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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: The situation in the pilot furniture plant*

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 R. Malis, furniture production technician

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Vienna

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* This document has not been edited.

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EXPLANATORY NOTES

- A full stop (.) is used to indicate decimals.
- A comma (,) is used to distinguish thousands and millions.
- Reference to dollars ($) is to United States Dollars, unless otherwise stated.
- The monetary unit of the Democratic People's Republic of Korea is the Won. During the period covered by this report the official exchange rate was 2.12 Wons to 1 US$.
- The Fifth Department of the Ministry of Foreign Trade is the Government's Central Coordinating Agency for the Operational Activities of Multilateral Cooperation.
- The General Bureau for Building Materials in Pyongyang is considered as the Government's Implementing Agency.
- The Pyongyang Wood Complex in Pyongyang is considered by the Government as the project site.

ABSTRACT

The activities covered by this report are a part of the IPF project DP/DRK/86/011, entitled "Assistance in the establishment of a pilot furniture plant", carried out in Pyongyang, the Democratic People's Republic of Korea. The expert mission was carried out from 2 March to 1 July 1988, as the first part of the eight months split mission.

During this mission two candidates for the study tour and four candidates for the group training abroad have been selected, and a programme for the group training proposed.

The production programme and approximate capacity of the future pilot furniture plant have been defined. The layout of the pilot furniture plant have been defined. The layout of the pilot furniture plant has been worked out with description of technology and selection of equipment to be provided by both the Government and UNIDO.

The requisitions for machines and tools to be supplied by UNIDO have been completed and forwarded to UNIDO for purchase.

Inter-operational transport has been defined with based technological characteristics needed for technical design and for the production of transportation means.

A product development methodology was prepared and discussed with the counterpart's designers, and work on development of products for the pilot furniture plant has been induced.

The new, revised, work plan for the execution of the project has been worked out.

All written material included in this report has been translated into Korean, copied and given to be used by the counterpart.

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INTRODUCTION

The expert assigned to the project as a Chief Technical Adviser carried out his mission from 2 March to 1 July 1988. The project document for this project has been signed on 11 November 1987 by the Government of the Democratic People's Republic of Korea (DPR Korea), the United Nations Development Programme (UNDP) and the United Nations Industrial Development Organization (UNIDO) as the executing agency.

According to the Project document, the existing furniture factory within the Pyongyang Wood Complex (PWC) was selected for transformation into a pilot furniture plant, with combined new and old reconditioned equipment. When the execution of the project started, the Government decided to use an existing old building in which to establish the pilot furniture plant, with new equipment.

The first idea was to design a universal factory for production of both solid wood furniture and case furniture made of panels. Owing to the lack of money for purchase of all necessary imported equipment for such a factory, the counterpart changed its decision and ordered to establish the pilot furniture plant with only one production line specialized for case (corpus) furniture, mainly made of veneered particle boards and plywood.

The counterpart defined products to be produced in the pilot furniture plant, and work on the product development has been organized. Since the expert for design did not come and the counterpart requested cancellation of post 11-03, the expert assigned as CTA also acted as a consultant for product development. A short product development methodology was prepared and discussed with designers and the product evaluation team was nominated. Within the limits of their capacities, the furniture designers of the PWC are developing a product line.

In accordance with the counterpart's decision, a technological process has been designed and layout of the pilot furniture factory worked out, covering one half of the mentioned building, while the rest of the building is left to be completed by the counterpart later on for the production of a solid wood furniture unit.

Equipment for the pilot furniture factory was defined and requisitions for the selected machines and tools to be purchased by UNIDO have been completed and forwarded for purchase.

The list of equipment to be provided by the Government was prepared. A part of that equipment is already bought, while for the remaining equipment, the counterpart claims that it will either be bought or produced locally in time.

The building foreseen for the pilot furniture plant is in a rather bad shape and needs serious reconstruction work. Also, it is necessary to complete all industrial installations.

These and all other activities, necessary for completion of the project, were listed in the work plan, showing what must be done, by whom and when in order to finish the project by the middle of 1989, as was requested by the Government authorities.

During this mission, the candidates for the study tour and for the group training abroad were selected and a 40 days training programme for four candidates has been proposed.

In order to train technicians and quality controllers to be able to perform a systematic integral quality control in furniture production, a training manual for quality control has been written. This manual was issued as a separate technical report.

The following points will be explained in detail in this report:

1. Selection of candidates for the study tour and the group training programme abroad;
2. Definition of the production programme;
3. Definition of the capacity of the pilot furniture plant;
4. Layout of the pilot furniture plant;
5. Description of technology;
6. Requisition of machines and tools;
7. Equipment to be purchased by the Government;
8. Internal transport;
9. Product development;
10. Conclusions and recommendations.

1. SELECTION OF CANDIDATES FOR THE STUDY TOUR AND FOR GROUP TRAINING ABROAD

1.1 Selection of candidates for the study tour.

According to the signed project document, a three week study tour for two technicians is foreseen. These two candidates were nominated by the Government prior to the commencement of the expert's mission. The expert conveyed the opinion of UNIDO that one candidate, who is not a technician, should be replaced by someone with the technical education who could benefit more from the study tour, but the Government authorities firmly stuck to their previous decision. Also, the Government selected the German Democratic Republic as host country for this study tour. The proposal of UNIDO to organize the study tour in the CSSR or in both CSSR and the German Democratic Republic was not accepted by the Government.

The nomination forms were not completed properly and have been sent to UNIDO without given them to the expert for checking.

Since the authorized agency in the German Democratic Republic requested four weeks time to organize the study tour, it was agreed to start it in the middle of June, contrary to the Government's previous plan to start as early as possible. For some reason, the Government requested shortening the study tour from three to two weeks.

Finally, the two week study tour has been arranged in the German Democratic Republic starting on 13 June 1988, with the following candidates:

- Mr. Li Song Hak, Chief of the Technical Department in the General Bureau for Building Materials in Pyongyang, and
- Mr. Ko Ju Chol, Officer in the Fifth Department, Ministry of Foreign Trade, in charge of the project.

Both the Government and UNIDO agreed that the expert accompany the study tour.

The study tour report has been completed by the expert and annexed to this report (see annex V).

1.2 Group training abroad

The 40 days group training abroad is foreseen in the project document for four technicians. These four technicians have been nominated by the Government. The Government selected Romania as the country where the training should be conducted.

Nomination forms were completed with repetition of all the mistakes made in the case of the study tour.

The nominated candidates are:

- Mr. Ryu Chun Gyu, Chief of the Technical Department in the Pyongyang Wood Complex;
- Mr. Chang Luk Won, Manager of the Furniture Factory;
- Mr. Li Yang Chun, Team leader in the Machining Department in the Furniture Factory; and
- Mr. Li Gi Bong, Team leader in the Assembly Department in the Furniture Factory.

In collaboration with Mr. Ryu Chun Gyu, who is supposed to lead the group to Romania, the training programme has been worked out and proposed to UNIDO. This training programme is enclosed to this report in Annex I.

According to the counterpart's plan the group training in Romania should start immediately after the study tour is finished.

The participants in the group training are supposed to prepare a report and submit it to UNIDO.

2. DEFINITION OF THE PRODUCTION PROGRAMME

In order to continue with other activities of the project, the production programme of the pilot furniture plant had to be defined. After being instructed by the expert on how to define products to be produced in the future factory, the management of the Pyongyang Wood Complex worked out a list of the products to be developed, with certain requirements to be respected.

2.1 List of products to be developed for the Pilot Furniture Plant.

(a) Type of furniture:

1. Wardrobe
2. Chest of drawers
3. Bookcase
4. Wall unit (sideboard)
5. Cupboard

(b) Type of use:

1. Wardrobe: storage of clothing (suits, overcoats, dresses, skirts, shirts, underwear, etc.)
2. Chest of drawers: storage of bedding (blankets, pillows, bed sheets, bed covers), underwear, etc.
3. Bookcase: to keep books, journals, souvenirs and various decorative objects.
4. Wall unit: to place television set, radio, record and tape players, drinks, glassware, souvenirs and other decorative objects and household articles.
5. Cupboard: to place tableware (plates, eating utensils, dishes), food and other articles daily used in a kitchen and a dining room.

(c) Expected market:

Household furniture for domestic (Korean) market.

(d) Style:

Modern furniture, customary in the Democratic Republic of Korea.

(e) Quality level:

Medium quality with high gloss finish.

(f) Price level:

1.	Wardrobe	120 to 180 Wons
2.	Chest of drawers	130 to 200 Wons
3.	Bookcase	60 to 90 Wons
4.	Wall unit	100 to 150 Wons
5.	Cupboard	70 to 100 Wons

(g) Preferable sizes:

		Width	Depth	Height (mm)
1.	Wardrobe	90/100	550	2300
2.	Chest of drawers	900	550	2300
3.	Bookcase	900	450	2300
4.	Wall unit	900	450/350	2300
5.	Cupboard	1800/900	450	650

(h) Types of raw materials:

- particle board
- veneer
- plywood
- solid wood (soft wood)

(i) Preferable dimensions of raw materials:

- particle board 2200 x 900 x 19 mm
- veneer (thickness) 0.7 mm
- plywood (thickness) 5 mm

(j) Available processing techniques:

- Panel sizing, veneering, trimming, edging and tenoning, edge banding (with veneer, plastic and wooden lathes) profiling, moulding, routing, dowel drilling, sanding and finishing corpus furniture with various paints and lacquers.

- Solid wood parts will be machined and prepared for sanding and finishing in cooperation with another factory.

(k) Assembly:

- Fixed construction, assembled after finishing, by using dowels and the available fittings.

(l) Special restrictions:

- Sharp edges and corners must be softened by hand sanding.

(m) Other requirements:

- Must be stable when placed on even, flat floor.

Authorized by:

Mr. Ryu Chun Gyu, Chief
Technical Department
Pyongyang Wood Complex

This product line, defined by the Management of the Pyongyang Wood Complex, is used from now on for design of technology, selection of equipment and for development of products as well.

3. DEFINITION OF THE CAPACITY OF THE PILOT FURNITURE PLANT

An approximate capacity of the factory has been framed by the counterpart's decision to install one simple production line for the production of case furniture.

The capacity expressed in the number of units per year is related to an average, representative product. For this estimate, a wall unit is chosen with outer sizes: 900 x 450/350 x 2300 mm, vertically divided into three sections (see fig. 1). An estimated sales price for this unit is 120 Wons.

Based on 275 working days per year, two shifts per day, 8 hours each, and 320 minutes (67%) working time per shift, the capacity has been figured out for the veneering press and other key machines.

The total volume of the production is	22,200 units/year
The total value of the production is	2,640,000 Wons/year
The number of workers (direct and indirect) is	200
The value of production per one employee is	13,200 Wons/year

Materials:
-particle board 19 mm
-plywood 5 mm
-veneer 0.7 mm
-glass 3 mm

Finish:
-natural colour
-nitrocellulosic lacquer
-high gloss

Package:
-each section separate
-into cardboard boxes

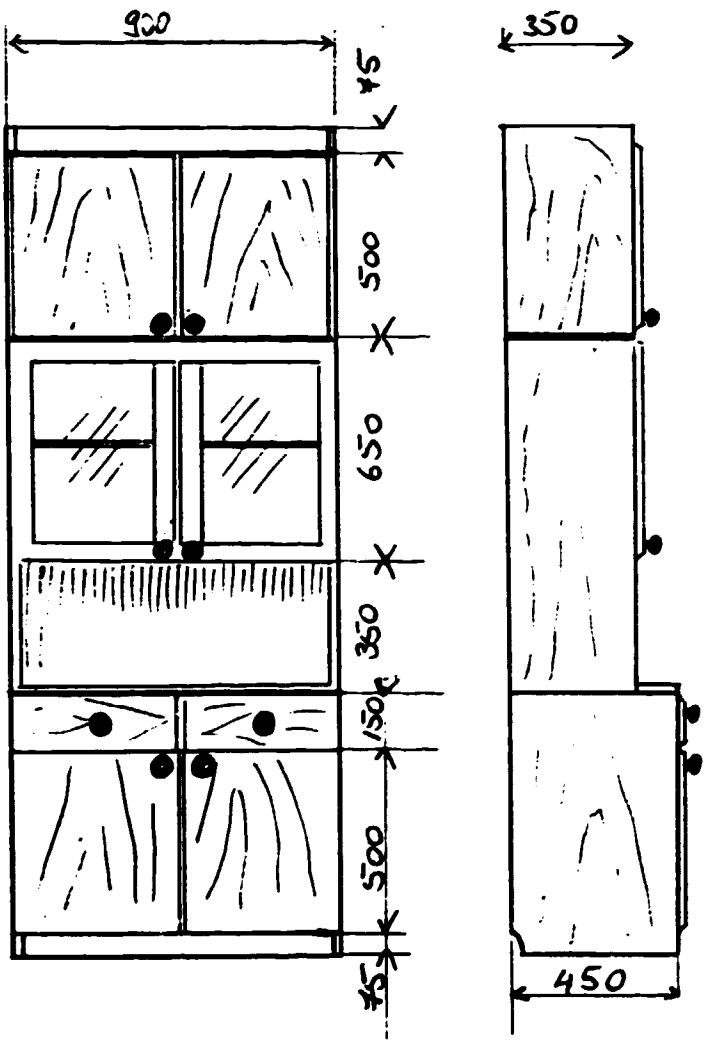


Fig. 1: Representative product (wall unit) chosen for estimation of capacity

To assure production at full capacity it is necessary to provide raw materials in time and in satisfactory quality. The following raw material is to be supplied:

- particle board 19 mm.....3,600 m3
- plywood 5 mm..... 360 m3
- veneer 0.7 mm..... 480 m3

More precise calculation of these and other materials will be done after a technical documentation for complete product line is complete.

4. LAYOUT OF THE PILOT FURNITURE PLANT

The counterpart decided to establish the pilot furniture plant in an existing old building located in the Pyongyang Wood Complex area. This building is 238 m long and 36 m. wide, with a surface of 8,568 m2. The building is divided into six sections, by two fire preventing and three other walls.

The first counterpart's idea was to use that whole building for a universal furniture factory, for both solid wood and case good furniture. But, after considering several proposals for such a factory, the counterpart realized that the money is short and have decided to use only half of the building for the establishment of a pilot furniture plant for case furniture.

Based on this decision, the layout of the factory has been worked out. Technology is designed for the production of a simple corpus (box like) furniture, mainly made of veneered particle boards, plywood and, when necessary, solid wood components.

The layout of the pilot furniture factory is made under following suppositions:

1. The building will be renovated to satisfy requirements for a modern factory.
2. Part of the machines with the corresponding tools will be purchased as a contribution of UNIDO (budget line 41: US$ 17,500 and budget line 42: US$ 125,000).
3. Part of the machines will be bought by the Government (foreseen contribution for the purchase of equipment US$ 271,000).
4. Several existing old machines for simple operations will be reconditioned and used in the pilot furniture plant.
5. Very simple equipment and transportation means will be made locally under the supervision of the counterpart.
6. All necessary industrial installations will be provided and installed by the counterpart.
7. All work tables for hand operations will be made by the counterpart.
8. Some machines will be indicated for purchase later on, and temporarily substituted by electrical hand tools.

Description of the technology is given in the next chapter.

The layout of the pilot furniture plant is added to this report as annex II.

4.1 List of equipment for the pilot furniture plant

Position in layout	Description of equipment	Provided by			
		UNIDO	Government	Reconditioned	Made locally
1	Semi-automatic panel sizing machine		x		
2	Veneer trimmer		x		
3	Zig-zag veneer splicer	x			
5	Inspection table				x
7	Wide belt sanding machine for particle board		x		
8	Glue mixer				x
9	Glue spreading machine	x			
10	Dead roller conveyor				x
11	Hot, six daylights, veneering press	x			
12	Narrow bandsaw		x		
13	Double edge trimming/ profiling machine	x			
14	Single end edge bending machine	x			
15	Single end dowel drilling machine	x			
16	Spindle moulder		x		
17	Router	x			
18	Single spindle vertical drilling machine			x	
19	Assembling tables (four pieces)				x
20	Semi-automatic two narrow belt sanding machine	x			
21	Narrow belt sanding machine		x		
22	Narrow belt edge sanding machine	x			
23	Narrow belt sanding machine for concave edges				x
24	Tool control table				x
25	Universal tool sharpening machine	x			
28	Roller and brush under-coating		x		

Position in layout	Description of equipment	Provided by UNIDO	Government	Reconditioned	Made locally
29	Spray booth				x
30	Curtain coating machine		x		
31	Wheel type conveyor				x
32	Lacquer evaporating tunnel				x
33	Lacquer drying tunnel				x
34	Lacquer sanding tables (two pieces)				x
38	Dead roller way				x
39	Ball table				x
40	Corpus clamp				x
41	Assembling tables (five pieces)				x
	- hand pallet trucks (hand jacks) 5 pieces		x		
	- trolley racks for drying lacquer 20 pcs				x
	- heavy duty pallets 100 pieces				x
	- light duty pallets, 200 pieces				x

4.2 List of machines to be purchased later on, and temporarily substituted by electrical hand tools

Position in Layout	Description
4	Tape veneer splicer
35	Lacquer sanding machine
37	Auxiliary boring machine (two pieces)

5. DESCRIPTION OF THE TECHNOLOGY

The pilot furniture plant is designed to produce simple case (box like) furniture made of veneered particle board,s plywood and solid wood parts. All parts made of panels will be manufactured in the pilot furniture plant, while all solid wood parts will be machined in another factory and delivered for sanding, finishing and assembling in this factory.

The technology designed for the pilot furniture plant is rather simple because the money for the purchase of equipment was short and therefore selection of equipment has been oriented to the limited number of simple panel processing machines. For the same reason the internal transport is based on the pallet system and hand lifting trucks (hand jacks).

Nevertheless, this factory will meet all needs for an industrial system of production of case furniture of a medium quality level.

This description of the technology is related to the layout of the pilot furniture factory, which was proposed by the expert and has been accepted by the counterpart.

The production starts with cutting panels on the panel sizing machine (position 1). Panel parts are cut to the rough sizes which are actually net sizes of parts with 10 mm addition on each edge for post veneering trimming. The sizing of the parts is done in accordance with sizing scheme drawn by the work preparation unit. This scheme assures maximal utilization of boards in the production of requested quantity of each size. It is recommended to use carbide tipped saw blades for sawing particle boards.

Cut panel parts are taken to the wide belt sanding machine (position 7) for sanding, in order to get an equal thickness, with a tolerance of plus or minus 0.2 mm to the nominal one. Due to the fact that the present production of particle boards has a big inaccuracy of thicknesses, both side sanding is necessary, which means that each part must pass two times through the sanding machine. In the case that a thickness of sanded parts is greater than the prescribed tolerance, sanding operation must be repeated. For sanding particle boards a sanding paper with a grit 60 is recommended.

Processing of veneer starts on the veneer trimming machine (position 2) which can be used for both cross-cutting and trimming. The purpose of this operation is to cut veneer to the specified sizes, to get an appropriate cut for jointing and to eliminate intolerable defects. Rough sizes of veneer sheets as well as the number of each size are given in the operational list, made out in the work preparation unit.

Before trimming, veneer must be selected for well exposed, less exposed and concealed parts. Cut veneer parts are stacked in the shelves placed between veneer trimming and veneer splicing machines.

Jointing veneer parts into full size veneer sheets is performed on the zig-zag splicing machine (position 3). The operator's assistant on this machine should have a hand veneer jointing machine for closing cracks and, if necessary, strengthening cross-section edges.

Since the capacity of one veneer jointing machine is about half of the capacity of other machines, temporarily this operation will be complemented by hand tape jointing tools. For future improvement a tape jointing machine (position 4) is foreseen.

The full size jointed sheets of veneer are stacked in the built in shelves or on the prepared pallets.

The veneering operation starts with preparing the glue, which is done in the glue mixer (position 8). The composition of working mixture of glue is in accordance with recommendation of a glue manufacturer. The factory, also, should try to get the most satisfactory and economical mixture of glue, water, hardener and filler, by making glue tests with different compositions of mixture. The glue mixer can be placed on a platform which is higher than the glue spreading machine and the force of gravity can be used for bringing glue to the glue spreading rollers.

Panel parts to be veneered are passed through a two side glue spreading machine (position 9) with a disc conveyor after the glue spreading rollers. The lower part of the discs dip into a water basin in order to keep the discs (you started a word with m) clean. The glue spreading machine must be regulated to spread about 120 to 150 g/m2 of glue on each side to be veneered.

Veneer is brought separately for each side next to the press, and positioned on both sides of the substrate. One pressing cycle contains 6 layers prepared on a dead roller way (position 10).

Veneering is performed by the hot (steam heated), six daylight press (position 11). The temperature of steam should be about 110 to 120oC. This is a hand loading and unloading press. Duration of pressing cycle depends on thickness of veneer and quality of glue. For the carbamide based glues, temperature of press 120oC and thickness of veneer 0.6 to 0.8 mm. The pressing time could be 60 to 70 seconds. In reality, it is always 2 to 3 minutes. The following pressing cycle is used to calculate the capacity of the press:

-	loading	1.0 min.
-	closing press	0.5 min.
-	pressing time	3.0 min.
-	opening press	0.5 min.
-	unloading	1.0 min.
	Veneering cycle	6.0 minutes

Specific pressure on wooden panels should be 0.4 to 0.6 MPa or approximately 4 to 6 kg/cm2.

After veneering the veneered panels should be piled on flat, perfectly even pallets and left for one night for cooling and stabilization of glue.

The next panel processing operation is on the double edge trimming and tenoning/mortising machine (position 13). All panels pass through this machine twice, to trim longitudinal and transversal edges. The panels are trimmed to net sizes, and if necessary profiled (tongue-and-groove, mortise and tenon, rabbet, etc.), or if necessary edges could be cut at any desired angle (usually 45o) for mitre joints.

Sizing must be very accurate and smooth to obtain surfaces suitable for edge banding or other kinds of jointing.

A single-end edge banding machine (position 14) will be installed for edge banding. Veneer, plastic strips or solic wood lathes can be used for banding panel edges on this machine. Gluing the bands to the edges is done with hot melting glue, which is continuously heated by an electrical heater built in the machine. Glued bands are chamfered to the right sizes by the same machine. The panels pass through the banding machine as many times as the number of edges is to be banded.

The follcwing operation is dowel drilling, which is to be done by the dowel drilling machine (position 15), having one horizontal and one vertical multi-spindle boring head.

The constructor of furniture must take care to adjust positions of borings with already fixed distances between boring drills. (it is usually 38 and rarely 32 mm).

Diameters of dowels are usually 6, 8 or 10 mm. For case furniture made of veneered particle boards 16 to 19 mm thick, the preferred diameter of dowels is 8 mm. Depth of dowel holes drilled on the surface of panels should be adjusted to leave about 6 mm between the bottom of the hole and the surface on the other side.

In the case of manufacturing panel parts with rounded edges, the narrow bandsaw machines (position 12) will be used, and edge banding will be done by hand, using appropriate jigs.

The frontal parts of furniture and sometimes the frontal edges should undergo processing on the spindle moulding machine. All mouldings and edge profiling operations will be performed on the spindle moulder (position 16).

For processing frames and making housings for hardware and handles the router (position 17) will be used.

Both the moulder and the router are universal machines, and if they are used with appropriate jigs and tools, many manufacturing tasks can be performed on them.

Simple, single boring can be done by a vertical single spindle drilling machine (position 18).

Preassembly of frames or other subassemblies, to be machined later on, is done on the work benches (position 19).

After machining veneered panels they must be checked and eventually repaired prior to sanding operations. This should be done on the work benches (position 19).

Sanding machined parts will be done by using 4 sanding machines. A semi-automatic two belt sanding machine (position 20) will be used for sanding visible face and front parts of furniture and for all larger parts. The sanding operation starts by the first belt with a hand guided pad. Final sanding is done by the second belt with a pneumatically pressed bar.

The less important surfaces will be sanded using a simple single belt sanding machine (position 21).

Concave edges will be sanded by using a small belt sanding machine (position 23).

Profiled edges must be sanded by a manual operation. Because of dust extraction it can be done on the machine (position 23) which will be free a great deal of the time.

The proper selection and quality of sanding paper is of utmost importance for the quality of sanding. For the first sanding grit No. 80 to 100 should be used and for the final sanding grit No. 120 to 150. The lower numbers apply for less expcsed surfaces and higher numbers for well exposed surfaces of furniture.

All sanded parts must be checked by the quality control and, if they do not satisfy criteria for good finishing, sanding must be repeated.

The finishing operations are performed in a separate finishing department, prior to assembling.

The first finishing operation is filling and/or undercoating, which is done by a filling (roller and brush) machine (position 28). Coated panels are taken from the wheel conveyor (position 31) and stacked on the movable drying stands. Drying is in the open air, or the drying tunnel can be used as well, if it is free. The same machine and the same technology can be used for applying a coat of stain.

Coating of edges is done on stacked panels by spraying in the spray booth (position 29).

After drying, both surfaces and edges must be sanded before applying the finish coating. Temporarily, sanding will be done by hand on the sanding tables (position 34) supplied with dust extracting filters. This operation can be improved later on with the provision of a lacquer sanding machine foreseen on position 35. The sanding paper grit No. 150 or 180 can be used for sanding undercoated panels.

The finish coating is done either by a curtain coating machine (position 30) or by spraying in the spray booth. Coated parts are stacked on the rack trolleys which, coupled to the chain conveyor, pass through an evaporating tunnel and after that through a drying tunnel (positions 32 and 33). Evaporating is done at lower, and drying at higher temperature with appropriate ventilation. The heating system must be adjustable for any temperature between 20 and 70oC.

After drying the finished parts should be cooled in the open air, in the forced ventilation zone.

The assembly of furniture is organized in two lines. The first line is foreseen for assembling corpuses (box-like bodies), and the second one for assembling drawers, mounting hardware on doors and other sub-assembly operations.

Necessary drilling operations will be done by electrical hand drills, and later on with special auxiliary drilling machines which can be provided (position 37).

The first assembly line is provided with dead rollers and one board for each corpus. Assembly starts on the roller way (position 38) and continues in the case clamp (position 40), to be completed on the roller after the clamp.

Assembling tables (position 41) and benches (position 42) are used for the second assembly line. Assembly tables should be provided with pneumatic cylinders and appropriate jigs.

After the assembly, the whole product must be checked and properly cleaned. It is most important to check the functioning of a product and completeness of all parts and hardware.

As a further improvement in the future, a small spray booth can be installed next to the roller way, in order to refresh the product with a slight lacquer coating on the outer surfaces. That very thin spray coat will be dried within a short time, before packing.

Once the assembly is finished a thorough end quality control is performed in the area (position 44). Only those products which fully satisfy the prescribed criteria are accepted and forwarded to the packing area (position 45). Accepted furniture is marked accordingly.

Packing is done in accordance with the design of the packing crate. The most suitable way of packing is cardboard boxes or, in the case of distant shipping by railway, in boxes made of low quality plywood and reinforced for wooden frames.

Storing of finished products is done in the storage room, so that each time of furniture is stored separately and is easily accessible.

Furniture to be delivered should be prepared in the designated area (position 47) and once again thoroughly checked comparing all elements with the shipping order before shipment.

This description of technology is written in order to describe and explain the proposed plan of the pilot furniture plant. Different materials and different products could cause certain differences in technology, but it will be explained in more detail in the production documentation.

6. REQUISITIONS OF MACHINES AND TOOLS

According to the project document UNIDO's contribution for the purchase of non-expendable and expendable equipment is foreseen as follows:

-	Non expendable equipment, budget line 42	US$ 125,000
-	Expendable equipment, budget line 41	US$ 17,500
	Total	US$ 142,500

Based on this amount, the designed technology and the agreement reached with the counterpart, requisitions for both non-expendable and expendable equipment were completed and forwarded to UNIDO, Vienna for the purchase.

6.1 Requisitions for non-expendable equipment.

Requisitions for the following machines have been completed:

Order of priority	Description of equipment	EUMABOIS number	Estimated price in US$
1	Hot veneering hydraulic press, six daylights, 2,500 x 1,500 mm. Heating by steam. Total pressure 150 tons. Hand loading and unloading. Instruments for measuring pressure, temperature and pressing time should be included. Total weight of press and number of pistons should be indicated and taken into consideration	31.331.1	28,680,--
2	Glue spreading machine for two side veneering, with minimal length of rollers 1200 mm. Number of dosing rollers and the shore number indicating hardness of the rubber and cost of replacement rollers should be indicated.	34.112	6,300.--
3	Multi-purpose double edge precise trimming and profiling machine (double tenoner), with scoring and tiltable trimming saws on both sides and with one additional machining head on both sides, tiltable and adjustable for tenoning/mortising or rabetting of panels.	82.2	24,800.--

4	Lengthwise zig-zag veneer jointing machine (eneer splicer). Polyester trade for continuous three month operation, on an 8-hour basis, should be supplied.	31.119.1	12.400.--
5	Single edge bending machine for veneer, laminate and solid wood laths, cost of additional cutting chamfering and sanding attachments should be quoted separately. Hot melt pallets for one month continuous operation should be included, as well as normal tools for cutting and chamfering.	83.151	14,800.--
6	Semi-automatic narrow belt sanding machine with two belts. The size of the sliding table should be: length about 2.25m and width 1.25m. Sandpaper and the device for gluing sandpaper into an endless belt should be quoted separately and bought as expendable equipment.	12.721.22	6,300.--
7	Universal sharpening machine for carbide tipped sawblades moulding cutters, boring tools and router bits. Necessary technical specifications of the grinding wheels that such a machine uses should be given.	55.7	18,800.--
8	Multi-spindle dowel boring machine with one vertical and one horizontal boring head. The maximal distance between two end borers should be about 1,250mm and distance between boring centers 32 or 38 mm	12.421	7,030.--
9	Narrow belt sanding machine for edges.	12.721.41	3,100.--

10	High speed router with minimum 18,000 rpm of the machine head	12.314	6,030.--

Estimated total amount for all ten machines is US$ 128,240,--

Two years spare parts should be included in offers. Due to the fact of declining value of the US dollar, dollar prices may be increased, and therefore the requisitions are written in an order of priority, and the purchase should be done following this order. Also, the cost of freight should be taken into consideration.

Since the pilot furniture factory is aimed at producing furniture of a medium quality level, made of panels, it is recommended that simple and reliable machines be purchased.

Delivery time is also very important due to the counterpart's desire that the factory be ready for production in the first half of 1989.

6.2 Requisition of tools

The requisition for tools has been completed in order to provide basic standards woodworking tools for the machines to be purchased by UNIDO.

Item	Tool for machine	Description of tool	Quantity required
1	Multipurpose double edge trimming and t ning ma..ine	Carbide tipped scoring saw blades: D-200mm, Z-42 to 64m B-3.2mm	1 pair
2	Lengthwise zigzag veneer jointer	Polyester thread	20 spools
3	Single-end edge banding machine	Hot melt pallets (melting glue)	20 kgs
		Carbide tipped cutters for chamfering banded edges (to fit selected machine)	1 pair
		Saw blades cutting banding strips to the right length	1 pair
		Narrow edge sanding belts (to fit selected machine)	10 pieces
4	Semi-automatic narrow belt sanding machine	Sanding belts No.100	10 pieces
		Sanding belts No. 150	10 pieces
5	Universal tool sharpening machine for carbide tipped saw blades and cutters	Diamond grinding wheel for grinding front face of close pitched carbide tipped circular saws	5 pieces
		Grinding wheels for short cutting knives	5 pieces
		Flaring cup grinding wheels for grinding edges on carbide tipped tools	5 pieces
		Flaring cup diamond grinding wheels for finish grinding the teeth on small cutting tools	5 pieces

Item	Tool for machine	Description of tool	Quantity required
6	Dowel boring machine	Precision dowel drills Z-2+2, normal type, carbide tipped, D-6mm, 1-27mm, (length of cutting part).	30 pieces
		Same drills D-8mm	60 pieces
		Same drills D-10mm	30 pieces
7	Narrow belt sanding machine for edges	Sanding belts No. 100	10 pieces
8	High speed router	Precision router bits D-10 mm, Z-1, 1-30 mm	5 pieces
		Precision router bits, single fluted (Z-1), D-15mm, 1-32 mm	5 pieces
		Precision router bits, D-20 mm, Z-2, 1-38 MM	5 pieces

When placing orders for tools, the type of the machine must be considered to define diameters of axes and other elements.

7. EQUIPMENT TO BE PROVIDED BY THE GOVERNMENT

According to the project document, the value of equipment to be purchased by the Government should amount to US$ 271,000.

The Fifth Department of the Ministry of Foreign Trade wrote a letter to the United Nations Development Programme in Pyongyang stating that all the remaining equipment which will not be covered by UNIDO contribution of US$ 142,500,- would be provided by the Government. However, equipment bought by the government so far is mostly for other factories and only four out of nine items are definitively purchased for and will be delivered to the pilot furniture plant.

Attempting to get clear information about the purchase of the remaining equipment, the expert learned that the counterparts plan to produce locally a great deal of lacking equipment. From the expert's point of view some simple equipment could be made locally if properly designed, but it is doubtful that some of the more complex machines can be made locally in such a short time, with a satisfactory quality.

There is one simple machine to be reconditioned and it can be done shortly.

7.1 Equipment to be purchased by the Government

No.	Description	Status
1	Semi-automatic panel sizing machine	Should be bought from Japan, but not ordered yet.
2	Veneer trimmer	Delivered from the USSR.
3	Wide belt sanding machine for particle board parts.	Unknown situation
4	Spindle moulder	Delivered from the USSR
5	Roller and brush undercoating machine	Unknown situation
6	Curtain coating machine	Should be bought from Japan, but not ordered yet.
7	Narrow bandsaw	Delivered, local production
8	Narrow belt sanding machine	Delivered, local production
9	Hand lifting pallet truck - five pieces	Unknown situation, will probably be made locally.

7.2 Machine to be reconditioned

1	Single spindle vertical drilling machine	Will be reconditioned before its relocation.

7.3 Equipment to be made locally

1	Veneer inspection table with glass top and lights below the glass. Size: 2500x1000x800mm	Will be made in the PWC (Pyongyang Wood Complex)
2	Glue mixer capacity 150 l placed on the platform next to the glue spreading machine, so that glue will pour into machine by the force of gravity.	Will be made locally within the PWC.

3	Disc conveyor, extension of the glue spreading machine, with lower parts of discs dipped into water. Length: 3000mm, width: 150^ mm height: to fit machine. Discs D-60mm Distances between discs 100 mm Distances between axles 200 mm Free running axles.	Will be made within the PWC
4	Dead roller conveyor between glue spreading machine and veneering press. Length: 6500 mm length of rollers -600 mm, height: 500 mm, D (roller) - 100 mm, distance of rollers' centers 400 mm	Will be made locally
5	Preassembling and assembling tables, four pieces. Size:2500 x 1000 x 800 mm. Metal top 10 mm. Holes D-15mm bored for positioning pneumatic cylinders. Distances between holes 100 mm	Will be made locally
6	Narrow belt sanding machine for sanding concave edges. Two side sanding: one side diameter 60 mm, the other side 200 mm	The counterpart endeavours to make it locally.
7	Tool inspection table 2000 x 900 x 800 mm 40 mm thick hardwood top. metal plate 300 x 200 x 20 mm built in on the right end. With stand for tool balancing scale	Will be made within PWC
8	Spray booth with water curtain, width 3000 mm height 1950 mm. Equipped with water pump, fan and filter	The counterpart will try to make it locally
9	Wheel type conveyor - two pieces (extension of undercoating and curtain coating machines) length 3000 mm, width 1000 mm, height to fit machines. Slope 5%. Free plastic wheels Diameter 50 mm, distances 150 mm.	Will be made locally
10	Lacquer evaporating tunnel and lacquer drying tunnel, length 12000 mm each, free profile 1000 x 2000 mm. Heating by steam. Temperature between 20oC and 70oC. Appropriate ventilation and exchange of fresh air. Chain conveyor built in, pulling trolley racks through both tunnels.	Counterpart will try to make it locally

11	Lacquer sanding tables for sanding by hand pads, two pieces. length 4000 mm, width 800 + 200 mm, height 800 mm. Fan and filter for separation of dust built in, drawers for dust at the bottom.	Can be made locally
12	Dead roller way for assembly line. length: 9500 + 30500 mm, width 600 mm, height: 300 mm. Rollers D100 mm. Distances of rollers' centers 250 mm. Wooden boards fixed between rollers.	Will be made locally
13	Ball table (in front of corpus clamp) size 3500 x 800 x 300 mm (DxWxH), balls D ca 30 mm, distances 100 mm	Will be made locally
14	Corpus assembling clamp with two assembling frames. Inner size: 3500 x 2000 x 600 mm. Two vertical and one horizontal adjustable beams carrying pneumatic cylinders can be fixed on the main frame using drilled holes in both frame and beams.	Could be made locally
15	Trolley racks for drying lacquer - twenty pieces. length 2000 mm, width 800 mm, height 1800 mm. 15 racks for panels at a distance of 100 mm. With all sides movable coasters and attachment for chain conveyor.	Will be made locally
16	Heavy duty pallets for hand pallet jack with metal frame - 100 pieces Size: 1200 x 800 x 160 mm	Will be made locally
17	Light duty pallets for hand jack - 200 pieces Made of wood. Size: 1000 x 800 x 140 mm	Will be made with PWC

7.4 Electric and pneumatic hand tools

The following electric and pneumatic hand tools are necessary for assembling and repairing work:

1.	Electric hand drill, 500 W, 2750 rpm	2 pieces
2.	Electric hand router, 1.5 kW, 2750 rpm	1 piece
3.	Electric hand sander with oscillating pad	2 pieces
4.	Electric veneer hand splicer with polyester thread	2 pieces
5.	Pneumatic driller	2 pieces
6.	Pneumatic screw driver	8 pieces
7.	Pneumatic nail gun for small headless nails 20 mm	2 pieces
8.	Pneumatic stapler for staples 8/16 mm.	2 pieces

The purchase order for these tools must be placed as soon as possible.

8. INTERNAL TRANSPORT

Inter-operational transport has been defined during design of the technology. The most simple and at the same time the most flexible system of internal transport has been chosen. It is fully in accordance with the level of technology which is based on a serial production in medium batches, using simple, but modern woodworking machines.

Pallets with five hand lifting pallet trucks are the only means of transportation, except for a couple of dead roller ways.

All transportation means are included in the list of equipment to be purchased by the government or made locally.

9. PRODUCT DEVELOPMENT

Development of the product line for the pilot furniture factory is a task of the first priority. All stages of product development must be finished by the time the factory is prepared to start production.

In the project document, this task is foreseen to be carried out by the expert for design. Since this expert has not been fielded in time, the CTA organized the counterpart's designers to work on product development, directing and correcting them from time to time.

A short methodology for production development has been written, translated into Korean and distributed to the designers and other people concerned with product development. This methodology is enclosed to this report in Annex III.

The product development evaluating team has been organized with the following members of the team:

1. Mr. Ryu Chun Gyu, Chief of the Technical Department
2. Mr. Pak Zang Nam, from the Production Department
3. Mr. Ri Miong Ha, Chief of the Sales Department
4. Mr. Han Se Iong, from the Purchase department
5. Mr. Zo Gan Gon, Head Designer
6. Mr. Kim Goan Hun, Chief of the Quality Control
7. Mr. Ri Shi Gu, from the Technical Department

The team members and designers have been introduced in the basic principles and procedures of production development. Furniture catalogues and catalogues of hardware have been given to the designers as examples.

Special emphasis has been put on modularity, interchangeability of parts, standardization, utilization of available materials and equipment, principles of design and construction, etc.

By the beginning of June 1988, activities on product development had been carried out in accordance with the work plan.

Ideas, sketches and constructions had been evaluated and each time appropriate corrections made. Designers accepted the proposed methodology, and improved their design work significantly.

The other team members were not involved as much as necessary, mainly because they were occupied with their ordinary tasks.

The construction work for prototypes was done very correctly, but the expert suggested to the counterpart not to start with making prototypes before they have calculated the production cost of each item. Only when sales prices and production costs have been compared could they decide whether to make the prototype or not. The decision to produce a prototype must be based on a positive difference between the sales price and the cost of production. Some of the design examples are shown on the following pages (see figures 2, 3 and 4.

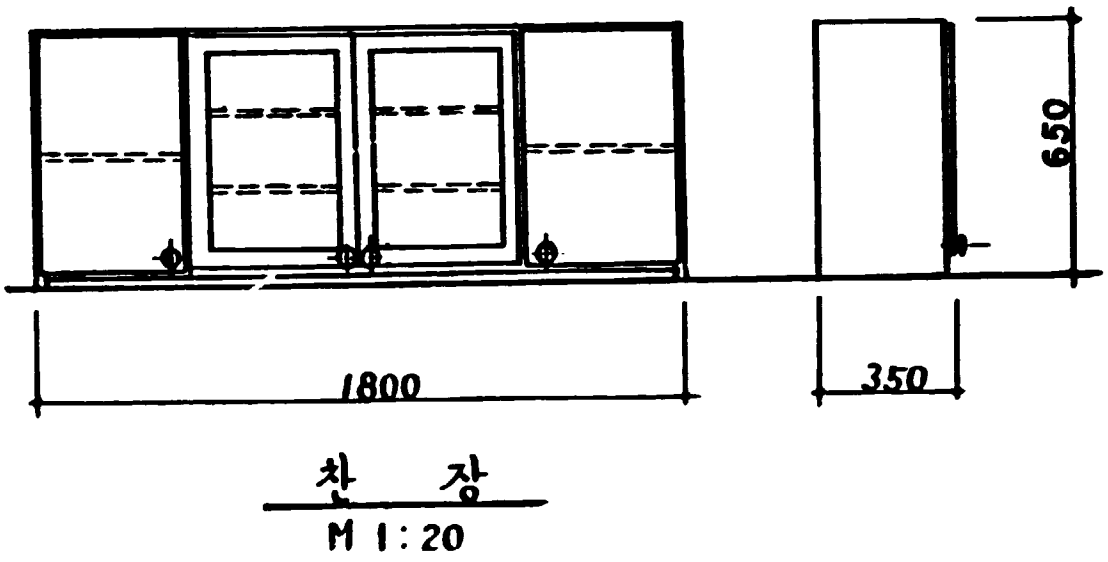


Fig. 2: Hanging part of a kitchen cabinet.

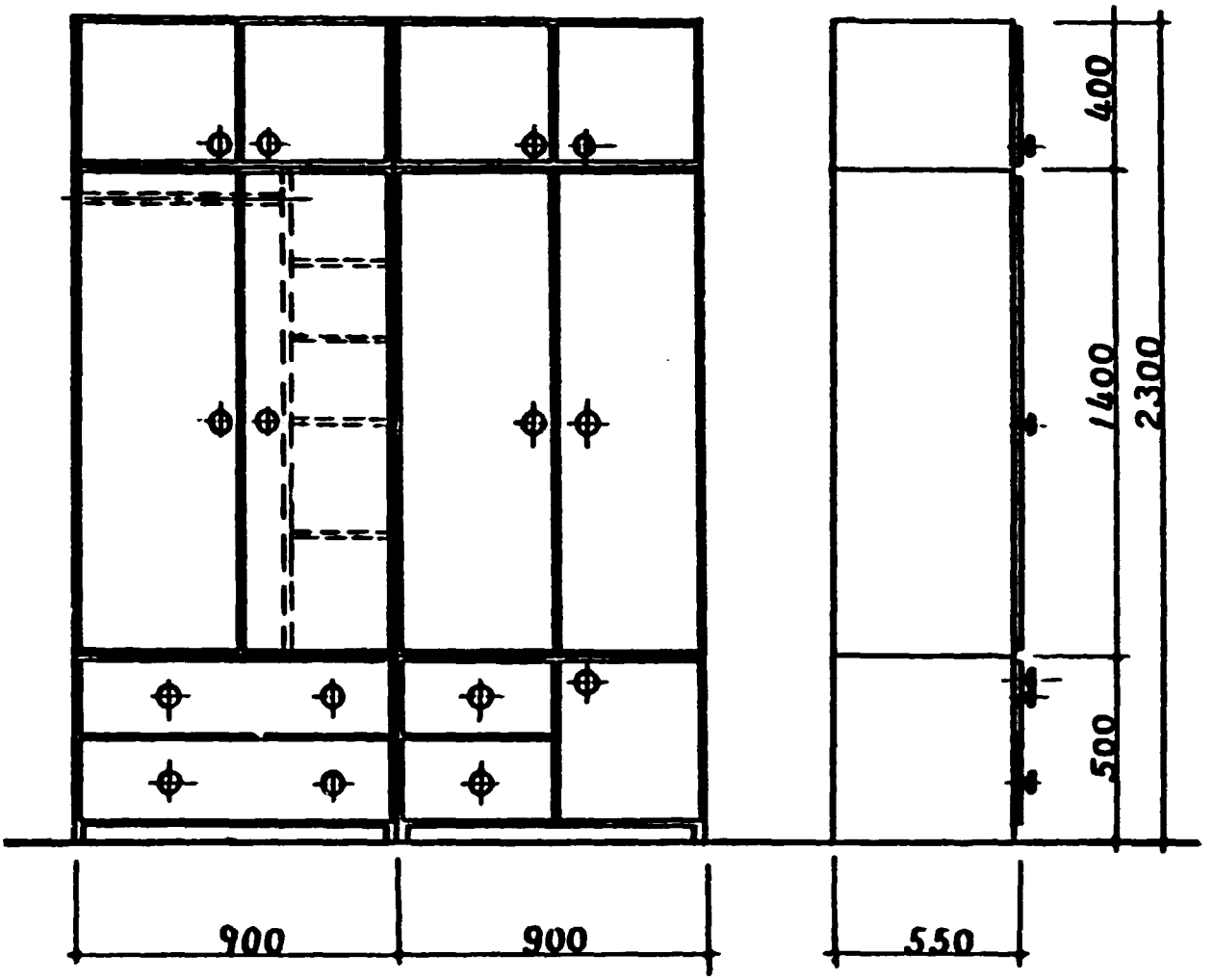


Fig. 3: Wardrobes for bedroom

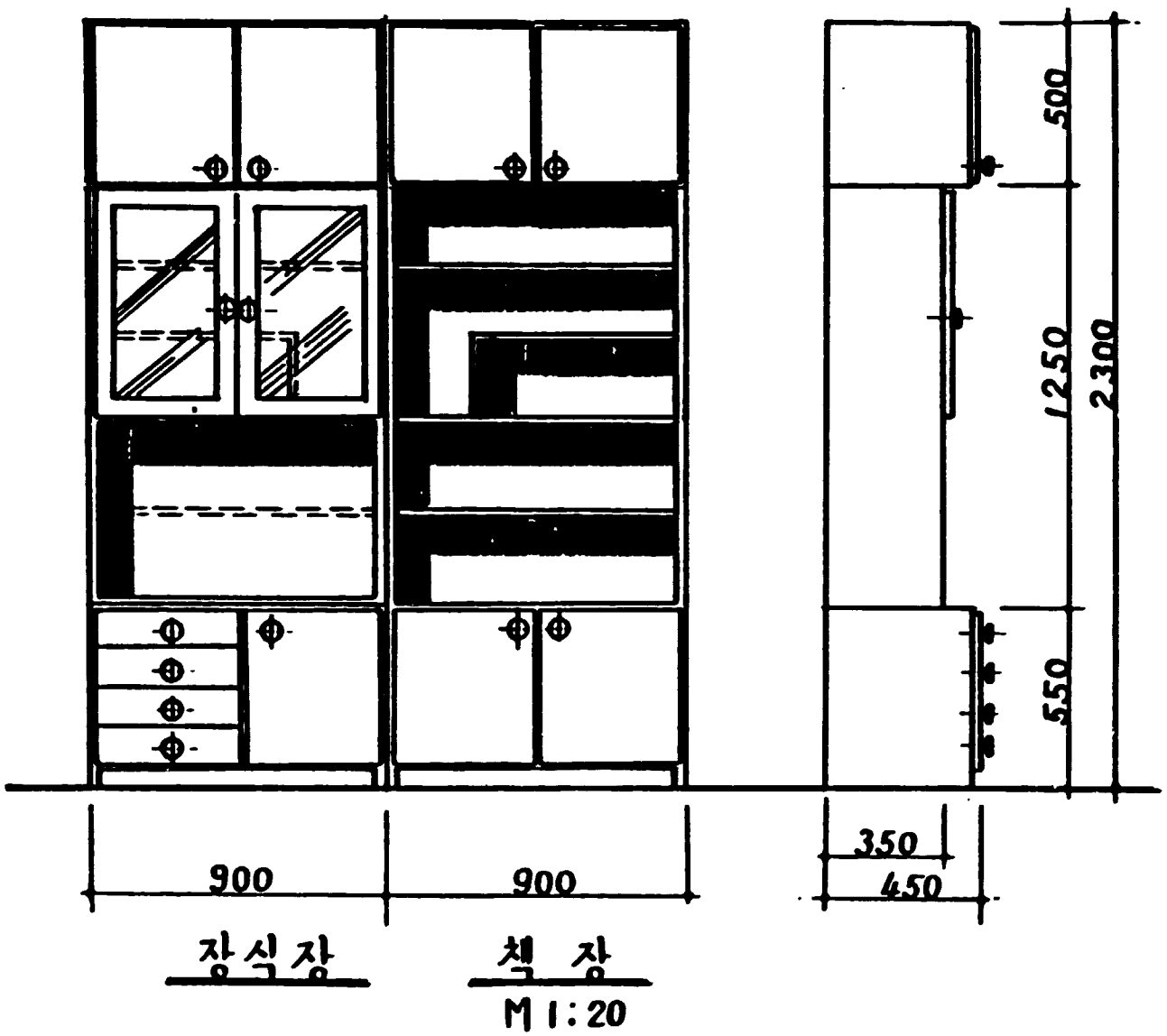


Fig. 4: Living room wall units.

10. CONCLUSIONS AND RECOMMENDATIONS

The assistance UNIDO is providing in the establishment of a pilot furniture plant in the Democratic People's Republic of Korea is of special importance to the future development of the furniture industry of the country. Introducing a new technology and industrial methods in this pilot plant will accelerate the production of furniture towards a more rational and efficient way of production.

These first steps in the development of a modern production will face many expected and unexpected difficulties. The main problem will be to supply the pilot furniture plant with adequate raw materials, auxiliary materials, components and tools. Workers' attitudes, who are accustomed to handicraft work of very low quality, will be difficult to change.

The critical point in providing the pilot furniture plant with equipment is that part of the equipment which is foreseen to be produced locally, since the quality of this end product is still unknown.

The time foreseen for the execution of the project is very short and it requires completion of all activities strictly in accordance with the work plan.

It will be very important that all experts foreseen in the project document be fielded in time, at the beginning of 1989.

The bidding for the purchase of equipment to be provided by UNIDO was finished during this mission and selected machines have been approved during the tripartite review meeting in Pyongyang, on 8 June 1988. At the same time, the conclusion was reached that the government should assure funds for the purchase of the electric and pneumatic hand tools specified in this report.

During the first CTA's mission, the majority of the training activities were organized abroad: a two week study tour and a 40 days group training. During the next CTA's mission, priority will be given to training activities organized in the pilot furniture plant.

Recommendations

1. In order to provide furniture factories with raw material of adequate quality, the Government should take into serious consideration the development of particle board production.
2. Domestic production of foils made of synthetic resins and lamination of particle boards with these foils would be ideal for the successful production of corpus furniture for the domestic market.
3. In order to shorten the preparatory period and start production on time, the counterpart should have at his disposal all staff and machine operators at the moment when installation of the equipment begins.

4. An expert for design should be engaged to assist the factory's designers in the introduction of a modular system and industrial design principles in the development of furniture products.

5. A tool maintenance expert should be fielded in time to train tool sharpeners and other concerned people in the selection, sharpening and management of tools.

6. In order to perform training activities in a satisfactory and useful way, the experts should have interpreters able to interpret simultaneously from English into Korean and vice versa, who are familiar with the technical vocabulary in both languages.

ANNEX I

PROPOSAL FOR A GROUP TRAINING PROGRAMME

Host country:	Romania (preferably)
Number of candidates:	Four
Duration of training:	40 days
Time:	Second half of June and July 1988.
Budget allotment:	US$ 30,400 (budget line 32)
Names and functions of participants:	1. Mr. Ryu Chun Gyu, Chief of the Technical Department in the Pyongyang Wood Complex 2. Mr. Chang Luk Won, Manager of the Furniture Factory 3. Mr. Li Yang Chun, Team leader (Foreman) in the machining department in the Furniture Factory 4. Mr. Li Gi Bong, Team Leader in the Assembling Department in the Furniture Factory.
Level of education:	All candidates have a technical education at three years college level or a university degree.
Purpose of training:	To operate the Pilot Furniture Plant at the higher level of productivity and quality of products. The knowledge gained during this training will help them organize production in a more efficient way.
Romanian companies proposed for group training and duration of training in each company (incl.weekends)	1. CEIL, Oradea, Wood exploitation and processing complex. Corpus furniture and style furniture 15 days 2. CLUJ, Napoca, Production of sanding paper 2 days 3. CIL, Constanta, Corpus furniture and decorative veneer 8 days 4. CIL Pipera, Bucuresti, Corpus furniture, kitchen furniture, TV boxes, plastic laminates, particle boards, etc. 10 days

- Trip to Romania and necessary contacts 3 days
- Return trip to the Democratic People's Republic of Korea 2 days
Total duration 40 days

The proposed training programme for each trainee is as follows:

1. Mr. Ryu Chun Gyu

He will lead and supervise the group and serve as an interpreter for all participants in this group training. His personal training aim is to study the organization and management system of the factories visited, and the facts important for designing wood processing technologies and other affiliated technical facilities.

In particular he needs to learn more about:

ORADEA
- Composition of processing lines,
- Electrical wiring, heating and dust extracting systems,
- Compositions and properties of finishing materials,
- Finishing equipment and finishing operations,
- Conditions of drying lacquers,
- Production and use of decorative elements made of synthetic resins.

NAPOCA
- Properties of abrasives, their appropriate selection and use in the wood processing industry,
- Grading methods and standards of abrasives and adhesives,
- Method of gluing sanding paper into endless belts,
- Technology for the production of sanding paper,

CONSTANTA
- Tropical wood used in the production of decorative veneer
- Veneer producing technology,
- Furniture finishing (as in Oradea)

BUCURESTI
- Furniture finishing (as in Oradea)

2. Mr. Chang Luk Won

ORADEA
- Production organization in the furniture factory,
- Method of accounting wages,
- Selection, sharpening and control of tools in the furniture production.
- Sawdoctoring methods for circular and bandsaw blades,

NAPOCA
- Same as for Mr. Ryu Chun Gyu.

CONSTANTA - Equipment for the sharpening of wood processing tools,
- Sharpening operations
- Control of tool parameters, precision of setting, sharpening, balancing and mounting of tools.

BUCURESTI - Same as in Constanta
- To learn special procedures and limitations concerning carbide tipped woodworking tools.

3. Mr. Li Yang Chun

ORADEA - Equipment and operations for sizing of particle boards and other panels.
- Equipment and operations for trimming and jointing veneer in the furniture production,
- Equipment and operations for veneering in the furniture production,
- Equipment and operations for machining furniture parts (trimming, profiling, tenoning, edging, drilling, moulding, routing, and sanding).

NAPOCA - Same as for Mr. Ryu Chun Gyu

CONSTANTA - Same as in Oradea

BUCURESTI - Same as in Oradea, paying more attention to the adjustment of the machines to given sizes and profiles and to the proper mounting of tools.
- Use of jigs in the machining of parts in the production of corpus furniture.

4. Mr. Li Gi Bong

ORADEA - Equipment and methods of assembling corpus furniture,
- Hand tools and jigs used in assembling corpus furniture,
- Hardware and fittings in the furniture production.

NAPOCA - Same as for Mr. Ryu Chun Gyu

CONSTANTA - Same as in Oradea,
- End quality control method,
- Packing and marking furniture.

BUCURESTI - Assembling of kitchen furniture,
- Materials used for assembling,
- Checking and packing knock-down furniture.

In addition to the training programme proposed above, the counterpart requests to enable all four members of the group to visit a particle board factory and a laminated board factory, both in Bucuresti. Requested duration 2 days in the particle board factory and two days in the production of laminates, out of a total 10 days planned for Bucuresti.

In the particle board factory they would like to see:

- production of chips (particles),
- drying of chips
- composition of a glue mixture and method of mixing with chips,
- mat-forming and pressing operations,
- cutting to format and sanding,
- deviations in thickness and tolerances,
- properties of boards produced and an average level of quality,
- equipment and methods for testing particle boards.

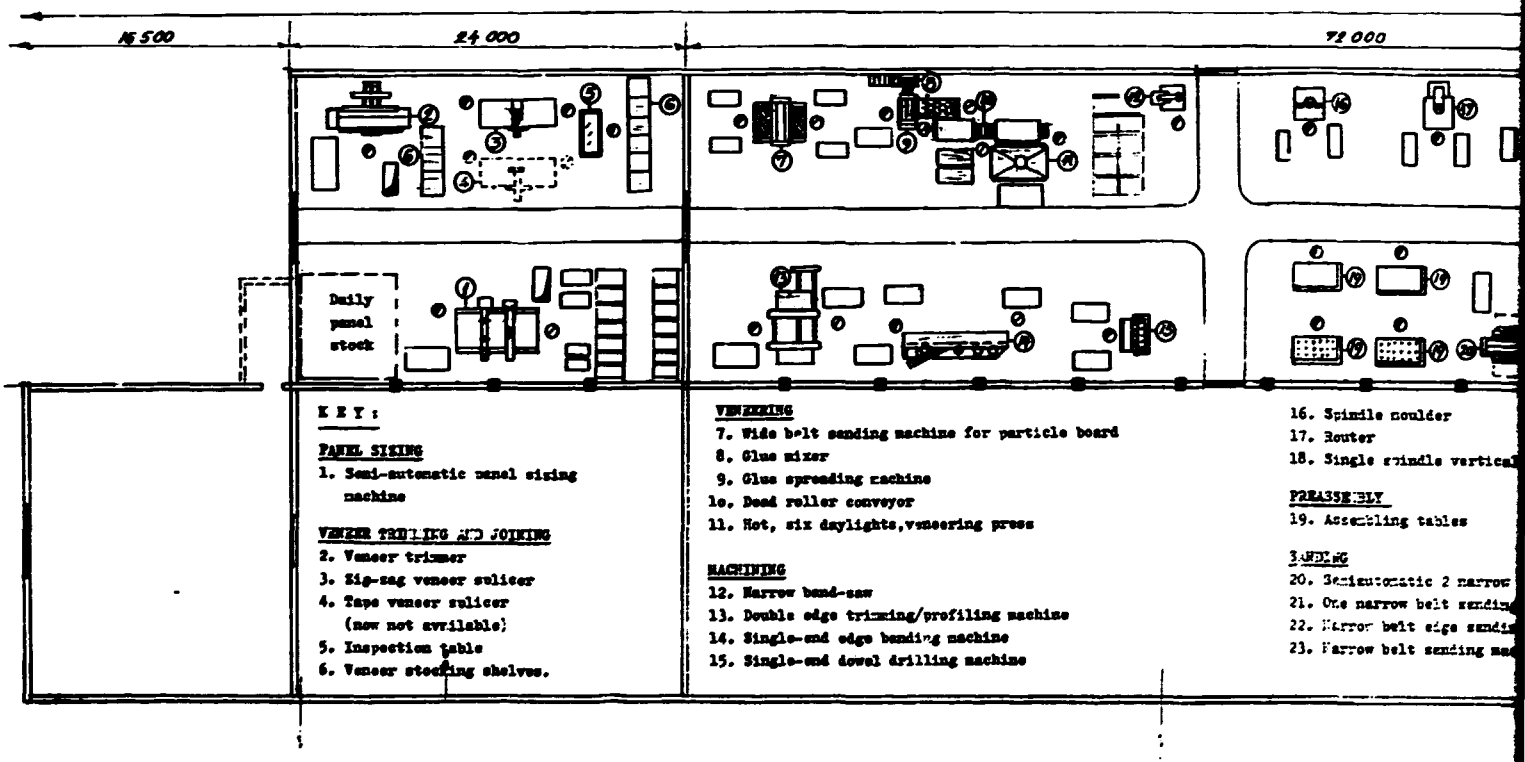
In the factory producing laminates and laminated boards, the participants of the group training would like to see:

- production of decorative paper,
- coating of paper with resins,
- equipment for the production of laminates,
- equipment and methods for pressing laminates on boards.

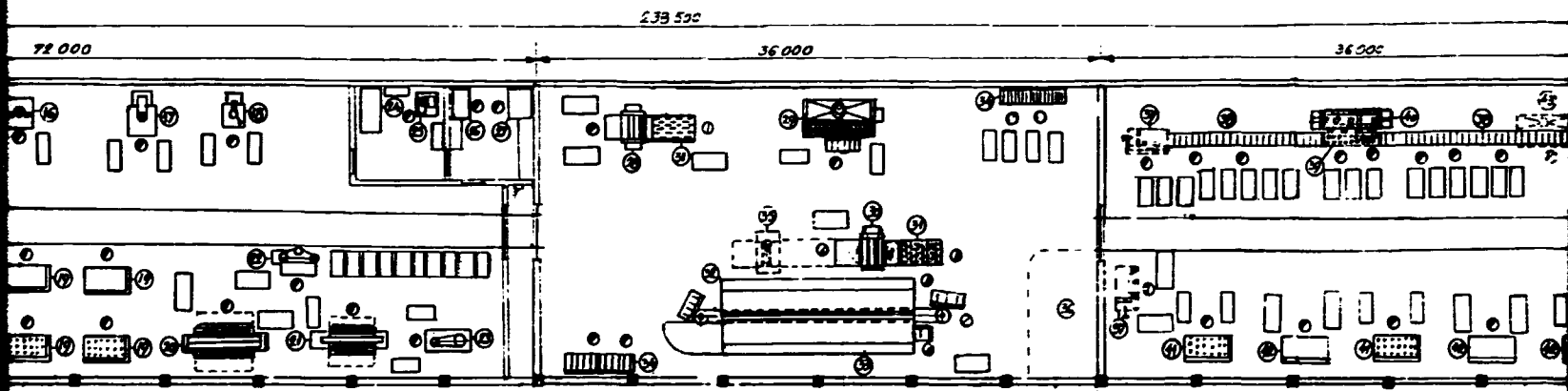
After finishing the group training, the participants are to prepared an appropriate report and submit it to UNIDO in Vienna.

Prepared by:
Mr. Ryu Chun Gyu, and
Mr. Radmilo Malis, CTA

ANNEX II
LAYOUT OF THE PILOT FURNITURE PLANT



SECTION 1



6. Spindle moulder
7. Router
8. Single spindle vertical drilling machine

ASSEMBLY
9. Assembling tables

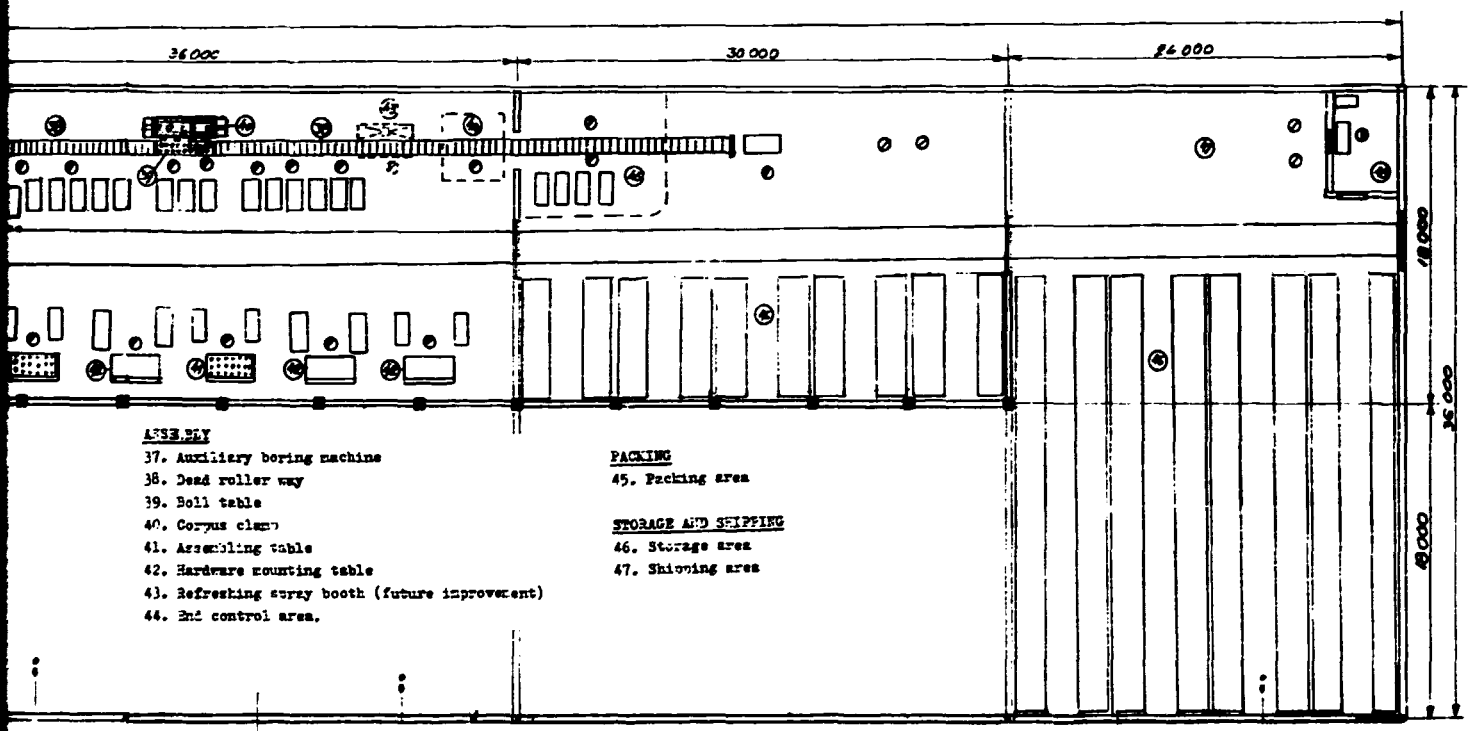
HANDLING
0. Semiautomatic 2 narrow belt sanding machine
1. One narrow belt sanding machine
2. Narrow belt edge sanding machine
3. Narrow belt sanding machine for concave edges

TOOL SHARPENING AND MAINTENANCE
24. Tool control table
25. Universal tool sharpening machine
26. Electrician on duty
27. Mechanic on duty

FINISHING
28. Roller and brush undercoating machine
29. Spray booth
30. Curtain coating machine
31. Wheel type conveyor
32. Lacquer evaporating tunnel
33. Lacquer drying tunnel
34. Lacquer sanding table
35. Lacquer sanding machine (future improvement)
36. Quality control of finish area

ASSEMBLY
37. Auxiliary boring machine
38. Dead roller way
39. Roll table
40. Corpus clamp
41. Assembling table
42. Hardware mounting table
43. Refreshing spray booth (fu
44. Exit control area.

SECTION .2



ASSEMBLY

37. Auxiliary boring machine
38. Dead roller way
39. Roll table
40. Corpus clamp
41. Assembling table
42. Hardware mounting table
43. Refreshing spray booth (future improvement)
44. End control area.

PACKING

45. Packing area

STORAGE AND SHIPPING

46. Storage area
47. Shipping area

PROJECT D/DIR/86/011 | APRIL 1986
ASSISTANCE IN THE ESTABLISHMENT OF A
PILOT FURNITURE PLANT
CASE FURNITURE FACTORY | SCALE
LAYOUT | 1:200

SECTION 3

ANNEX III

PRODUCT DEVELOPMENT OF FURNITURE

A production programme, in any manufacturing company, is the most important and fundamental aspect of a successful enterprise. In furniture production, product development has a special importance, and must be carried out as a permanent task.

Product development is a team work, divided in many steps, connected with feedback control loops.

Market research and analysis of marketing information are treated as prerequisites for appropriate decisions about kind, style, type and quality of products to be developed.

In order to develop a product line which will fit production possibilities, the factory's capacities as well as the existing product line must be analyzed. The findings of these analyses should be used for defining a new production programme.

The design of products is the most important and the most delicate part of product development. Here, some aspects of this very complex task, including a couple of basic rules will be explained and suggestions made.

Special attention must be paid to the implementation of standardization and the interchangeability of parts in the product line.

Prototype making, value analysis, construction and detailed drawings are part of a technical work in making a product ready for manufacturing.

Every manufacturing company has to examine its product strategy from time to time, and to strengthen its ability from the product development point of view. The general level of the product line, which we wish to achieve, is determined by certain requirements with a view of:

- originality of products,
- quality of products,
- low production expenses,
- high reliability,
- short production cycle,
- high flexibility,
- speed of delivery, etc.

Many factors ought to be analyzed in choosing the right strategy, but the most important are: the factory's own possibilities, capabilities, experience, the skill of its staff, resources available and its position in the market.

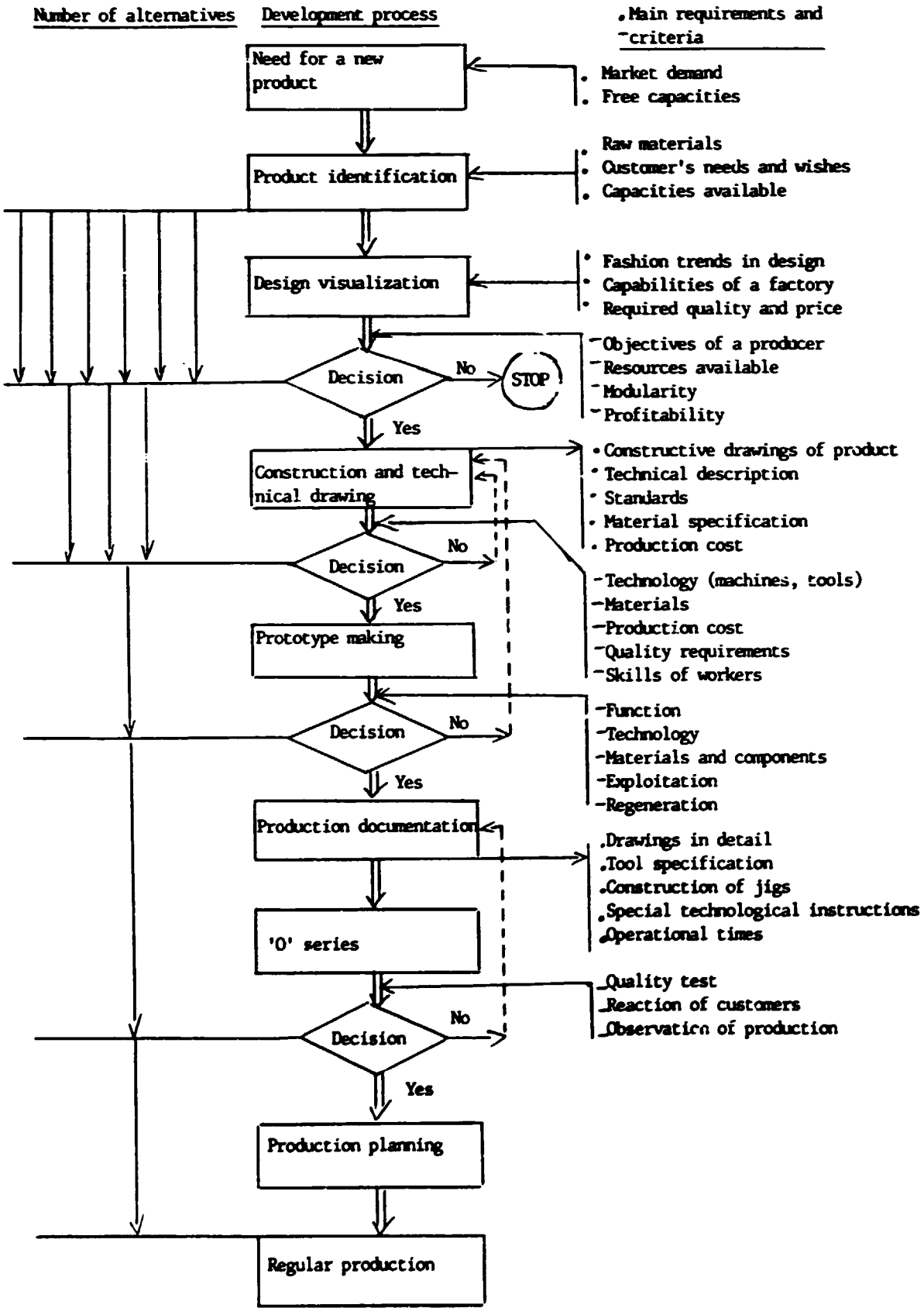
Some of the key strategic considerations concerning product development are: specialization, diversification, cooperation and balance between these. Cooperating with other similar factories and other manufacturers can achieve a higher degree of diversification, in spite of their own very specialized production.

It is not easy to get a new product developed to the stage when it is ready for sale. Product development passes through different steps and it takes months of systematic work. In order to get a few good products a company has to develop a great number of new ideas. Most of these new ideas are dropped during the initial screening test, showing incompatibility with the company's objectives and resources. The ratio between the number of successfully developed products and the number of ideas, generated at the beginning, is different, depending on the quality of the ideas and the skills and experience of people working on product development.

These steps of new product development are as logical as they are indispensable. In each stage of product development some questions should be asked: whether the product satisfies the criteria set or not. It is always cheaper to change, or even to drop an idea in the earlier than in the more advanced stages of development. At the same time, the effects of changes are much higher in an earlier than in a later stage.

Most production people do not think that way, so all their effort is concentrated towards the improvement of the manufacturing process and almost none to product development. To avoid that, all companies should establish some rules and procedures as a guide on the right and rational way. For the case of a medium size factory, like ours, we are proposing a product development model, which in the form of a block diagram, determines all the steps to be taken in the various stages of technical development of products.

SCHEME OF PRODUCT DEVELOPMENT PROCEDURES



The first step is the collection of ideas for a new product.

A designer should visualize these ideas in the form of sketches, and with the brief description and calculation of cost and propose them for evaluation.

The evaluation team must be composed of specialists working in: sales, product development, purchase, quality control and production units. The evaluation should determine whether the idea fits the objectives, resources and planned profitability. At this stage of the evaluation, facts are still scarce and the experience of the team members if of great value. Products rejected by this evaluation are no longer subject for consideration.

For accepted products, the next step is the preparation of technical documents for a prototype. These documents are: drawings, technical description, design of packing, standards, material specifications and calculation of production cost.

When the prototype is made it is subject to evaluation by the same team and, if possible, by more people dealing with marketing and quality control.

The evaluation of the prototype should assess whether the product satisfies criteria for: function, technology, materials, product exploitation, and possibility of regeneration. All these criteria must be determined in advance and cannot be matter of guessing and bargaining.

If the product does not satisfy the criteria determined, the documentation for the prototype must be changed and all procedures repeated once more. At the next evaluation, the product should be either accepted or rejected.

The next step for accepted products is the preparation of production documentation, as determined by work preparation procedures.

When production documentation is prepared, the first production should start as a 'ZERO' series. The 'ZERO' series is usually a minimal number of products needed to test both the documentation and the production process, and to screen all hidden defects or weak points which have to be corrected before regular production starts.

In order to satisfy users of the products and develop products with features corresponding with unfulfilled customers' needs it is necessary to collect information for product development and other business decisions. This information must answer the following questions:

- Where is the market?
- What does the market buy?
- When does the market buy?
- Who is involved in the buying?
- Why does the market buy?
- How does the market buy?

This information helps determine how people feel about furniture, their needs for specific items, what makes furniture most attractive to the customer, and what priority furniture has among other household goods.

Appearance is considered an additional attraction to furniture. The form given by the designer, and aesthetics in general, have top importance for the opinion of customers, and designers should know what the current prevailing considerations in making a decision prior to buying are.

In working on product development, production capacity cannot be ignored. Each factory has certain limitations which should be taken into account. The product line or single products must be adjusted to the capacity of the factory.

Analyzing the factory's capacities, the following factors should be taken into consideration:

- location of the factory,
- equipment,
- capacities,
- raw material,
- auxiliary materials,
- tools and technical supplies,
- skilled personnel,
- experience,
- qualit of products,
- organization,
- maintenance,
- energy,
- motivation, responsibility and attitude.

The above factors are analyzed hereunder for the Pilot Furniture Factory and an example from which can be learned is given.

(a) Location of the factory:

The factory is located in Pyongyang, the capital and the major consumption center of the country. From the domestic market point of view this factory has an ideal location. Transportation distances to the users are very small, therefore furniture can be assembled at the factory.

(b) Equipment:

The factory is equipped with machines for processing panels and for the production of simple case furniture, without possibility to process solid wood. The solid wood parts must be produced in cooperation with another factory. The possibilities of that factory must also be known.

(c) Capacities:

The average production of the factory is about 'x' different pieces of furniture per month. In the case that the factory can organize serial production of standardized and well designed and prepared products, the production can be increased by 25 percent. The estimated possible production assumes a good organization and a regular supply of materials and tools.

(d) Raw materials

Particle boards, veneer and plywood are basic raw materials. All three are available within the Pyongyang Wood Complex. In order to achieve a better utilization of materials the quality standards and sizes of boards must be taken into consideration. The quality of the furniture mostly depends on the quality of the raw materials.

(e) Auxiliary materials

Newly designed furniture should be produced with auxiliary materials manufactured in the country and usage of imported such materials must be reduced to the minimum. However, designers must be acquainted with all possibilities and initiate their introduction and production using different auxiliary materials in the country.

(f) Tools and technical supply

The factory relies partially on imported tools and other technical supplies (spare parts, instruments, etc.). This requires standardization of joints, profiles and other constructive elements, so that the number of different imported tools could be minimized.

(g) Skilled personnel:

Designers must know what kind of skills the workers in production have. This will determine the complexity of the products and quality criteria. It is always better to set lower criteria which can be achieved, than higher ones which could not be fulfilled. Transition to the more complex products should be achieved gradually.

(h) Quality of products

The present production is of a very low quality. To improve quality, design of new products must include strict quality standards, written and adhered to.

(i) Experience

Since the present production is based mostly on handwork, there is a lack of experience in production using industrial methods. To gain new positive experience designers of new products must try to adjust construction to the more productive industrial work.

(j) Organization

From the organizational point of view it is important that all details are drawn properly and that all production documents are completed. For all new products proper work preparation and paperwork must be assured.

(k) Maintenance

The quality of maintenance has a big influence on both quality and productivity. Tolerances for new products must be set in accordance with the real precision of the machines.

(l) Energy

Veneering and some other technological operations depend on proper heating. Also the working conditions as light, heating and ventilation are conditional upon various sources of energy. All this has a certain influence on the quality of products, and the designer must take it into account.

(m) Motivation, responsibility and attitude

If motivated, people can always accomplish more than we expect, and if not they will always accomplish less than we expect. This is true not only in the quantity but mainly in the quality of products. Closely related with the motivation is the responsibility towards success in general.

The product is always a compromise between desires of the customers and technical and other possibilities.

Going back to the existing product line it can stated that it consists of many different products, belonging to different groups and sorts of furniture. Some products are closely related and some not at all.

Collecting and selecting new ideas

Gathering ideas is the first activity in the technical development of a new product. Some ideas can be generated intuitively, but the best results are obtained when this task is organized systematically. As many new ideas as possible should be collected. As mentioned earlier, a company has to develop a great number of new product ideas in order to finish with a few well accepted products.

There are many sources which can be used for the generation of new ideas. The present and potential customers are the logical starting point in the search for new product ideas. Customers should be asked not to give new product ideas directly but to describe their problems with the current products and what household problems they have not solved yet.

The new technical and scientific development very often gives ideas which can be used in new product development. These could be new materials, new technological possibilities, new household equipment, hardware (fittings) etc.

Professional literature, periodicals, patent institutions, commercial publications, catalogues, consultants, marketing research firms and many others can be used as sources for generating new ideas.

The purpose of idea generation is to create a large number of ideas, but the selection of new ideas reduces the number of ideas. By screening the ideas collected those ideas which do not satisfy the criteria for acceptance should be dropped. New product ideas which are not compatible with the company's readiness to be successful with that product should not be taken into consideration. Two kinds of errors are possible: to drop out a good idea or to accept a bad one.

A company should create rules and standardized forms for describing and rating new ideas.

Design of products

Those ideas surviving the selection must undergo further development. The next development is assigned to a designer, and his task is to visualize the ideas selected.

As an orientation guide, the designer must have a written order which expresses a product policy. For instance: 'Design a knock-down dining table for six persons, in the low/medium price range, made out of local softwood and veneered particle boards, in good design and quality'.

The designer should get all pertinent information without having his hands bound.

The designer also has to know the present production situation and how it is going to be developed. He must know not only the possibilities of the equipment but also the bottlenecks.

The first step is making a number of sketches in the form of axonometric pictures, rather than orthogonal technical drawings. Details of particular interest can be shown in 1:1 scale and as an 'exploded' drawing when a construction is complicated.

It is important to make many proposals with possibly numerous variations of separate themes. It is not advisable to start detailed construction at this stage, because it restricts imagination and causes resistance to changes. These proposals should be discussed by a team covering the factory's best knowledge of the market, technology and economy.

Product development is a high level team work and the composition of the team has been described earlier. The proposals should be discussed in a positive manner, and even if a proposal is not accepted it may contain details that can be used in other products.

The main criteria for evaluation and acceptance of solutions, at this stage, are in connection with the company's objectives, resources and profitability. That means that the new product has to follow the company's strategy, that the company has available materials and equipment to produce it, and that the expected price could assure the necessary profitability. Products which cannot pass this criteria must be rejected, and those passing this selection as satisfactory are subject of further development.

To help both the designer and the team working on product development, more facts important for a successful design are considered hereunder.

Design as economic factor in the furniture industry.

Design has the strongest influence on the economies of furniture production. Design by itself is the product of aesthetics, techniques, communications and economics. On the other hand, it is the product of a production-oriented industry, which fits the desired functions and has an acceptable cost of production. Nowadays, the task is not to produce luxurious furniture for the high society, but simple social furniture for the majority of the population.

Design is demand for improvement of our life environment.

Design factors are closely connected with the factors determining production expenses. But it is hard to establish an appropriate connection, because the designer sees only aesthetic components and the producer only sees the cost of manufacturing. It is very important to build up a bridge of reciprocal understanding between the designer and the production people, that is between design factors and factors determining product cost. Finally customers expect a purposeful design at an acceptable price.

Design factors

The design factors are certain conditions, influences and requirements the product is subject to, determined by the use and production. There are two groups of design factors in connection with the use of products: objective and subjective factors.

The objective design factors are equally valorized by all customers. They are related to: purpose of product, function, reliability, durability, ergonomics, etc.

The subjective design factors correspond to individual desires of customers and they are related to: form, comfort, size, fitting to related products, material, assembling, nationality, correspondence to the style of the customer's ages, etc.

Production design factors are limited by law, standards, government regulations, patents, etc.

Norms and standards are mandatory and they determine sizes, quality, health protection and other important characteristics of products.

Company standards serve as means of rationalization.

Quality control is a very important factor in a production.

A number of different components is a design production factor which, if large, increases production costs.

Some rules and principles of design

Division of spare and areas

Every product has a primary mass composed of major and minor masses, or areas, and these are composed of subdivisions which may or may not be of equal size and importance. Dominant lines should lead the eyes in a vertical direction on a vertical primary mass, and horizontally on a horizontal primary mass.

When a mass is to be divided vertically into two parts, one part should be greater than the other but balanced. If the mass is divided into three areas the lowest area should be the greatest, with each succeeding area smaller in size.

When a mass is to be divided into two parts horizontally, the parts may be equal in size or one area greater than the other, but balanced.

A mass may be divided horizontally into three equal areas or by making the central area greater and placing it between two smaller areas equal in size. When more than three horizontal areas are necessary, they may be equal in size and importance or symmetric.

Curved lines and elements

The designer may use curved lines and elements to round corners, relieve their mechanical severity or produce quaint effects. A beautiful one direction curve has no straight line in its composition. The reverse curve is always most beautiful if the curve is sharper on one bend than the other, and has no straight line in its composition. Curves in turnings and mouldings should connect with fillets close to a right angle.

Proportion

The division of masses, the planning of curved lines and the determination of proper proportions are closely related problems and should be solved simultaneously. To secure good proportions the contrast between the length and width of a mass should not be too great. Appropriate proportions are 2 to 3, 3 to 5, 5 to 8 and so on. The starting point in working out proper proportions is a fixed, standardized element which the designer cannot change.

Ornaments

Furniture ornaments could be chosen among: abstract forms, naturalistic motifs and artificial objects. Outlines, borders, panels and moulded surfaces are well suited for ornaments. Ornaments must not destroy but emphasize the logical structure of a product and must be a harmonized part of a unified whole. The ornament of the borders should strengthen and support this outline. Ornaments should be placed on a major center of interest, taking care of symmetry.

Colors

Colors used in furniture production must be harmonious. It is essential for a successful scheme of furnishing. The greater the area to be colored, the less intense the colors should be. Harmony by analogy is secured by relating all the colors in a scheme to one major color.

Standardization and interchangeable parts

Standardization is a very important product development and design factor. Its purpose is to rationalize production and to simplify work organization. This factor is related to the standardization and minimization of different furniture parts and sizes to the most rational and reasonable number. It refers, also, to the standardization of materials, joints, tools, jigs, documents, and so on.

Company policy should determine how far it can go with standardization, not to reduce its assortment below acceptable level. That could be expressed by a standardization factor, showing the ratio between the number of different parts and the number of different products in the production programme.

x = number of different parts
y = number of different products
Sf= standardization factor

$$SF = \frac{x}{y}$$

Though a danger of excessive uniformity always exists, a professional approach can eliminate such fears by creating a modular system of products or extending a product line by using interchangeable parts.

A very important part of standardization, which does not have a significant influence on the assortment, is the standardization of joints. Next is the standardization of materials, and then standardization of general constructions. A factory must decide which type of construction it will use in its production. That will determine the technological process and the selection of tools, jigs, materials, etc. Also, basic sizes and quality of each kind of product should be standardized and they will predetermine sizes and quality of raw materials.

The sizes of furniture pieces, as well as angles and other ergonomic characteristics, must be based on the average size of the human body and its physiological requirements.

Standards are very helpful and useful for product development, work preparation, materials supply and manufacturing.

The designers and other people working on product development must be familiar with standardization and standards related to developing products.

Standardized furniture parts or assembly groups, once done, can be used any time, and for any product, without repeating constructive and preparatory work.

Prototype Production

Though visualization is the most important part of the designer's work, his concern is stretched far beyond making drawings: he is following product development through the market.

The next stage, in the development of an accepted product is making technical documents for a prototype. These basic technical documents are:

- technical drawings
- technical description
- design of packing
- specification of standards
- calculation of production cost.

In this stage, it is not necessary to work out drawings in detail, because further corrections are possible after the evaluation of the prototype.

The next step, founded on the basic technical documents, is making a prototype of a new product. The finished prototype is subject to a new team evaluation. This time, the main criteria are in connection with: function, technology, materials and end use of product.

The first time, an idea is analyzed and expressed in words. The second time, the designs are evaluated by viewing sketches (pictures), and the evaluation of the product as a physical object takes place, and many new arguments, pro and con, might arise. This is the last and most important decision, and accepted products - whether good or bad - go immediately into the production stage. If a prototype is not acceptable, the technical documents must be changed and then a new prototype should be made according to the new documentation.

There are other purposes for producing a prototype. Defects in construction are discovered, dimensions are checked, as well as the strength, the appearance and function. Therefore, the prototype must be made to look the same as the products expected in the regular production. The prototype and each separate part should be analyzed from every point of view.

Value analysis

The value analysis method was developed in order to assure the continuous development of products and to find out the most suitable materials and methods of production.

The best results are obtainede on new products, during their development, studying parallel designs, materials and production methods. So, the value analysis methods should be an integral part of product development procedures, carried out by the same team working on product development.

Value analysis is not only a method analysis but also a development technique. Value analysis is a systematic, function-oriented method, seeking to find out an optimal combination of function and cost.

In value analysis, value is defined as function divided by cost. In function analysis, the product is split into components and functions. The value of each component is estimated and compared with the cost. The cost can be reduced by retaining the same function or improving the function retaining the same cost. All other combinations are also possible.

Under different living conditions and materials supply, values have different meanings. If the best materials are not available, the next available is acceptable.

The basic things which should be analyzed are:
- completeness of construction
- production function,
- cost of materials used, and
- cost of processing.

The cost of material is often higher than necessary because of wrong specifications of materials and insufficient knowledge concerning quality prices, and construction possibilities. The same applies to the cost of processing. By using value analysis, the above mentioned aspects can be improved.

Since value analysis can only be done as a team work, the organization of a team is the first step.

Construction

The main aim of furniture construction is to enable rational establishment of a technological process and maximal utilization of materials.

Furniture construction is closely related to technological processing and therefore must be carried out by specialized technologists.

Furniture construction searches for adequate methods of joining parts of a product, their mutual positioning, taking care about strengths (both product and parts), function, economy, production possibilities and specific characteristics of wooden raw materials.

Several basic elements of furniture construction are distinguished:
- frame elements,
- flat elements,
- combination of frame and flat elements,
- case elements,
- upholstered elements, etc.

Very often furniture products have one prevailing type of construction, but other constructive elements are also used.

Regarding the way of assembling furniture elements into final product, the following can be distinguished:
- fixed constructions, mostly glued, and
- knock-down constructions, joined with fittings and other separable joints.

Even in knock-down constructions some parts are fixed permanently.

To ensure the adequate strength of the product, dimensions and directions of constructive elements must correspond to the maximum load during use.

The furniture constructor should respect some basic rules such as:

- Wooden products must be constructed in a way to enable unavoidable changes of dimensions caused by changes of moisture content, without affecting the form and strength of the product.

- Single details of a product must be constructed in a way to minimize dimensional changes.
- All details of a product should be designed and constructed in a way that all joints can be made on available machines.
- All details of a furniture product should be constructed based on nominal sizes of standard dimensions of the material used.
- Furniture products must be designed and constructed to have rational forms and sizes to correspond to the purpose of the product and to satisfy technical, sanitary, hygienic and aesthetic criteria.

There are several major group of joints:

- glued joints,
- carpentry joints,
- screwed joints,
- connecting with metal joints, and
- joints with staples and nails.

Dowel joints, mortise and tenon joints, tongue-and-groove and corner-lock joints are the most often used for fixed constructions, while screws and different types of fasteners are mostly used in joining knock-down furniture components.

It is strongly recommended to use joints which allow finishing separate parts and assembling them after finishing.

Also joints should be used which allow better utilization of raw materials and use of multi-purpose machines, without the need for manual work or hand-fitting during assembling operations.

Construction drawings ought to be made according to a given scale. The 1:10 scale is very practical, but for small details it could be 1:5 or for important details 1:1.

Construction drawings should show the product as a whole in all orthogonal projections, with measures, joints and other details. Single assembling groups as well as other constructive elements can be shown separately.

A construction drawing must contain the specification of all parts and construction elements, with their dimensions, type of material and number of pieces in the product. Additional descriptions are desirable to avoid any ambiguity.

For assembling purposes so-called exploded drawings are easier to understand. All construction drawings and other documents must be signed by the constructor and his supervisor.

Detailed drawings

For the purpose of manufacturing and preparation of tools, jigs and setting machines, all details should be drawn in three basic projections (in some cases two are enough) showing all profiles, joints and other dimensions and characteristics.

Standardized details, once drawn can be used at all times. Some important details as joints might be dimensioned with tolerances.

To conceal dimensional inaccuracies it is better to foresee overlaps, rabbets or bevellings on the joining ends of the parts. Description of drawing should indicate: name, code number, material and requirements regarding quality of processing treatment.

Working drawings have considerable influence on choice of machines, tools, jigs and method of processing. Personnel taking part in producing working drawings must be familiar with technology. It would be best if the same people are trained to prepare detailed drawings and jigs for all operations.

Detailed drawings must be signed by the draughtsman and constructor.

There are special schools for industrial design, and there are people possessing talent for creating new products. Selecting such people and training them in schools for designers is the best way to solve design problems in a factory.

ANNEX IV

LIST OF ACTIVITIES FOR COMPLETING THE PROJECT

No.	ACTIVITIES	WHO	WHEN PLANNED	WHEN ACCOMPLISHED
1.	PRODUCT LINE DEVELOPMENT			
1.01	Study the existing product line	CTA	03/88	03/88
1.02	Write a methodology for product development	CTA	04/88	04/88
1.03	Acquaint the management and designers with the methodology	CTA	04/88	04/88
1.04	Nominate the evaluating team for product development	CTA CTP	04/88	04/88
1.05	Define products to be developed with basic requirements	CTP	04/88	04/88
1.06	Make sketches for new products	Designers	05/88	05/88
1.07	Evaluate visual design	Team/CTA	05/88	05/88
1.08	Make technical drawings and descriptions (material, quality, cost)	Designers	06/88	06/88
1.09	Define standards for new products	Designers/ CTA	01/89	
1.10	Evaluate construction and possibility of production (equipment, materials)	Team/CTA	06/88	06/88
1.11	Make prototypes	CTP	12/88	
1.12	Evaluate prototypes	Team/CTA	01/89	
1.13	Make necessary corrections	CTP	02/89	
1.14	Make detailed drawings of parts	Designers	03/89	
1.15	Produce production documents	CTP	04/89	
1.16	Have products ready for the production	CTP	05/89	
2.	TECHNOLOGY AND EQUIPMENT			
2.01	Define location of the Pilot Furniture Plant (PFP)	CTP	03/88	03/88
2.02	Define the capacity of the PFP	CTP	03/88	03/88
2.03	Define raw materials	CTP	03/88	03/88
2.04	Define kind of products for the PFP	CTP	03/88	03/88
2.05	Work out design of technology	CTA/CTP	03/88	03/88
2.06	Complete requisitions for equipment to be bought by UNIDO	CTA	03/88	03/88
2.07	Make complete list of equipment for the PFP	CTA	04/88	04/88
2.08	Make drawing of the lay-out for the PFP	CTA/CTP	04/88	04/88
2.09	Description of technology	CTA	04/88	04/88
2.10	Ordering remaining equipment to be purchased by the Government	CTP	04/88	
2.11	Technical requirements for equipment to be made locally	CTA/CTP	05/88	06/88
2.12	Design of equipment to be made locally	CTP	08/88	
2.13	Production of equipment to be made locally	CTP	12/88	

2.14	Delivery of the purchased equipment	Suppliers	/88	
2.15	Inspection of equipment received	CTP	/88	
2.16	Installation of equipment	CTP		
2.17	Construction of work tables	CTA/CTP	01/89	
2.18	Production of work tables	CTP	03/89	
3.	TOOLS AND JIGS			
3.01	Selection of standard tools for woodworking machines	CTA/CTP	04/88	06/88
3.02	Requisition of standard tools	CTA	04/88	06/88
3.03	Specification of electric hand tools	CTP/CTA	06/88	05/88
3.04	Requisition of electric hand tools	CTA	08/88	
3.05	Delivery of electric hand tools	Supplier	12/88	
3.06	Definition of basic jigs	CTA/CTP	02/89	
3.07	Manual for tool maintenance	Exp.11-03	03/89	
3.08	Construction of jigs	CTP/CTA	03/89	
3.09	Training tool sharpeners	Exp.11-03	03/89	
3.10	Standardization of tools	Exp.11-03	04/89	
3.11	Specification of special tools for woooworking machines	Exp.11-03	04/89	
3.12	Ordering special tools	CTA/CTP	04/89	
3.13	Specification of tool control instruments	Exp.11-03	04/89	
3.14	Ordering tool control instruments	CTA/CTP	04/89	
3.15	Production of jigs	CTP	04/89	
3.16	Documents and procedures for tools and jigs management	Exp.11-03	04/89	
3.17	Acquaint the management and team leaders with the management of tools and jigs	Exp.11-03	04/89	
4.	RECONSTRUCTION OF THE BUILDING FOR THE PF-			
4.01	Make design for reconstruction of the building	CTP	05/88	06/88
4.02	Supply the necessary building materials	CTP	06/88	05/88
4.03	Finishing reconstruction work	CTP	09/88	
4.04	Foundations of machines	CTP	10/88	
4.05	Finishing factory floor	CTP	10/88	
4.06	Sanitary facilities	CTP	10/88	
4.07	Office rooms	CTP	10/88	
4.08	Smoking (resting) rooms	CTP	10/88	
4.09	Dust preventing space between the sanding and finishing area	CTP	10/88	
5.	INTERNAL TRANSPORT			
5.01	Define inter-operational transport details	CTA/CTP	05/88	05/88
5.02	Make design for rack trolleys for drying lacquer coating	CTA/CTP	06/88	
5.03	Make design for assembling conveyors	CTA/CTP	06/88	
5.04	Construct pallets	CTA/CTP	06/88	
5.05	Design of pneumatic dust extraction system	CTP/CTA	06/88	
5.06	Purchase of equipment and materials for the dust extraction system	CTP	09/88	

5.07 Purchase of hand lifting trucks (hand jacks) 5 pieces	CTP	09/88	
5.08 Make pipes and connecting elements for the dust extraction system	CTP	09/88	
5.09 Installation of the dust extraction system	CTP	11/88	
5.10 Production of the rack trolleys	CTP	11/88	
5.11 Production of the assembling conveyors	CTP	11/88	
5.12 Production of the pallets - 400 pieces	CTP	12/88	
5.13 Check-up of the dust extraction system	CTP	12/88	
6. INDUSTRIAL INSTALLATIONS			
6.01 Design of electrical wiring (a) for power driven equipment (b) for lighting	CTP	08/88	
6.02 Design of heating system (a) for technological needs (b) for heating the factory	CTP	08/88	
6.03 Design of compressed air system	CTP	08/88	
6.04 Design of water supply installations (a) drinking water (b) sanitary water (c) water for technological needs (d) fire extinguishing needs	CTP	08/88	
6.05 Design of drainage system	CTP	08/88	
6.06 Purchase of necessary materials, components and equipment for all industrial installations	CTP	10/88	
6.07 Installation of electrical system	CTP	11/88	
6.08 Installation of the heating system	CTP	11/88	
6.09 Installation of the water supply system	CTP	11/88	
6.10 Connection to the drainage	CTP	11/88	
6.11 Provision of fire extinguishing equipment	CTP	11/88	
6.12 Installation of lighting conductors	CTP	11/88	
6.13 Installation of the compressed air system	CTP	12/88	
6.14 Air refreshing installations in offices	CTP	01/89	
6.15 Telephone installations	CTP	01/89	
6.16 Check up carting of machines	CTP	01/89	
7. IMPROVEMENT OF THE QUALITY OF PRODUCTS			
7.01 Survey of the existing quality standards	CTA	04/88	04/88
7.02 Proposal to improve quality standards	CTA	04/88	04/88
7.03 Writing a manual for quality control procedures	CTA	04/88	05/88
7.04 Translation of the manual into Korean	Interpreter	05/88	05/88
7.05 Training quality controllers in quality control methods	CTA	05/88	06/89
7.06 Selection and ordering instruments for quality control	CTA/CTP	06/88	
7.07 Delivery of the quality control instruments	Supplier	12/88	

8. WORK PREPARATION			
8.01 Survey of the existing work preparation system	CTA	01/89	
8.02 Proposal of improved work preparation system	CTA	02/89	
8.03 Acceptance of the proposed system	CTP	02/89	
8.04 Design of work preparation documents	CTA/CTP	03/89	
8.05 Training work preparation staff	CTA	03/89	
8.06 Purchase of necessary equipment for the work preparation	CTA/CTP	04/89	
8.07 Introduction of standardization	CTA/CTP	04/89	
8.08 Introduction of inventory control	CTA/CTP	04/89	
8.09 Introduction of cost control	CTA/CTP	04/89	
8.10 Introduction of capacities utilization control	CTA/CTP	04/89	
8.11 Introduction of materials utilization control	CTA/CTP	04/89	
9. OTHER TRAINING ACTIVITIES			
9.01 Study tour programme	UNIDO	03/88	03/88
9.02 Selection of study tour participants	CTP	03/88	03/88
9.03 Selection of the country for the study tour	CTP	03/88	03/88
9.04 Completing study tour nomination forms	CTP/CTA	03/88	03/88
9.05 Programme for the group training abroad	CTA/CTP	04/88	04/88
9.06 Selection of the country for the group training	CTP	04/88	04/88
9.07 Selection of participants for the group training	CTP	04/88	04/88
9.08 Completing nomination forms for the group training	CTP/CTA	04/88	04/88
9.09 Conducting the study tour	Participants and CTA	06/88	
9.10 Conducting the group training	Participants	07/88	
9.11 Training manual for production operations	CTA	02/89	
9.12 Training 30 operators and assemblers	CTA	03/89	
9.13 Training two technicians on how to design jigs	CTA	03/89	
9.14 Training team leaders in safety and work protection	CTA	04/89	
10. IMPROVEMENT OF ORGANIZATION			
10.1 Survey of the existing production orgarization	CTA	01/89	
10.2 Design an improved system of the production organization	CTA	02/89	
10.3 Train the factory management in procedures of new organization	CTA	03/89	
10.4 Acquaint the management with the marketing of furniture	CTA	04/89	

11.	REPORTING		
11.1	Study tour report	CTA/participants	07/88
11.2	Group training report	CTP	08/88
11.3	Technical report - 1st CTA mission	CTA	06/88 06/88
11.4	Technical report - 2nd CTA mission	CTA	04/89
11.5	Tool maintenance technical report	Exp.11-03	04/89
11.6	CTA terminal report	CTA	04/89
11.7	Project's progress report and other eventual reports	CTA	on request

ANNEX V

STUDY TOUR REPORT

1. Basic data:

Project Number:	DP/DRK/86/011
Country:	The Democratic People's Republic of Korea
Project title:	Assistance in the establishment of a pilot furniture plant.
Output (5)	Two fellows trained abroad with better knowledge of production of furniture.
Names and titles of participants	1. Mr. Li Song Hak Chief of the Technical Department General Bureau for Building Materials in Pyongyang and National Director of the Project. 2. Mr. Ko Ju Chol Senior Officer in the Fifth Department Ministry of Foreign Trade in Charge of UNIDO projects
Country and companies visited	The German Democratic Republic furniture factories within the Furniture Combine (Moebel Kombinat) Berlin.
Duration	Two weeks
Period	From 13 to 26 June 1988
Funds allotted (bl 32)	US$ 14,000
Participants accompanied by	Mr. Radmillo Malis, Furniture production expert.
Report prepared by:	Radmilo Malis, CTA of the project.

II. Introduction

This study tour has been organized for the Democratic People's Republic of Korea as part of the IPF project DP/DRK/86/011 entitled 'Assistance in the establishment of a pilot furniture plant'. US$ 14,000 have been allocated under budget line 32 to cover a three week study tour for two participants. The government insisted to shorten this study tour to two weeks and its request was accepted.

The programme for the study tour was prepared by INTERCOOP, Berlin, Foreign Trade Company, responsible for international collaboration in the GDR. Two furniture factories within the Furniture Combine Berlin have been selected for the study tour. All the required information about production in these factories, as well as necessary technical assistance, have been given by the personnel working in the Furniture Combine, Berlin.

III. Itinerary

Departure from Pyongyang	9 June 1988, 9:00 hours
Arrival in Berlin	9 June 1988, 15:00 hours
Study tour in the GDR	13 to 26 June 1988.
Visiting the central office of the Furniture Combine Berlin and consideration of the study tour programme	13 June 1988.
Departure from Berlin	14 June 1988, 6:30 hours
Arrival in Meyenburg	14 June 1988, 9:00 hours
Visiting Furniture Factory in Meyenburg	14 to 16 June 1988.
Departure from Meyenburg	17 June 1988, 8:00 hours
Arrival in Berlin	17 June 1988, 10:30 hours
Weekend in Berlin	18 and 19 June 1988
Departure from Berlin	20 June 1988, 11:00 hours
Arrival in Trebbin	20 June 1988, 12:00 hours
Visiting Furniture Factory in Trebbin	20 to 23 June 1988
Departure from Trebbin	24 June 1988, 10:00 hours
Arrival in Berlin	24 June 1988, 11:00 hours
Visiting the Central Office of the Furniture Combine, Berlin, final conclusions and drawing official protocol	24 June 1988
Writing the study tour report	25 and 26 June 1988
Departure of R. Malis from Berlin for Vienna	27 June 1988, 09:55 hours
Departure of study tour participants from Berlin	30 June 1988
Arrival in Pyongyang	1 July 1988

Note:

Since the study tour participants insisted to travel by the direct flight Pyongyang/Berlin and Berlin/Pyongyang, scheduled once a week by the Korean Airline, the departure from Pyongyang had to be brought forward and departure from Berlin had to be postponed.

IV. Factories visited:

The study tour has been organized in two furniture factories, considered to be among the best in the German Democratic Republic. Both these factories are part of the Furniture Combine (Moebel Kombinat) Berlin.

The first visited factory was VEB Meyenburger Moebelwerk located in Meyenburg. It produces corpus furniture for household, made of veneered and laminated particle boards.

The second factory visited was VEB Maerkische Moebelwerk Trebbin, located in Trebbin. It produces office furniture made of laminated boards with metal and plastic components.

V. Review of observations

The purpose of this report is to point out those facts that could be useful for the improvement of the furniture producing industry in the Democratic People's Republic of Korea, and for the successful completion of the Pilot Furniture Plant in Pyongyang.

1. VEB Meyenburger Moebelwerk, Meyenburg

This factory is specialized in the production of corpus furniture for household. The product line is composed of various wall units, bookcases, chests of drawers, wardrobes and similar products designed mainly by the foreign buyers. The furniture is made of veneered particle boards (about 40 percent) and of laminated particle boards (remaining 60 percent). Almost all production (99.6 percent) is exported to the Western European market (Federal Republic of Germany, Sweden, Switzerland, France, Austria), and to the Middle East. The Swedish company IKEA is a major customer and this factory is producing strictly in accordance with IKEA design and quality standards.

Design is rather simple and well adapted to the machines installed. Very good quality of raw materials, high accuracy of machining and good workmanship contribute to the high quality of products. The productivity in this factory, measured by the value of production per employee, is about 70 percent above an average productivity in the Furniture Combine Berlin.

The factory has three production departments:

(a) Cutting boards, trimming and splicing veneer, veneering, edge trimming with tenoning/mortising and edge banding.
(b) Drilling, machining by moulders and routers and sanding.
(c) Finishing assembling and packing.

The first department is located in a separate building, about one kilometer from the main factory location.

The number of employees in all three departments is 450, of which 328 workers work in direct production, while the other employees are in administration, maintenance and other auxiliary services.

The factory was developed from a private workshop founded in 1948. In 1953 the factory became a cooperative and is since 1972 a nationally owned enterprise. Since 1968 the factory exports its products to the western market.

The development of the factory was gradual, adding new buildings and equipment. The buildings are rather unsuitable with long transportation ways. The equipment is in very good condition. Some machines have been installed in 1970, but since 1984 the majority of the equipment has been replaced by modern production lines.

The factory mostly accepts customer's designs, and preparatory work as well as production documentation is minimal. Quality control is performed mainly by operators, but also by special controllers. All defective parts are returned for repair to the workplaces where the defects were caused.

The factory has a separate prototype making shop, used also for training apprentices. Product development, which is actually making prototypes according to customer's drawings, is very fast and takes only one to two weeks.

The exporting company and the Government authorities are concerned with pricing of products. The manufacturer is paid in accordance with the production cost. Due to the fact that this factory is producing exclusively for export to the hard currency market it is well stimulated and supplied with materials and up to date equipment.

The production technology of each department is described hereunder:

Department No. 1

Sizing particle boards is done by an automatic panel sizing machine (G. Stefani, Italy) with computerized programming and control. 50 to 60 m3 of boards are cut in one shift, which is sufficient for the present capacity of the factory.

For veneer trimming and splicing a new complete line (Rueckle, Stuttgart, FRG) has recently been bought and installed.

The line is composed of the following machines:

- veneer cross-cutting machine
- veneer trimming machine with computerized calculation of surface and total quantity of each size,
- edge gluing machine spreading thermoplastic glue on both edges of veneer,

- crosswise veneer splicing machine with shears for cutting leaves to the needed width,
- lengthwise veneer splicing machine joining already glued edges.

Veneer inspection tables with glass top and lights are installed next to each veneer splicer.

This veneer producing line is still new and at an experimental stage of exploitation, but it produces satisfactory quality and has a very high productivity.

Besides this new line, an old veneer trimming machine and several tape veneer splicers are still in use.

The thickness of veneer is usually 0.7 mm. Oak, but also pine and some other species of wood are used.

Veneering is done on two single daylight presses. One is a Wemhoener (FRG) and the other is made in Poland (Sopmasz).

Urea formaldehyde glue is used for veneering. It is prepared using one big mixer for both presses and pumped to the glue spreading machines. Small mixers are installed next to the glue spreading machines to add hardener. Glue is prepared adding water, filler and hardener. Flour (7 percent) is used as a filler in the case of veneering, and mineral filler (20 percent) in the case of laminating. The viscosity of the working glue mixture is 55 sec. (ford cup 4 mm). Pressing is done at a temperature of 120oC for 45 seconds for veneering and 38 seconds for laminating.

One press is used for veneering and the other for laminating.

Two identical (Stefani) panel processing lines, each composed of two double end tenoners and two double edge banding machines, are used to get the final size of the furniture parts. Such parts are transported on pallets to the department No. 2, located in the main factory.

Department No. 2

Department No. 2 is equipped with drilling machines, moulders, routers and sanding machines. All these machines, except two automatic belt sanding machines (Heesemann) are made in the GDR. The 'Jonsdorf' drilling machines, produced in the GDR, are very good.

Sanding paper is also produced in the GDR, and sanding belts are glued in this factory. A textile tape is glued over the specially prepared joint. and this joint is pressed for about 30 minutes.

A different grit of sanding paper is used for different kinds of sanding.

Kind of sanding	Grit of sanding paper	
	GDR standards	DIN
Veneer sanding	EK 20 - EK 8	80 - 150
Foil sanding	EK 6 - EK 5	220 - 280
Lacquer sanding	F 40 - F 8	320 - 400

After sanding and a thorough control, furniture parts are delivered to the department No. 3 for finishing, assembling and packing.

Department No. 3

Finishing is done on two finishing lines. One of these lines (Buerkle, FRG) is fully automatic and operators are substituted by mechanical manipulators for loading, stacking on drying shelves and unloading of furniture parts.

Laminated surfaces are painted with colored lacquers, mostly white and black, but also other colors. Mainly nitro-cellulose based lacquers are used. The finish coating is a transparent lacquer, and in some cases SH lacquer is used for final coating. Veneered parts are coated, always with transparent lacquers.

A part of the furniture produced is assembled and packed, while the majority is delivered as knock-down furniture, to be assembled by the end users.

Packing is very well designed and it gives a good protection and appearance to the furniture. All cartons are labeled with nice labels showing a picture of the product and the main information important for the identification of the carton's content.

Assembling instructions which are packed with the product, are very illustrative. Due to the fact that the same type of furniture is exported to different countries all instructions are given in the form of pictures instead of words.

This factory is rather big and equipped with modern and expensive machines. The level of production is rather high, especially with regard to quality and productivity. Raw materials and other components used are of the best quality. The work force is skilled and experienced.

It is not realistic to expect a similar production in the DPR of Korea in the next couple of years. But many details of production such as: construction of furniture, standardization, single machine operations, tool sharpening, construction and use of jigs, quality control, production documentation etc. can be used in any industrial plant for the production of furniture. After visiting this factory all dilemmas of the participants about advantages of industrial methods of furniture production were eliminated. The advantage of a specialized furniture production has been proven, and the study tour participants were convinced that successful furniture production depends on many factors and not only on equipment.

Planning and management procedures were discussed, and some solutions could be easily applied in the DPR of Korea. Direct production expenses are under careful control in the factory, while fixed expenses are out of their consideration. They are probably comprised in the overhead determined by the government authorities.

In the case of lower costs or higher productivity the factory receives an additional incentive (bonus) which is a good motivator for the workers.

The factory staff was very helpful, giving us all the required information and assistance during the days spent in their factory.

2. VEB Maerknische Bueromoebel Fabrik (Office furniture factory)

Seven economically independent factories belong to this enterprise as subbranches, but from the production point of view they are coordinated as one company. This enterprise is also a part of the Furniture Combine Berlin.

Apart from office furniture, which is the main product line, an additional programme of small case furniture and joinery is produced in some of the factories belonging to this company.

70 percent of the production is exported, mainly (about 90 percent) to Western Europe. Furniture is assembled for the domestic market and for the Federal Republic of Germany, while the furniture to be exported to all other countries is shipped knock-down.

The factory has the quality label from the FRG because of the very high quality of its products. In order to keep good quality the factory uses hardware only after it has been approved by a specialized and authorized institute.

The factory in Trebbin is sizing particle boards for all its subbranches. It cuts about 130 m3 of particle boards daily. The factory works in two shifts, except the assembling department, which works in only one shift.

All production is based on laminated particle boards as raw material, metal frames and plastic drawers are standard components bought from specialized factories.

For lamination, three different types of foil are used:
- melamine resin foil,
- polyester foil,
- urea resin foil.

50 percent of the boards are laminated in this factory and 50 percent is bought already laminated.

The factories belonging to this enterprise produce about 500 different items.

All development, material supply, sale, and preparatory work is centralized and carried out by the central factory in Trebbin.

The factory has its own research and development department. The task of products development is carried out by this department.

Marketing information is obtained from the exporting company and also people from this factory are visiting furniture exhibitions in Europe.

They permanently work on innovations of the present products, either at the request of customers or based on their own experience. These requirements are studied taking into account standards of importing countries, which must be respected.

The order for a new product development contains: scope of the programme, materials, required design, economical aspects and intended market.

The price of a product is calculated based on the production time necessary to produce DM 1000 worth of furniture.

The complete procedure of the product development passes through 12 different steps. In the case of urgency a simplified procedure is followed.

Besides two designers employed in the factory, designers out of the company are engaged as well. Also other specialists from various departments are taking part in the evaluation of a product at various stages of development.

As a rule they make two prototypes. Many aspects of construction, raw material utilization, technology, tools, jigs, gauges, and strength are analyzed on the first prototype, and, if necessary, changed. The second, improved prototype is a subject of commercial consideration and some customers are also invited to approve the product. The second prototype is usually sent to be exhibited at furniture fairs.

At the time of product development, the packing must be designed. Sometimes even the size of a piece of furniture is corrected in order to get a functional packing.

The preparation of production for the accepted product is as follows:

- detailed drawings,
- material lists,
- operational procedures,
- calculation of salaries,
- specification of tools,
- construction of jigs,
- assembly instructions, etc.

It takes about nine months to develop one product. In the case when special hardware is designed it takes about one year, because special tools are required.

Production technology

The production starts sizing particle boards. Half of the boards are already laminated and the other half is to be laminated in this factory. A fully automatic sizing line is used. It is an Anthon panel sizing machine produced in the Federal Republic of Germany.

The optimal cutting schemes are prepared using a computer. Entering sizes and quantities of furniture parts and sizes of panels to be cut, and using specially designed software the computer is set to calculate an optimal cutting scheme. This scheme is shown on display and printed, showing also a percentage of utilization of boards. That percentage can be changed by changing the specification. The final solution is memorized on a tape which is actually the programme for the panel sizing machine.

Trimming and edge banding of furniture parts is done on two Stefani lines, each composed of two double end tenoners and two double edge bancing machines. Drilling/dowelling is done on Jonsdorf drilling machines.

The next operation is a combination of the quality control, cleaning and softening of edges. It is done using various hand tools and sanding pads. After this operation, the parts are ready for preassembling and packing, or, if required, for assembling and packing.

Counting and packing hardware is done using a special machine, brand NAGEMA, made in Dresden, GDR. Actually, this machine is designed to pack candies, but it is very well adapted for packing hardware (screws, dowels handles, pulls, hinges and various jointing elements and fittings). This machine is used to pack hardware for all subbranches of this factory.

Cardboard for packing is bought already prepared for stapling, and cartons are made in this factory using a simple stapling machine.

Special attention is given to the assembly instructions and other information to the customer. This information is packed with KD furniture, and also attached to the labels stuck on the cartons.

Tool maintenance is organized in a separate department, well equipped with various tool sharpening machines and controlling devices. They consider quality of tool preparation as one of the main prerequisites for the quality of manufacturing and products.

Machine maintenance is controlled and repairs made in accordance with the maintenance plan.

Apart from the maintenance department there is a separate department for small automation and innovation of technology. This department has its own construction bureau. They produce small equipment, devices for automation, special tools and controlling gauges. It is impressive to see how successful this factory is in producing original devices for innovation of technology.

Furniture factory in Lukenwalde

This factory is a subbranch of the Maerknische Office furniture factory, Trebbin. Originally it was producing office furniture, but at present starts producing small items of case furniture for households (shelves, chests, chests of drawers, etc.). This furniture is made of laminated particle boards. In order to get higher quality and prices one single side softforming machine is added to the very simple technology. All other technological procedures are similar to those described.

This factory was of a special interest for the study tour participants, because of the very simple technology used and of the rather inexpensive equipment which could be acceptable and affordable for the DPR of Korea at its present stage of development.

Thanks to the very helpful collaboration and friendly reception in the factories visited during this study tour, the participants have learned many useful facts and procedures about a modern industrial production of furniture. It was very important and useful for them to see successful cooperation between various factories. Quality of raw materials, components and workmanship are in accordance with exporting standards, and the study tour participants have learned how the good quality control system operates and how machine operators also perform quality control.

VI. Conclusions

The two week study tour was organized by the INTERCOOP, Foreign Trade Organization, Berlin. The two factories chosen to be visited belong to the best furniture producers in the GDR. The level of technology in these factories is very high and too far from a technology acceptable for the DPR of Korea.

Staying about one week in each factory gave a chance to the participants to study the complete structure and production system of these factories, and to discuss many details they were interested in.

The reception in both factories visited and from the Central Office of the Furniture Combine, Berlin was very warm and friendly, showing readiness to answer all questions and showing all details in the production.

Unlike the very helpful assistance and hospitality found in the factories visited, the part of the organization carried out by INTERCOOP was rather bad. They failed to make room reservations and accommodation was the main problem during most of the time spent in the GDR.

Travel in the country was organized by train, and the study tour participants had to pay their train tickets.

Interpretation was very good and the interpreter was very helpful in solving the problems of accommodation.