OCCASION

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

DISCLAIMER

FAIR USE POLICY

CONTACT

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

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

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

06231

Distr.
LIMITED

ID/WG.200/9
17 March 1975

ORIGINAL: English

United Nations Industrial Development Organization

Workshop on Wood Processing
for Developing Countries
Vienna, 19[illegible]

PRODUCTION OF SOLID WOOD FURNITURE IN DEVELOPING COUNTRIES: AN ANALYSIS OF ALTERNATIVES [1/]

by

Ernst Maendlein*

* Project Manager, Gerhard Schuler Consulting Agency, Pfalzgrafenweiler, Federal Republic of Germany

1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

id.75-3859

CONTENTS

Chapter		Page
	Introduction	1
1.	Data and Manufacturing Programme of this Study	
1.1.	Manufacturing Programme of this Study per 8 hour shift	1
1.2.	Alternative Manufacturing Programme per 8 hour shift	2
1.3.	Quantity Analyses	7
2.	Processes Involved in Flatboard Furniture Production	
2.1.	Production Flow Chart	14
2.2.	Basic Information on the Manufacturing Programme	15
2.3.	Working Operations and Possibilities of Machinery for Different Stages of Mechanization	20
3.	Analysis of Special Factories	
3.1.	Analysis of Individual Operations/Processes	25
3.2.	Investment Costs for Installations and Auxiliary Operations	30
3.3.	Summary of Labour Requirements	31
3.4.	Buildings (Areas and Costs) and Size of Land Plot	32
3.5.	Total Capital Requirement	33
4.	Summary of Process Combinations	
4.1.	Possibilities of Different Production Capacities	34
4.2.	Criteria for Selecting One of the Two Alternatives	35
	Conclusion	36
	Annexes:	
I	Interlinking: Surface planer - thicknesser	37
II	Band saw jig-guide	38
III	Turning table for pre-assembly and assembly or spraying	39
IV	Upholstering of chair seats in a rubber membrane	40
V	Special truck for chairs	41
VI	Energy supply equipment for carcass assembly line	42
VII	Machine shop - raw frame	43
VIII	Machine shop - upholstered furniture	44

INTRODUCTION

This study deals with the production of solid wood furniture such as chairs and tables. Only the tops of the tables are manufactured of particle board and blockboard.

This study comprises the following solid wood furniture: living and dining room chairs and tables, hotel and restaurant chairs and chairs for public utilities, garden and camping furniture, school furniture (desks and chairs) and upholstered furniture.

A prior condition is the availability of natural woods. Imported expensive materials like melamine faced boards and special lacquers will not be used.

The following materials will be produced:

for tables and chairs frames:	solid hard woods
for tabls tops:	solid hardwood or veneered chipboard or blockboards
for upholstery:	basic upholstery - rubber NOSAG springs, polyurethane and neoprene foams
cover material:	soft cover (fabrics), vinyl and natural leather
lacquer material:	nitro-cellulose lacquer for hard-wearing table tops, acid catalised lacquer will be used

On account of the variety of models and design, technology and processing techniques, it is impossible to elaborate a standard type furniture factory.

Despite this fact, by means of a simple production programme, with particular reference to developing countries, this paper tries to demonstrate a study of a solid wood furniture producing factory.

The reader will become acquainted with the problems arising in the manufacture of solid wood furniture. The study indicates which machines and equipment have to be chosen because of their capacities and because of a specific personnel situation, the investment and installation costs, labour force and space requirements and finally capital requirements for a furniture factory with certain capacities.

As in almost all countries the size of furniture factories is limited to plants with an average of about 100 employees (labourers), examples chosen have a similar size.

1. DATA AND MANUFACTURING PROGRAMME OF THIS STUDY

1.1. Manufacturing Programme of this Study per 8 hour shift

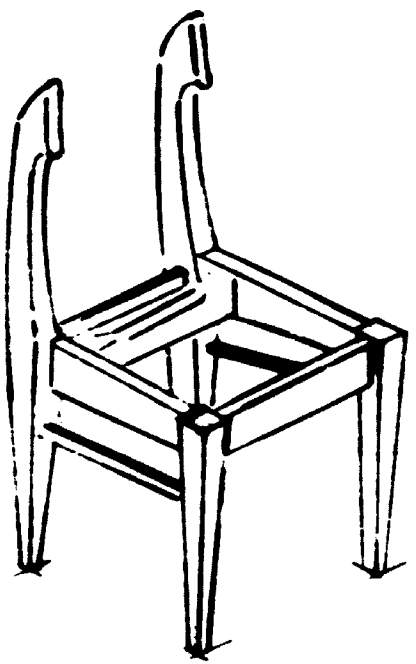
Chair A (Anne) seat and back upholstered	120 chairs
Chair B (Jane) seat upholstered, back with 5 cross rails	60 chairs
Chair C (Valeri) seat upholstered, back with 6 uprights	60 chairs

Remarks: Seat and front parts (rails and 2 legs) of chairs A, B and C are identical. Variations occur only in the back rails.

Chair D (rustic style) Seat solid wood, back with 2 cross rails	120 chairs
Extension table, rectangular 1700 x 900 mm	60 tables
Production units per shift:	420 units

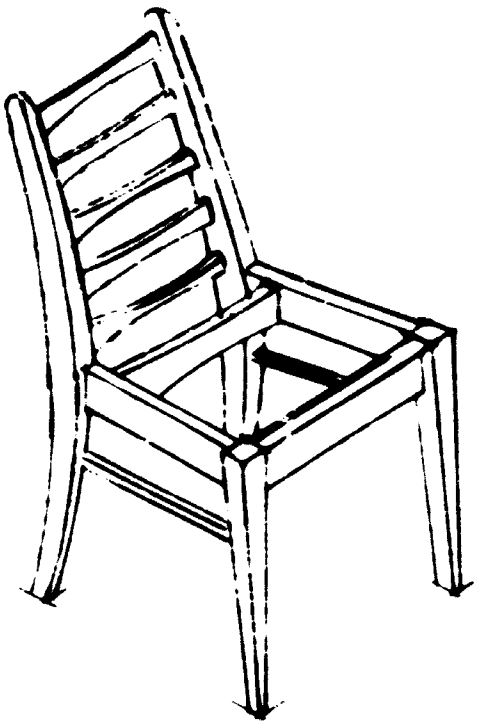
1.2. Alternative Manufacturing Programme per 8 hour shift

	Alternative Programme I	Alternative Programme II	Alternative Programme III	Alternative Programme IV
	units	units	units	units
Study desk (model Erik) size of top 150 x 60 mm	60	162		
Pupil chair (model Lars) rocker chair with curved seat and back	120	324		
Folding chair (model Janett) folding and stacking chair	210		800	
Upholstered chair (model Romeo) with loose back and seat cushion	60			106
Upholstered bench (model Julia) with loose back and seat cushion	30			54
Production units per shift	390	486	800	160



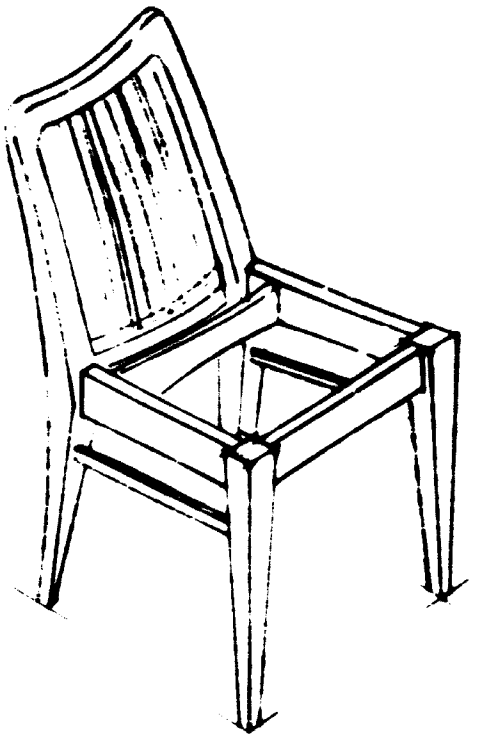
Chair A

Anne



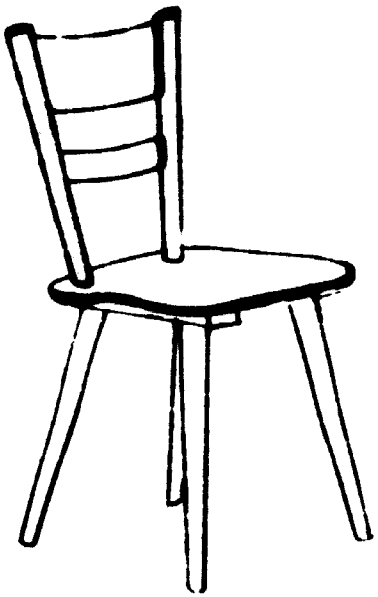
Chair B

Jane

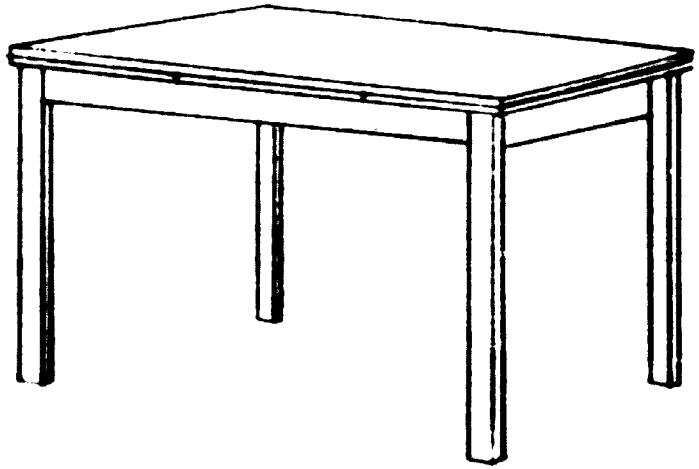


Chair C

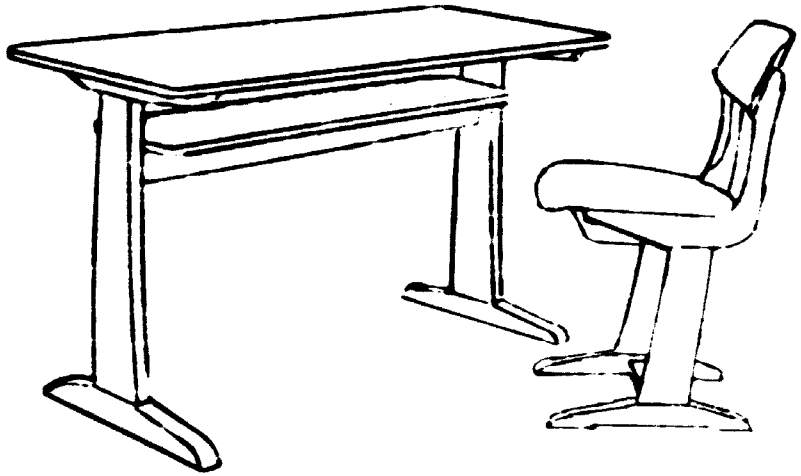
Valeri



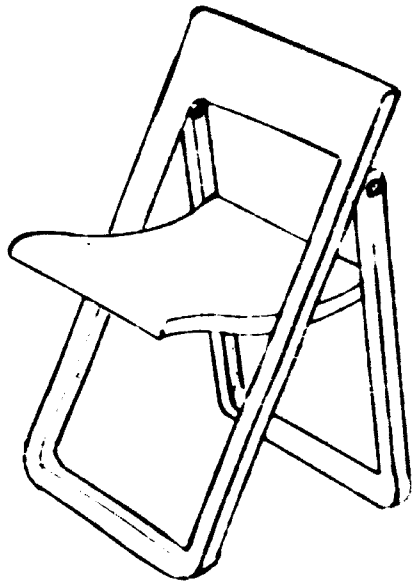
Chair D
Rustic style



Extension table

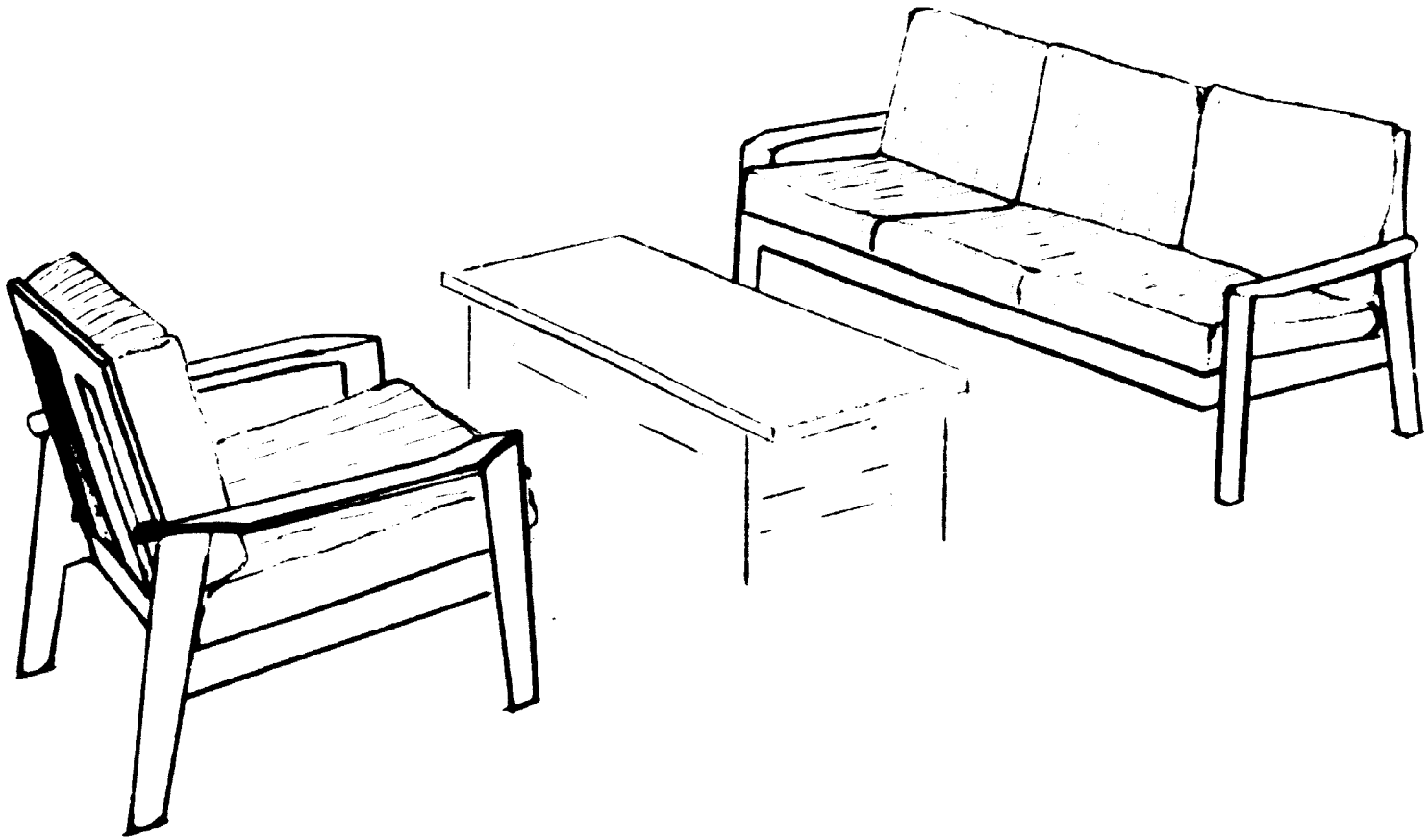


Study desk
Model Erik



Pupil chair
Model Lars

Folding chair
Model Janett



Upholstered chair
Model Romeo

Upholstered bench
Model Julia

1.3. Quantity Analyses

1.3.1. Quantity Analysis : Analysis of Production Figures of this Study

model		description	production per shift (8h) units 100%	time per unit hours	production time per shift (8h) hours 100 %	selling price per unit DM	selling price per unit US$ 1/	production value per shift (8h) DM	production value per shift (8h) US $
1.1.1	chair A	(Anna)	120	1,7	204	64	25,6	7.680	3.072
	chair B	(Jana)	60	1,8	108	73	29,2	4.380	1.752
	chair C	(Maleri)	60	1,9	114	82	32,8	4.920	1.968
1.1.2	chair D	(rustic style)	120	1,1	132	41	16,4	4.920	1.968
1.1.3	extension table		60	2,6	156	202	80,8	12.120	4.848
Total per shift (8 hours)			420		714			34.020	13.608
Total per year (220 shifts)			92.400		157.080			7.484.400	2.993.760

1/ Based on an exchange rate of DM 2.5 = US$ 1.

1.3.2. Quantity Analysis and Compilation of the Raw Material Requirements for this Study

Input per shift

model	solid wood			boards			upholstery material		
	input net m^3	waste %	input gross m^3	input net m^2	waste %	input gross m^2	input net m^2	waste %	input gross m^2
chair A (Anna)	0,72	60%	1,15	53	12	60	33,6	15	38,6
chair B (Jana)	0,48	60%	0,77	12	12	14	11,5	15	13,2
chair C (Velvet)	0,48	60%	0,77	12	12	14	11,5	15	13,2
chair D (rustic style)	0,96	60%	1,54						
extension table	0,72	60%	1,16	120	12	135			
input per shift			5,4			223			65

1.3.3. Quantity Analysis (Alternative Programme B: Analysis of Production Figures

model		description	production per shift (8h) units 100 %	time per unit hours	production time per shift (8h) hours 100 %	selling price per unit DM	selling price per unit US$ 1/	production value per shift (8h) DM	production value per shift (8h) US $
1.2.1	study desk	(Birki)	60	2,2	132	138	55,2	8.280	3.312
	pupil chair	(Lena)	120	1,1	132	40	16,0	4.800	1.920
1.2.2	folding chair	(Jansen)	120	0,9	108	41	16,4	4.920	1.968
1.2.3	upholstered chair	(Ramos)	60	3,0 *	180	156 *	62,4	9.360	3.744
	upholstered bench	(Julia)	30	4,5 *	135	258 *	103,2	7.740	3.096
Total per shift (8 hours)			390		687			35.100	14.040
Total per year (220 shifts)			85.800		151.140			7.722.000	3.088.800

1/ Based on an exchange rate of DM 2.5 = US$ 1.

* figures include upholstery

1.3.4. Quantity Analysis And Compilation Of Raw Material To Be Worked Up (Alternative Programme I)

Input per dish

model	solid wood			boards			upholstery material		
	input net m^2	waste %	input gross m^2	input net m^2	waste %	input gross m^2	input net m^2	waste %	input gross m^2
study desk (Stift)	2,46	60%	3,94						
pupil chair (Lasse)	0,84	60%	1,34	100,6	12	112,7			
folding chair (Jumbo)	0,36	60%	0,58	48,6	12	54,4			
upholstered chair (Ramona)	0,78	60%	1,25				60	15	69
upholstered bench (Julia)	0,60	60%	0,96				90	15	103
Input per dish			8,1			167			172

1.3.5. **Quantity Analysis (Alternative Programme II) : Analysis of Production Figures**

model	description	production per shift (8h) units 100%	time per unit hours	production time per shift (8h) hours 100%	selling price per unit DM	selling price per unit US $ 1/	production value per shift (8h) DM	production value per shift (8h) US $
study chair	(Stuhl)	162	2,2	356	138	55,2	22.356	8.942
pupil chair	(Kurs)	324	1,1	356	40	16	12.960	5.184
total per shift (8 hrs .)		486		712			35.316	14.126
total per year (220 shifts)		106.920		156.640			7.769.520	3.107.720

1/ Based on an exchange rate of DM 2.5 = US$ 1.

1.3.6. **Quantity Analysis (Alternative Programme III) : Analysis of Production Figures**

model	description	production per shift (8h) units 100%	time per unit hours	production time per shift (8h) hours 100%	selling price per unit DM	selling price per unit US $ 1/	production value per shift (8 h) DM	production value per shift (8 h) US $
folding - chair	(Jawett)	800	0,9	720	41	16,4	32.800	13.120
total per shift (8 hrs.)		800		720			32.800	13.120
total per year (220 shifts)		176.000		158.400			7.216.000	2.886.400

1/ Based on an exchange rate of DM 2.5 = US$ 1.

1.3.7. **Quantity Analysis (Alternative Programme IV). Analysis of Production Figures**

model	description	production per shift (8h) units 100%	time per unit hours	production time per shift (8h) hours 100%	selling price per unit DM	selling price per unit US $ 1/	production value per shift (8h) DM	production value per shift (8h) US$
Frame and upholstery								
upholstered chair	(Romeo)	106	3,6	382	260	104	27.560	11.024
upholstered bench	(Julia)	53	6,3	334	430	172	22.790	9.116
total per shift (8hrs.)		159		716			50.350	20.140
total per year (220 shifts)		34.980		157.520			11.077.000	4.430.800
lacquer-treated wooden frame								
upholstered chair	(Romeo)	106	3,0	318	156	62,4	16.536	6.615
upholstered bench	(Julia)	53	4,5	239	258	103,2	13.674	5.470
total per shift (8 hrs.)		159		557			30.210	12.085
total per year (220 shifts)		34.980		122.540			6.646.200	2.658.700

1/ Based on an exchange rate of DM 2.5 = US$ 1.

TIMBER PROCESSING

PANEL PROCESSING

UPHOLSTERY DPT.

① STRAIGHT COMPONENTS

② SHAPED COMPONENTS

③ TURNED COMPONENTS

④ MOULDED PARTS

⑤ BOARD COMPONENTS

⑥ UPHOLSTERY COMPONENTS

2.1 SEASONING

2.2 SAWING CONDITIONING

2.3 CROSS CUTTING

3.4 SAWING - SPLITTING RIPPING

2.4 SHAPE WORK

3.4 SAWING - SPLITTING RIPPING

2.5 PLANING - THICKNESSING

2.6 CUTTING TO LENGTH

3.5 CUTTING TO LENGTH

3.6 WOOD TURNING AND SANDING

4.1 CUTTING UP OF BOARDS

4.2 MOULD PRESSING

4.3 SHAPE CUTTING

4.4 SANDING

4.5 DRILLING

4.6 SANDING OFF SEAMS

5.2 EDGE LIPPING

5.3 EDGE TRIMMING

5.4 FACE SANDING

5.5 EDGE SANDING

2.7 SANDING - MORTISING

2.8 DOWELLING - TENONING

2.9 ROUNDING OFF CHAMFERING

2.10 FACE SANDING

2.11 EDGE SANDING OF CURVES

PRE-ASSEMPLY SOLID COMPONENTS

7.1 CHECKING AND COMPONENT STORAGE

SURFACE TREATMENT AND FINAL ASSEMBLY

7.2 ASSEMBLY

7.3 STAINING - DRYING

7.4 BASE COAT SPRAYING DRYING

7.5 INTERMEDIATE SANDING RE-MOPPING

7.6 TOP COAT SPRAYING DRYING

7.7 FINAL ASSEMBLY

7.8 CHECKING

7.9 FINISHED GOODS STORE

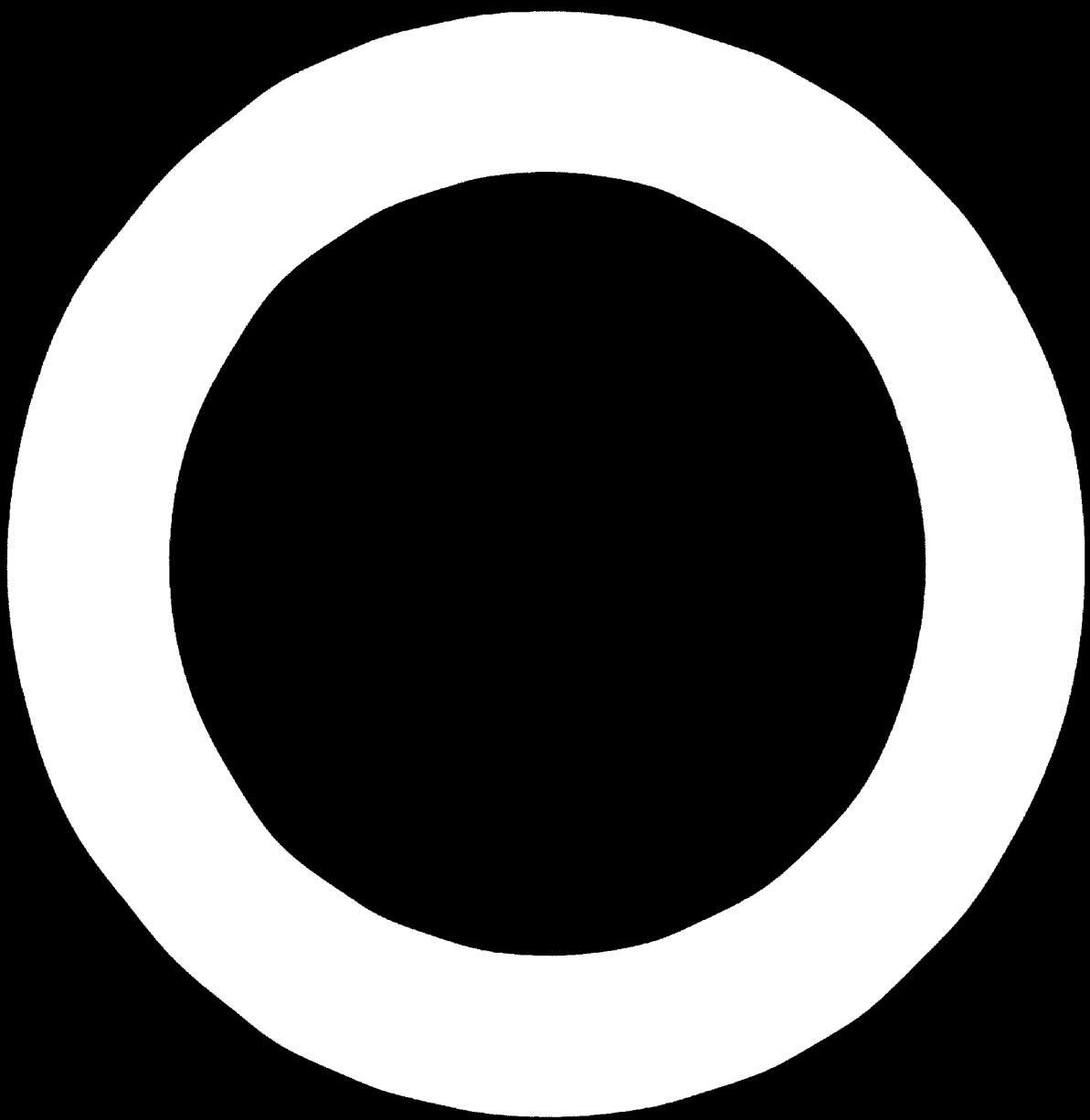
5.1 CUTTING FABRICS AND FOAM

5.2 SEWING FOAM

5.3 SEWING OFF SEAMS

5.4 UPHOLSTERY

2.1 Production Flow Chart



2. . Basic Information on the Manufacturing Processes

Timber Processing

Organizational feature: The different furniture components are produced in large series in the machining section and put into the intermediate components storage. Each of the different components is stacked separately, i.e. frames and front legs of all types.

Advantages: large quantities
reduction in setting time
optimum utilization of machinery

Production flow

Timber stacking:

Because of the danger of decay, hardwood is bound to certain felling and cutting times. Consequently it is necessary to store the quantity needed for 6 - 8 months' production in covered piles for open air drying. For an input of more than 10 m³ lumber per day, the use of a fork lift truck is to be considered.

Drying:

Drying of the boards up to the fibre saturation point must be done in the open air, otherwise kiln drying would take too long and a risk of splitting would occur. The drying time depends on the different species of wood, thickness and initial moisture content. An average of [illegible] hours can be considered for meeting the demand of approximately [illegible] m³ per shift. Three dry kilns, each of a capacity of 18 m³, are chosen.

Cross-cutting:

Short components are cut in multiples of the desired length. In most cases it is sufficient to use a manually operated overhead cross cut saw with a roller table.

Edging:

The use of an automatic rip saw should be considered above a daily input of [illegible] m³ lumber. After having planed the boards, they are traced and curved on a band saw.

Splitting:

A better wood selection is possible for simple curved parts.

Curving:

Curving with roller fence on band saw.

Planing and Thicknessing:

Standard machines are preferred, because the major quantity of the parts are curved or conical and planed on two sides only. The use of a 6-cutter or an edge joiner should only be considered if straight and parallel parts predominate. Conical parts may be planed by means of a counter jig; turned parts are not to be planed.

Cutting to length:

The quantity to be cut is too small for the economic use of a double-end tenoner. The capacity of a cross cut saw is sufficient to work up 13 components per minute.

Usually, several components can be put together per one operation at the double cross cut saw.

Turning - Sanding:

The components to be turned are worked on a semi-automatic turning lathe and sanded manually. For a quantity exceeding 300 turned wood articles per hour, fully automated machines for turning and sanding should be provided.

Profiling:

Approximately three componsnts have to be profiled per minute. This quantity is done with a double spindle moulder and a bench moulder. For this operation the parts are fixed to a jig and profiled. The tearing out of the surface can be prevented by using both sides of the counter-rotating spindles of the double spindle moulder. The use of semi-automatic (or fully automated) copy shapers can be considered for a capacity exceeding five components per minute. Large series of similar components, however, are required.

Dowelling:

For structural and fitting holes of a chair, dowels are used. Back rails and cross rails are joined by tenons. The dowel holes are to be drilled by pneumatic or electro-pneumatic fed machines. By means of multi-spindle heads, different patterns are drilled. Distances between dowels depend on sections of work pieces.

Cutting Tenons and Boring Slots:

Tenon holes are bored by means of an oscillating boring machine. The tenons are profiled, rounded off and chamfered in one working operation. For the example taken here, single-sided standard machines have been chosen. Double-sided machines should be provided if the capaity exceeds 50 percent of the present input. The use of automated machines should be considered if the capacity is three times more, but for the same large series.

Surface Sanding:

Quite often standardized open belt sanders are sufficient. However, it is advisable to sand the straight solid wood parts on a wide belt sander with two motors, even for the indicated capacity.

First motor: sanding drum
Second motor: sanding pad

Sanding Curves and Edges:

Edges and curves are sanded on manually-operated bobbin sanders, open belt sanders and pneumatic drum sanders.

Pre-assembly of Solid Components

Back and front parts of the chairs are glued in pneumatic or hydraulic cramping tables and cleaned off. Subsequently these parts are stacked into the intermediate components storage. This pre-glueing is advisable because thus the bending and twisting of the small single components of back or front parts can be prevented.

Panel Processing

Panel Breakdown:

Table top material:	ready veneered particle- or blockboard
Material for chairs:	plywood, 10 mm
Material for back top-rails:	plywood, 6 mm thick composed of two 3 mm plywood pieces to be glued in the moulding press

Blockboards, chair seats and plywood for moulded back rails of standard panels are cut on a dimension saw with wheeled table.

Mould Press:

Moulded back top rails may be glued in multiple width either in a simple spiral press with a pressing matrix or in a moulding press with resistance heating. Suitable glues for cold glueing are polyvinyl acetate glues, for hot glueing urea formaldehyde glues. When glueing using the cold method, several back rails can be stacked on top of each other and pressed within one form.

Curving, Profiling, Boring, Edge Lipping:

After pressing, the moulded back rails are pre-curved on a band saw. After these operations they are profiled on a spindle moulder with a jig. Dowel holes are bored by means of a vertical boring machine and edges are rounded off on a curve sander.

Table Top - Glueing Edges, Edge Profiling, Edge Sanding Surface Sanding:

The edges of the table tops are glued in a single-sided edge banding machine of simple construction, cut, equalized and sanded. The components are sanded on an open belt sander with roller table and subsequently checked and trimmed.

Intermediate Component Storage

Organisational feature:	Back rails and front legs of the chairs are glued in the solid wood pre-assembly department. This results in the following advantages: no distortion of the components, less single parts, consequently better storage.

Assembly

Organisational feature:	The daily requirements are taken from storage of components. Small series are assembled according to customers' orders.
Advantages:	A well assorted stock in the component storage increases the preparedness for delivery. The assembly of several models which are similar in small series shorten the setting periods at the assembly cramps.

The frames of the chairs and tables are glued on a hydraulic frame press and the joints are cleaned off and sanded by hand.

Surface Treatment

Staining and Drying:

Glued parts are dip-stained manually, softened and equalised by means of a brush and sponge and put on pallets and roller conveyors, pushed forward manually, passing the flash off wall. A more sophisticated construction would be feasible. It would be a factory-made drying tunnel with heating radiators and good ventilation; transportation would be as above.

Base Coat Spraying and Drying:

Spraying is done at a water curtain spray booth on turning tables. The frames are put on a pallet (in double width) and roller conveyors, pushed manually through a factory-made drying tunnel. Table tops are laid onto lacquer drying trolleys (drying racks).

Intermediate Sanding:

After the drying of the base coat, the components are sanded to smoothen the surface for the application of the top coat. If suitable, hand sanders can be used.

Top Coat Spraying and Drying:

In principle similar to base coat application.

Final Assembly

Organisational feature: Final assembly according to customers' orders and forwarding instructions.

Upholstered seats and top back rails are assembled to the already lacquered frames. Table frames and table tops are assembled. Use of hand tools, electric tools and work benches.

Checking:

Checking for conformity of the types and quantities according to order. Quality control inspection (colours and surface quality).

Ready Goods Storage:

Ready for dispatch, eventually packed.

Upholstery Department

Cutting Fabrics and Foam:

Cutting cover materials and foam in several layers by means of a straight knife cutting machine.

Foam Glueing:

Neoprene adhesive should be provided. Application by means of a spray gun near a wall in which an exhaust fan has been installed.

Rounding off of Foam Edges:

The edges of the fixed foam are rounded off by a sanding disc. In other cases this is not necessary.

Upholstering:

Components are to be covered with cover material and stapled to the bottom (pneumatic stapler). If possible, use of simple upholstery presses (pneumatic operation).

Working operations and possibilities of Machinery for different stages of mechanization

	simple	'000 $	%		Intermediate Technology Machinery	'000 $	%			'000 $	%	
	DESCRIPTION REFERRING TO CHAIR- AND TABLE MANUFACTURING PROGRAMME											
	- TIMBER PROCESSING -				- TIMBER PROCESSING -					- TIMBER PROCESSING -		
2.1 Wood drying 2.2 and 2.3 conditioning	dry kiln		100		dry kiln		100			dry kiln	1.0	
	a) brick or concrete construction equipment only with semi automatic controls	10,0			prefabricated all-metal kiln modular construction semi automatic controls	35,0				prefabricated all-metal kiln modular construction fully automatic controls and recorders	35.0	
	b) prefabricated chamber motor only	8.0										
	capacity 18 m^3 effective				capacity 18 m^3 effective					capacity 18 m^3 effective		
3.1 Cross-cutting	overhead cross-cut saw				pneumatic undertable cross-cut saw with length stops					pneumatic undertable cross-cut saw stops and scissor lift infeed side		
	locally made infeed and outfeed											
	Quality: good Tolerance: ± 1,0 mm	3,6	50	1 S 2 L	Quality: good Tolerance: ± 0,5 mm	10,0	75	1 S 1 L		Quality: good Tolerance: ± 0,5 mm	18,0	100 1 S
3.2 Edging 3.3 Splitting 3.4 Ripping	circular saw bench with sliding table	3,6	30	1 S 1 L	power feed saw bench	5,2	50	1 S 1 L		multiple rip saw with return belt conveyor	18,4	100 1 S 1 L
	Q sufficient				Q: good T: ± 1,0 mm					Q: very good T ± 0,5 mm		
	Lateral cutting	saw bench with rip fence				saw bench with rip fence					saw bench with rip fence	
	Q: good T ± 0,4 mm	3,2	100	1 SK	Q: good T: ± 0,4 mm	3,2	100	1 SK		Q: good T: ± 0,4 mm	3,2	100 1 SK
	Shape work	band saw saw wheel ∅ 630	2,9	90	1 S	band saw saw wheel ∅ 800	3,4	100	1 S		band saw saw wheel ∅ 800	3,4	100 1 S
	Q: good T ± 0,8 mm				Q: good T: ± 0,6 mm					Q: good T: ± 0,6 mm		
3.5 Surface planing and 3.6 thickness planing	hand feed planer surfacing capacity 410 mm				planer with feeder surfacing capacity 630 mm					planer with feeder surfacing capacity 630 mm with edge joiner		
	Q: good T ± 0,1 mm	3,4	75	1 SK 1 L	Q: good T: ± 0,1 mm	3,9	75	1 SK 1 L		Q: good T: ± 0,1 mm	4,4	100 1 SK 1 L
	thicknesser capacity 630 x 200 mm				thicknesser capacity 630 x 200 mm					thicknesser capacity 630 x 200 mm		
	Q: good T ± 0,1 mm	5,1	100	1 SK 1 L	Q: good T: ± 0,1 mm	5,1	100	1 SK 1 L		Q: good T ± 0,1 mm	5,1	100 1 SK 1 L

2.3	Working operations and possibilities of Machinery for different stages of mechanization	Note: capacity refers to stage at 100 % Labour: S = semi-skilled SK = semi-skilled L = labour	Date: Nov 74

code	operations	simple machinery	'000 US $	cap %	labour	intermediate technology machinery	'000 US $	cap %	labour	advanced machinery	'000 US $	%	labour
	Four-side moulding	four-side moulder type of construction - light 3 spindles Q: good T: ± 0,1 mm	10,0	80	1 SK 1 L	four-side moulder type of construction - medium with planer equipment and 5 spindles Q: good T: ± 0,1 mm	15,5	90	1 SK 1 L	four-side moulder type of construction - heavy with planer equipment and 6 spindles Q: good T: ± 0,1 mm	18,0	100	1 SK 1 L
1.6 2.6 2.6	Length dimensioning	saw bench with sliding table saw cant to 45 degrees combined with laying attachment Q: good T: ± 0,4 mm	4,7	20	1 S	double cross-cut saw saw cant to 45 degrees cutting cap. 1200 x 1200 mm Q: good T: ± 0,2 mm	5,7	40	1 SK 1 L	double end tenoner cutting length 2500 mm sawing saw hogging saw spindle Q: very good T: ± 0,1 mm	36,0	100	1 S 1 L
3.6.1	Wood turning and sanding	wood turning lathe working length 800 mm Q: good T: ± 0,5 mm	4,4	40	1 S	wood turning lathe semi-automatic working length 800 mm Q: good T: ± 0,5 mm	11,0	80	1 S	automatic wood turning lathe with sanding machine Q: good T: ± 0,3 mm	19,8	100	1 S
3.7	Shaping - moulding	spindle Q: efficient	2,1	10	1 S	double spindle Q: good	6,2	30	1 S	automatic double sided template shaper with sanding attachments Q: very good T: ± 0,3 mm	31,2	100	1 SK
	Spindle work moulding - planing	spindle Q: good T: ± 0,2 mm	2,1	40	1 S	spindle with feeder Q: good T: ± 0,2 mm	2,9	100	1 S 1 L	spindle with feeder Q: good T: ± 0,2 mm	2,9	100	1 S
		router	3,8	100	1 S	medium duty router	4,8	100	1 S	high speed heavy duty router	5,2	100	1 S
		Q: efficient T: ± 0,2 mm											
1.8 2.8	Dovetailing - tenoning	spindle with tenoning attachment Q: good T: ± 0,3 mm	3,6	20	1 SK	single end tenoner and mortiser Q: very good T: ± 0,2 mm	8,6	40	1 SK	double sided tenoning machine and mortiser Q: very good T: ± 0,2 mm	11,2	100	1 SK
		horizontal dovetailing machine Q: efficient T: ± 0,3 mm	1,4	20	1 SK	single sided mortising and tenoner Q: very good T: ± 0,1 mm	2,2	80	1 SK	double mortising and tenoner Q: very good T: ± 0,1 mm	3,8	100	1 SK

2.3 Working operations and possibilities of Machinery for different stages of mechanization

	simple Machinery	1000 $			Intermediate Technology Machinery	1000 $				1000 $			
	single cut-off and dowel hole boring machine Q good T ± 0,3 mm	7,2	50	1 SK	single cut-off and dowel hole boring machine Q good T ± 0,3 mm	7,2	50	1 SK		automatic double cut-off and dowel hole boring machine Q good T ± 0,3 mm	19,2	100	1 SK 1 L
	horizontal dowel hole boring machine with multi spindle heads Q good T ± 0,2 mm	2,1	40	1 SK	pneumatic horizontal dowel hole boring machine multi spindle heads Q good T ± 0,2 mm	2,3	50	1 SK		pneumatic horizontal dowel hole boring machine two multi spindle heads Q good T ± 0,2 mm	2,9	100	1 SK
	vertical multi spindle boring machine inclinable Q sufficient T ± 0,2 mm	1,4	40	1 SK	vertical universal boring stand with pneumatic boring unit Q good T ± 0,2 mm	2,1	60	1 SK		vertical inclinable boring machine with two units and multi spindle heads Q good T ± 0,2 mm	3,2	100	1 SK
	sensitive drill Q sufficient	1,0	40	1 SK	electro-pneumatic drilling unit Q good	1,5	60	1 SK		electro-pneumatic drilling unit with compound rest Q very good	2,4	100	1 SK
	tenon compressioner	1,2	100	1 L	tenon compressioner	1,2	100	1 L		tenon compressioner	1,2	100	1 L
1.9.1	Surface sanding open belt sander table size 2500 x 800mm Q sufficient	3,0	25	1 SK	wide belt sander with one sanding unit working width 1100 mm Q good T ± 0,2 mm	21,6	75	1 SK 1 L		wide belt sander two sanding rollers working width 1100 mm Q very good T ± 0,1 mm	29,6	100	1 SK 1 L
1.10	Edge and profile sanding vertical belt sander Q good	2,4	40	1 SK	vertical oscillating belt sander belt 200 mm Q very good	6,0	100	1 SK		vertical oscillating belt sander belt 200 mm Q very good	6,0	100	1 SK
	bobbin sander Q good	2,0	100	1 SK	bobbin sander Q good	2,0	100	1 SK		bobbin sander Q good	2,0	100	1 SK
	bobbin and curve sander 1 bobbin and 1 belt Q good	2,8	100	1 SK	bobbin and curve sander 1 bobbin and 1 belt Q good	2,8	100	1 SK		bobbin and curve sander 1 bobbin and 1 belt Q good	2,8	100	1 SK

23 Working operations and possibilities of Machinery for different stages of mechanization

line	operations	simple machinery	1000 US $	qp %	labour	Intermediate technology machinery	1000 US $	qp %	labour	Sophisticated machinery	1000 US $	qp %	labour
		- SUB-ASSEMBLY -				- SUB-ASSEMBLY -				- SUB-ASSEMBLY -			
2.11 3.11	Sub-assembly	jig assembly table for front legs	2,4	60	1 SK 1 L	pneumatic cramping table for front legs	3,2	75	1 SK 1 L	hydraulic cramping table for front legs	4,8	100	1 SK 1 L
		jig assembly table for back legs	2,4	60	1 SK 1 L	pneumatic cramping table for back legs	3,2	75	1 SK 1 L	hydraulic cramping table for back legs	4,8	100	1 SK 1 L
		- PANEL TREATMENT -				- PANEL TREATMENT -				- PANEL TREATMENT -			
5.1	Breakdown of boards	saw bench extended table equipped with scatops				vertical panel saw				vertical panel saw with automatic saw advancement			
						Q: sufficient				Q: good			
			3,4	20	1 SK 2 L	T: ± 2,0 mm	4,5	80	1 SK 2 L	T: ± 1,0mm			
		dimension saw bench				double cross cut saw with scoring saw cutting size 2200 x 2800 dp				double end tenoner scoring saw hogging saw spindle			
						Q: good				Q: very good			
			3,4	20	1 S	T: ± 0,2 mm	6,4	40	1 SK 1 L	T: ± 0,1mm	28,0	100	1 S 1 L
6.2	Mould pressing	open strobe press with moulds				open strobe press with low voltage heating moulds				hydraulic mould press			
		Q: sufficient	2,0	20	1 SK	Q: good	4,0	60	1 SK 1 L	Q: very good	14,0	100	1 SK 1 L
6.2	Edge lipping	gluing stand with electrical heating bar				pneumatic jig table with low voltage heating attachment				single sided edge bander with edge trimming and end trimming units			
		Q: sufficient	2,4	10	1 SK 1 L	Q: good	3,6	20	1 SK 1 L	Q: very good	11,4	100	1 SK 1 L
6.3	Edge trimming	portable router				edge trimming spindle single sided							
		Q: sufficient	0,4	10	1 SK	Q: good T: ± 0,5mm	2,8	20	1 SK 1 L				
		- ASSEMBLY -				- ASSEMBLY -				- ASSEMBLY -			
7.2	Assembly	pneumatic chair cramp	3,6	60	1 SK 1 L	pneumatic chair cramp	3,6	60	1 SK 1 L	hydraulic chair cramp	5,4	100	1 SK 1 L
		glue application with brush				glue application with plastic bottle				pneumatic glue container nozzle-gun	0,2	100	

Working operations and possibilities of Machinery for different stages of mechanization

	simple	1000 $			Intermediate technology machinery	1000 $				1000 $			
	[illegible] veneering and [illegible] band				chair levelling device					chair levelling device			
					Q: good	0,8	100	1	SK	Q: good	0,8	100	1 SK
	- SURFACE TREATMENT -				- SURFACE TREATMENT -					- SURFACE TREATMENT -			
[illegible] of surface treatment	stain dipping tank with stirrer	0,6	100	1	SK	stain dipping tank with stirrer	0,6	100	1	SK	stain dipping tank with stirrer	0,6	100	1 SK
	exhaust fan in wall	0,8				exhaust wall approximately 2m	2,8				exhaust wall approximately 2 m	2,8		
	manual transport			2	L	gravity roller conveyer with pallets approximately 15 m	0,9				slat conveyor approximately 6 m	6,0		
	drying at ambient temperature					drying tunnel for stain	7,2				drying tunnel for stain	7,2		
	hand sanding - dedusting				L	sanding table with exhaust fan				L	sanding table with exhaust fan			L
	base coat water curtain spray wall with turning table	4,4				base coat under-floor water curtain spray wall with turning table	6,4				base coat under-floor water curtain spray wall with turning table	6,4		
	base coat drying ambient temperature					base coat drying tunnel double width	22,6				base coat drying tunnel double width	22,6		
	fresh air inflow units	4,4				fresh air inflow units	4,4				fresh air inflow units	4,4		
	lacquer spraying device with airless gun	1,2	10	1	SK	curtain coater with 1 head	7,2	40	1	SK L	curtain coater 2 heads	12,0	100	SK L
	portable hand sander	0,3			L	open belt sander	4,0		1	SK	dedipping machine			SK L
	Q: sufficient					Q: good					Q: very good			
	drying racks	2,0				drying racks	2,0				drying racks	2,0		
	airless lacquer spraying equipment with 2 spray guns	1,2				airless lacquer spraying equipment with 2 spray guns	1,2				airless lacquer spraying equipment with 2 spray guns	[illegible]		
	- FINAL ASSEMBLY -					- FINAL ASSEMBLY -					- FINAL ASSEMBLY -			
7.7 Final Assembly						portable electric power tools					portable pneumatic tools			

3.1 Analysis of individual operations / processes for the chosen production capacity

Note: production capacity as per chapter 1

Date: Nov. '74

code	operations (refers to chapter 3.1)	I Simple machinery — machine plant	No.	investment '000 US$	labour			II Intermediate Technology Machinery — machine plant	No.	investment '000 US$	labour		
		- TIMBER PROCESSING -						- TIMBER PROCESSING -					
1.1 2.1 3.1	Timber stacking	manually				2	3	manually				2	3
1.2 2.2	Drying - conditioning	dry kiln brick or concrete construction semi automatic controls capacity 18 m³ effective equipment only and semi automatic control unit	3	18,0 18,0 18,0	1			dry kiln prefabricated all-metal kiln modular construction fully automatic controls capacity 18 m³ effective	3	35,0 35,0 35,0	1		
1.3 2.3 3.3	Cross-cutting	overhead cross-cut saw kanol construction working tables length stop with hinges, adjustable	1	3,6	1		3	pneumatic undertable cross-cut saw roller table, with pneumatic controlled length stops hydraulic scissor table infeed side		18,0	1		2
3.4	Edging	circular saw	2	2,8 2,8	2		2	single sided automatic circular saw	1	7,5	1		1
1.4	Ripping	saw bench with fence	1	3,2	1		1	saw bench with fence	1	3,2	1		1
2.4	Moulding	band saw saw wheel ∅ 630mm		2,9 2,9	2			band saw saw wheel ∅ 800 m	1	3,4 3,4	2		
1.5 2.5 3.5	Planing Thicknessing	surfacer working width: 510 mm	1	3,4		1	1	surfacer working width: 630 m	1	3,9		1	1
		thicknesser working width: 630mm	1	5,1		1	1	thicknesser working width: 630 m	1	5,1		1	1
1.6 2.6 3.6	Length dimensioning	circular saw with roller table saw cant to 45 degrees	3	4,7 4,7 4,7	3			double cross-cut saw saw cant to 45 degrees	1	5,7		1	1
								circular saw with roller table saw cant to 45 degrees	1	4,7		1	
		radial cross-cut saw	1	1,6	1			radial cross-cut saw	1	1,6	1		
		subtotal		79,8	11	4	11	subtotal		145,8	7	6	10

3.1 Analysis of individual operations / processes

to the chosen production capacity

Note: production capacity as per chapter 1

Date: Nov 74

No. operations (refers to table 2)	I Simple machinery: machine / plant	No.	investment '000 US$	labour: skilled	labour: semi-skilled	labour: unskilled	II Intermediate technology machinery: machine / plant	No.	investment '000 US$	labour: skilled	labour: semi-skilled	labour: unskilled
			71,8	11	4	11			161,5	7	6	10
3.6 Wood turning	wood turning lathe working length 800 mm	2	4,4 4,4	2			wood turning lathe semi automatic controls working length 800 mm	1	11,0	1		
2.7 Shaping - moulding	spindle	3	2,7 2,7 2,7	3			double spindle	1	6,2	1		
							spindle	1	2,7	1		
1.8 Doweling - 2.8 boring	horizontal dowel hole boring machine with multi-spindle head	3	1,8 1,8 1,8		3		horizontal pneumatic dowel hole boring machine with multi spindle head	2	2,1 2,1		2	
	sensitive drill	2	1,0 1,0			2	electro-pneumatic drilling unit with compound rest	1	2,4			1
Tenon	manual slot boring machine	3	1,4 1,4 1,4		3		double sided oscillating slot mortiser	1	2,2			1
	single end tenoning and round off machine	1	3,6		1		single end tenoning and round off machine	1	3,6		1	
Dowel making	dowel making machine capacity approximately 200 to 300 m/h	1	0,9			1	dowel making machine capacity approximately 200 to 300 m/h	1	0,9			1
	dowel cross-cut and chamferring machine capacity approximately 2000 cuts/h	1	1,5				dowel cross-cut and chamferring machine capacity approximately 2000 cuts/h	1	1,5			
1.9.1 Surface Sanding	open belt sander with sliding table 2500 x 800 mm width of belt 150 mm length of belt 7200 mm	1	3,0		1		open belt sander with sliding table 2500 x 800 mm width of belt 150 mm length of belt 7200 mm	1	3,0		1	
Sanding solid components	open belt sander with sliding table 2500 x 800 mm width of belt 150 mm	1	3,0		1		speed sander 2 sanding units width of belt 430 mm length of belt 2800 mm	1	12,4		1	1
	table belt sander width of belt 400 mm length of belt 980 mm	1	1,8			2						
	subtotal		114,1	16	13	16	subtotal		211,6	10	11	14

3.1	Analysis of individual operations / processes for the chosen production capacity	Note: production not to be as per chapter 1	date Nov. '84

code	operations refers to chapter 2	I Simple machinery machine / plant	No.	investment '000 US$	labour	II Intermediate Technology Machinery machine / plant	No.	investment '000 US$	labour
				114,1	16 13 16			211,6	10 11 14
1.10 2.10	Sanding edges and curves	vertical belt sander width of belt 120 mm	1	2,4	1 1	vertical belt sander width of belt 200mm	1	4,0	1 1
		bobbin and brush sander	2	2,0 2,0	2 2	bobbin and brush sander	1	2,0	1 1
						bobbin and belt sander for curves - profiles	1	2,8	1 1
		- PRE-ASSEMBLY SOLID COMPONENTS -				- PRE-ASSEMBLY SOLID COMPONENTS -			
1.11 2.11 3.11	Pre-assembly of front and back components	pneumatic jig and assembly table panel size 3000 x 1500 mm 2 pressing points	2	2,4 2,4	2 2	pneumatic jig and assembly table panel size 3000 x 1500 mm 2 pressing points	2	2,4 2,4	2 2
		subtotal		125,3	16 18 21	subtotal		227,2	10 16 19
		- PANEL PROCESSING -				- PANEL PROCESSING -			
4.1 5.1	Panel cutting plywood - chipboard and squaring	dimension saw with built on wheeled table	1	3,4	1 1	dimension saw with built on wheeled table	1	3,4	1 1
4.2	Mould-press for tanks	open stroke press cold glueing method	1	2,0	1	open stroke press with low voltage heating pressing form	1	4,0	1
5.2	Edge lipping for table tops	pneumatic glue stand with low voltage heating bar	1	2,0	1 1	single sided edge lipping machine	1	11,4	1 1
		electrical portable router for edge trimming		0,5		edge trimming and chamfering edge sanding			
		subtotal		7,9	1 2 2	subtotal		18,8	2 1 2
		subtotal		133,2	17 20 23	subtotal		246,0	12 17 21

3.1	Analysis of individual operations / processes [illegible] production capacity	Note production capacity as per chapter 1	Date Nov 74 [illegible]

[illegible]	I Simple machinery machine - plant	No.	investment '000 US$	labour [illegible]	labour [illegible]	labour [illegible]	II Intermediate Technology Machinery machine - plant	No. of	investment '000 US$	labour [illegible]	labour [illegible]	labour [illegible]
			133,2	17	20	23			246,0	12	17	21
	- ASSEMBLY -						- ASSEMBLY -					
7.2 Assembly	pneumatic chair cramp	1	3,6		1	1	pneumatic chair cramp	1	3,6		1	1
	glue application by brush						glue application by plastic - bottle					
	chair levelling and trimming by hand				1		chair levelling device with chamfering and trimming		0,8		1	
	subtotal		3,6		2	4	subtotal		4,4		2	3
	- SURFACE TREATMENT -						- SURFACE TREATMENT -					
7.3 Surface 7.4 treatment 7.5 7.6	stain dipping tank with stirring device	1	0,6		1	1	stain dipping tank with stirring device	1	0,6		1	1
	built-in fan capacity approximately 10 times change of air per hour		0,8				exhaust wall length 2 m		0,8			
	manual transport					4	gravity roller conveyor with pallets, approximately 15 m		0,9			
	drying at ambient temperature						drying at ambient temperature					
	water curtain spray wall with turning table working width 2,5 m	2	4,4 4,4	2			water curtain spray booth under-floor with turning table working width 2,5 m	2	6,4 6,4	2		
	drying at ambient temperature					4	drying tunnel base- and top coat with gravity roller conveyor length approximately 15 m	1	29,6			
	lacquer pressure box with 2 spray guns	2	1,2 1,2				airless device with 2 spray guns	2	1.2 1.2			
	sanding by hand					6	pneumatic vibration sanding	3	0,3 0,3 0,3			3
	lacquer drying in trays with approximately 12 daylights	10	2,0				lacquer drying in trays with approximately 12 daylights	10	2,0			
	subtotal		[illegible],4	19	[illegible]	42	subtotal		[illegible],4	14	[illegible]	[illegible]

3.1 Analysis of individual operations / processes
for the chosen production capacity

Note: [illegible]

Code	operations (refers to chapter 2)	I Simple machinery machine / plant	pieces	investment '000 US$	shifts			II Intermediate Technology Machinery machine / plant	pieces	investment '000 US$	shifts		
				151,4	19	23	42			300,4	14	20	28
		fresh air inflow unit for at least 10 times change of air per hour	1	4,4				fresh air inflow unit for at least 10 times change of air per hour	1	4,4			
		subtotal		19,0	2	1	15	subtotal		54,4	2	1	4
		- FINAL ASSEMBLY -						- FINAL ASSEMBLY -					
7.7	Final assembly	tools for manual treatment		0,02	3	2	1	portable electric power tools		0,7	3	1	
		- UPHOLSTERY DPT. -						- UPHOLSTERY DPT -					
6.1	Upholstery	single lay out with scissors			1		2	lay-cutting with round or straight knife cutting machine		0,6	1		
6.2	Foam glueing	application of adhesive by brush					2	application of adhesive by spray gun and exhaust unit		2,0		1	
(6.3)	foam edges roundings-off	with knife or disc grinder					2	sanding disc	1	0,2			1
6.4	Upholstery	manually with staple gun		1,0	7			manually simple upholstery press and staple gun		3,0	4		
6.4.1	back top rails closing up	manually				3		manually				3	
		subtotal		1,0	8	3	6	subtotal		5,8	5	4	2
		Grand Total		156,82	39	39	49	Grand Total		411,3	22	29	30
					127						77		

3.2 Investment Costs for Installations and Auxiliary Operations (approximate)

Pos.		Model I DM	Model I US $ 1/	Model II DM	Model II US $
1	means of conveyance and storage equipment (trolleys, gravity roller conveyors, shelves, stacking trucks)	100.000,-	40.000,-	170.000,-	68.000,-
2	electrical installation	110.000,-	44.000,-	140.000,-	56.000,-
3	heating installation (excluding room heating, because it is not necessary in subtropical and tropical countries)	60.000,-	24.000,-	100.000,-	40.000,-
4	installation for chip and dust exhaust	35.000,-	14.000,-	45.000,-	18.000,-
5	compressed air installation (including compressor plant)	15.000,-	6.000,-	18.000,-	7.200,-
6	equipment for sharpening department and grinding shop as well as van	50.000,-	20.000,-	60.000,-	24.000,-
7	installation and equipment for commercial and technical administration (office furniture, office machinery, telephone, means of organization and similar)	45.000,-	18.000,-	55.000,-	22.000,-
	Total	415.000,-	166.000,-	588.000,-	235.200,-

1/ Based on an exchange rate of DM 2.5 = US$ 1

3.3 Summary of Labour Requirements

according to the stage of mechanization

Pos.		I Simple Machinery Persons	II Intermediate Technology Machinery Persons
1	timber processing	55	45
2	panel processing	5	5
3	assembly	6	5
4	surface treatment	18	7
5	final assembly	6	4
6	upholstery dpt.	15	11
	in production	105	77
	overhead labour	10	8
	substitutes for holidays and illness	9	6
	subtotal	124	91
	foremann / chargehand :		
	timber yard	1	1
	timber breakdown department	1	1
	machining	1	1
	sanding	1	1
	assembly	1	1
	surface treatment department	1	1
	despatch	1	1
	sharpening and maintenance	6	6
	factory manager	1	1
	production planning and organization	5	5
	administration	8	8
	GRAND TOTAL	151	118

3.4 Buildings (areas and costs) and Size of Land Plot

Pos.	Buildings (simple construction without heating and special heat insulation)	m2	Price per Unit US $	Total US $
1	Machinery Shop	1.900	100,-	190.000,-
2	Storage Rooms	1.400	75,-	105.000,-
3	Auxiliary Rooms	540	140,-	75.600,-
4	Chip Silo (built in accordance with safety rules)	40	195,-	7.800,-
5	Garages and similar (calculated incl. levelling and foundation)	120	70,-	8.400,-
	Total for Buildings	4.000		386.800,-
6	+ other costs : planning fees payable to local autharities 15 percent site preparation water and power supply roads and similar			59.000,-
	Total costs excluding land plot			445.800,-

Required Size of Land

The premises should be on plain level and in such a size that possibility of expansion at least three times is assured (planning of long term for approximately 30 years).

Size of plot for possibility of expansion 3 times = 20.000 m2.
Size of plot for possibility of expansion 2 times = 14.000 m2.

3.5 Total Capital Requirement (own or loans including working capital)

Pos.			Model I US $	Model II US $
3.1	machinery		156.820,-	311.300,-
3.2	installation and auxiliary equipment		166.000,-	235.200,-
3.4	buildings,		445.800,-	445.800,-
	land (estimated)		60.000,-	60.000,-
	working capital :			
	raw material	80.000,-		
	semi-finished goods	150.000,-		
	finished goods and outstanding liabilities	280.000,-	510.000,-	510.000,-
	total capital requirements		1.338.620,-	1.562. 300,-
	possible yearly turnover		2,4 million to 2,8 million	2,55 million to 3,15 million

4.1 Possibilities of Different Production Capacities

	capacity turnover US $ x 10^6	investment US $	covered area m2	labour requirements	total capital US $
1. half the capacity of study II	1,3 - 1,6	634.800	2.400	62	915.300
2. study I	2,4 - 2,8	828.620	4.000	154	1.338.620
3. study II	2,55 - 3,15	1.022.100	4.000	119	1.562.100
4. double capacity of study II	5,1 - 6,3	1.910.000	7.200	225	2.900.000
5. double capacity of study II combined production	6,3 / 5,8 - 6,9	2.220.000	6.400	180	3.250.000

Investments : machinery + installations and equipment + auxiliary operations + buildings + land

Total capital : investments + working capital

4.2. Criteria for Selecting One of the Two Alternatives

The decision about the size, the investment and the labour requirements of an industrial undertaking is to be considered from two points of view:

(a) Point of View of Economics

There is the demand to also create work posts simultaneously with the erection of a factory, and to produce with a minimum of invested capital and a large number of labourers.

For developing countries Alternative I has been chosen because of the following considerations:

(i) the minimisation of the invested capital, the equipment of the machines, installations and buildings have been kept in a simple form

and

(ii) the low level of education and the low level of wages of the labourers available is to be taken into account.

(b) Point of View of Industrial Management

It has to be guaranteed that the funds invested will be used efficiently to increase productivity and the capacity to compete and the profitability of the company.

The amount of funds invested depends on the level of wages of the location where the factory will be erected.

If one compares the total funds invested and the labour forces of alternative factory I and alternative factory II

	total funds invested	labour requirements
Alternative factory I	US$ 1,337,620	151
Alternative factory II	US$ 1,561,300	118

one can find that in alternative factory I the invested capital is US$ 223,680 more; however 33 less persons are employed. On the assumption that an application of high quality installations (alternative factory II) should amortise within four years with an interest payment of capital of ten percent, the annual surplus charge of alternative II would be US$ 63,000.

When choosing alternative II, the personnel costs have to be reduced annually by this amount.

Alternative II employs 33 persons less than alternative I.

$$\frac{\text{US\$ } 63,000}{33 \text{ labourers}} = \text{US\$ } 1,900$$

Alternative I should be chosen in cases where the annual costs of a labourer are below US$ 1,900. In case these costs exceed US$ 1,900 per year considerably, alternative II should be implemented.

CONCLUSION

The examples used in this study show the comprehensive volume of tasks and jobs for planning a furniture factory.

The first building phase of a new factory is the most expensive, because of the important investments which become necessary, for instance:

site development with roads, water and electric supply, drainage, transformer station, boiler house (if necessary) and compressor plant, silo for shavings and dust exhaust, administration and welfare rooms.

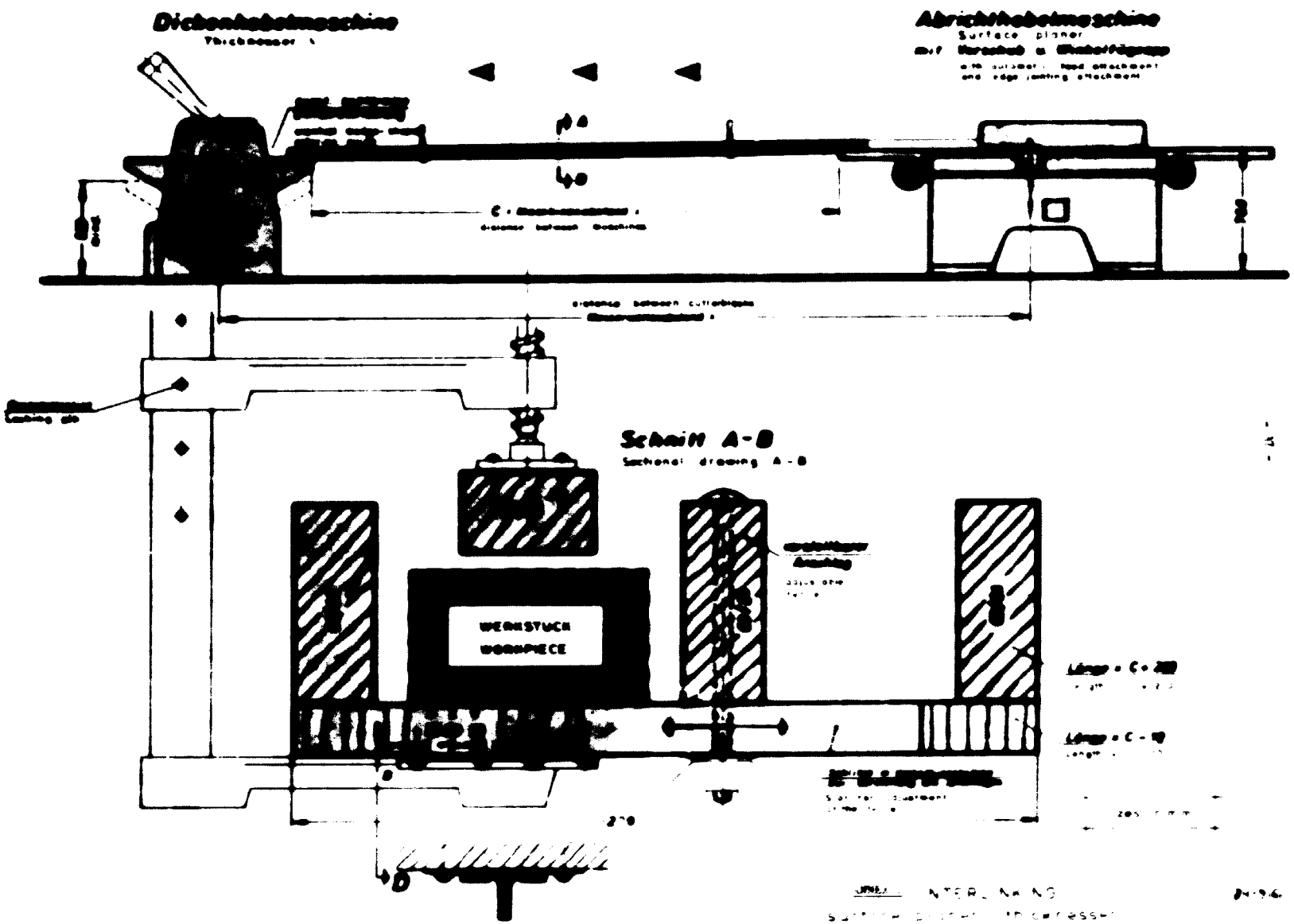
Those investments form the basis for all further factory and capacity extensions. The first building phase should be chosen so that an organic development and extension will be possible at any time. Firms specialised in the industrial planning have comprehensive know-how for this task.

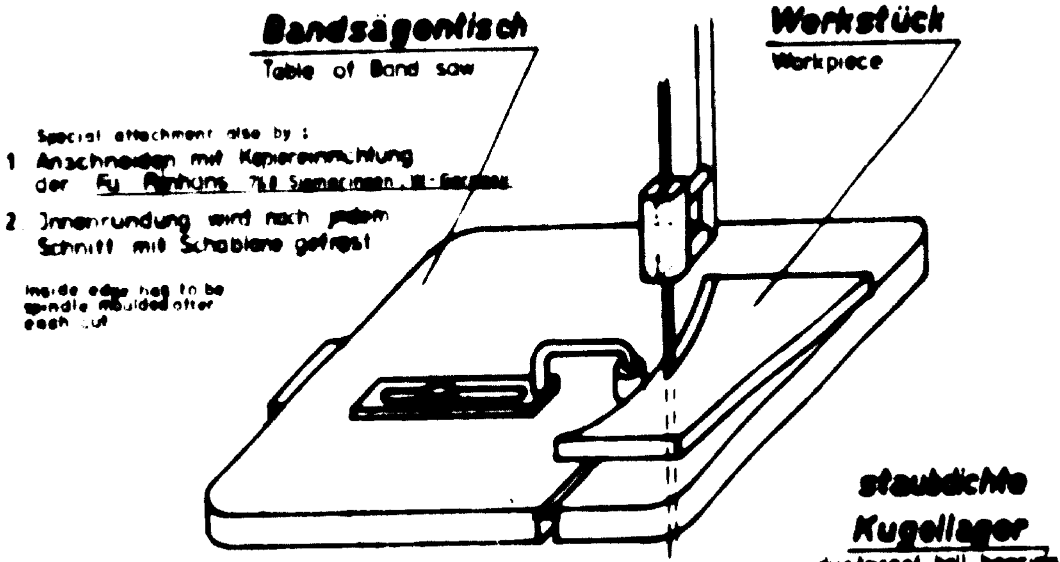
Important studies must be carried out before planning a factory, for example:

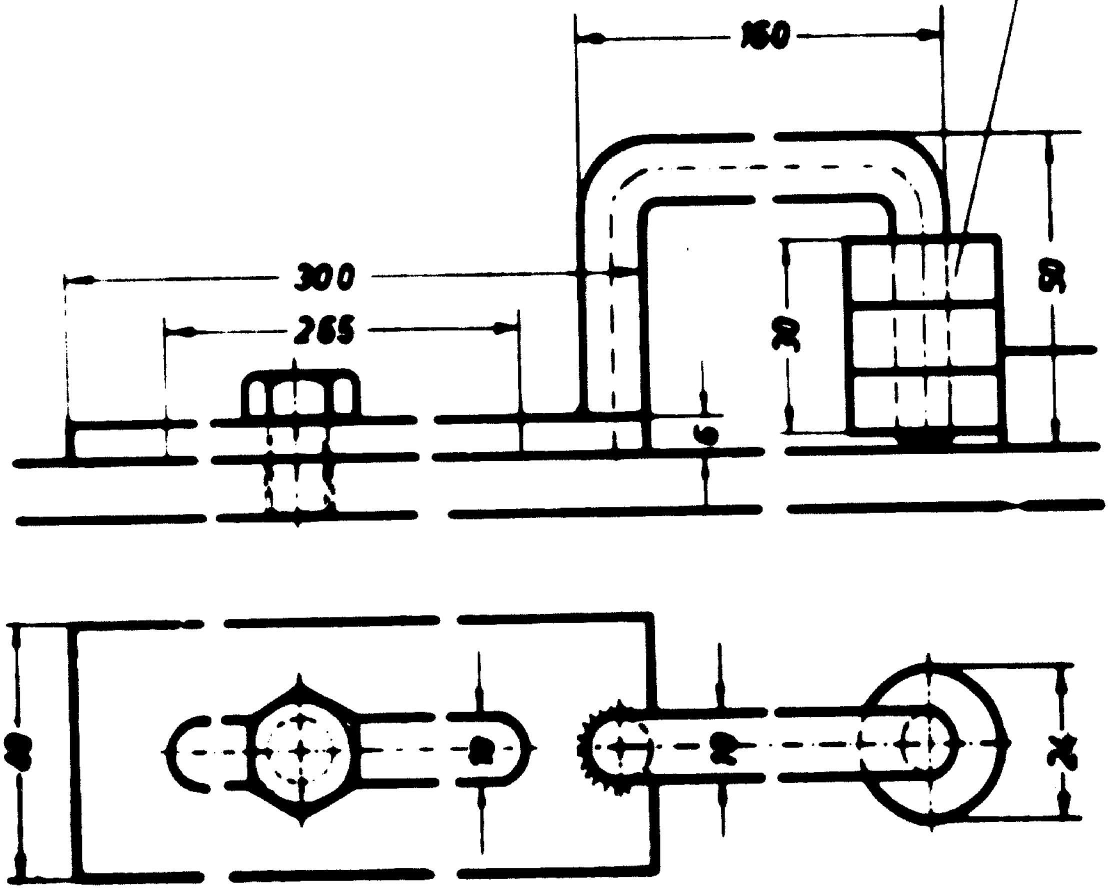
market surveys
analysis of choice of site
analysis of industrial structure

To this belong details like location of the site with respect to the main traffic, raw material sources, markets, providing of labour forces and training of employees and similar considerations.

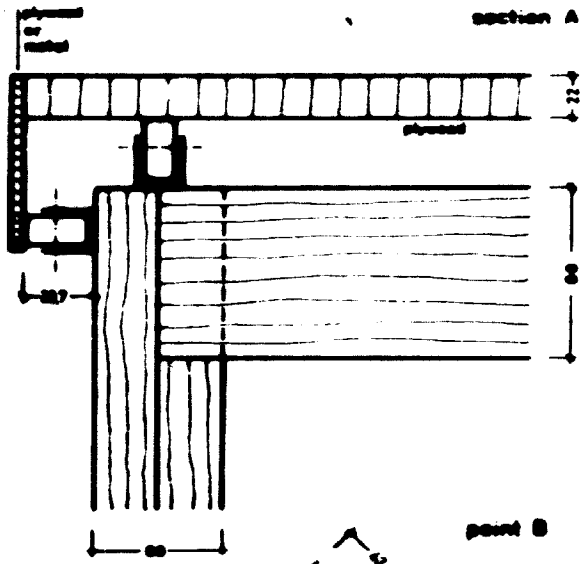
Only specialised consultants should be entrusted with these jobs, as well as product planning and the corresponding process techniques, layout planning, installation plans (electric, compressed air, shaving and dust exhaust system, internal transport, etc.), improvement of work posts, instruction of personnel and commissioning of the factory.

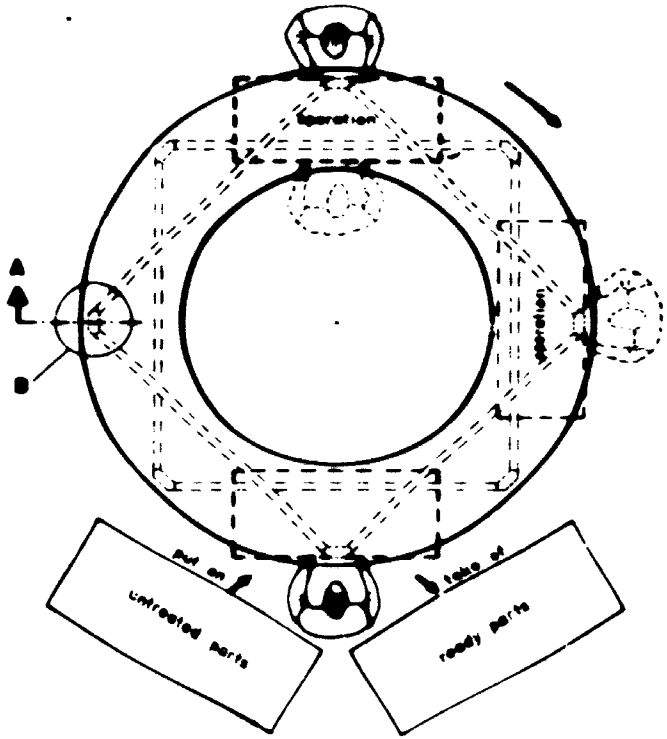

Dickenhobelmaschine
Abrichthobelmaschine
Surface planer
Schnitt A-B
WERKSTUCK
WORKPIECE


Bandsägentisch
Table of Band saw
Werkstück
Workpiece
Special attachment also by :
1 Anschneiden mit Kopiereinrichtung
2 Innenrundung wird nach jedem Schnitt mit Schablone gefräst
Inside edge has to be spindle moulded after each cut
staubdichte Kugellager
dustproof ball bearing


160
300
265

8433/90

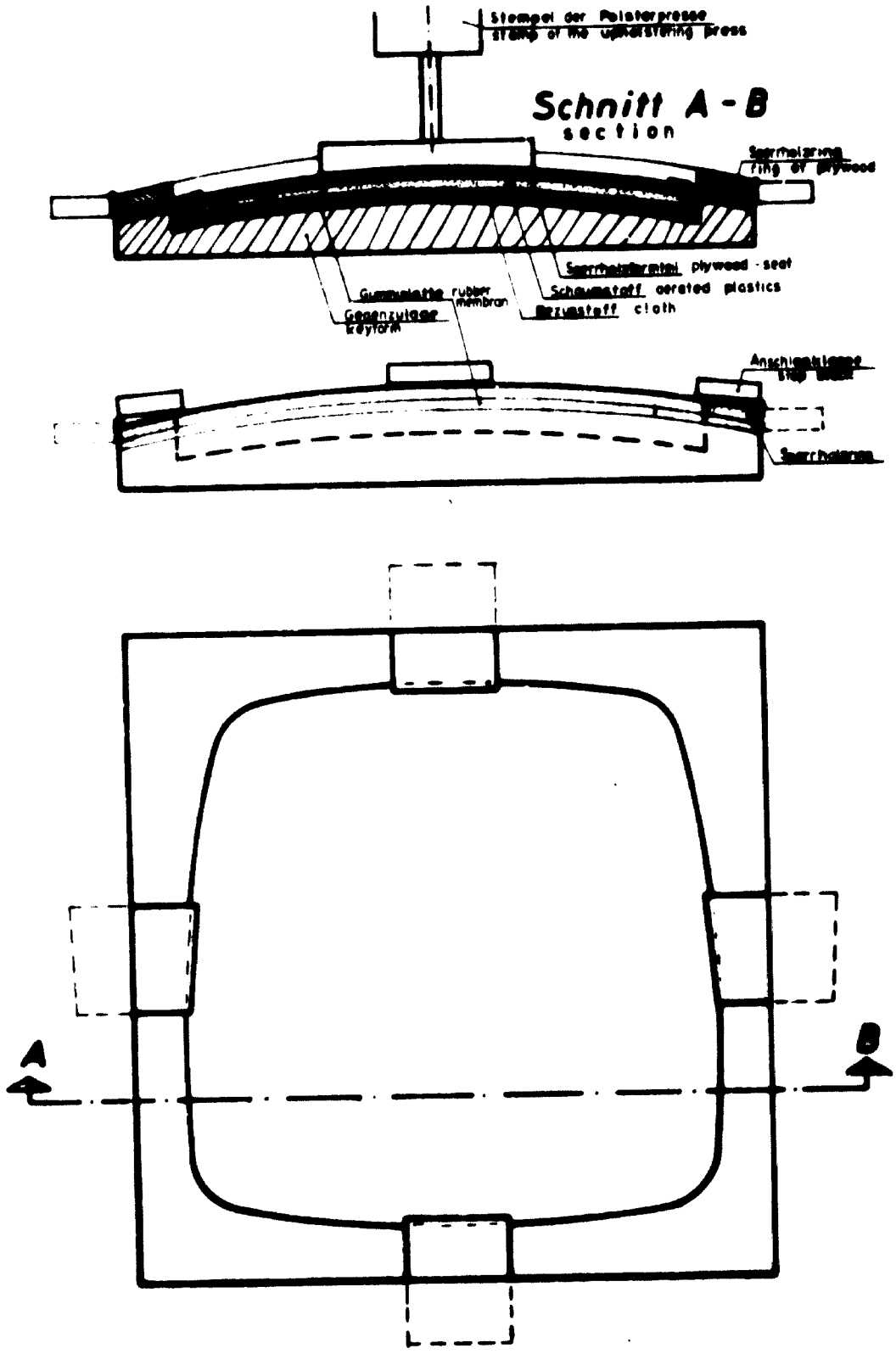




ANNEX III

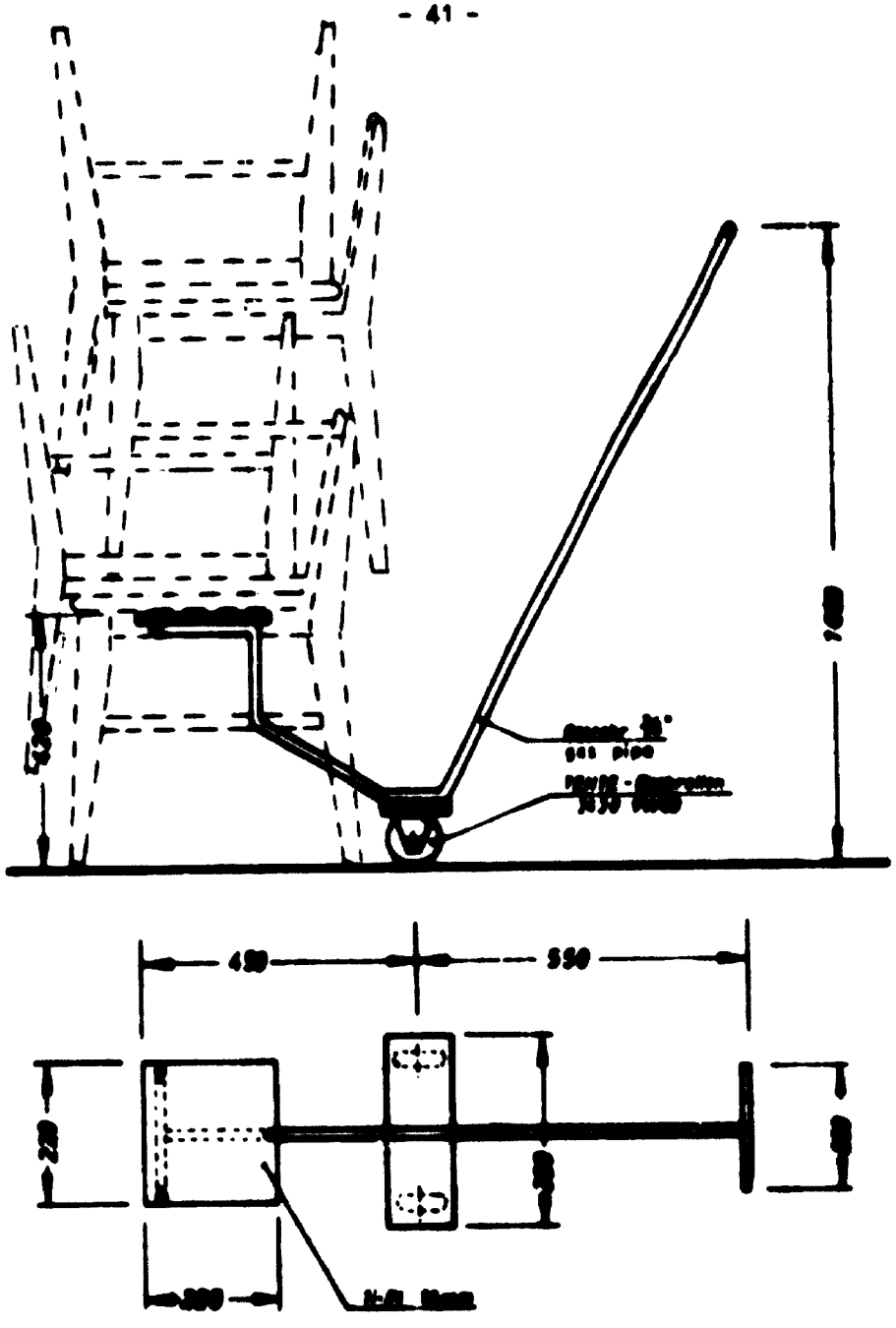
turning table for pre assembly and assembly or spraying

8473/86



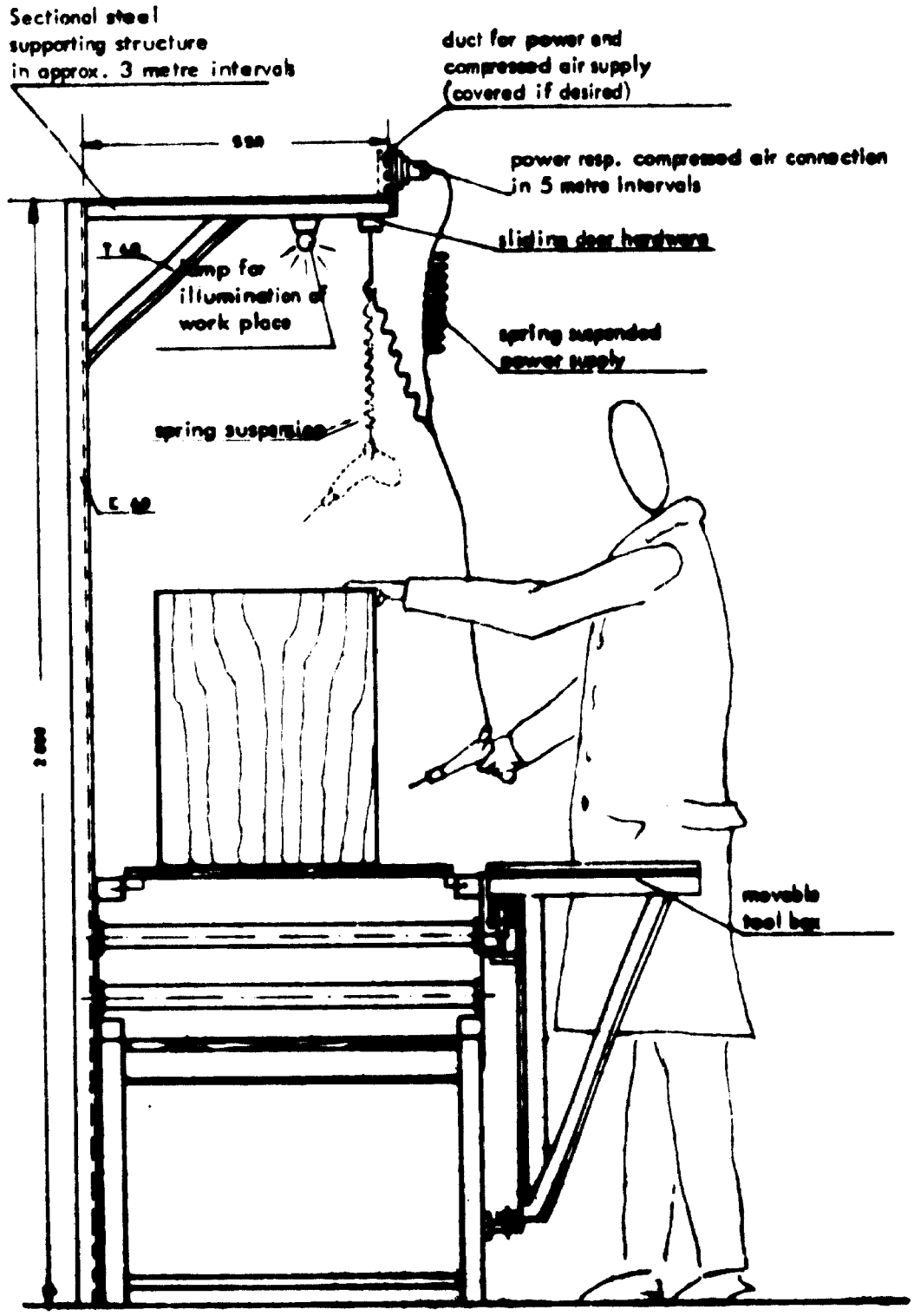
ANNEX IV

upholstering of chair - seats in a rubber membrane



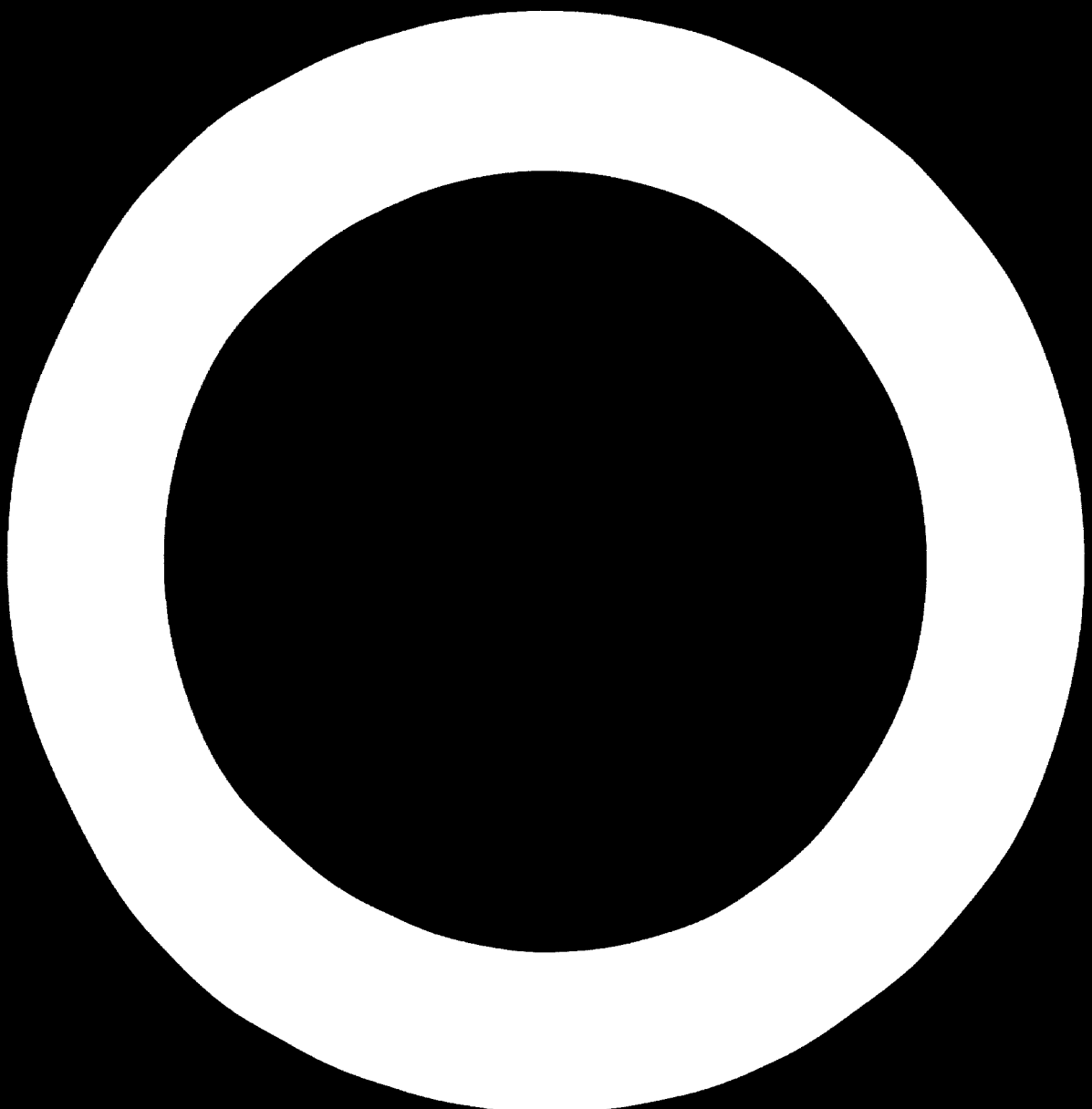
007/12b

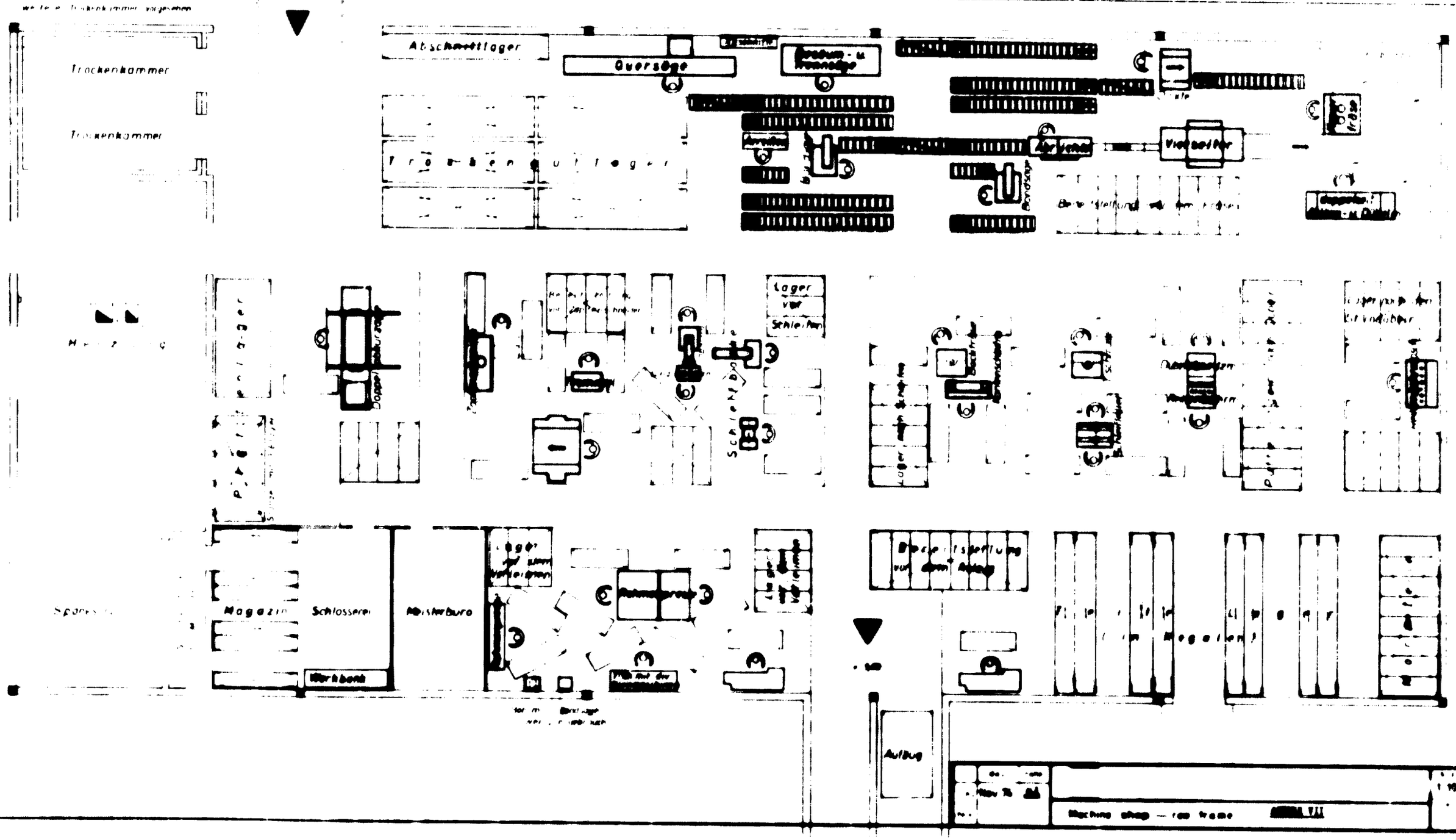
ANNEX V Special Truck for Chairs

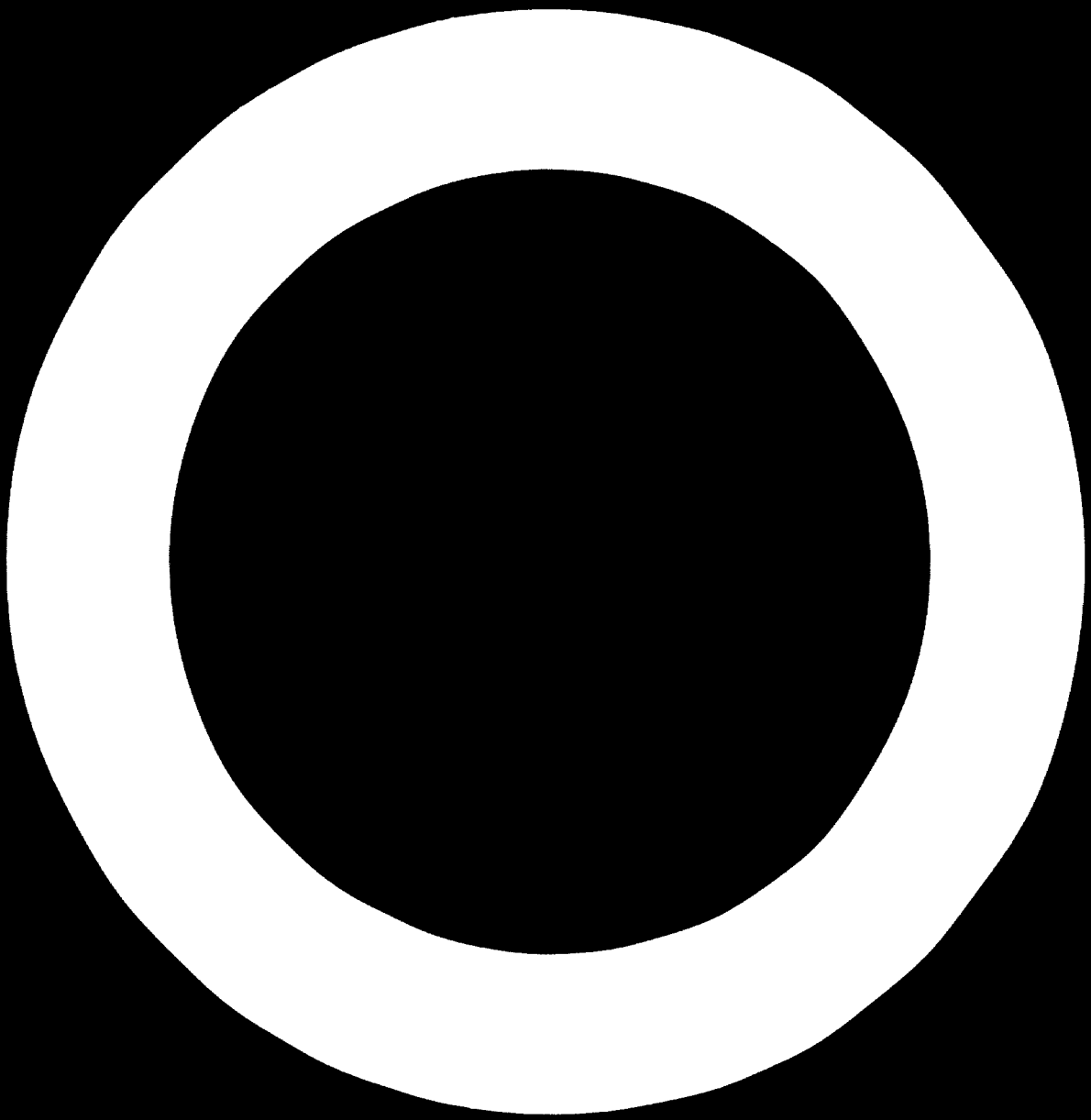


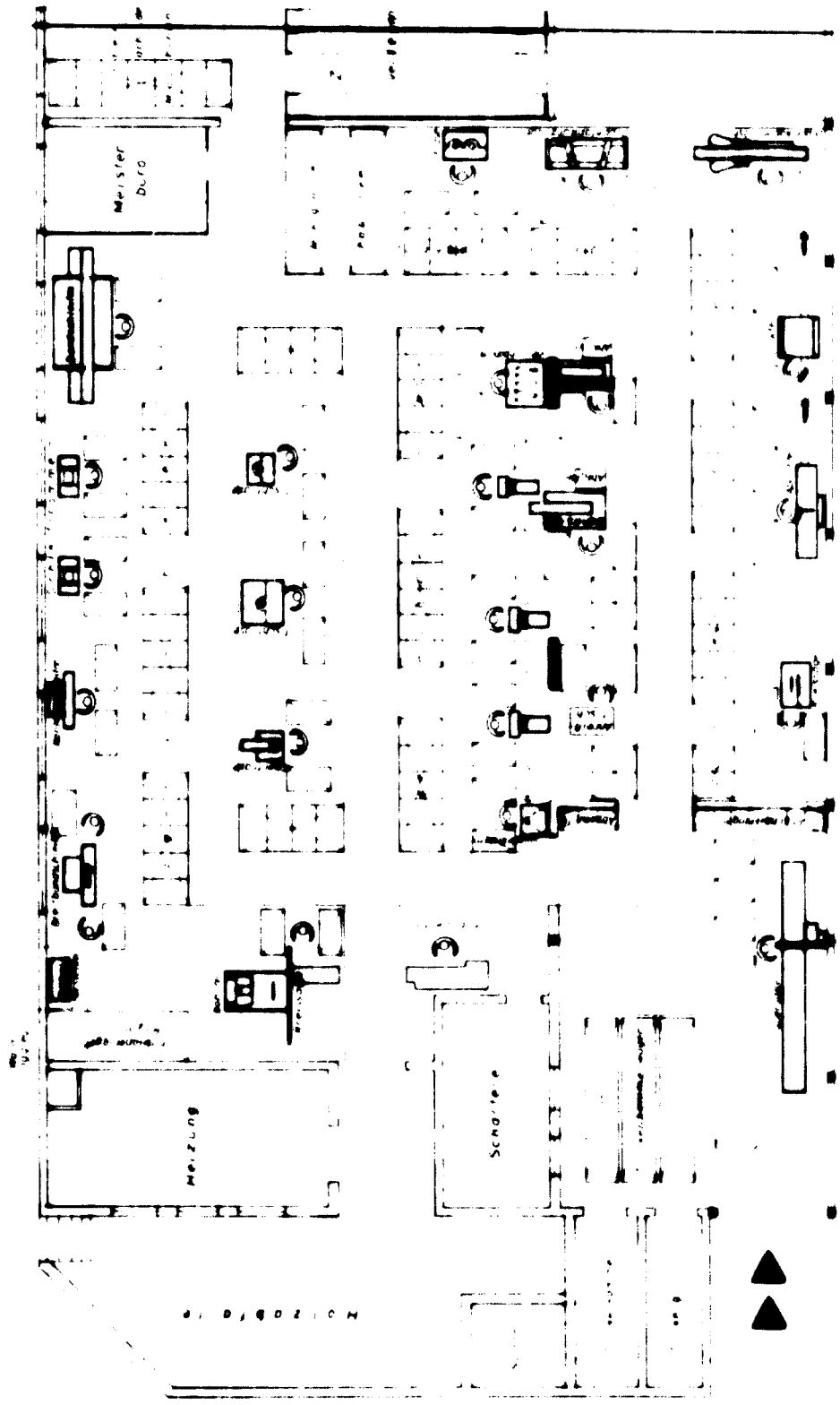
ANNEX VI Energy Supply Equipment For Assembly Line
Car casses

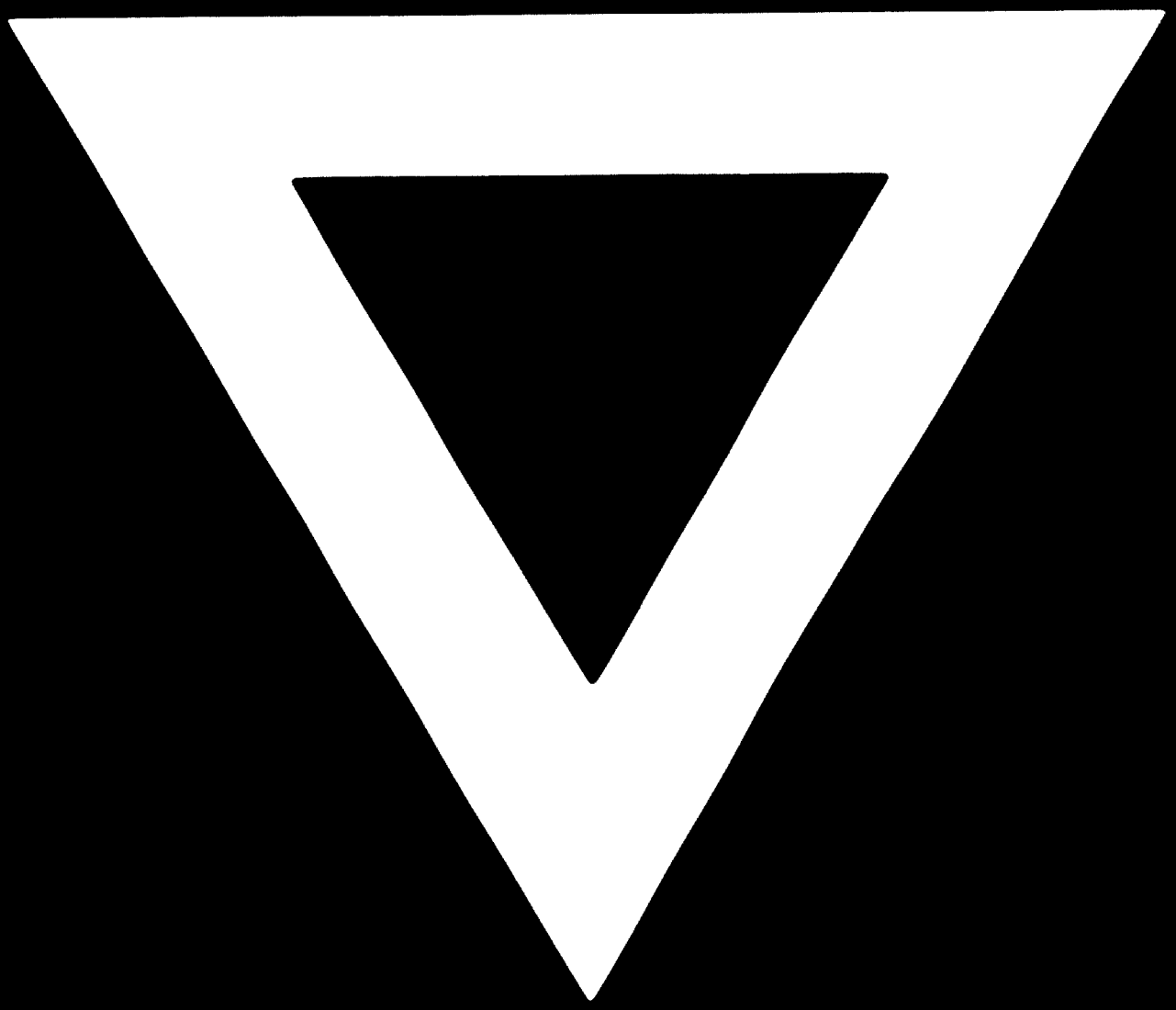
8487 I/4e




Trockenkammer
Trockenkammer
Abschnittlager
Quersäge
Magazin
Schlosserei
Aufzug




Meister
Duro



75.08.11