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ASSISTANCE IN THE ESTABLISHMENT OF A PILOT FURNITURE PLANT

DP/DRK/86/011

THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

Technical report: Training manual on sanding*

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

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* This document has not been edited

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PREFACE

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

This manual deals with sanding operations.

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

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

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

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

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

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

1. Introduction

Sanding is a very important operation of the secondary wood processing industry. The quality of finishing with paints or transparent lacquers depends to a large extent on the quality of sanding. If sanding is not satisfactory, the consumption of lacquer is greater and the quality of finish is greatly lowered.

Sanding is a special and separate operation of furniture production. The equipment and tools used are not similar to any of those used for other machining operations.

The objective of this technical report is to acquaint the machinists and other wood processing technicians with the basic elements and techniques of sanding, and to prepare them for the correct performance of this operation.

2. The importance of sanding in furniture production

Smooth surfaces are achieved on furniture parts through sanding. The wood surface is not smooth enough after planing, moulding, routing, carving, etc. Two types of roughness can be distinguished on the surface of wood:

- the roughness caused by machining, and
- the roughness originating in the wood structure.

Roughness resulting from machining can be smoothed, while structural roughness cannot be corrected since it is part of the nature of the wood.

In essence, sanding is a form of cutting. The cutting tool consists of a particle of mineral or some synthetic material which has sharp edges. Sanding is the last machining operation before surface finishing. The quality of surface finishing depends considerably on the quality of sanding. The effect resulting from sanding depends on the direction of sanding and on the direction of the grain. Three kinds of sanding can be distinguished: longitudinal, perpendicular and crosscut sanding.

The purpose of sanding can be: to attain the final dimensions, to obtain the required flatness of the surface, to prepare the surface for coating with paints or lacquers, and to coat the surfaces with pigmented paints or transparent lacquers.

Sanding in order to attain the final dimensions is done by taking off thin layers of material with coarse sanding paper (grit lower than 100). All three dimensions, i.e. thickness, width and length can be reduced operating either on one or both opposite sides.

The panels to be veneered must be flat and of equal thickness. The surface to be veneered should be sanded with a lower grit sanding paper.

The surface to be coated with paints, to cover the structure of wood, must be sanded with papers with a grit between 100 and 150. Visible sanding scrapes are allowed.

When the sanding surfaces are to be coated with transparent lacquers, they must be very smooth to reduce the consumption of lacquers and to give a high quality of finish.

Sanding is done in two to three phases, each phase using a sanding paper with a higher grit number. Sanding veneered panels is riskier than sanding solid wood since the risk of sanding through the thin veneer is greater. The veneer should not become so thin as to be transparent.

To obtain a satisfactorily smooth surface, and in order not to sand through the veneer, the workers must be skilled, the machine must be precise and well set, and the correct grit of sanding paper should be selected. In this case, grit numbers 50 to 70 should be avoided, and higher numbers used.

Coarse surfaces with glue, paper or dirt should first be sanded with lower grit sanding paper. Decorative veneer produced by slicing, is usually smooth and can be sanded with a fine sanding paper with a grit from 150 to 180. Each furniture factory should prescribe the grit numbers of the sanding paper for each type of sanding.

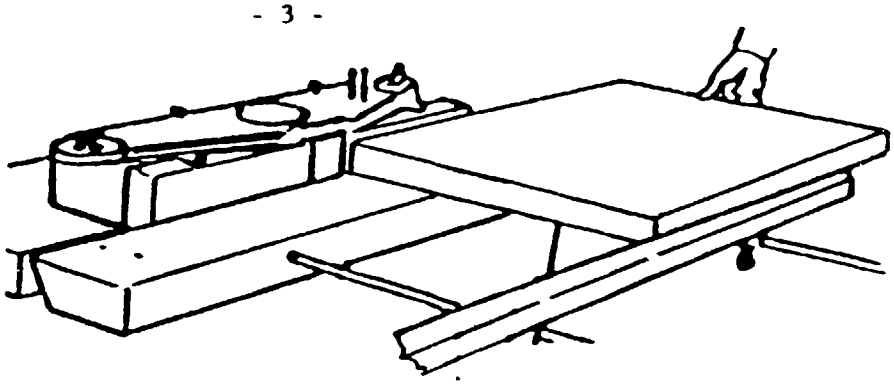
3. Classification of sanding machines

Depending on the form of the material to be sanded, the machines used could be classified as follows:

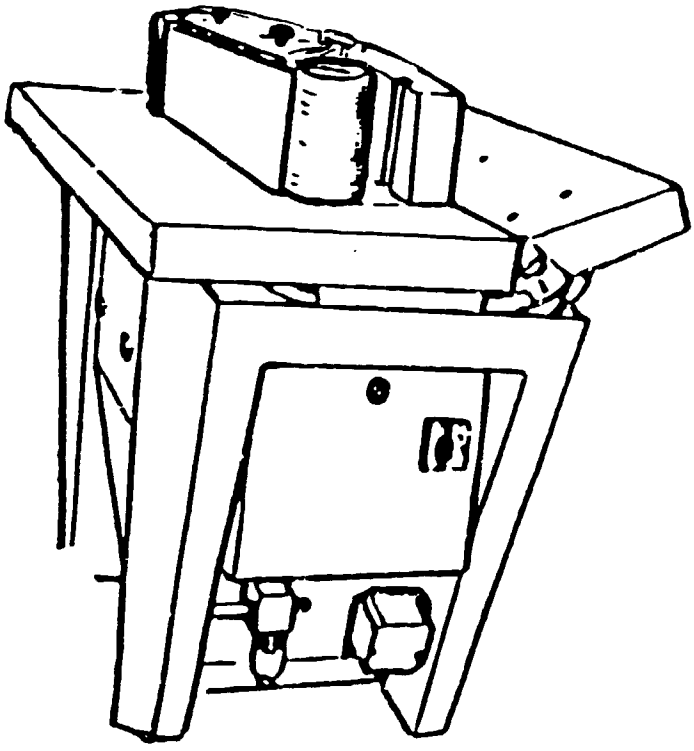
- narrow belt sanding machines, horizontal or vertical,
- wide belt sanding machines, for upper or lower sanding,
- single drum sanding machines,
- disc sanding machines,
- brush sanding machines
- cylindrical sanding machines, and
- special purpose sanding machines.

Narrow belt sanding machines are used for sanding panels and other flat elements. These machines are constructed either with the work-table sliding perpendicularly to the belt's direction of movement or with a fixed work table. The first is used for sanding large work-pieces, while the latter is mostly used for sanding small pieces. The narrow belt sanding machine with sliding table works in such a way that the workpiece moves together with the sliding table below the sanding belt. The contact between the sanding belt and the workpiece is achieved by means of a pad which is pressed to the workpiece and moved along the belt by the operator.

The narrow belt sanding machine with a fixed table usually has a vertical belt. When they have a vertical axles, these are used for sanding the edges of panels, and when the axles are horizontal, they are used for sanding cylindrical turned workpieces. The first is usually a universal machine and can be used for sanding straight, concave and curved edges, and the latter could be combined with a drum or with a sanding disc on the same axle (see figs. 1 and 2).



(a) Utilization of an extension table



(b) General view

Fig. 1: Universal narrow belt sanding machine (vertical)

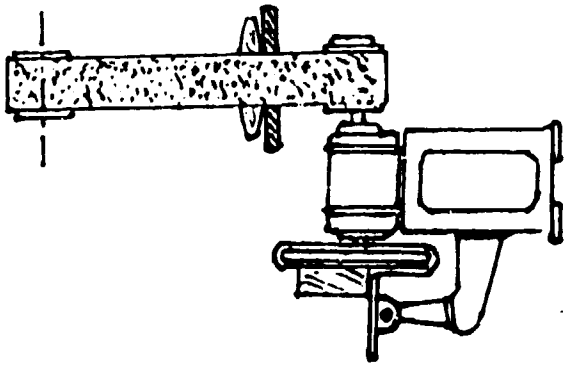


Fig. 2: Combined vertical narrow belt and disc sanding machine

The wide belt sanding machine is used either for calibrating the thickness of a workpiece or as a precise contact sander for sanding veneered surfaces before surface finishing. When used as a precise contact sander, it is also used for sanding the first coating of lacquers (the prime coat). The machine is constructed either for upper or lower sanding. If both systems are installed in a line, both sides of the panels can be sanded at the same time.

Single drum sanding machines are used for sanding the concave sides of curved forms. The surface of a drum, rotating on a console axle, is wrapped with sanding paper, and the feeding of the workpiece is done manually.

Brush sanding machines are mainly used for sanding profiled and carved workpieces. One end of the strips of sanding paper are fixed to the drum, together with brush elements which press the sanding paper strips to the surface to be sanded.

Cylindrical sanding machines are pushed into the background by the wide belt sanding machines, and are rarely used in modern furniture factories. They usually have three cylinders wrapped with sanding paper. The sanding cylinders can be placed for either sanding the upper side or the lower side of a workpiece.

Special purpose sanding machines are foreseen for sanding complicated forms such as profiles produced by turning, carving or shaping.

The sanding machines predominantly used in furniture factories will be described in greater detail further in the text.

4. Classification of sanding papers and belts

Sanding tools are particles of abrasive material, glued on to a strong paper or textile backing. Abrasive particles are made of glass or minerals. The glass is very fragile and sanding papers with glass abrasives are rarely used for sanding wood. Aluminum oxide is the most common abrasive. However, silicon carbide is better suited for sanding hardwoods. Flint is the main abrasive material used for sanding belts. Its grain is sharp and hardens after a thermal treatment. Garnet grain is somewhat harder than flint.

Aluminum oxide (Al_2O_3), also known as corundum, is made artificially by melting bauxite in electric furnaces under high pressure. Corundum grain has very good mechanical characteristics and is considered the best. It is better if it contains a higher percentage of aluminum oxide (Al_2O_3). Ordinary corundum contains 96-98 per cent of Al_2O_3, whereas refined corundum contains 98-99.5 per cent of aluminum oxide. The latter one is used for sanding very hard materials.

Silicon carbide (SiC) is a very hard, artificially made, abrasive material, with a hardness close to that of diamond, but its grain is rather fragile and it is thus not used for sanding very often.

Abrasive made of glass is used mainly for manual and only rarely for mechanical sanding (see Table 1).

Table 1: Sanding materials

Sanding material	Origin	Color	Breaking form	Toughness	Hardness (moss)	Usage
Class	Synthetic	Light green to white	Sharp and pointed	Fragile	4-6	Manual sanding of wood and paint
Flint	Natural	Gray	Pointed	Breakable	5-6	Manual and mechanical sanding
Garnet	Natural	Reddish-yellow to brown	Sharp and shell-like	Rather breakable	7	Mechanical sanding of all kinds of wood
Electro-carbo-rundum	Synthetic	Light gray to brown	Granular shell-like, sharp	Breakable	8-9	Mechanical sanding of hardwood and veneer
Silicon carbide	Synthetic	Green to black	Sharp edges and pointed	Fragile	9	For special cases of sanding hardwoods

Apart from the hardness, it is important that the abrasive grain has sharp edges and that it be tough. In practice, the hardness of an abrasive material must be between 4 and 9 on the Moss scale. Abrasive particles are obtained by grinding one of materials mentioned in Table 1 above. The grains vary in size and must be graded using sieves. Abrasive particles glued on a paper backing must be of approximately equal sizes. In order to distinguish the large number of various sizes of sanding grain, the grit numbers, which are based on the average size of the particles (i.e. the size of openings of the sieve), is given. According to the German DIN standard the grit numbers are as shown in Table 2 hereunder.

Table 2: Grit numbers of sanding papers

Grit number	Size of grain	Grade of smoothness of sanded surface
16	1.200	Up to 6
20	850	
24	700	
30	600	
36	500	Up to 7
46	355	
54	350	Up to 8
60	300	
70	210	
80	180	
90	150	Up to 9
100	125	
120	105	
150	85	
180	75	Up to 10
220	63	
240	53	
280	48	
320	42	
428	20	

Based on the grit numbers, the coarseness of the abrasive grain can be classified, as shown in Table 3 hereunder.

Table 3: Coarseness of the abrasive grain

Coarseness of abrasive grain	Grit number
Extra rough	14 - 17
Very rough	18 - 22
Rough	24 - 40
Medium	50 - 80
Fine	90 - 120
Very fine	150 - 220
Extra fine	240 - 400

The coarseness should be selected as follows:

For the first sanding, grit number 50 to 70,
For the second sanding, grit number 80 to 100
For the third sanding, grit number 120 to 150

The sanding belts consist of a backing, the bonding glue and the abrasive grain.

For the backing of the grain, strong paper or textile made of cotton or nettles are used. This backing must be both strong and elastic. The papers used for backing of sanding belts must meet the following requirements:

- weight: 200-240 g/m^2
- tensile strength: minimum 20 kgs/mm^2
- stretching: very little
- resistance to puncture: high
- endurance to bending: high
- difficult to peel
- glue bond: very good
- hygroscopicity: very small
- inner surface: smooth
- friction: little

The elasticity of sanding paper is usually marked by the following capital letters: A, B, C, D, E, and F, but some producers have their own system of marking.

Glutin, urea formaldehyde and some other synthetic glues are used for bonding. They must be elastic and resistant to a temperature of up to 60°C. The glues on sanding papers which are to be used under wet sanding conditions must be resistant to moisture. Normally 1/3 of the grain's height must be sunk in the glue layer, while the remaining 2/3 are free. The abrasive grain's density is either sparse or dense. Sanding belts with a thick grain layer are used for fine sanding of hardwoods, while those with thin grain layers are used for sanding softwoods and species containing resins.

Sanding papers used for manual sanding are different from those used for mechanical sanding.

There exist different sanding papers for sanding softwoods, hardwoods and paints and lacquers.

Depending on the sanding method used, there exist different types of paper for dry sanding, for wet sanding, and for sanding metal surfaces.

The life duration and efficiency of sanding paper depends on the quality of the backing, the quality of its bonding, the quality of the abrasive grain, the sanding pressure (pressure of the sanding belt on the surface of the material to be sanded), the speed of sanding, the nature of the sanded material, the quality of preparation of the sanding belts.

The durability of sanding belts is related to the effects of sanding, the type of sanding machine, the hardness of the abrasive grain and to the toughness of the bonding glue. The durability can be expressed either by the total area (m^2) or by the volume (cm^3) of sanded material removed.

The specific pressure (in g/cm^2) varies in a reciprocal relation to the durability of sanding paper.

The speed of sanding is very important. A better smoothness of surface is achieved at higher speed of sanding. By increasing the sanding speed, the sanding efficiency is also increased. The speed of sanding is nonetheless limited by the nature of the sanding paper and by technological reasons.

The highest permissible sanding speed for solid wood is 55 m/sec, whereas the lowest speed is 5 to 10 m/sec. Most belt sanding machines operate at a speed ranging from 15 to 30 m/sec which can be increased to a maximum of 40 m/sec. The sanding speed for lacquers is usually lower and ranges from 5 to 10 m/sec.

5. Selection of proper grits of sanding papers, depending on the type of sanding.

A summary of sanding papers for wood sanding is given in Table 4 hereunder which can be used as an orientation for the selection of the correct grit.

The selection of the appropriate grit for the first sanding depends on the thickness of the veneer, its smoothness, its species, the way it was produced (peeled or sliced), and the type of finish (high gloss, matt, painted, etc.).

The most common sanding defect is: sanding through the veneer. It is caused by careless work, uneven thickness, swung workpieces, or by the inaccurate setting of the sanding machine.

Table 4: Summary for wood sanding papers.

Type of sanding	Description of sanding	Grit number
Coarse (rough) sanding	- sanding to the final dimensions - sanding to get flat surfaces - equalizing of glues boards - sanding of veneer	16-50
First sanding	- sanding of planed surfaces - cleaning thicker veneers - pre-sanding of thick veneers - sanding of paint	60-100
Second sanding	- final sanding of solid wood - final sanding of veneers with large pores - intermediate sanding (after wetting)	100-150
Third (fine) sanding	- final sanding of veneer with small pores	180-220

6. Preparation of sanding belts

The sanding belts can be prepared by a producer (ie cut to size and glued), or sold as rolls of tape of a certain width and length. The working elements of the belt sanding machines are endless belts. Very often, the belts are cut to required length in the factory and then joined into endless belts. The width and length of the belt depends on the sanding machine's technical characteristics.

After cutting to length and width, the ends of the tape are connected. This is done in various ways. The slices are always at an angle, usually 45°, and with an overlap of 100 to 200 mm. Well connected sanding belts should have a tension strength of about 2 MPa (mega Pascals). This connection on the sanding belt can be either with or without a backing pad. The best backing pad is made of strong thin textile. The joint can be either straight or wavy. The glue used for joining sanding belts must be elastic and resistant to higher temperatures.

The procedure for splicing a sanding belt is as follows:

- measuring the length of the sanding belts,
- cutting off the ends of the tape at 45°,
- placing the ends against each other and checking the straightness of the belt,
- cutting off a backing pad made of textile,
- spreading hot glue over the backing pad and the belt's joint,
- placing the belt in a joining clamp and checking its alignment,
- tightening the clamp with pressers,
- and, finally waiting 10 to 15 minutes before use.

Special devices for cutting and clamping which ease the preparation of the sanding belts exist. This is then more precise and faster.

The thickness of the joint should be close to the thickness of the sanding paper, it should be elastic and strong.

7. Wide belt sanding machine

Wide belt sanding machines are used for operations such as planing and smoothing solid wood and veneered flat elements and for sanding lacquer coated surfaces. Operating the machine is quite simple in spite of its great versatility. The push-buttons on the control panel are clearly marked by symbols showing all possible operations.

The workpiece is fed by a special rubber conveyor, moving in the same direction as the sanding belt. The width of the feeding conveyor and the sanding belt are significant technical characteristics. These range from 600 to 1800 mm.

The conveyor's feeding speed can be changed. The wide belt sanding machine used for furniture production can be constructed with one or two sanding belts for sanding either the upper side or the underside. The advantage of two sanding belts is that it is possible to use a lower grit belt for calibrating the thickness and a higher grit for the final sanding in one pass.

Each sanding belt has two sanding rollers, the first being rigid and used for calibrating and the second being flexible and used for contact sanding. In some machines, the second roller can be electronically controlled. The machine can be equipped with an electronically controlled sanding pad placed between two rollers (see Fig. 3).

The sanding belt oscillates 10 to 15 mm on either sides, at a rate of about 100 cycles per minute. This oscillation is produced by the tensioning device and by pneumatic or electronic relays.

A suction hood is designed for each sanding belt. Most wide belt sanding machines are equipped with a rotating brush which is foreseen for cleaning the sanded surfaces. A more detailed description and operating instructions are given in the producer's manual.

The main technical characteristics of wide belt sanding machines are as follows:

- working width: 600 to 1800 mm
- Feed rate: 4 to 30 m/min
- Sanding speed: 22 to 26 m/sec.
- Power of motor for driving the sanding belt: 9 to 22 kW
- Belt system: pneumatically controlled.

8. Narrow belt sanding machine

Horizontal narrow belt sanding machines are the most commonly used sanding machines in furniture production. The moving direction of the workpiece is ortogonal to the moving direction of the sanding belt. The workpiece rests on a sliding work-table. The operator moves the pressure pad along the work-table with his right hand and the sliding table with his left hand.

Sanding is usually done with the lower part of the sanding belt. The friction between the sanding belt and the pressure pad is reduced with a graphite lining on the pad. Equal tensioning of the belt during sanding time is assured by means of a lever and a weight.

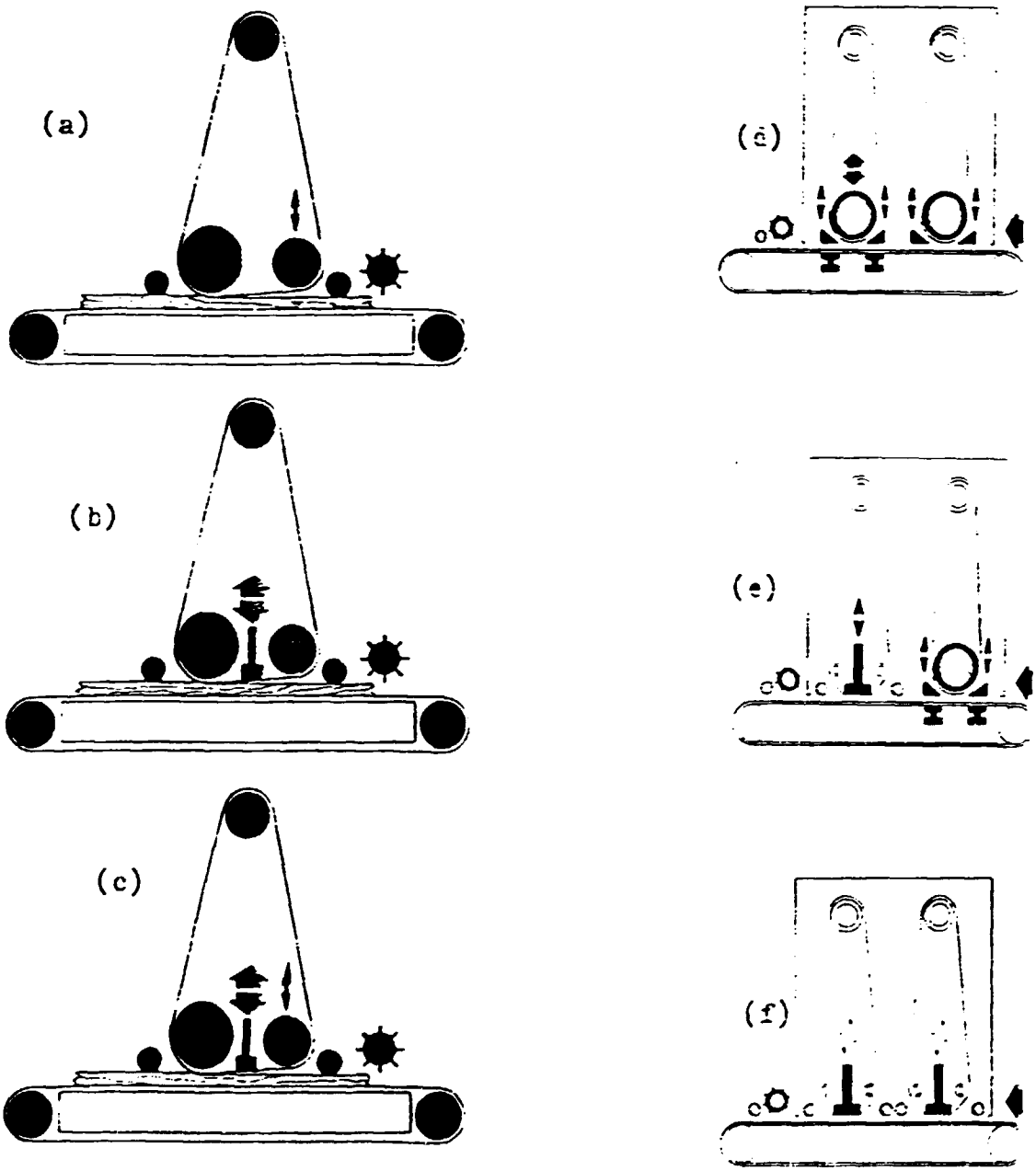


Fig. 3: Principles of the wide belt sanding machine
(a) with calibrating and contact sanding rollers,
(b) and (c) with two rollers and contact pad,
(d), (e) and (f) with two belts: 2 rollers, a roller and a pad and with two sanding pads.

The height of the sliding table can be adjusted manually by turning the hand wheel, or by a separate motor. The right height of the sliding table is when the sanding belt, turning free, is 5 mm above the workpiece to be sanded. The pressure pad counter weight is mounted on the opposite side for ease of handling. Narrow belt sanding machines are very often equipped with a dust exhaust fan. The main technical characteristics of horizontal narrow belt sanding machines are:

- Width of belt: 100 to 150 mm
- Working width: 2200 to 2500 mm
- Speed of belt (sanding speed): 20 to 25 m/sec.
- Power for driving the sanding belt: 3 to 4 kW.

Vertical narrow belt sanding machines are universal sanders with a sanding belt placed on two vertical axles.

Working tables are placed at the long sides of the machine. One side is equipped with a pressure pad foreseen for sanding curved edges of panels. This pressure pad can be profiled to enable sanding of profiles edges. The opposite side, with a straight support of the sanding belt is used for sanding straight edges and other square parts. Both work-tables can be tilted and fixed at a certain angle, ranging from 0 to 45°.

In order to use the sanding belt's entire width, it is possible to lift or to lower it and its support.

Tensioning the sanding belt is done by exerting pressure on one of the pulleys with a pneumatic piston. The opposite pulley can be used for sanding concave edges and curved surfaces. The belt oscillates up and down. The oscillating amplitude is regulated and controlled by two pneumatic nozzles, positioned to limit the amplitude.

The motor running the sanding belt has two speeds: the first is 1400 rpm with a sanding speed of 9 m/sec and the second 2800 rpm with a sanding speed of 18 m/sec.

The machine can be started by turning a three-position switch (see Fig. 4).

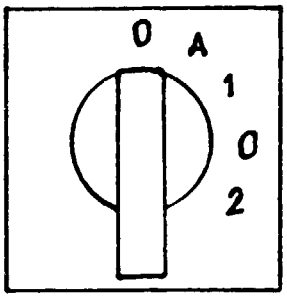


Fig. 4: Three position switch

The first position (a) serves for activating the solenoid valve which controls the belt. Position (1) corresponds to the first and position (2) to the second sanding speed.

9. Brush sanding machine

Brush sanding machines are used for sanding carved, profiled and other complicated forms. Brush elements and narrow sanding tapes are fixed alternately on the lateral surface of a drum. The abrasive tapes are supported by the brush elements. The upper half of the drum is free and is used for sanding, whereas the lower portion is covered with a dust suction hood.

10. Drum sanding machine

This machine is similar to the brush sanding machine, but the circumference of the drum is wrapped with sanding paper, thus making a sanding cylinder. It is used for sanding bent parts of furniture. In order to get soft sanding, the surface of a drum is covered with felt or rubber.

11. Disc sanding machines

It can have one or two discs fixed on a horizontal axle. The sanding paper is glued on the front surface of the disc. The work-table is adjustable and can be tilted to enable sanding at the desired angle. This machine is predominantly used for sanding solid wood parts, especially cross-cut surfaces.

12. Operating instructions for a wide belt sanding machine

The belt selected should have the correct grit should be selected. The sanding belt should be placed on the rollers from the side of the machine and tensioned. The thickness of the workpiece should be adjusted by lifting or lowering the working table. The sanding belt can then be started. The feeding speed can then be selected and the conveyor started. The workpiece is now placed on the feeding conveyor and the result of sanding is then checked. If necessary, the thickness of sanding or the speed of feeding can be corrected. To sand the opposite face, the pallet which is filled with parts sanded on one face is returned to the feeding side of the machine. The whole width of the sanding belt should be used through a staggered loading of the workpieces on the feeding conveyor.

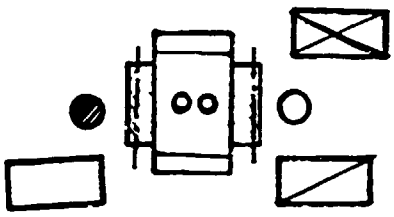
13. Operating instructions for a narrow belt sanding machine

A belt of proper grit should be selected and placed on the machine. The belt's tension should be adjusted. The height of the table is then to be adjusted. The belt can now be started. The dust exhaust fan should also be started. A workpiece should be placed on the sliding work-table against the fence, so that the wood grain is oriented in the direction of the sanding belt. The sanding pad is pressed slightly to obtain a pressure between the sanding belt and the surface of the workpiece. The pad is moved from on end to the other of the workpiece, maintaining an equal pressure. With the left hand the sliding table is moved for the next width of sanding pad. This can be continued till the workpiece is completely sanded. The quality of sanding is then checked and the pressure and speed of movement of the pressure pad is adjusted as required. The opposite side can either be sanded with the same sanding belt or with a different grit belt. Care should be taken when sanding the ends of veneered panels not to sand through the veneer. It is sometimes advisable to use hand pads for sanding the ends of veneered panels.

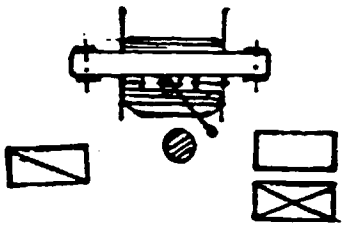
14. Organization of the work area

An operator and an assistant should operate the wide belt sanding machine. The pallet with parts to be sanded should be brought to the right hand side of the operator, close to the feeding conveyor. Two pallets should be placed at the unloading side, one for finished parts and the other for parts which should be returned for repeated sanding (see Fig. 5).

(a) wide belt sanding machine



(b) narrow belt sanding machine



(c) Disc and brush sanding machine

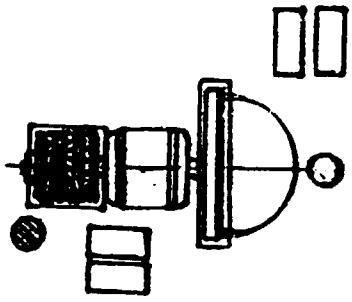


Fig. 5 Organization of the work area.
(◍ is the operator, ◯ is his assistant, ▭ the parts for sanding, ▱ the parts for additional sanding and ⊠ the finished parts.)

Narrow belt sanding machines, brush -, drum - and disc sanding machines are operated by one operator only. The pallets with the parts to be sanded and the one with the finished parts should be placed next to each other in front of the machine, close to the operator.

15. Control of the quality of the sanded surfaces

Visual control of the sanded surfaces is satisfactory for practical needs. The surface should be sanded equally without scratches or unsanded spots. Sanding through the veneer is not allowed. The forms of the profiled parts must remain. The smoothness of the surface should be according to the requirements and depends on further processing and the parts' intended end uses.

16. Safety measures

Wood sanding machines are not dangerous, but sanding dust is harmful to the health. Therefore, the main safety measures are directed towards protection of the work area from sanding dust.

- The extraction system for the sanding dust must assure clean air in the work area.
- The slices on the sanding belts should correspond to the direction of the belt's movement.
- When setting the sanding belt, the protective contractor should be switched off.
- The sanding belt should be protected by a cover, with the exception of the working portion.
- Damaged or badly spliced sanding belts must not be used.
- The required speed of sanding must be maintained.
- If the machine does not sound normal, it should be stopped and the fact must be reported to the supervisor or the maintenance department.

Wood dust is highly inflammable and even explosive at high concentration, so great care should be taken when handling it.

ANNEX I

TRAINING PROGRAMME FOR FURNITURE MANUFACTURING

1. Introduction

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

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

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

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

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

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

The planned activities of the quoted outputs are:

For output No. 6:
6.1 Prepare a training programme for furniture manufacturing.
6.2 Prepare a training manual for each of the major production operations.
6.3 Train 20 machine operators, 10 assemblers and four team leaders to manufacture furniture of acceptable quality.

For output No. 8:
8.1 Train two wood technicians to design, produce and maintain jigs and other furniture production fixtures.

For output No. 10:
10.3 Train factory management in modern industrial production methods.
10.4 Acquaint the managerial staff with the basic elements of export marketing.

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

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

2. Training programme for the Pilot Furniture Plant

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

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

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

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

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

3. Methodology of training

There is an old Chinese wisdom which says "What I hear I will forget, what I see I will remember, and what I have done I will know." The output of this training should be knowledge learned by workers who will increase their ability for effective production. To achieve this, the training method will rest on three steps as follows:

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

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

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

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

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

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

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

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

4. Selection of trainees

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

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

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

5. Training programme

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

Detailed syllabi for each topic are given in Annex II.

ANNEX II

Topic 9: Sanding

ITEM	TOPICS	TRAINING TIME (in hours)		LEVEL OF COMPETENCE TO BE REACHED
		Theoretical	Practical	
9.1	Introduction	0.25	-	Understanding the purpose of the course.
9.2	Importance of sanding in furniture production	0.5	-	Understanding the role of sanding and its influence on the quality of surfece finishing.
9.3	Classification of sanding machines	0.5	-	Elementary knowledge of the types of sanding machines and their basic characteristics.
9.4	Classification of sanding papers and belts	0.5	-	Knowledge of the used materials and properties of sanding papers. and the respective end uses of each type.
9.5	Selection of correct grits of sanding papers according to the type of sanding to be performed	0.25	-	Understanding grit numbers and knowing how to select the correct grit of sanding paper.
9.6	Preparation of sanding belts	-	1	Ability to prepare a sanding belt and to glue it correctly.
9.7	Wide belt sanding machines	0.5	-	Knowledge of the construction and working principles of a wide belt sanding machine
9.8	Narrow belt sanding machines	0.25	-	Knowledge of the construction and working principles of a narrow belt sanding machine.
9.9	Brush sanding machines	0.25	-	Knowledge of the construction and use of brush sanding machine.
9.10	Drum sanding machines	0.25	-	Knowledge of the construction and use of drum sanding machine
9.11	Disc sanding machines	0.5	-	Knowledge of the construction and use of a disc sanding machine.
9.12	Operating instructions for a wide belt sanding machines	-	1	Ability to operate a wide belt sanding machine
9.13	Operating instructions for a narrow belt sanding machine	-	1	Ability to operate a narrow belt sanding machine
9.14	Organization of the work area	-	0.25	Ability to organize the work area rationally.

ITEM	TOPICS	TRAINING TIME (in hours)		LEVEL OF COMPETENCE TO BE REACHED
9.15	Quality control of sanded surfaces	-	1	Ability to control the quality of sanded surfaces, in accordance with the quality standards set.
9.16	Safety measures.	0.5	0.5	Knowledge of the sanding dust and its hazards to health and of the safety measures to protect the health and risks of explosions and fire.
	TOTAL	4.25	4.75	