITLE	TRAINING HOURS	
	Theoretical	Practical
1. Wood, affiliated products and other materials used in the production of case furniture	4.5	1.25
2. Furniture products: design, construction and quality standards.	2.75	0.5
3. Production organization and work preparation	4.75	2
4. Panel sizing operation	2.75	3.5
5. Veneer trimming and joining	2.75	4.5
6. Veneering	5	4.5
7. Processing of veneered furniture parts: trimming, tenoning, edge banding and drilling	4.5	9.25
8. Moulding and routing	2.75	4.75
9. Sanding	0.25	4.75
10. Finishing	4.25	6.75
11. Preassembling, assembling and packaging	4.5	8.5
12. Tools, jigs and measuring instruments	5.75	4
13. Quality control	5	2.5
14. Safety measures and work protection in the furniture industry	5.5	1.25
15. Management of production in a modern industrial factory	10.25	4
16. Basic elements of marketing	5.25	-
<b>GRAND TOTAL</b>	<b>70.50</b>	<b>62.00</b>

Detailed syllabi are given in Annex II.

ANNEX II

Topic 2: Furniture Products: Design, Construction and Quality Standards.

ITEM	TOPICS	TRAINING TIME (in hours)		LEVEL OF COMPETENCE TO BE REACHED
		Theoretical	Practical	
2.1	Introduction	0.25	--	Understanding the purpose of the course.
2.2	General knowledge about furniture production	0.5	--	Understanding the main characteristics of secondary wood processing and classification of furniture products.
2.3	Importance of product development for the successful production of furniture	0.25	--	Understanding the necessity of permanent work on innovation and product development.
2.4	Strategic approach and main stages of product development in the furniture industry	0.25	--	Understanding the product development process from an idea to a finished prototype.
2.5	Design of furniture products and what a designer must take into consideration when making a new design	0.25	--	Better understanding of functions of products and the compromise between the customer's requirements and the possibilities of production. Comprehending the importance of design.
2.6	Standardization and interchangeable parts, the uniformity of components and variety of products	0.25	--	Full understanding of the advantages of production based on standardized interchangeable parts.
2.7	Construction of case furniture and use of appropriate constructive joints and fittings suitable for an industrial manufacturing method.	0.5	0.5	Ability to understand principles of construction of case furniture, for industrial production, and to read simple construction drawings.
2.8	Detailed drawings of furniture parts and reading of drawings	0.5	--	Easy understanding and reading of detailed drawings in order to select tools and set up a machine for an appropriate operation.
2.9	Fixed and knock-down furniture constructions, the major differences, advantages and prerequisites	0.25	--	Understanding the knock-down furniture constructions and conditions required for such production.
2.10	Furniture quality standards and their use in the furniture production, how to measure the precision of machining and to estimate quality of materials.	0.5	--	Understanding and ability to use the furniture quality standards. Ability to recognize defects and to measure precision of work.
TOTAL		3.50	0.50	