



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

RESTRICTED

19363

DP/ID/SER.A/1534
2 January 1992
ORIGINAL: ENGLISH

STRENGTHENING THE TECHNICAL AND MANAGERIAL CAPACITIES
OF THE CARPENTRY COOPERATIVES IN MUKALLA AND SEIYUN

SM/PDY/87/005

THE REPUBLIC OF YEMEN

Technical report: Training Manual on Panel Sizing*

Prepared for the Government of the Republic of Yemen
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of: Radmilo Malis
Expert in Furniture and Joinery Production

Backstopping officer: Antoine V. Bassili
Agro-based Industries Branch

United Nations Industrial Development Organization
Vienna

* This document has not been edited.

V.92-50008

TABLE OF CONTENTS

Introduction	1
Panel sizing	1
1. List of dimensions, panel sawing scheme and utilization of boards	1
2. Panel sizing saws	4
3. Characteristics of sawblades for panel sizing machines	5
4. Panel sizing operations	8
5. Safety measures	9
6. Organization of the working area	10
ANNEXES	
I Training programme for furniture and joinery production	13
II Syllabus of the course on panel sizing	17

INTRODUCTION

This training manual is one of a series prepared by a UNIDO expert while serving as Chief Technical Adviser on a UNDP financed and UNIDO executed project in the Republic of Yemen, to strengthen the Technical and Managerial Capacities of the Carpentry Cooperatives in Mukalla and Seiyun (project No. SM/PDY/87/005).

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.

PANEL SIZING

Panel sizing is the first processing operation in the manufacture of case furniture. Though simple, this operation is very important for the optimal utilization of raw materials and to ensure a rational production.

This short course is aimed at training people to prepare production documents and machine operators, in the correct performance of panel sizing operations.

1. List of dimensions, panel sawing scheme and utilization of boards.

The list of dimensions "panel sizing list" is a production document which contains sizes and quantities of parts to be produced using a panel sizing saw (see Fig. 1). It contains the following information:

- Consecutive number of the list.
- Date of issue.
- Production order number.
- Name of product.
- Name of part.
- Material (including dimensions).
- Dimensions of parts.
- Number of pieces required for each part.
- Evidence of pieces produced.

The sizing list must be signed by the persons who issued and approved it. It has also to be signed by the operators and verified by a supervisor after the work has been completed. One panel sizing list is prepared for each production order.

Based on the panel sizing list, a panel sizing diagram must be drawn out showing how the panels should be sawn in order to achieve maximum utilization. These schemes should be drawn in scale 1:10, on the A-4 size paper (see Fig.2). In order to get better utilization of boards, all the parts of a product should be taken into consideration, as well as some parts of other products if they could be produced using what otherwise would be considered offcuts. The saw kerfs must be taken into account, reckoning approximately 3 mm for kerf. Also, the direction of the grain of the surface veneers in blockboard and plywood must be taken into consideration. The utilization factor of the boards is a percentage obtained on dividing the total surface cut of the parts obtained by the total surface area of the raw (uncut) panels.

Fig. 2: Panel Sizing diagram.

CSCC Mukalla		Workshop: _____	
Product:	Code:	P.O. No.:	Date:

SIZING DIAGRAM:

15 x 1940 x 500 - 100 pcs	cut 50 sheets of plywood 15 mm. thick.
15 x 900 x 450 - 50 pcs	
15 x 200 x 800 - 150 pcs	

2440
1940 x 500
1940 x 500
200 x 800
200 x 800
200 x 800

900 x 450

1220

Prepared by: Date:	Approved by:	Operator: Date:	Supervisor:
-----------------------	--------------	--------------------	-------------

2. Panel sizing saws.

The selection of a panel sizing saw depends on the capacity required. For a production rate of 5 to 10 m³ of panels per day, it is sufficient to have a circular saw with a sizing carriage supporting the panels while sawing. Two workers should operate the machine, an operator and an assistant. If necessary, this machine can also be used also for other operations.

For a production rate of 8-15 m³ per day, a vertical single blade panel sizing machine is frequently used. This machine has a structure to support the pack of panels positioned edgewise. The single blade is guided along an arm for both lengthwise and crosswise sawing. Two workers, an operator and an assistant, are needed to operate this machine.

A higher production requires high capacity panel sizing machines with one or more sawing units.

The basic technical data for the selection of panel sizing machines are:

- maximum width of workpiece,
- number of circular sawblades,
- maximum and minimum distance between two sawblades,
- diameter of circular sawblades,
- diameter of axle holding the circular sawblades,
- maximum depth of cut,
- cutting speed,
- feed rate,
- power requirements,
- overall dimensions,
- weight.

Also, the manufacturer's name, the type and the year of production are important data for the identification of this equipment.

Since the capacities of all production units within the two cooperatives (Mukalla and Seiyun) are below 5 m³ of panels per day, it is advisable to use a circular saw with both scoring and sawing blades and with a sizing carriage supporting the panels. The same machine can be used for sizing laminates and laminated boards, and for other precise sawing and edge trimming operations.

The base of the machine is usually cast in one piece. Besides having a robust fixed table, the machine is also equipped with a sliding table and an outer supporting table with an arm for handling panels up to 2500x3200 mm. The main circular saw is driven by a powerful (4 kW or more) three speed motor, and the scoring saw is driven independently by a separate high speed motor. The rip fence has a micro adjustment and the graduated telescopic crosscut fence has turnover stops.

The machine can be equipped with a calibrated mitre fence. The riving knife and the top guard are integral parts of the machine. A single saw panel sizing machine is shown in Fig. 3.

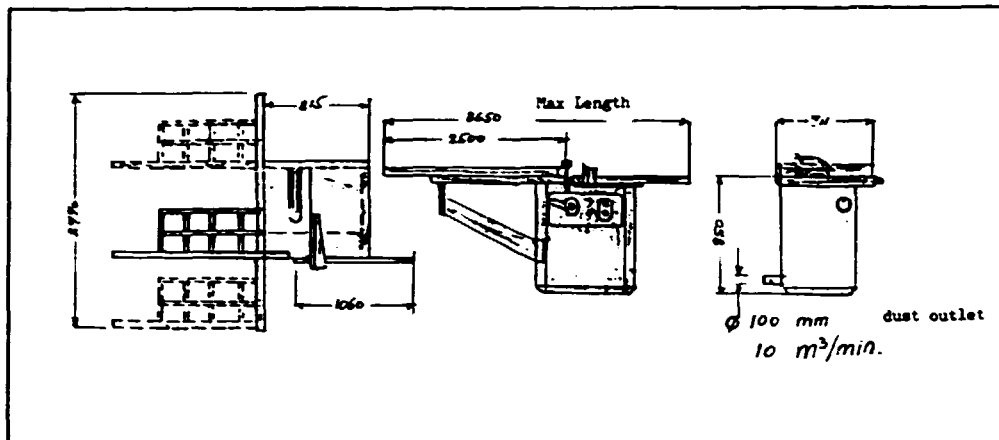


Fig. 3: Single saw panel sizing machine.

3. Characteristics of sawblades for panel sizing machines.

The circular sawblades for panel sizing machines are chosen taking into account the material being sawn and the method of feeding the material. Woodbased panels contain synthetic adhesives which cause a rapid wear of the tools. Therefore, it is highly recommendable to use circular sawblades with carbide tipped teeth (CTT). If CTT circular saws are not available, then circular sawblades made of high speed steel (HSS) must be used.

The diameter and bore of the circular saw is determined by the machine's characteristics. The diameter of a circular sawblade must be related to the depth of cut. The thickness of the blade, the set of teeth and the kerf depends on the diameter of blade, the depth of cut and the feed rate.

For panel sizing and carbide tipped teeth, the "KV" form should be used. In the case of manual feeding, and when High Speed Steel blades are used, the "NV" form is also acceptable. The best guidance for the selection of proper tools are the tool producer's catalogues. As a guide, the parameters of circular sawblades used for sizing plywood, blockboard and particle board are given in the table hereunder.

PARAMETER	SYMBOL	DIMENSIONS FOR RESPECTIVE FORM OF TEETH	
		"KV"	"NV"
Diameter of sawblade	D	300-700	200-500
Tooth pitch	t	0.06 D	0.07 D
Thickness of blade	s	0.01 D	0.01 D
Tooth height	h	0.5 t + 2	0.5 t + 1
Kerf	B	1.6 s	1.5 s
Diameter for tightening plates		5/D	5/D
Clearance angle	α°	15-20	25-35
Wedge angle	β°	60-65	40-50

PARAMETER	SYMBOL	DIMENSIONS FOR RESPECTIVE FORM OF TEETH	
		"KV"	"NV"
Hock angle	γ°	10	15
Bevel angle	δ°	10	10
Gullet radius	R	3	2

For circular sawblades with carbide tipped teeth, the peripheral speed is limited and the maximum cutting speed must not exceed to 80 m/sec.

The cutting speed (v) depends on the diameter of the sawblade (D) and the number of rotations per minute (n).

$$v = \frac{D\pi n}{60000} \text{ (m/sec)}$$

$$\begin{aligned} v &= \text{cutting speed m/sec} \\ D &= \text{diameter of sawblade} \\ n &= \text{number of rotations (rpm)} \\ \pi &= 3.14 \end{aligned}$$

For example, when $D = 400$ mm, and $n = 2750$ rpm

$$v = \frac{400 \times 3.14 \times 2750}{60000} = 62.8 \text{ m/sec.}$$

The elements of a circular sawblade and its teeth are shown in Fig. 4.

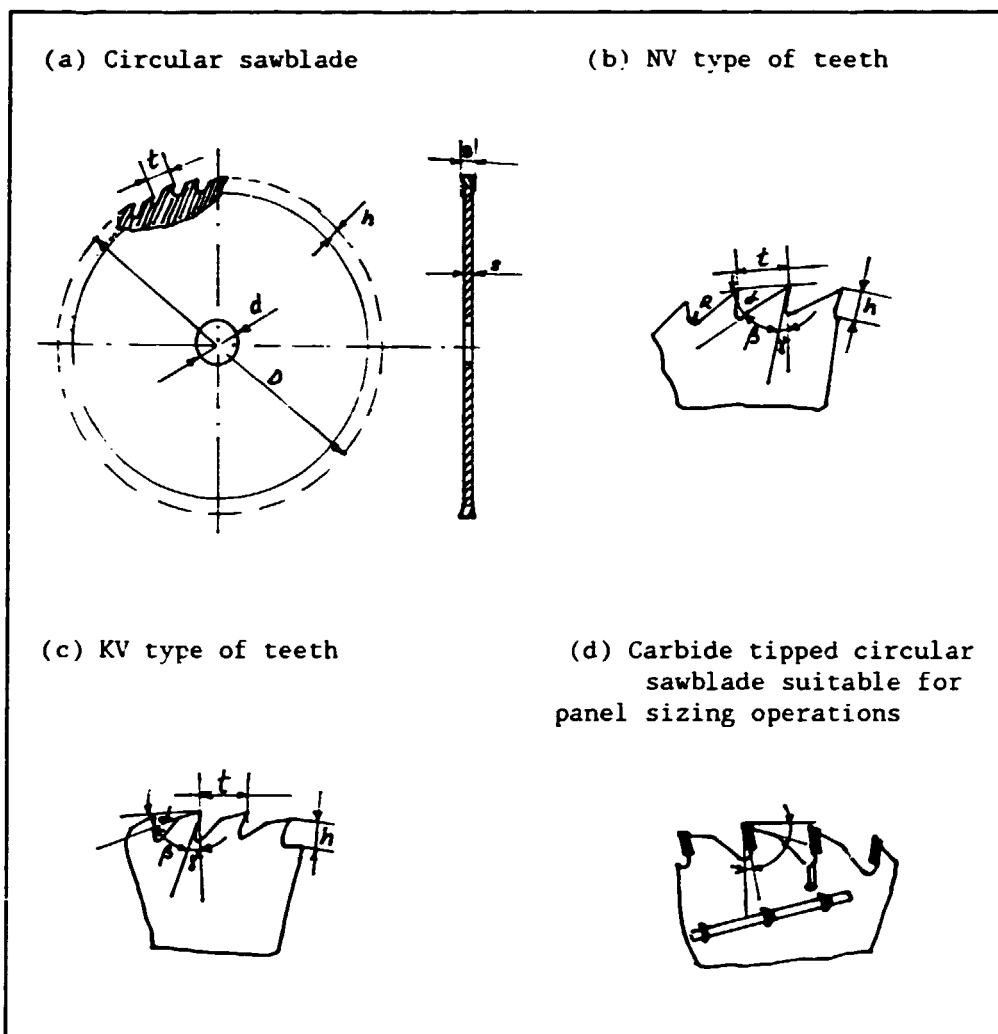


Fig. 4: Elements of a circular sawblade.

When ordering sawblades for a panel sizing saw, a producer's catalogue should be used and the following data must be specified:

- Type of sawblade (HSS or TCT)
- Diameter (D) mm
- Size of bore (d) mm
- Kerf (B) mm
- Number of teeth "Z"
- Material to be cut (plywood, melamine faced panels, etc.)
- RPM (rotations per minute)
- Rate of feed (m/min.)
- Mechanical or manual feeding.

The catalogue identification numbers of a selected tool are useful information which can avoid a wrong shipment

4. Panel sizing operations.

Before starting any production work, the operator must check that everything has been prepared. He should:

- (i) Check documents (panel sizing list and panel sizing diagram), and, in the case that everything is not precisely defined, the request for completion of documents.
- (ii) Check the material brought to be cut (dimensions, thickness, quality and quantity). If it is not as requested, report this to the supervisor.
- (iii) Check whether the sawblades are correctly sharpened and set. Do not start working with defective tools because it is dangerous for the operator and harmful for the machine and the material. The sawblade must be parallel with the rip fence and, in the perpendicular position, to the crosscut fence on a sliding table. The steering wheels must be tightened after adjustment.

After ensuring that the machine is properly set and the material is appropriate, the operator can start panel sizing operation by turning on the tool driving motor and positioning panels on the sliding table. Sawing, both lengthwise and crosswise, is done in accordance with the panel sizing diagram. If the edges of the panel are damaged, they must be positioned in such a way that the damaged edges are part of the unavoidable waste. In the case of manual pushing of the sliding table two or three superimposed panels can be sawn at a time. To avoid slipping of the panels, they must be fixed or pressed by hand. The feeding rate must be adjusted to the power of the sawblade, without getting the sawblade stuck.

At the beginning of the sawing operation, and from time to time, the operator must check precision of sawing (sizes and perpendicularity) and, if necessary, make adjustments. He and his assistant must control the number of pieces of each size already obtained and assure that it does not exceed the figure in the panel sizing list.

In addition to these instructions, the recommendations for the maintenance, setting and operation, prescribed by the producer of the machine must be adhered to.

- (iv) Overall check of the machine watching electrical instruments, listening to sound and looking out for possible irregular vibrations and overheating. If there is any abnormality noticed the operator must stop the machine, report it to his supervisor and request the maintenance service.
- (v) Check if the machine is properly lubricated and if the "V-belts" are tight and have the correct size.
- (vi) Check that all the protective devices (riving knife, top guard, etc.) are correctly fixed).
- (vii) If there is any unnecessary material or waste in the working area it must be taken away before starting work on the machine.

The operator's most important duty is to set the machine and working tools in accordance with the requirements of a particular operation. Both circular sawblades (for scoring and sawing) must be aligned in the same vertical plane. The plates must be free of resin and properly tightened. The height of the scoring sawblade should be set so that its teeth sink about 3mm in the panel. The height of the main saw must be set so that the teeth should stick out of the cut by about 15 mm.

To change the blades, the sawguard should be removed and the nut on the saw shaft loosened, turning the nut in the direction of the saw's rotation.

5. Safety measures

The panel sizing machines are basically circular saws. Unfortunately, injuries occur very often on such machines. The most common are injuries of the hands, though sometimes serious injuries of internal organs and eyes also occur.

Besides general safety measures, it is necessary to follow certain safety rules and work protection pertinent to the panel sizing machines:

- The machine should be checked to see that it is in good working condition. The saw opening slot in the work table must not exceed 10 mm or a maximum of 3 mm on each side of the blade.
- The sawblade must be checked to ensure that it is properly maintained and sharp. The diameter of the blade must correspond to the thickness of the pack of panels to be sawn.
- The dust exhaust pipe must be checked to see that it is properly connected to the machine.
- The saw must be checked to make sure that it does not wobble when it rotates. If it does, the sawblade should be replaced with one which rotates without fluttering.
- In the case of manual feeding, the machine must have a proper riving knife behind the sawblade, which should be adjusted both horizontally and vertically (see fig. 5).

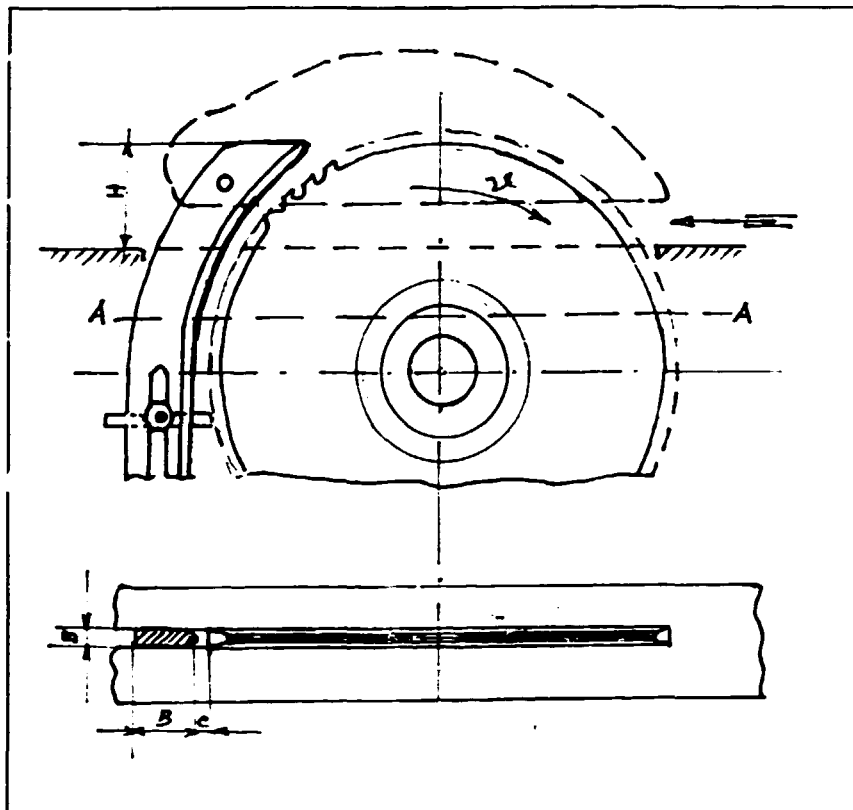


Fig. 5: Riving knife and top guard.

- Anything that could cause injuries or lessen productivity must be removed from the working area.
 - The operator must hold the panels firmly against the fence of the sliding table with his left hand and push the table with his right hand.
 - The electrical installations on the machine must be fully isolated and the machine must be properly grounded.
 - No attempt should be made to stop the saw by pressing against the blade a piece of wood or anything else. The sawblade must only be changed once the saw stops to rotate.
 - It is only during setting that parts of the machine can be taken off.
 - Haste is very often the cause of injuries. Work should be carried out at a normal pace and the safety measures must be adhered to.
6. Organization of the working area.

The purpose of organizing the working area is to obtain, with a minimum effort, a high productivity, maximum safety and a satisfactory quality.

The organization of the working area for a panel sizing machine consists of determining the position of the raw material (panels to be cut), parts already cut and waste with respect to the machine and the production flow.

For a panel sizing circular saw with a sliding table, and assuming internal transport with pallets and hydraulic hand lift trucks, the layout of the working area could be similar to the one shown in Fig. 6.

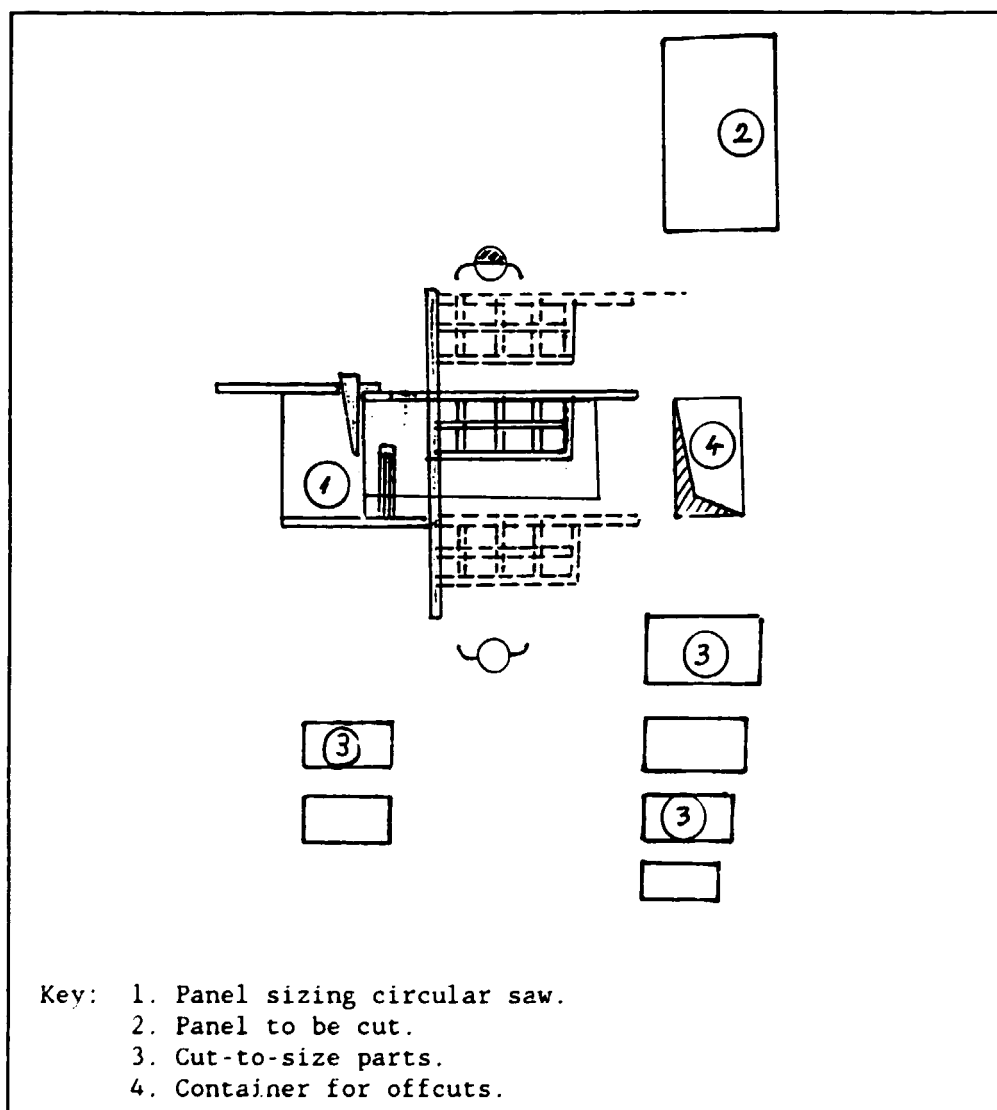


Fig. 6: Organization of the working area.

The panels to be cut (2) should be brought close to the left hand of the operator and oriented in the direction of the first cut. The pallets for the cut-to-size furniture parts (3) should be placed behind the machine, on both sides of the assistant.

The container for offcuts (4) should be placed next to the supporting table so that both the operator and his assistant can push the offcuts in the container.

When the required quantity of a certain part is attained, the pallet with that part should be taken away to free the place for the next part to be produced.

Proper illumination, air circulation, and an efficient extraction of dust are part and parcel of a good organization of the working area.

Furthermore, a small cabinet for tools, production documents and measuring instruments should be placed next to the machine.

The working area should be organized so as to minimize efforts and fatigue and to ensure safety.

ANNEX I

TRAINING PROGRAMME FOR FURNITURE AND JOINERY PRODUCTION

This training programme is designed to achieve the objectives and outputs of the project entitled "Strengthening the Technical and Managerial Capacities of the Carpentry Cooperatives in Mukalla and Seiyun" (project No. SM/PDY/87/005).

After visiting all the production units of these Cooperatives. (the three units of the Coastal Strip Carpentry Cooperative and the four units of the Carpentry Cooperative, Seiyun). and after studying the present state of their production. it has been concluded that a thorough training of operators and managerial staff is a prerequisite for all improvement. Due to this conclusion, the training programme prepared and proposed hereunder is more comprehensive, and the training activities are more numerous than originally planned in the project document. It has been designed to meet the specific requirements of the cooperatives which are on the point of transitting from handicraft to industrial production. The topics for the training courses selected are:

COURSE NUMBER	TITLE OF COURSE	DESIGNED FOR:
1.	Production systems and types of production in the wood processing industry.	Management staff of the Cooperatives and their production units.
2.	Furniture products, classification, standards, design and construction	Production Department staff
3.	Joinery products, classification, standards, design and construction	Production Department staff
4.	Product development in the secondary wood processing industry	Staff of the production and sales departments.
5.	Organization and planning of production.	Production planning staff.
6.	Work allocation and control of production	Production planning staff, supervisors and foremen.
7.	Planning, cost accounting, pricing, cost control and optimization of a product line.	Accountants, salesmen and staff of the production department.
8.	Inventory control and purchasing techniques.	Purchasing unit's staff and staff of the production department concerned with material planning.
9.	Basic elements of marketing	Management, sales and production department staff.
10.	Modern industrial production management	Managerial staff.
11.	Information and documentation systems in the secondary wood processing industry.	Managerial staff, top and middle management of the cooperatives.
12.	Plant layout	Staff of the production department and production supervisors.

COURSE NUMBER	TITLE OF COURSE	DESIGNED FOR:
13.	Wood, affiliated products and other materials used in the production of furniture and joinery	The technical department's staff, supervisors, foremen and operators.
14.	Wood seasoning and preparation	The technical department's staff and people working in the timber yard.
15.	Crosscutting and trimming of sawwood	Operators of crosscutting and ripping machines, and foremen in the wood cutting area.
16.	Panel sizing.	Operators of panel sizing machines and their foremen.
17.	Veneering and laminating surfaces and edges of wood based panels.	Operators laminating surfaces and edges of panel furniture components.
18.	Surface planing and thicknessing of components	Operators of surface planers jointers and thicknessers and their foremen.
19.	Tenoning, mortising and drilling	Operators of tenoning, mortising and drilling machines and their foremen.
20.	Moulding and routing	Operators of moulding and routing machines and their foremen.
21.	Sanding and surface finishing.	Operators of sanding and surface finishing machines and their foremen.
22.	Preassembling, assembling and packaging.	Assemblers, packagers and their foremen.
23.	Managing of quality and quality control	Managerial staff at all levels, foremen and quality controllers.
24.	Jigs, templates and fixtures in the secondary wood processing industry.	Production department's staff.
25.	Tool sharpening, maintenance and managing.	Tool sharpeners and persons in charge of ordering tools.
26.	Internal transport, receiving and storage of materials and shipping of products.	Persons working in storage and internal transport services.
27.	Maintenance of equipment	Maintenance personnel.
28.	Safety measures in the secondary wood processing industries	Foremen and supervisors in workshops.
29.	Motivation of employees	Managerial staff at all levels.
30.	Innovation and development techniques and methods.	Managerial and production department staff.

PURPOSE AND METHOD OF TRAINING

Training of employees is an integral part of production in modern industrial enterprises. Technical and technological developments offer new technical means and new production methods which make human work easier, safer and more productive. To be able to utilize such advancement, people working in industry have to learn and to train in order to achieve new knowledge and skills necessary for handling modern equipment and processes.

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

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

1. The lecturer will explain a new method.
2. The lecturer will demonstrate the new method.
3. The trainee will perform the new method under the lecturer's supervision.

Short manuals written in a simple language, understandable to the workers, will be prepared by lecturers for each course, translated into Arabic and distributed to the trainees. All graphs, tables and formulas will be adjusted to the level understandable to the people to be trained.

Theoretical teaching will be conducted 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 training will be performed by the CTA, other experts in the project and by United Nations Volunteers assigned to the project.

The practical part of the training will be organized at the work areas of the respective production operations. This part of the training will be carried out jointly by the experts and the UN Volunteers. The working area must be organized in a proper way, including the prepared production documents, tools, jigs, gauges, protective devices, pallets, materials and everything that is necessary for safe, productive and good quality work. The lectures should explain and show how to check a machine, tools, jigs, and in the case of wrong adjustment, how to correct them and how to prepare correctly all that is needed for the production operation.

The lecturer will show the correct way of performing the operation and supervise the performance of the trainees until he concludes that their work is fully acceptable and that the quality of the products is satisfactory. The counterparts with higher skills and experience will also be engaged to train less qualified labourers and to supervise their practical work.

Most of the training courses conducted for the Coastal Strip Carpentry Cooperative will be repeated for the Carpentry Cooperative in Seiyun, while in some cases the trainees from Seiyun will be invited to come to Mukalla. Persons from the production units outside of Mukalla and Seiyun will be travelling to these two places. Some of the practical training could and should be carried out in the satellite units by the UN volunteers.

SELECTION OF TRAINEES

Trainees will be selected by the counterpart, according to their job 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, supervisors, management staff, maintenance personnel, etc. can be included in the training. 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 each course.

TIMING OF TRAINING COURSES

The training courses will be prepared and conducted mostly during the experts' missions, and those to be conducted by the volunteers will be scheduled in between those missions. The priority should be given to the courses which are a prerequisite for the better understanding of other topics.

The timetable of all courses is a part of this programme, though the exact schedule can be changed depending on the timing of the future missions by the experts.

Some of the courses are intentionally foreseen for the last mission, hoping that by that time the workshops will be the missing equipment, which is indispensable for a proper training of the operators.

SYLLABI OF COURSES

This programme contains syllabi of all courses planned to be conducted during the project execution. The courses are broken down into topics, and, for each topic, the training duration, both theoretical and practical, and the level of competence to be reached are given.

The selection of topics and the required level of competence is aimed to reach a minimum knowledge needed for successful manufacturing of furniture and joinery products in a medium-scale factory.

Each course has its number and topics are subdivided into a decimal classification following the numbers of the courses.

Once all the training courses are completed the training material can be compiled into a printed handbook to be used throughout the country.

ANNEX II

SYLLABUS OF THE COURSE ON PANEL SIZING
(course No. 16 in Annex I)

This course is foreseen for the operators of panel sizing machines.

STAGE	TOPICS	TRAINING TIME (hours)		LEVEL OF COMPETENCE TO BE REACHED
		THEO- RY	PRAC- TICE	
16-1	Introduction	0.25	--	Understanding the purpose of the course.
16-2	Sizing lists, panel sawing schemes and optimal utilization of boards.	0.50	--	Being able to understand a cutting list and sizing scheme and to produce parts in accordance to these documents.
16-3	Panel sizing saws.	0.50	1	Being able to operate panel sizing saws.
16-4	Characteristics of sawblades for panel sizing saws.	0.25	--	Knowing the appropriate sawblade parameters for sawing wood-based panels and laminated boards.
16-5	Panel sizing operations.	0.5	1	Being able to perform panel sizing operations in accordance with the production documents.
16-6	Safety measures.	0.25	0.50	Being familiar with safety measures.
16-7	Organizing the working area.	0.25	0.50	Being able to organize the working area for safe and comfortable work.
	TOTAL	2.5	3	