



Selected Learning Materials

Industrial Technology

AIM OF THE MODULE

• To acquire necessary skills to be able to independently manage the technological processes of wood processing in order to ensure high quality (compliant with quality requirements) and efficient work process.

ASSESMENT FORM

- Within a module, during the learning process, the trainee prepares a description of the quality of the raw materials and at the end of the module describes how raw materials quality influences the production process and end result.
- Within the module, the student prepares the scheme of technological process and functional parameters (equipment settings, processing parameters, cutting tool parameters, productivity, and raw material characteristics) of the equipment. At the end of the module, the student presents an analysis of the production technological processes and proposals for improving efficiency.
- During the module, the student monitors the adequacy of technological processes to ensure product quality. At the end of the module the student identifies the major quality mismatches and makes proposals for their timely elimination.
- During the module trainee analyses the possibilities to improve management and production processes and presents the possibilities to implement recent technological development advantages of digitalization, automatization and robotization in his company.

TARGET GROUP

Wide range of learners of various profiles and scales of woodworking and furniture manufacturing companies, as well as different levels of responsibility and competence - from employees directly involved in production technological processes to a medium-sized woodworking plant manager.

WORK-BASED-LEARNING

The implementation of the project is based on the allocation of fields of responsibility based on the area in which their company works, or personal interest. Work based learning is following all the models from the beginning to the end of the studies.

All the topics have been chosen to be relevant to the working environment in a wood processing or furniture company, and all the discussions and case studies have been related to a real work environment, including practical, drafting, layout, planning work. This is also reflected in the Methods and ideas for learning process and Assessment of acquired learning outcomes (optimal level)).



READING LIST

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- Postel J. Furniture Design. Hoboken, N.J.: John Wiley & Sons, inc, 2013. 434 p.
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- Aghayere A., Vigil J. Structural Wood Design: A Practice-Oriented Approach. Hoboken, New Yersey: JohnWiley. 2007. 396 p.
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- Handbuchtechnishes Zeichnen und Entwerfen Möbel und Innenausbau. Germany: Deutsche Verlags Anstal, Germany, 2004. 280 S.
- Lefteri C. Wood, Materials for Inspirational Design. Switzerland: RotoVision, 2003. 160 p.





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- 1. MODULE 'INDUSTRIAL TECHNOLOGIES' (Edvīns Grants)
- 2. WOOD MOISTURE AND WOOD DRYING (Edgars Bukšāns)
- 3. MANUFACTURE OF WOODEN CONSTRUCTIONS (Kārlis Pugovičs)
- **4. PRODUCTION OF WOOD BASED PANELS: GENERALLY AND THEORY** (Uldis Spulle)
- 5. PRODUCTION OF WOOD BASED PANELS: FIBERBORDS (Uldis Spulle)
- 6. PRODUCTION OF WOOD BASED PANELS: PARTICLEBOARDS AND ORIENTED STRAND BOARDS (Uldis Spulle)
- 7. PRODUCTION OF WOOD BASED PANELS: PLYWOOD (Uldis Spulle)
- 8. NEW RENEWABLE MATERIALS: SOME EXAMPLES AND TRENDS (Andrejs Domkins)
- 9. WOOD FURTHER PROCESSING OPTIONS (Andrejs Domkins)
- 10. FINAL EXAMINATION



Topic:

"INDUSTRIAL TECHNOLOGIES"

Author Edvīns Grants







MODULE 'INDUSTRIAL TECHNOLOGIES'

"SKILLS FOR BALTIC WOOD INDUSTRY EUROPEAN QUALITY IN VOCATIONAL EDUCATION AND TRAINING"

ERASMUS + K2 SSA PROJECT TRAINING PROGRAMME





Meža un koksnes produktu pētniecības un attīstības institūts, SIA Researcher, Building Fire Protection Engineer



Rodentia, SIA

Construction Designer



Latvia University of Life Sciences and Technologies



"Student of the Year" 2019



SCHEDULE

Time	Activities	Place						
09:00 – 10:15	 Classification of wooden buildings by type of construction Classification of wood materials used in wooden constructions 3rd floor 							
10:15 – 10:30	Pause							
10:30 – 12:00	 Classification of the most common connectors in wooden constructions; Structural protection of wooden constructions against the effects of atmospheric conditions; 							
12:00 – 13:00	Lunch break							
13:00 – 13:15	g to SIA "IKTK" 46 Rubeņu Road, Raubēni,							
13:15 – 14:45	Excursion in the company SIA "IKTK"	Ozolnieku County, Latvia						
14:45 – 15:00	Going to SIA "Nordic Homes" 36 <i>Celtnieku</i> Street, Āne, Cenu							
15:00 – 16:30	Excursion in the company SIA "Nordic Homes"	Parish, Ozolnieku County, Latvia						
16:30 – 16:45	Return to the Faculty of Forestry, Department of Wood Processing							
16:45 – 17:30	 Chemical protection of wooden constructions against the effects of atmospheric conditions; Closing 	41 Dobeles Street, Jelgava, Latvia, 3rd floor						

BREAKDOWN OF WOODEN BUILDINGS – BY TYPE OF CONSTRUCTION



From hewn logs

Log buildings From turned timber logs

From machined timber logs





BREAKDOWN OF WOODEN BUILDINGS – BY TYPE OF CONSTRUCTION



Lightweig ht timber frame Modular timber frame buildings

Solid timber frame (Full lattice)

Pile buildings





BREAKDOWN OF WOODEN BUILDINGS





Sakyamuni Pagoda of Fogong Temple, China

 $H - 67.31 \, \text{min}.$

Age ~1000 years



CIRCULATION AND CONFORMITY OF CONSTRUCTION PRODUCTS

CONSTRUCTION PRODUCT REGULATION NO. 305/2011 PROVIDES THAT ALL CONSTRUCTION PRODUCTS IN CIRCULATION SHOULD HAVE THE CE MARKING

THE CE MARKING MAY ONLY BE PLACED ON PRODUCTS WHICH MAY BE MANUFACTURED IN ACCORDANCE WITH ANY STANDARD APPROVED IN EUROPE

MOREOVER, THE CE MARKING SHOULD NOT BE PLACED ON THE PRODUCT UNTIL THE MANUFACTURER HAS ISSUED A "DECLARATION OF PERFORMANCE" FOR THE PRODUCT.

CIRCULATION AND CONFORMITY OF CONSTRUCTION PRODUCTS

• WHAT ARE THE STANDARDS?

	CE marking procedure and the assessment procedure	Test standards		
Harmonised standards	European Assessment Documents (EAD + ETA)	Descriptions of test procedures	Classification standards	EXAP standards
Mandatory in Europe	Product evaluation is carried out on a voluntary basis	Descriptions of calculation procedures		
EN 14080	EAD 130005-00-0304	Tabulated values		



CIRCULATION AND CONFORMITY OF CONSTRUCTION PRODUCTS

• WHAT DOES THE CE MARKING MEAN?



Hygiene, the <u>environm</u>ent

Mechanical strength and stability



Usage

Fire

use of natural resources



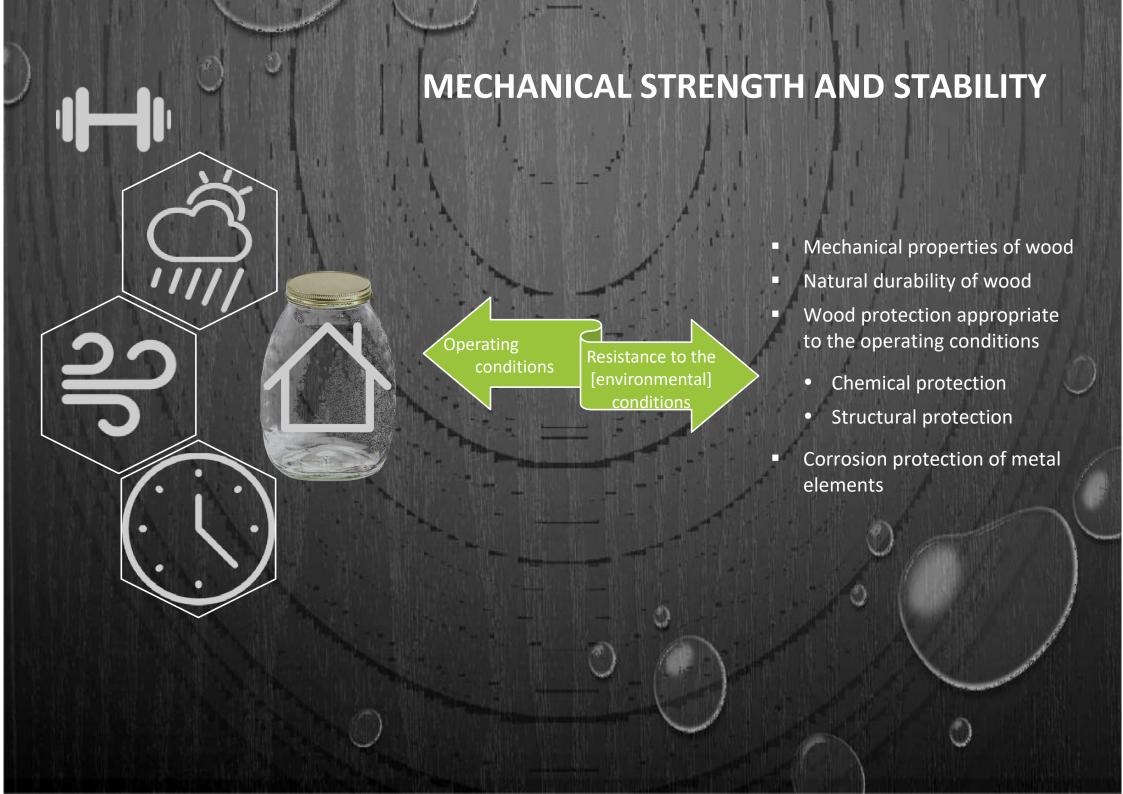


Energy saving





Category of the planned service life	Service life, expressed in years	Examples
1	10	Temporary structures
2	10-25	Replaceable building elements of buildings
3	15-30	Agricultural buildings
4	50	Buildings and their constructions
5	100	Monumental structures such as bridges
LVS EN 1990		







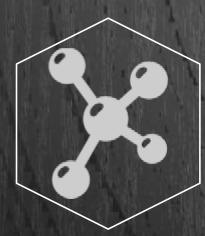


How much will we be able to save?
How much do we plan to save?

- Fire reaction of finishing materials
- Fire resistance of load-bearing and enclosing structures
- Fire protection equipment
- Maintenance of fire protection equipment
- Evacuation support
- Conformity of the structure to the specifics of rescue works



HYGIENE, HEALTH AND ENVIRONMENT



Wood preservatives contain substances that include harmful fumes or leachates



Insufficient detail of the construction project leads to ill-considered solutions, which can result in moisture problems during operation

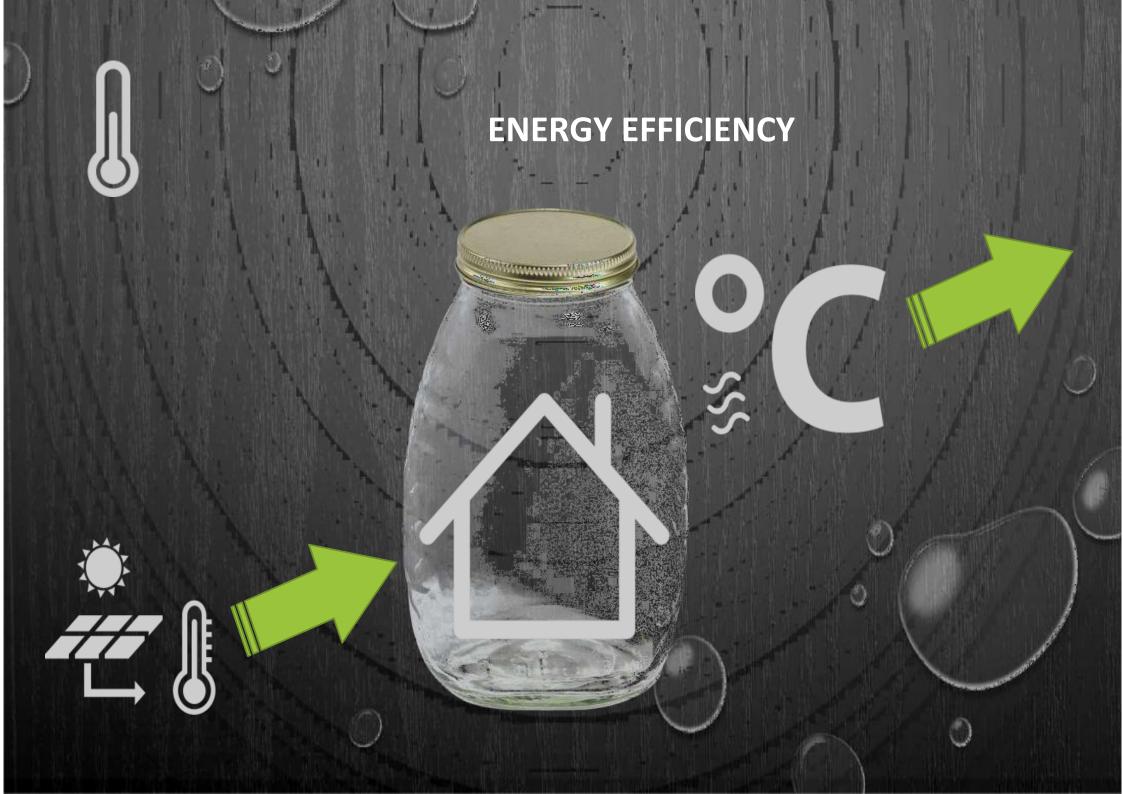


SAFETY





Noise protection





SUSTAINABLE USE OF NATURAL RESOURCES



What methods are used to ensure service life?



Is maintenance required?

Where is everything stored when the service life is over?

WOOD MATERIALS IN CONSTRUCTION

Wooden Constructions

Structural Composite Materials

Wood thermal insulation materials

Wood finishing materials

Windows/d

Modified wood

Building constructions (beams,

Building

Construction boards

Structural lining

Structural elements

Building constructions (beams, columns, girders)

Construction boards

Building kits

Thermally modified wood

Chemically modified wood

CIRCULATION AND CONFORMITY OF CONSTRUCTION PRODUCTS

• WHAT ARE THE EVALUATION SYSTEMS?

AVCP 1+	AVCP 1	AVCP 2+	AVCP 3	AVCP 4
Т	he manufacturer shall de	evelop a control system	of the production proces	SS
				The manufacturer shall determine the product type
The notified certification body assesses the characteristics of the product	The notified certification body assesses the characteristics of the product	The manufacturer or the notified laboratory shall assess the characteristics of the product	Notified laboratory shall assess the characteristics of the product	The manufacturer evaluates the properties of the product
The notified certification body shall certify the product and the manufacturing process	The notified certification body shall certify the product and the manufacturing process	The notified certification body shall certify the manufacturing process	-	-
The certification body carries out regular monitoring and testing	The certification body carries out regular monitoring	The certification body carries out regular monitoring	-	-
The manufacturer shall prepare the DOP	The manufacturer shall prepare the DOP	The manufacturer shall prepare the DOP	The manufacturer shall prepare the DOP	The manufacturer shall prepare the DOP

DETERMINATION OF CONFORMITY



- WE WISH TO ACHIEVE THE REGULATED LEVEL;
- 2. WE WISH TO IMPROVE THE PERFORMANCE OF BUILDINGS BY RAISING THE REQUIREMENTS ABOVE THE REGULATED LEVEL;
- WE WISH TO HAVE MEASURABLE PARAMETERS TO ENSURE THE PERFORMANCE OF A BUILDING OR PARTS THEREOF;
- 4. WE WISH FOR RELIABLE RESULTS;
- WE WANT TRACEABILITY;
- 6. WE WANT SOMEONE TO BE LIABLE IF PROBLEMS ARE IDENTIFIED.

DECLARATION OF PERFORMANCE

identification code: KD 002 revision 01

Type, batch or serial number. Flush Casement.

Intended use(s): Communication in domestic and commercial locations

4. Manufacturer:

Name: Address K & D Joinery Ltd Joinery House

69 Chequers Lane Dagenham RM9 6QJ

- 5. Authorised representative: Not Applicable
- 6. Assessment and Verification of Constancy of Performance (AVCP) System: System:

 Name and identification number of the notified body. University of West Hungary, Faculty of Wood Science. FAIMEI Material and Product Testing Laboratory, NB 2385

Performed: Calculations under system: AVCP System 3 and issued: Calculation reports

- 8. European Technical Assessment, Not Applicable
- 9. Declared performance

Essential characteristics	Performance	Harmonised technical specification					
Watertightness	npd						
Dangerous substances	The materials in this product do not release any hazardous substances in excess of any European or national requirements						
Resistance to wind load	npd	EN 14351-1 2006+A1 2010					
Load-bearing capacity of safety devices	npd	EN 14351-12006+A12010					
Acoustic performance	npd						
Thermal transmittance	Setter than 1.6 W/m²K						
Radiation properties	npd						
Air paymeability	npd						

10. The performance of the present identified in points 1 and 2 is in continuous with the declared performance in point 9. This declaration of performance is assess under use sole responsibility of the manufacturer identified in point 4.

Signed for and on behalf of the coop facturer by:

Name

Larry Kearns Managing Direct

Signatu

20mo Di

1 11 2012

Place of issue: John

CONSTRUCTION STANDARDS AND EUROPEAN TECHNICAL ASSESSMENT DOCUMENTS

- 1. A LIST OF CURRENT VERSIONS OF PRODUCT STANDARDS IS AVAILABLE:
 - HTTP://EC.EUROPA.EU/GROWTH/SINGLE-MARKET/EUROPEAN-STANDARDS/HARMONISED-STANDARDS/CONSTRUCTION-PRODUCTS/
- 2. ALL INFORMATION ON APPROVED CEN STANDARDS AND TECHNICAL REPORTS CAN BE FOUND:
 - HTTPS://STANDARDS.CEN.EU/DYN/WWW/F?P=CENWEB:105:0:RESET::::
- 3. NATIONAL STANDARDS OF LATVIA CAN BE FOUND:
 - HTTPS://WWW.LVS.LV/
- 4. EUROPEAN TECHNICAL ASSESSMENT DOCUMENTS ISSUED BY THE EUROPEAN ORGANISATION FOR TECHNICAL ASSESSMENT CAN BE FOUND:
 - HTTPS://WWW.EOTA.EU/EN-GB/CONTENT/HOME/2/







STRENGTH GRADED SAWN TIMBER

Mechanical strength and stability

LVS EN 14081-1



• LVS EN 338 – STRENGTH CLASSES OF STRUCTURAL TIMBER

Table	1 — Stren	gth o	classes fo	or softv	vood b	ased o	on edge	ewise t	endin	g tests -	stren	gth, sti	ffness	and de	nsity v	alues			
					Class		C14	C16	C18	C20	C22	C24	C27	C30	C	35	C40	C45	C50
Strength properties in N/m	m²											elle e							~
Bending					$f_{m,k}$		14	16	18	20	22	24	27	30		35	40	45	50
Tension parallel					$f_{t,0,k}$		7,2	8,5	10	11,5	13	14,5	16,5	19	1 12	22,5	26	30	33,5
Tension perpendicular					f=90.4		0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	A STATE OF THE STA	0,4	0,4	0,4	0,4
Compression parallel					$f_{c,o,k}$		16	17	18	19	20	21	22	24	9	25	27	29	30
Compression perpendicular					$f_{c.90.k}$		2,0	2,2	2,2	2,3	2,4	2,5	2,5	2,7	9	2,7	2,8	2,9	3,0
Shear					$f_{n,k}$		3,0	3,2	3,4	3,6	3,8	4,0	4,0	4,0	ğ	4,0	4,0	4,0	4,0
Stiffness properties in kN/r	nm²											400							
Mean modulus of elasticity pa	rallel ben	ding			Emame	00%	7,0	8,0	9,0	9,5	10,0	11,0	11,5	12,0)	13,0	14,0	15,0	16,0
5 percentile modulus of elasti	icity parall	lel be	ending		$E_{oi,0,k}$		4,7	5,4	6,0	6,4	6,7	7,4	7,7	8,0	ž	8,7	9,4	10,1	10,7
Mean modulus of elasticity pe	erpendicul	lar			E _{m.90.m}	iean	0,23	0,27	0,30	0,32	0,33	0,37	0,38	0,40	0,	43	0,47	0,50	0,53
Mean shear modulus					G_{mean}		0,44	0,50	0,56	0,59	0,63	0,69	0,72	0,75	0,	81	0,88	0,94	1,00
Density in kg/m³					72	1.0	- 0);; 11	7.0		11)		100					Ž:
5 percentile density					ρ_k		290	310	320	330	340	350	360	380	1 8	390	400	410	430
Mean density					Pmean		350	370	380	400	410	420	430	460	Ĕ j	470	480	490	520
	Table 2 –	– Str	rength cl	asses	for sof	twoo	d base	d on te	ension	tests -	strens	zth. sti	ffness	and de	ensity	values	HAUTE		
	Class	T 8	ers	T 10		T 12	VOLUMENTS VINC	9 94803190	T	77.45		T 18	CONTRACTOR NAME	nesantees	STEELENS IN	T 26	=Tel=altre	T 28	T 30
Table 3	— Streng	th cl	asses for	hardv	voods	based	on ed	gewise	bendir	ng tests	- stre	ngth, st	tiffness	s and d	ensity	value	s s	1,11	2011
Sitting 1			Class	D18	D2	4 D	27 1	D30	D35	D40	D45	D50	D55	D6	0 D	65 1	070	D75	D80
			Stellyste	1000	(0.05%)	5 120	E522	135.64 /.	1894 (6t) / L	7050 PA	1503	1000000	1.025-017	N	E (1977)	0.654	DE0/09/11	0.000000	Ministra



Strength graded sawn timber with rectangular cross section (EN 14081-...)

- General requirements for visually and mechanically graded sawn timber (EN 14081-1);
- Additional requirements for mechanically graded sawn timber (EN 14081-2 and EN 14081-3);



	Performance or level example
. The unique identification code of the product type:	Strength graded structural timber with rectangular cross section
2. The intended use/s:	Buildings and bridges
I. The manufacturers name, registered	Any Timber Company Ltd
trade name/ trade mark and contact address	Newtown, Ireland
The authorised representative (if appro- priate)	Not appropriate
i. System/s of AVCP	2+
i. (a) Harmonised standard	EN 14081-1:2016
(b) Notified body	TimberCert NB xxxx
7. Declared performance/s	
Mechanical resistance:	
Sending strength	Minimum C16 to EN 338.
Compressive strength	
Tensile strength	
Shear strength	
Modulus of elasticity (mean)	
Fire resistance	Species group PCST
	Declared by strength class above
Reaction to fire	D-s2,d0 CWFT
Durability	Durability class 4-5 for fungal attack according to EN 350
Release of dangerous substances	NPD
Appropriate Technical Document and/or Specific Technical Documentation	



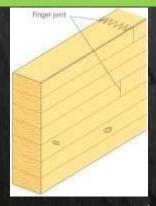
Solid wood timber with finger joints (EN 15497);

• The product parameterisation is the same as for strength graded materials with some additional requirements for finger joints.

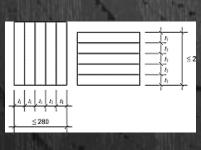


Glued timber (EN 14080);

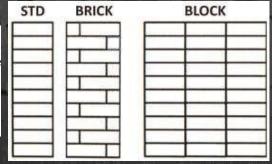
The product subtypes and strength classes are listed in that standard



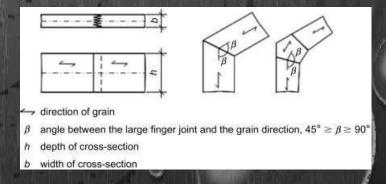
Homogeneous and combined glulam beams (Gl... h; Gl... c)



Solid glulam beams (Gl...h; Gl...c)



Alternately glued beams, block glulam beams, sawn beams



Glued finger joint constructions



Prefabricated structural members assembled with punched metal plate fasteners (EN 14250);

 The load-bearing capacity of the product is determined by designing the construction in accordance with the applicable Eurocodes in accordance with one of the methods of application of the Eurocodes (European Commission Guideline L).



Wooden poles for overhead lines (EN 14229);



Laminated structural timber (EN 14374);

 Product types, classification and load-bearing capacity parameters are different for each manufacturer. They are determined by testing the product assortment for each manufacturer individually.



Factory made wood wool (WW) products (EN 13168):

Intended use – thermal insulation material



Factory made wood fibre (WF) products (EN 13171):

• Intended use – thermal insulation material



Wooden flooring (EN 14342):

• Intended use – Finishing products for indoor floors



Solid wood panelling and cladding (EN 14915):

 Intended use – Finishing materials for partitions, external walls, and ceilings

CONSTRUCTION WOOD AND WOOD CONSTRUCTION PRODUCTS – CONSTRUCTION WOOD BOARDS



Solid wood panels (EN 13353) SWP/1-3 structural; SWP/1-3 non-structural.

Plywood (EN 636-...) and LVL (EN 14279): EN 636-1 (S), LVL/1; EN 636-2 (S), LVL/2; EN 636-3 (S), LVL/3.



OSB/1 – for indoors, not moisture resistant;

OSB/2 – for furniture production;

OSB/3 – for indoors, humid conditions;

OSB/4 – abrasion resistant for indoors, moisture

Particleboards (EN 312):

P1–P7 – Even class is for boards intended to be used in dry conditions, but odd – for wet

Cement-bonded particleboards (EN 634-2): Types 1 and 2

Fibreboards (EN 622-2): B or HB. (...)

Medium boards (EN 622-3 and 622-5):
MB (...), MDF (...)

Softboards (EN 622-4 and 622-5): SB (...)

A list of the current versions of the harmonised standards in force is available at: http://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/construction-products/

CONSTRUCTION WOOD AND WOOD CONSTRUCTION PRODUCTS – WOOD CONSTRUCTION PRODUCTS, WHICH COMPLY WITH EOTA GUIDELINES













STRENGTH GRADED SAWN TIMBER – MECHANICAL STRENGTH

Mechanical strength and stability

LVS EN 14081-1



• LVS EN 338 – STRENGTH CLASSES OF STRUCTURAL TIMBER

Table	1 — Stre	ngth	classes f	or softv	vood b	ased o	n edge	ewise b	endin	g tests	- stren	gth, sti	ffness	and de	nsity v	alues			
					Class		C14	C16	C18	C20	C22	C24	C27	C30	С	35	C40	C45	C50
Strength properties in N/n	nm²											-110							
Bending					fmk		14	16	18	20	22	24	27	30		35	40	45	50
Tension parallel					$f_{\text{t.0.k.}}$		7,2	8,5	10	11,5	13	14,5	16,5	19	1 12	22,5	26	30	33,5
Tension perpendicular					f=90.4		0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	N. S.	0,4	0,4	0,4	0,4
Compression parallel					$f_{c,o,k}$		16	17	18	19	20	21	22	24	9	25	27	29	30
Compression perpendicular					$f_{c.90.k}$		2,0	2,2	2,2	2,3	2,4	2,5	2,5	2,7	9	2,7	2,8	2,9	3,0
Shear					$f_{n,k}$		3,0	3,2	3,4	3,6	3,8	4,0	4,0	4,0	1	4,0	4,0	4,0	4,0
Stiffness properties in kN/	mm²				400							4							
Mean modulus of elasticity p	arallel be	nding			Emame	NO/E	7,0	8,0	9,0	9,5	10,0	11,0	11,5	12,0)	13,0	14,0	15,0	16,0
5 percentile modulus of elast	ticity para	illel b	ending		$E_{o,0,k}$		4,7	5,4	6,0	6,4	6,7	7,4	7,7	8,0	1	8,7	9,4	10,1	10,7
Mean modulus of elasticity p	erpendicu	ular			E _{m.90.n}	nean	0,23	0,27	0,30	0,32	0,33	0,37	0,38	0,40	0,	43	0,47	0,50	0,53
Mean shear modulus					G_{mean}		0,44	0,50	0,56	0,59	0,63	0,69	0,72	0,75	0,	81	88,0	0,94	1,00
Density in kg/m³					72		- "		27 12	7.0		11-		AC.					70-
5 percentile density					ρ_k		290	310	320	330	340	350	360	380		390	400	410	430
Mean density					Pmenn		350	370	380	400	410	420	430	460	É ja	470	480	490	520
	Table 2	— St	rength (lasses	for so	ftwoo	d hase	d on te	nsion	tests -	strens	rth sti	ffness	and de	nsity	value	HILL		
	Class	Т	2220	T 10		T 12		VARCULUS	т	T 15	- Caro	T 18	Transfer to the	Tre-catrices	CONTRACTOR OF THE PARTY.		=nerate	T 28	T 30
Table 3	— Stren	gth c	lasses fo	r hardy	voods	based	on eds	gewise	bendir	ng tests	- stre	ngth, s	tiffness	and d	ensity	value	s	in the	
E MASSE			Class	D18	1	-	- 1	-	D35	D40	D45	D50	1		-		D70	D75	D80
	10.511.012.00	1711177																-	18

TYPES OF SAWN TIMBER GRADING

Sawn timber

Grading by strength

Mechanical

grading

Load-bearing

wooden

constructions

Visual grading

Load-bearing wooden constructions

Grading by visual appearance

Grading by sawn timber defects

Non-load-bearing wooden constructions

Grading by sawn timber pruning cut

constructions

Non-load-bearing wooden

Non-load-bearing wooden constructions

Grading by the

intended use of sawn

STANDARDS FOR STRENGTH GRADED SAWN TIMBER

EN 14081-1

The main standard in Europe (sets requirements and regulates the affixing of the CE marking)

BS 4978

INSTA 142

DIN 4074-1

Standards of other European countries

NLGA

British (Irish)
coniferous sawn
timber grading
standard

Scandinavian
countries (Finland,
Sweden, Denmark,
Norway, Iceland)
grading standard for
coniferous sawn
timber

German (Austria, the Czech Republic, Slovenia) coniferous sawn timber grading standard

France, Italy, the Netherlands, Portugal, Spain, Slovakia

Canadian coniferous sawn timber grading standard

STRENGTH GRADED SAWN TIMBER

LVS EN 1912

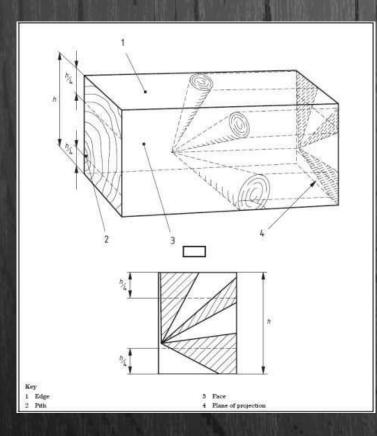
GRADING RULES – 14 NATIONAL TIMBER VISUAL GRADING METHODS ARE RECOGNISED IN EUROPE. FOR MECHANICAL GRADING, EACH PIECE OF EQUIPMENT HAS ITS OWN SETTINGS

Nordic countries	T3 T2 T1 T0	Nordic grading rules – INSTA 142:2009 Nordic visual strength grading rules for timber

Each tree species has its own grading rules, depending on the place of origin of the trees

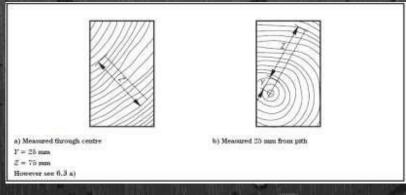
C30	France	ST-I	Spruce & Fir	France	1, 22	
ex	Germany, Austria & Czech Republic	S13, S13K S13, S13K S13, S13K S13, S13K	Spruce Pine Fir Larch	CNE Europe CNE Europe CNE Europe CNE Europe	22 47 1 15	
mo ^{liti} ones (gr	Italy	S1	Douglas fir	Italy	54	Maximum width and thickness 100 mm
) SE	Nordic countries	T3 T3 T3 T3	Pine (Redwood) Spruce (Whitewood) Fir Larch	NNE Europe NNE Europe NNE Europe NNE Europe	47 22 1 15	

STRENGTH GRADED SAWN TIMBER



BS 4978

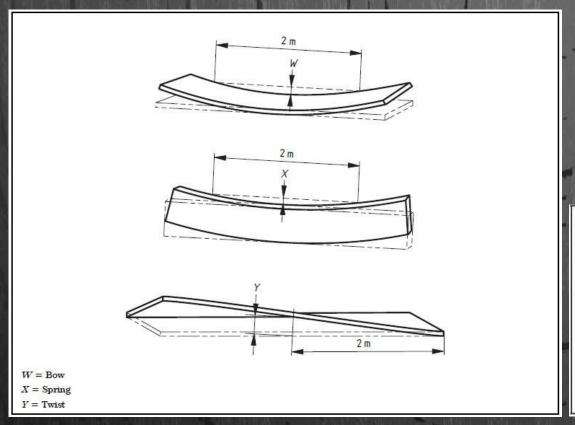
- Determination of the moisture content of sawn timber;
 - Grading of green wood moisture content
 > 20%;
 - Grading of dry wood moisture content > 20%;
- Determination of branching of sawn timber determination of the ratio of branch size and projection area to cross-section;
- 3. Fibre direction cross fibred, or fibre deviation in relation to the straight edges of the board;
- 4. Length of the annual rings;



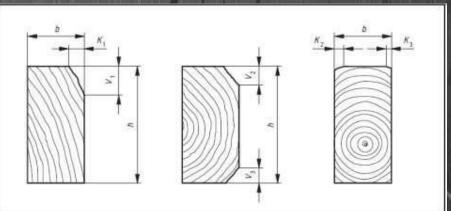




Grading of strength graded sawn timber



- 5. Location and length of cracks;
- 6. Permissible deformations of sawn timber;
- 7. Resin pockets allowed;
- 3. and ingrown bark is not allowed;
- 9. Volume of wane < 1/3 of the face width;



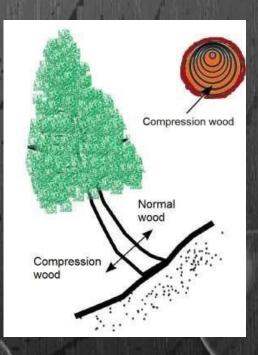


Grading of strength graded sawn timber

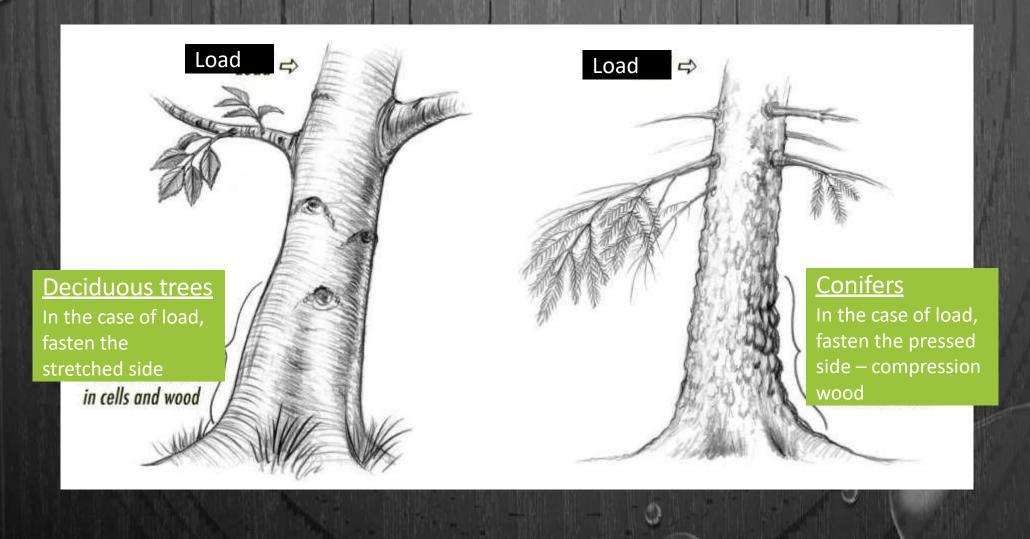


- Insect damage minor damage is allowed except for damage caused by wasps;
- 11. Fungal damage;
 - blue stain is permissible;
 - solid rot is valued by volume;
 - soft rot is not allowed;
- 12. Compression wood < 30% of cross section.





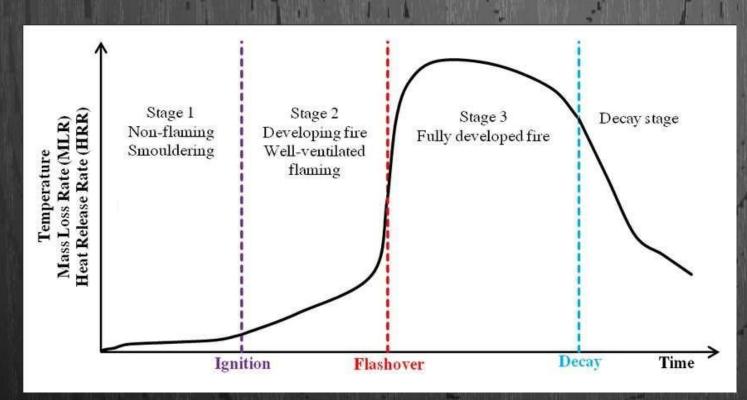
FORMATION OF REACTION WOOD



FIRE SAFETY OF WOODEN CONSTRUCTIONS

DESIGN OF FIRE-RESISTANT WOODEN CONSTRUCTIONS

1. DETERMINATION OF FIRE ACTION DURING THE DESIGN TIME:



Components of fire:

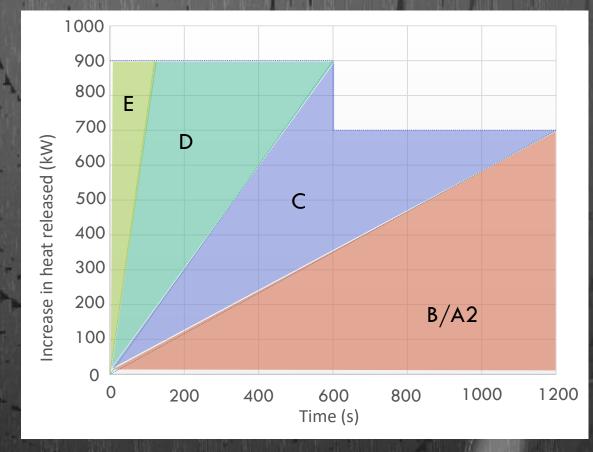
FUEL

- 1. Fuel;
- 2. Oxygen;
- 3. Heat;

TESTING AND CLASSIFICATION OF FIRE REACTION

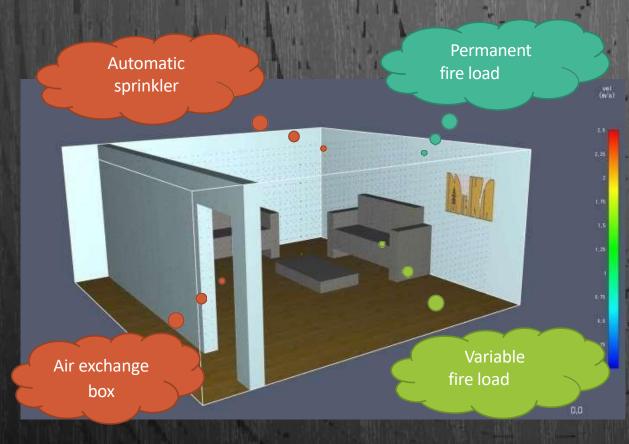


LVS EN 13823 Test

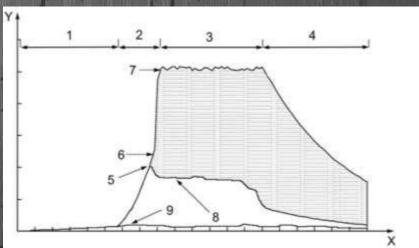


LVS EN 13501-1

LINKAGE BETWEEN CLASSIFICATION OF THE FIRE REACTION AND FIRE CHARACTERISTICS AND COMBUSTION CHARACTERISTICS

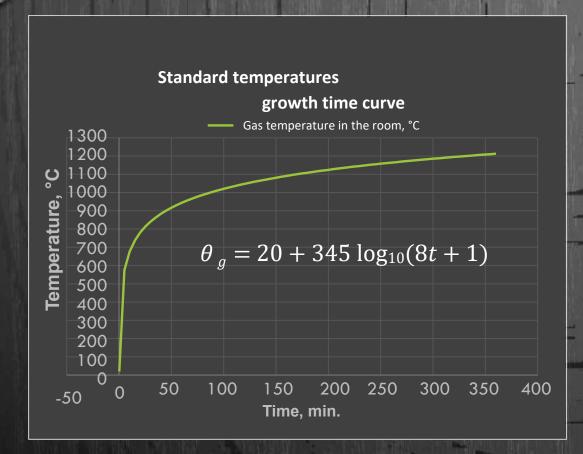


ISO 16733-1



- 1 ignition
- 2 increase in burning
- 3 maximum combustibility
- 4 end of fuel, cooling
- 5 sprinkler activation
- 6 complete ignition
- 7 ventilation-controlled maximum combustibility
- 8 sprinkler-controlled combustibility
- 9 smouldering burning
- X time
- Y increase in heat of combustion

FIRE RESISTANCE



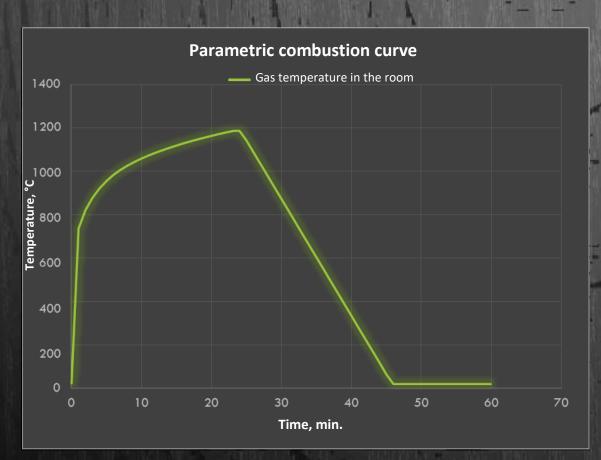
Charcoalization rate of wood when a standard fire scenario is used

	β₀ mm/min	β _n mm/min
a) Softwood and beech Glued laminated timber with a characteristic density of ≥ 290 kg/m³ Solid timber with a characteristic density of ≥ 290 kg/m³	0,65 0,65	0,7 0,8
b) Hardwood Solid or glued laminated hardwood with a characteristic density of 290 kg/m³ Solid or glued laminated hardwood with a characteristic density of ≥ 450 kg/m³	0,65 0,50	0,7 0,55
c) LVL with a characteristic density of ≥ 480 kg/m³	0,65	0,7
d) Panels Wood panelling Plywood Wood-based panels other than plywood The values apply to a characteristic density of 450 kg	0,9 ^a 1,0 ^a 0,9 ^a	-

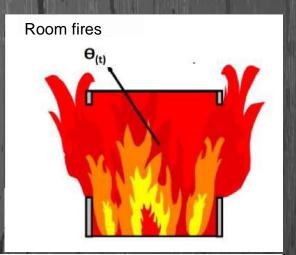
3.4.2(9) for other thicknesses and densities.

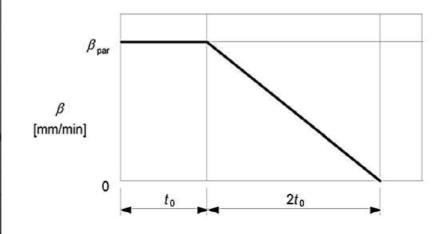
LVS EN 1991-1-2

Influence of fire load on fire resistance



LVS EN 1991-1-2 LVS EN 1995-1-2





$$\beta_{\text{par}} = 1.5 \ \beta_{\text{n}} \frac{0.2\sqrt{\Gamma} - 0.04}{0.16\sqrt{\Gamma} + 0.08} \qquad t_0 = 0.009 \frac{q_{\text{t,d}}}{O}$$

Laiks

design of fire-resistant wooden constructions

• THE PURPOSE OF CALCULATING OR TESTING THE FIRE SITUATION IS TO ENSURE THAT:

$$\textit{E}_{d,fi} \leq \textit{R}_{d,t,fi}$$

THE STRESSES CAUSED BY THE EFFECTS OF THE FIRE DO NOT EXCEED THE STRENGTH LIMITS OF THE STRUCTURE AND THEIR CONNECTIONS IN THE DESIGNED FIRE SITUATION.

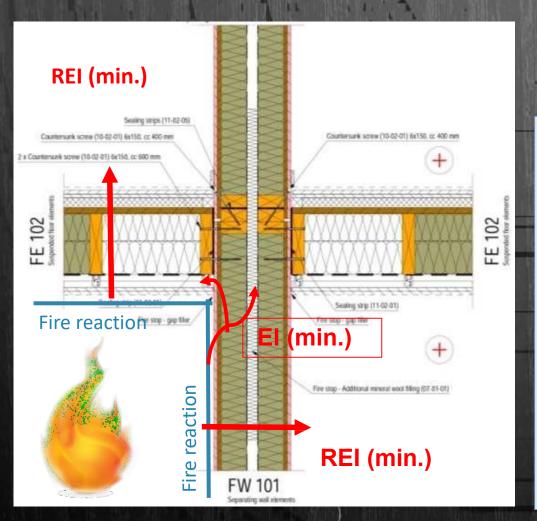
- THE FIRE SITUATIONS OF THE WOODEN
 CONSTRUCTION ARE DESIGNED IN TIME DIMENSION,
 BECAUSE IN A STANDARD AND PARAMETRIC FIRE
 MODEL, THE MAIN PARAMETER AFFECTING THE
 LOAD-BEARING CAPACITY IS THE CHARCOALIZATION
 RATE OF WOOD;
- THE EXTENDED FIRE MODEL ALSO CONSIDERS
 REDUCTION FACTORS OF THE LOAD-BEARING
 CAPACITY OF WOOD AS A RESULT OF TEMPERATURE
 INCREASE.

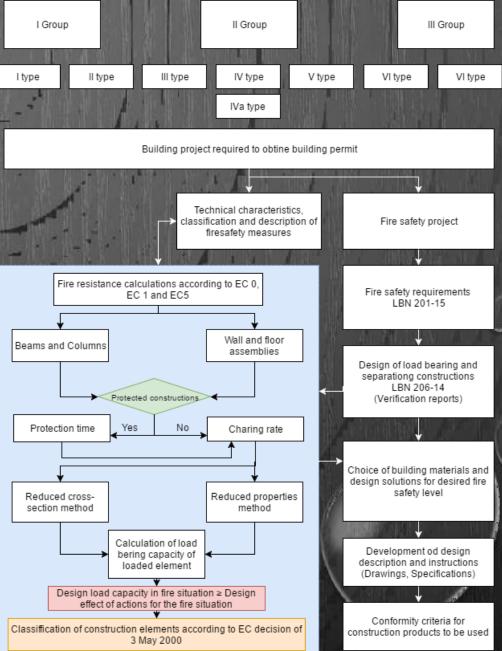
Load-bearing elements with fire containment function											
End use of construction products		for	walls								
Verification standards				•		•		2; EN 1 .999-1.		.2; EN :	1994-
Classification:											
RE			20	30		60	90	120	180	240	360
REI	1	.5	20	30	45	60	90	120	180	240	360
REI-M				30		60	90	120	180	240	360
REW			20	30		60	90	120	180	240	360
Remarks	_	,									

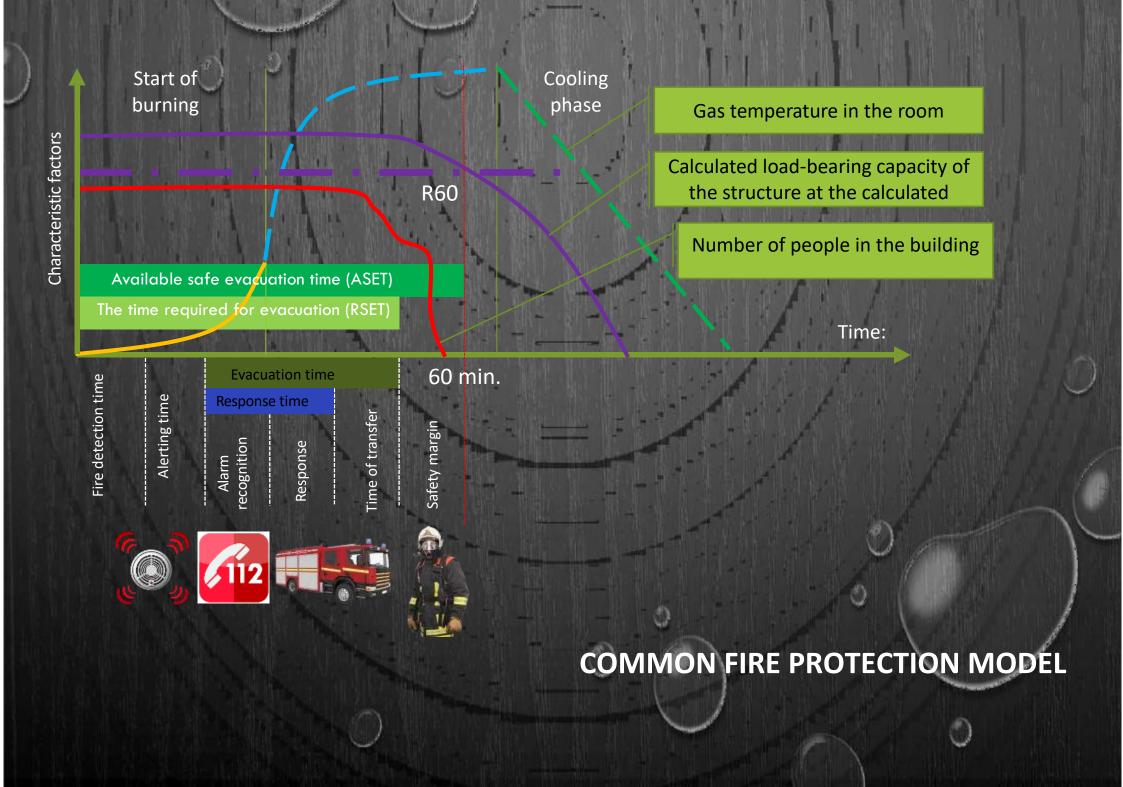
DECISION OF THE COMMISSION 2000/367/EK

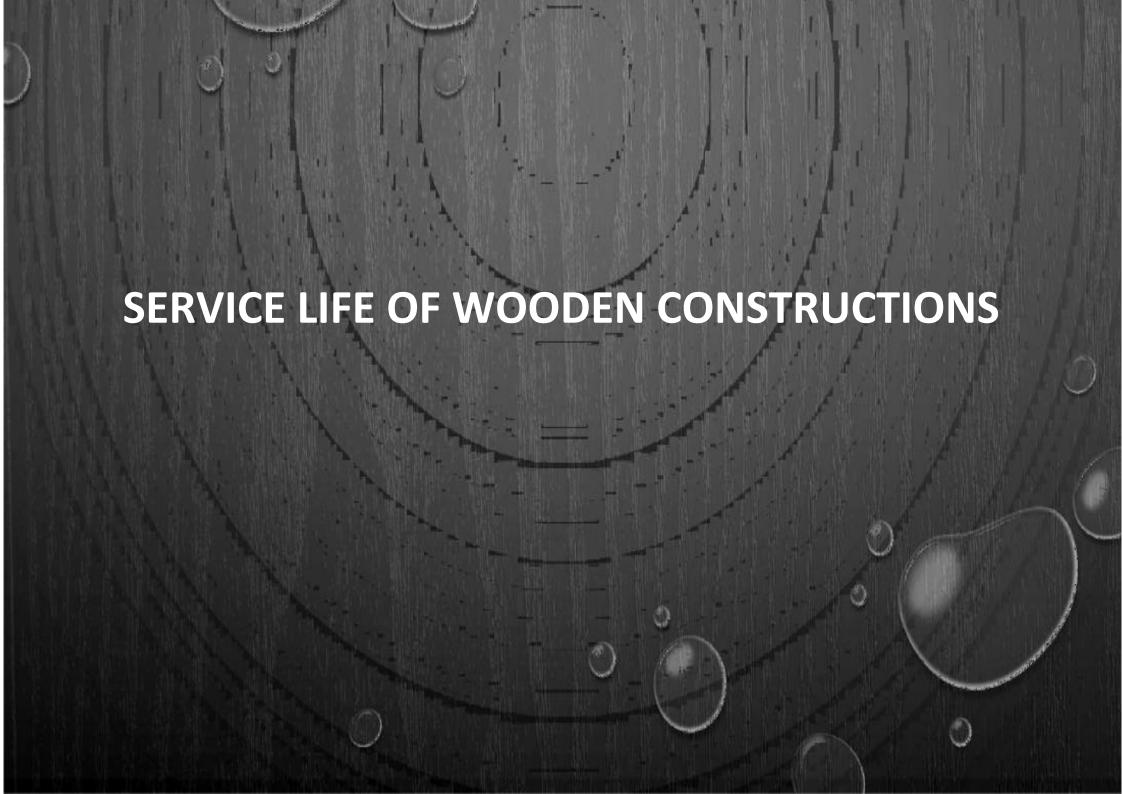
(3 May 2000)

design of fire-resistant wooden constructions











Category of the planned service life	Service life, expressed in years	Examples
1	10	Temporary structures
2	10-25	Replaceable building elements of buildings
3	15-30	Agricultural buildings
4	50	Buildings and their constructions
5	100	Monumental structures such as bridges

LVS EN 1990

RESISTANCE OF WOOD ELEMENTS TO MOISTURE



EN 1995-1-1 – 5. Eurocode

- 1. Service Class
 - ... Service Class
- 3. Service Class

EN 335

- 1. Usability class
- Usability class
- 3. Usability class
- 4. Usability class
- 5. Usability class

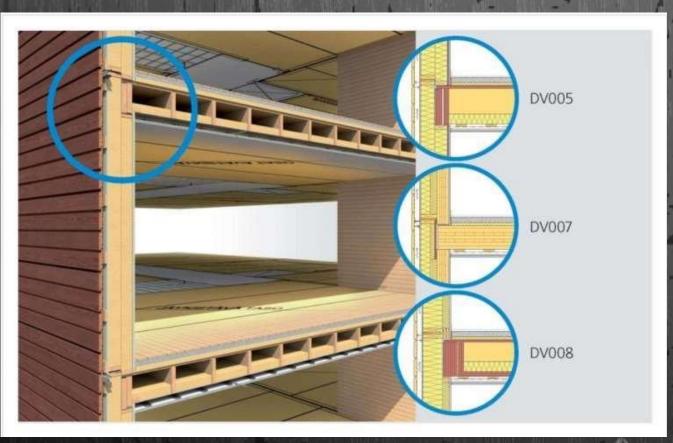


- NATURAL RESISTANCE OF WOOD TO MOISTURE IS DEFINED IN <u>EN 350</u>
 - IN ALL SITUATIONS, THE SAPWOOD IS UNSTABLE;
 - TRUE WOOD MAY BE RESISTANT TO MOISTURE;
- CONSIDERING THE FACT THAT SAPWOOD IS NOT SEPARATED FROM TRUE WOOD, THE EXPOSED WOOD IS ASSUMED TO BE UNSTABLE

Sapwood

True wood

STRUCTURAL PROTECTION OF WOODEN CONSTRUCTIONS AGAINST ATMOSPHERIC CONDITIONS



- 1. Carefully work out the detail for each building, considering:
 - Where does the condensation stay?
 - Where is the precipitation?
 - Are the metal parts protected and will they be resistant enough?

BUILDING FASTENERS OF WOODEN CONSTRUCTIONS



Bracket Type	1. Service Class	2. Service Class	3. Service Class
Nails and screws (EN 14592 or ETA) d ≤ 4 mm	No galvanising required	39 μm	49 μm
Bolts, pins, nails, and screws (EN 14592 or ETA) d > 4 mm	No galvanising required	No galvanising required	49 μm
Clamps (EN 14592)	39 μm	39 μm	Stainless steel
Perforated nail plates (EN 14545)	39 μm	39 μm	Stainless steel
Steel plates (EN 1090- 1) t3-5 mm	No galvanising required	39 μm	49 μm
Steel plates (EN 1090- 1) t > 5 mm	No galvanising required	No galvanising required	49 μm
Construction glue	EN 301 (type II)	EN 301 (type II)	EN 301 (type I)

CHEMICAL PROTECTION OF WOOD – EN 15228

Wood preservation class	Application	Labelling and penetration
NTR/M	Pine wood in seawater (salinity 0.5–3%) • Jetties • Poles • Other wooden structures in saltwater	NTR M Colour code: blue
NTR/A	Pine wood in contact with ground or freshwater, plus structures above ground where personal safety requires that they are not weakened or that can be difficult to inspect or replace Posts Fence posts Bridges Garden woodwork External stairs Balconies Decking directly on the ground Freshwater structures (jetties, etc) Sills Timber frame under decking Playground and fitness equipment	NTR A Colour code: white

NTR/AB	Pine wood above ground Fencing Trellises and pergolas Exterior cladding Bargeboards and fascia boards Roof battens Decking above ground	NTR AB Colour code: yellow
NTR/B	Pine wood above ground, finished exterior joinery • Windows and external doors	NTR B Colour code: red
NTR /Spruce	Spruce wood for exterior cladding - Exterior cladding - Bargeboards and fascia boards - Counter battens and battens - Nailing battens	NTR Spruce Colour code: orange
NTR/GW	Spruce wood for windows Window components	NTR GW Colour code: brown

CHEMICAL PROTECTION OF WOOD – EN 15228

NWPC wood protection classes in relation to EN 351-1 and EN 335

Penetra to EN	ation class according 351-1	Use classes UC1-UC5 according to EN 335 and their relation to the wood protection classes NTR M, NTR A, NTR A pole, NTR AB, NTR B, NTR GRAN and NTR GW							
Class	Penetration requirement	UC 1	UC 2	UC 3	UC 4	UC 5			
NP 1	None			NTR GRAN** NTR GW**	*				
NP 2	Min 3 mm lateral into sapwood								
NP 3	Min 6 mm lateral into sapwood			NTR B					
NP 4*	Min 25 mm								
NP 5	Full sapwood			NTR AB	NTR A NTR A pole	NTR M			
NP 6	Full sapwood + 6 mm into heartwood								

 ^{*} Applies to round-wood of resistant species only, i.e. treatability classified 3-4 according to EN 350.
 ** See NWPC Document No 1, Part 2, applicable to preservative-treated spruce.









THANK YOU FOR YOUR ATTENTION!

- EDVĪNS GRANTS
- SIA "MEŽA UN KOKSNES PRODUKTU PĒTNIECĪBAS UN ATTĪSTĪBAS INSTITŪTS"
 - SIA "RODENTIA"
 - EDVINS.GRANTS@E-KOKS.LV



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Topic:

"WOOD MOISTURE AND WOOD DRYING"

Author Edgars Bukšāns

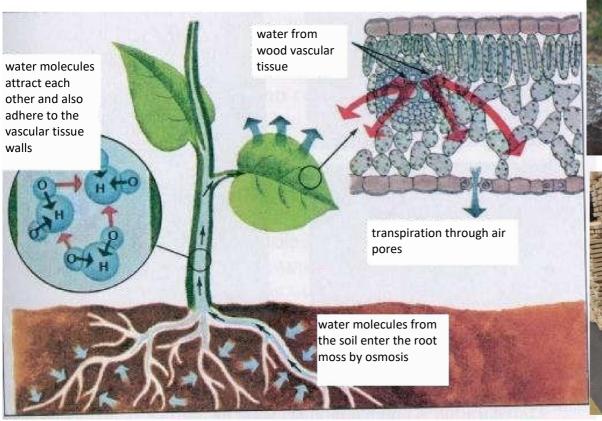
Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA



Wood moisture and wood drying

Edgars Bukšāns

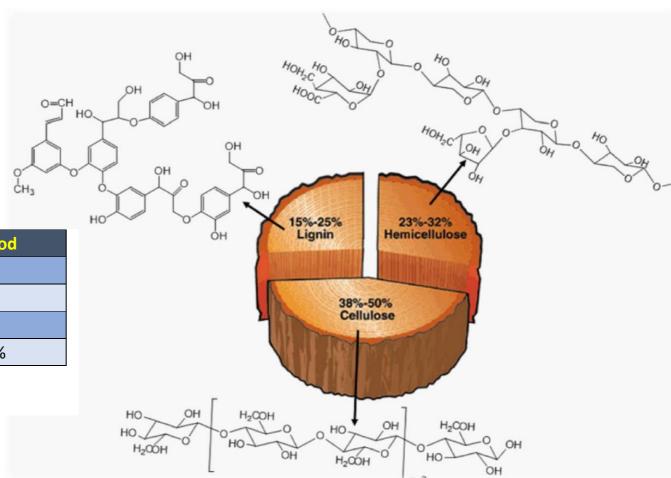
Wood-water system







Chemical construction of wood



Chemical composition of wood							
Carbon (C)	~50%						
Hydrogen (H)	5-6%						
Oxygen (O)	44%						
Nitrogen	0.05-0.25%						



- Absolutely dry wood wood without water or wood with a moisture content of 0%.
- **Moisture content of wood, W** mass of water in wood, expressed as a percentage of absolutely dry mass of wood.
- **Wood end use moisture content** wood moisture in materials and products during their operation.
- Wood moisture, W abbreviated name of absolute wood moisture.
- **Relative humidity of wood,** Wr mass of water in wood, expressed as a percentage of the total wood and the mass of water in it.

Absolute humidity of wood

• **Absolute humidity** – W – The ratio of the mass of water in the wood to the mass of completely dry wood, also known as the moisture content of wood.

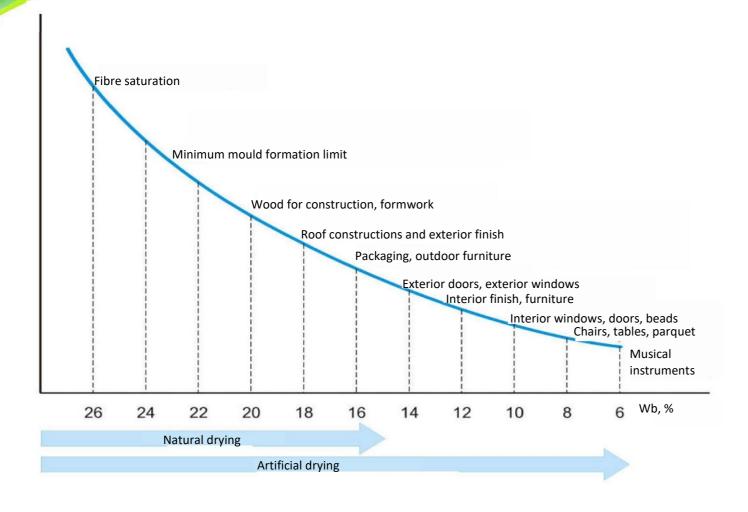
$$W = \frac{m_1 - m_2}{m_2} *100\% = \frac{m_{H_2O}}{m_2} *100\%$$

- m₁ mass of wood before drying, kg
- m₂ mass of wood before drying, kg
- mH₂O mass of water removed from wood during the drying process, kg

Wood drying tasks

- The main task is to facilitate the treatment and to ensure that the moisture content of the wood at the place of operation does not change.
- After sawing, the wood **contains a large amount of water (200-400 kg/m³).** The high initial moisture content of the wood during the drying process must be removed from the wood and reduced to the value required for the economic use of the wood.
- Wood is a hygroscopic material that has the natural property of **absorbing or releasing moisture** depending on the environmental parameters, in which it is located; for this reason, the wood is dried to a moisture content similar to that of the environment in which it is subsequently used.

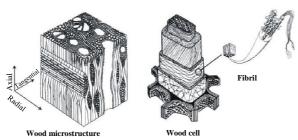
Wood end use moisture content

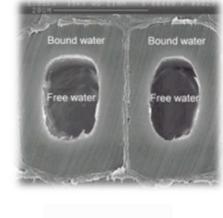


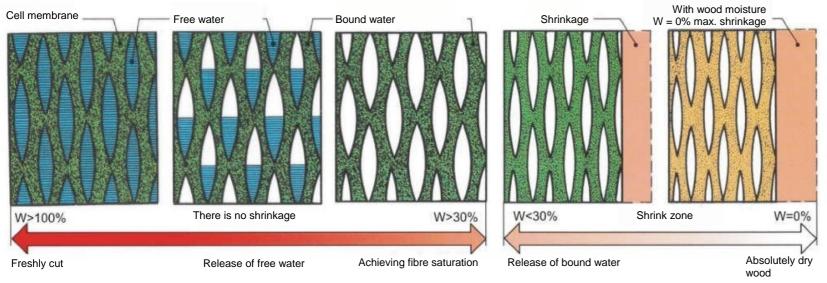
Bound and free wood moisture

- **Free moisture** water, which is freely in the stem recess, can be easily separated during the drying process.
- **Bound moisture** located in wood cells, it is more difficult to remove; it begins to evaporate when the free moisture has evaporated; in order for the bound moisture to evaporate, additional energy must be supplied.
- **Fibre saturation** (~30%) at this moisture point, the evaporation of free moisture ends, and the evaporation of the bound moisture begins.

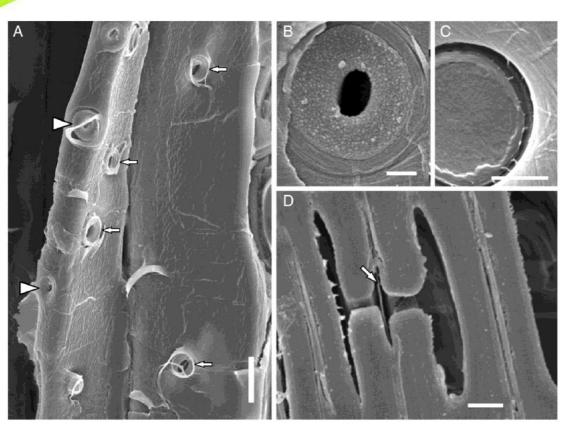












A – tangential section of late wood tracheid, identifying cell pores with arrows;

B – increase of cell pores with removed membrane;

C – enlargement of cell pore membrane;

D – cell pore cross-section; an arrow identifying the cell pore membrane).

Scale: (A) = 12 μ m;

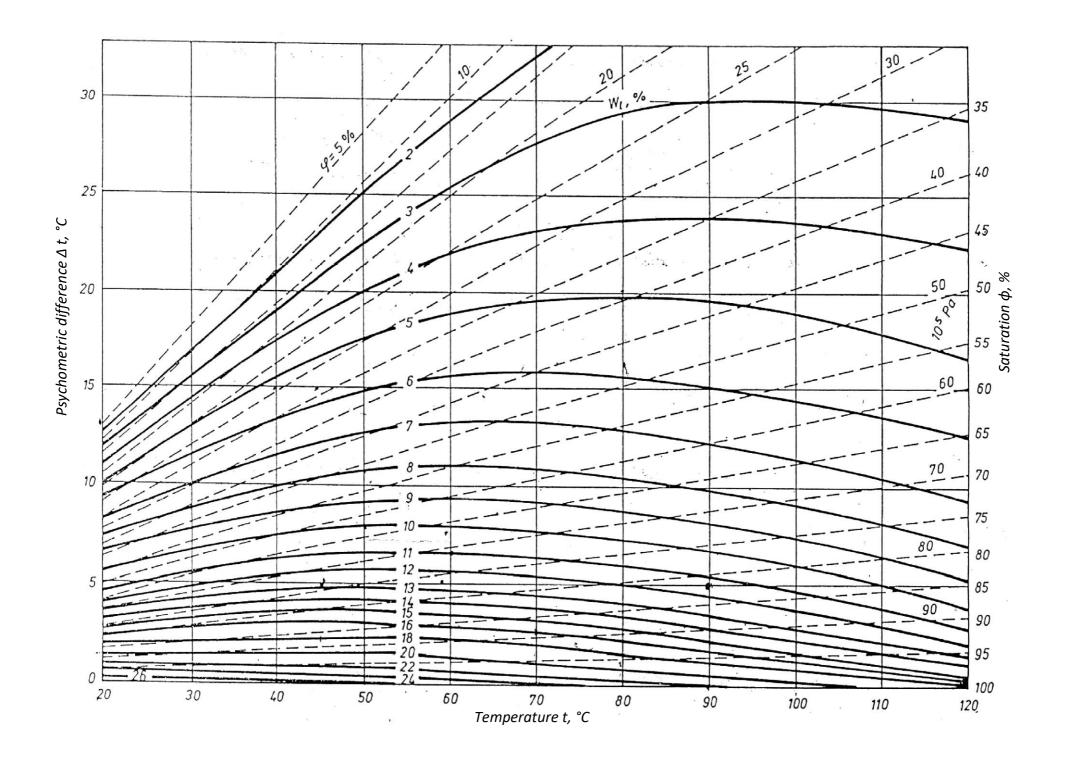
(B) = $2 \mu m$;

(C) = $2.5 \mu m$;

(D) = $3 \mu m$.

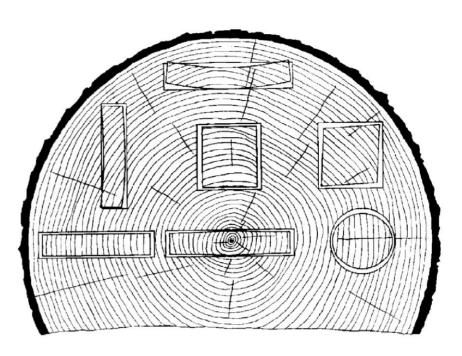
Equilibrium moisture content of wood

- The moisture that drying wood tends to withstand with constant parameters is called the equilibrium moisture content of wood.
- Diagrams based on experimental results are usually used to determine the equilibrium moisture content of wood.

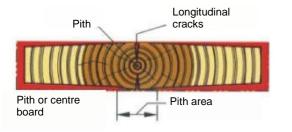


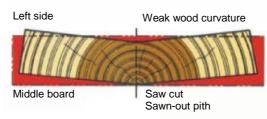
Wood shrinkage, maturing

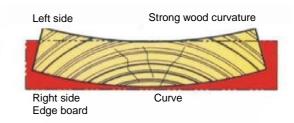
- axial fibre direction the smallest 0.1
 ... 0.3%
- radial shrinkage 2.3 ... 7.8%
- tangential shrinkage 12%
- radial shrinkage/tangential shrinkage = 1.65



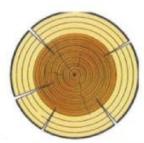
Deformations from wood shrinkage



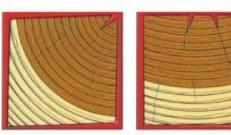




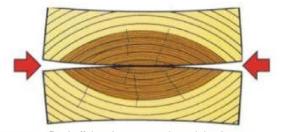
Shrink-shaped boards and beams



Drying cracks in roundwood

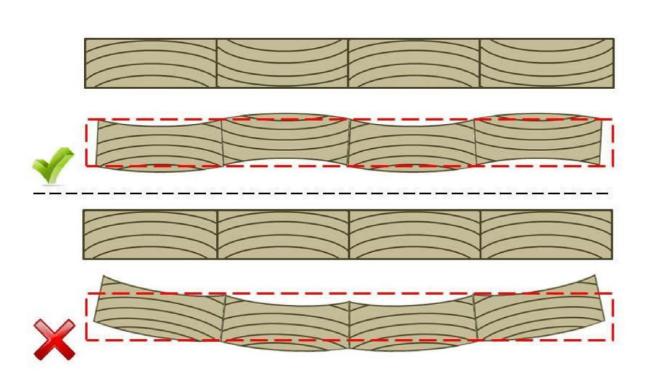


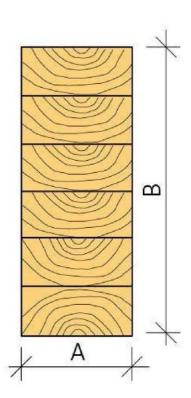
Shrinkage shape for edges and beams



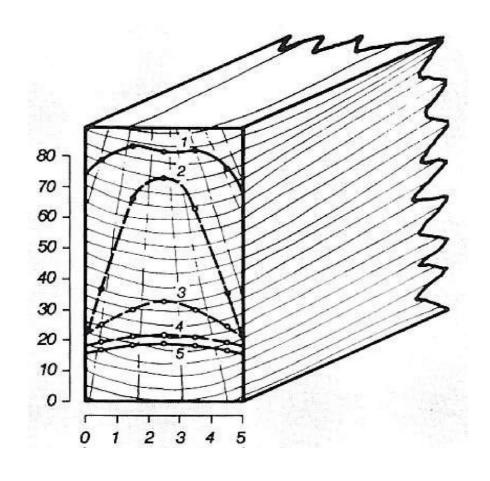
Peel off the glue seam, when gluing it into the thickness

Manufacture of glued wood products



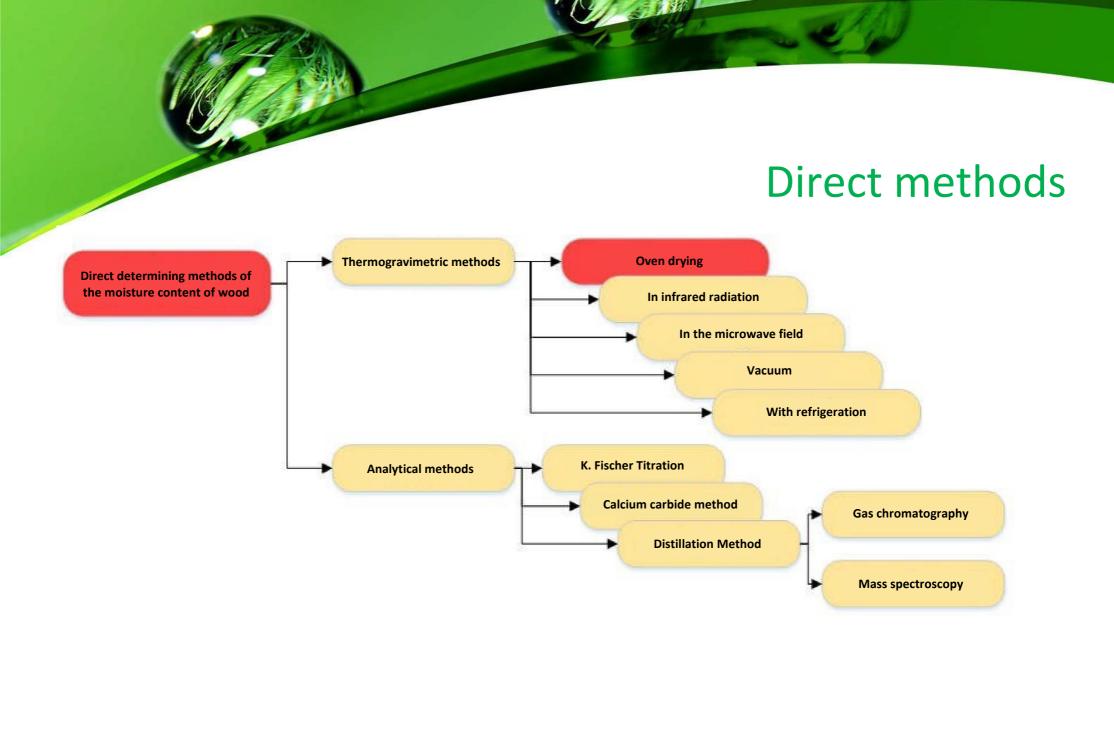


changes in wood moisture in the cross-section of sawn timber

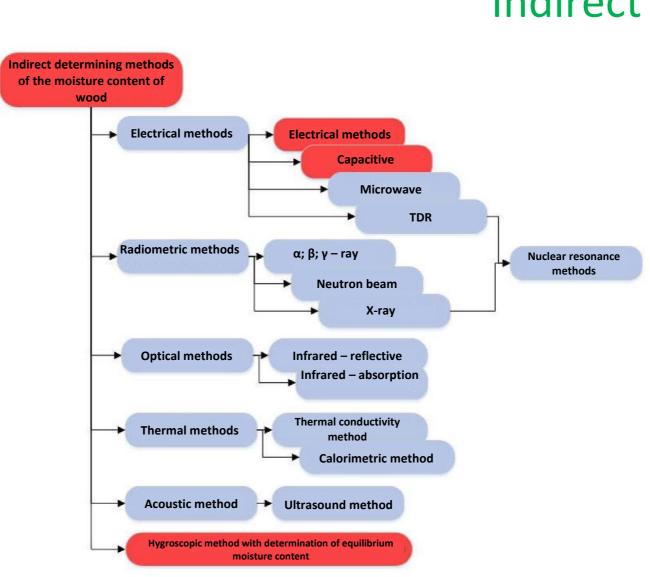




- All methods for determining the moisture content of wood can be divided into 2 groups:
- 1. Direct;
- 2. Indirect.







Electrical resistance humidity meters

Wood resistance depends on wood moisture, tree species and wood temperature.







Capacitive humidity meters

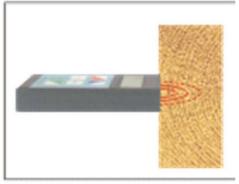
These moisture meters require measurement correction depending on the density of the wood.











Electrical resistance moisture meters only provide accurate measurements for wood moisture below the fibre saturation point.



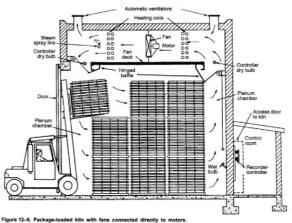
Measured humidity: 53%

Actual humidity: 100-130%

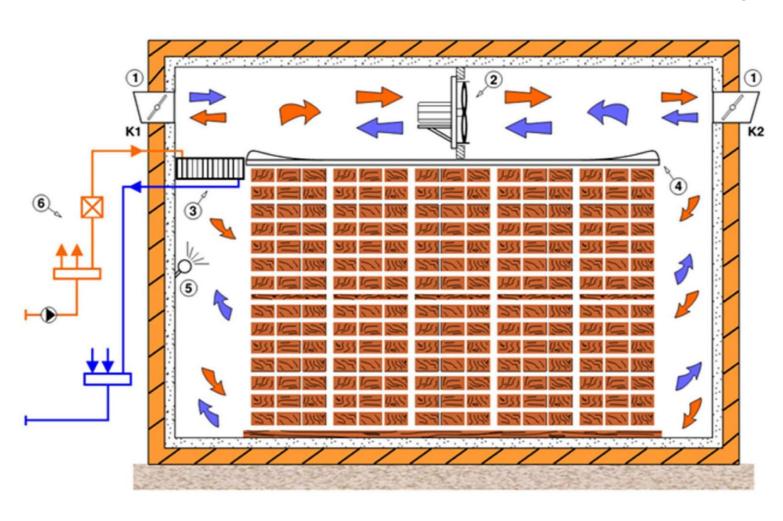
History of wood drying

- Until 1700, natural drying.
- 1844 the beginnings of artificial drying by forced convection.
- 1900 the origins of convection type drying in the United States as it is known today. It only developed rapidly in Europe after World War II.





Air convection drying kiln



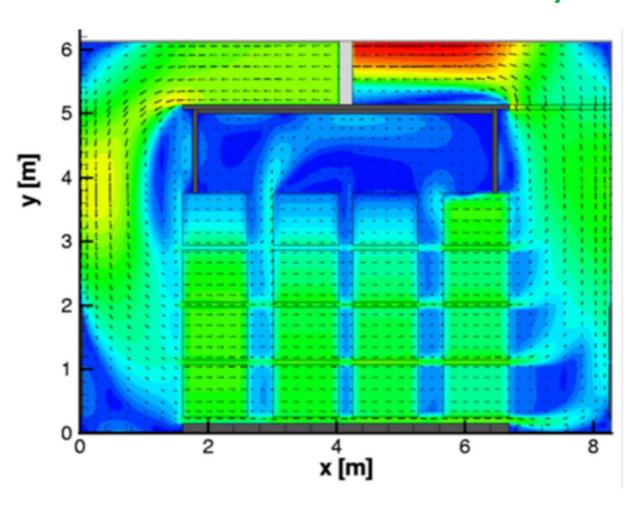
Recuperation system dryers



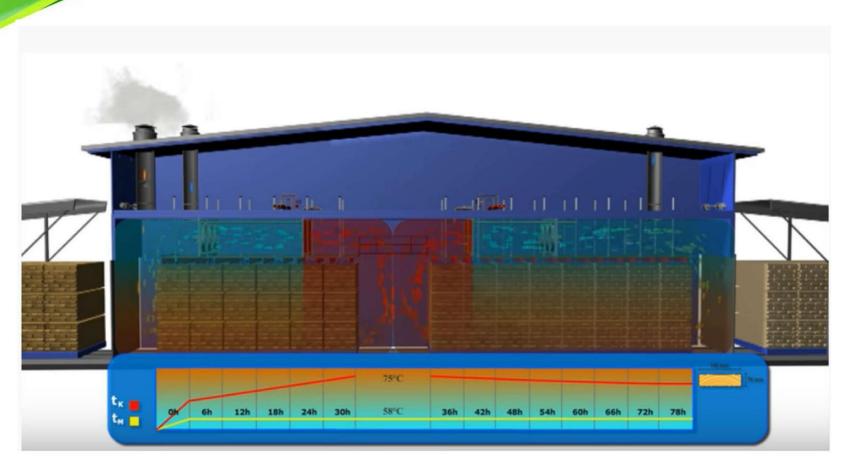


Mühlböck Type 603

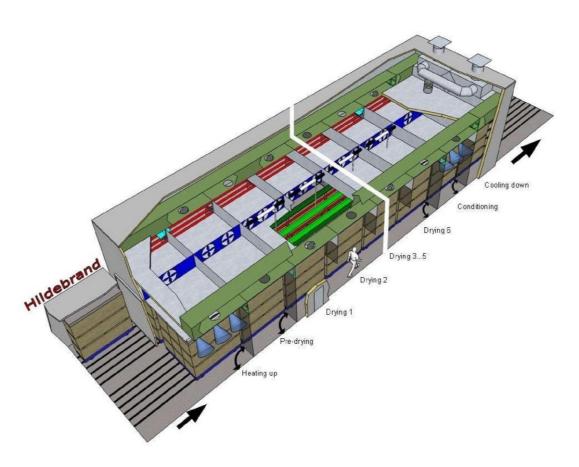
Drying agent circulation aerodynamic model



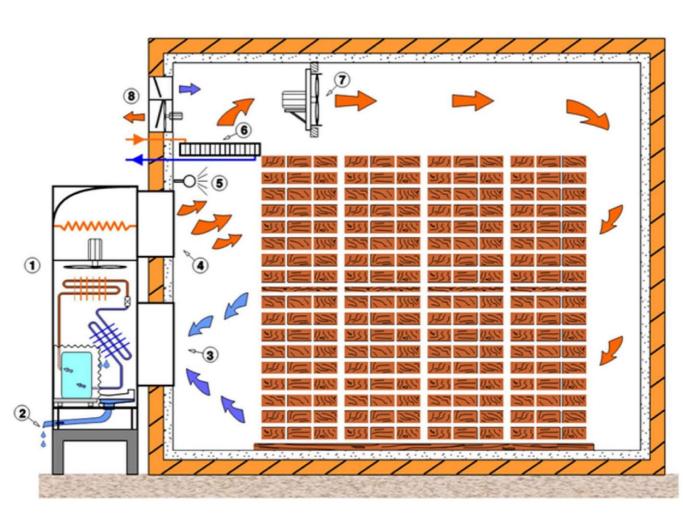
Continuous drying kiln



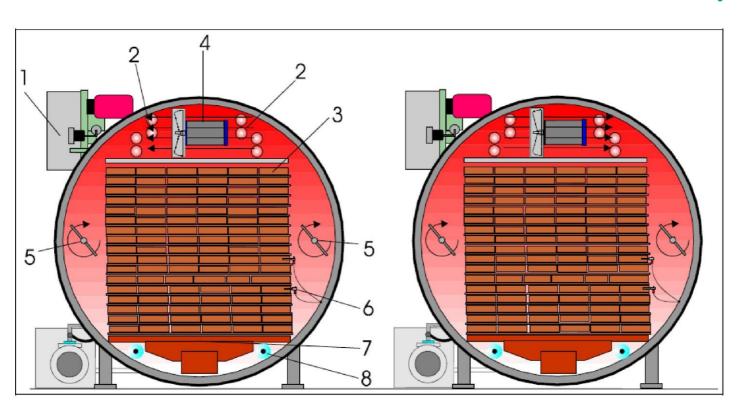
Continuous drying kilns with transverse air circulation



Condensing drying kiln



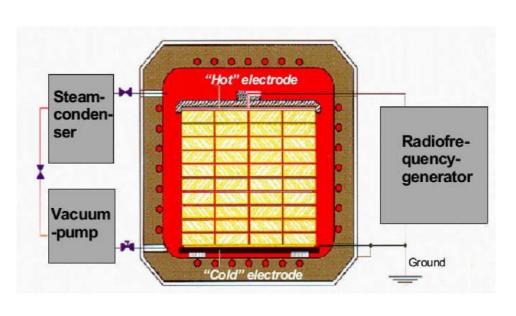
Vacuum drying kiln



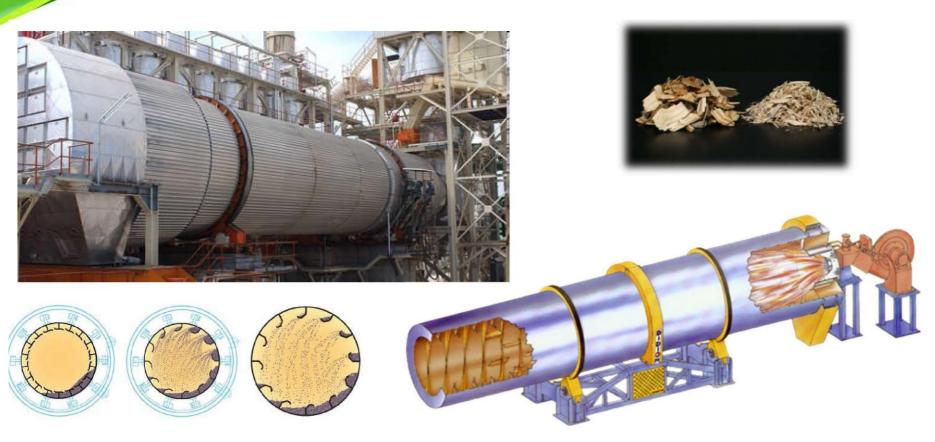
1	Control frame (Vacutronic)	5	Turbolences
2	Hot water cell or electrical resistors	6	Moisture and temperature probes
3	Drying timber	7	Charge motorized cart
4	Altrnate flux fans	8	Condensers

Combinations of wood drying technologies – vacuum + microwaves





Indrical flue gas drying kiln for chopped wood

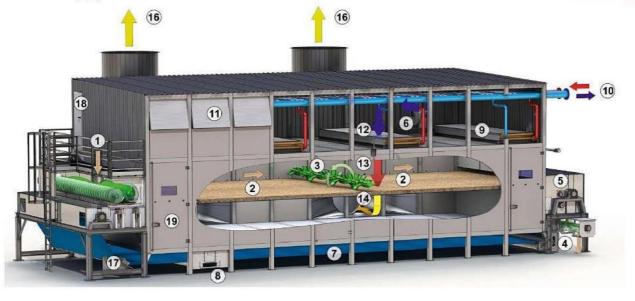




- 1 = feeding station
- 2 = product layer
- 3 = turning device
- 4 = discharge screw
- 5 = belt cleaning system (dry)
- 6 = fan for belt cleaning system
- 7 = web belt
- 8 = belt cleaning system (wet)
- 9 = heat exchanger
- 10 = heat supply

- 11 = fresh air intake
- 12 = fresh air
- 13 = heated air
- 14 = exhaust air
- 15 = exhaust air fan
- 16 = exit air
- 17 = belt alignment
- 18 = access housing for heat generation
- 19 = door for inspection







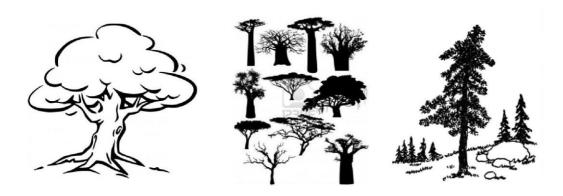


DRINOR

Drying time in air convection drying kiln

 One of the main factors influencing the cost of drying is the duration of drying. In general, the faster the drying process, the lower the drying costs.

In general, the drying time is influenced by factors such as tree species, sawn timber thickness, initial humidity, quality requirements, drying chamber configuration, stack width, drying temperature, humidity in the drying kiln and others.







To improve is to change: to be perfect is to change often. Winston Churchill

Quality criteria of drying:

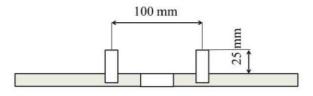
- Evaluating the drying quality of sawn timber after drying is an important step in improving and optimising drying processes.
- First you must find the answer to the question, what is the quality of drying?
- Average final humidity
- Moisture gradient
- Internal stresses
- Cracks
- Deformation
- Colouring

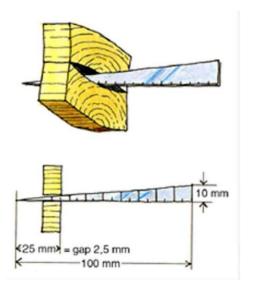


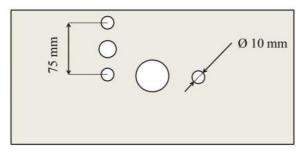
Evaluation of drying quality of sawn timber

- EN 14298 Assessment of drying quality.
- CEN/TS 12169 Criteria for the assessment of conformity of a lot of sawn timber.
- INSTA 141 or Swedish Standard SS 232740.
- EDG guidelines. Drying quality of sawn timber.

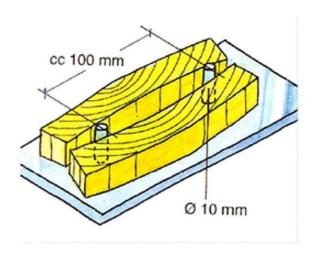
M 14464 Methods for the assessment of residual internal stresses and strains and EDG guidelines







Template



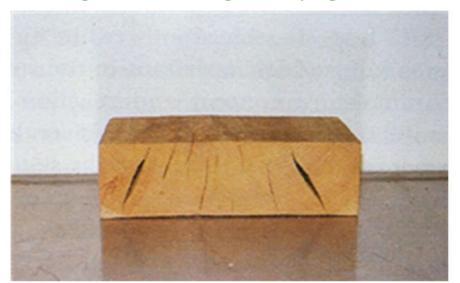
Stress in wood during drying

Before drying	During drying			After drying
	Stage 1	Stage 2	Stage 3	
Wet wood	External stress	Internal stress	Stress reduction	Dry wood
No stress	The outer layer of wood dries quickly. Tensile stress is outside Compressive tension on the inside	wood dries slowly, fast – on the inside.	When steam or water is injected, stresses are reduced by condensation	No stress

Internal cracks

Occurs during drying (at the end of the drying stage), very characteristic of deciduous trees. (Conifers are characterised by the formation of external cracks during the initial stage of drying.





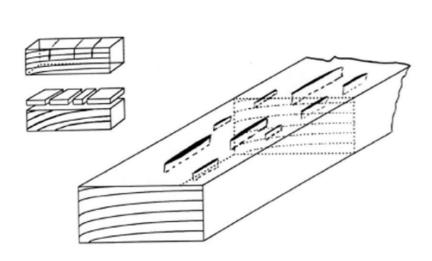






External cracks

Occurs during the initial period of drying of the material, while the moisture of the wood is up to the fibre saturation point. Small cracks at a depth of 2 to 3 mm are not considered a defect, as they are milled during further processing.







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Topic:

"MANUFACTURE OF WOODEN CONSTRUCTIONS"

Author Kārlis Pugovičs

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA







Manufacture of Wooden Constructions

Kārlis Pugovičs, Mg.Sc.ing.

Schedule

5 December

09:00 – 10:30 Manufacture of wood composite materials for use in wooden constructions.

10:45 – 12:15 Usability of the most common connectors in wooden constructions.

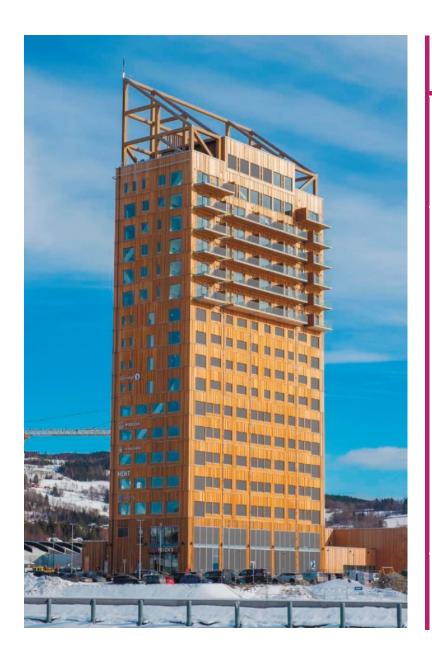
12:30 – 14:00 Conditions for the incorporation of the most common connectors in wooden constructions.

14:00 - 15:00 Lunch break.

15:00 – 16:00 Visit to SIA "Cross timber systems".

16:00 – 17:30 Compatibility of wooden constructions and connection with other materials.

Wooden constructions nowadays



Mjøstårnet



Brumunddal, NOR.

85.4 m 18 floors March 2019



Source: https://www.dezeen.com/2019/03/19/mjostarne-worlds-tallest-timber-tower-voll-arkitekter-norway/



Brock Commons



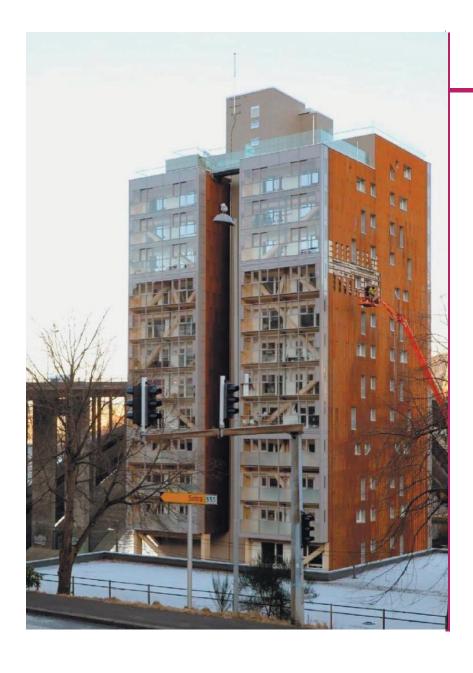
Vancouver, CAN.

53 m 404 students 18 floors 2016





Source: https://www.archdaily.com/879625/inside-vancouvers-brock-commons-the-worlds-tallest-timber-structured-building



Treet



Bergen, NOR.

52.8 m

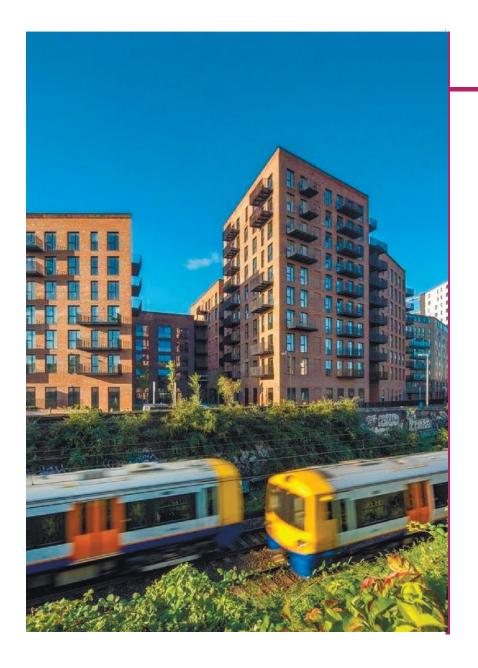
62 apartments

14 floors

2015



 $Source: \underline{https://www.buildup.eu/en/practices/cases/treet-wooden-high-rise-building-excellent-energy-performance}$



Dalston Works



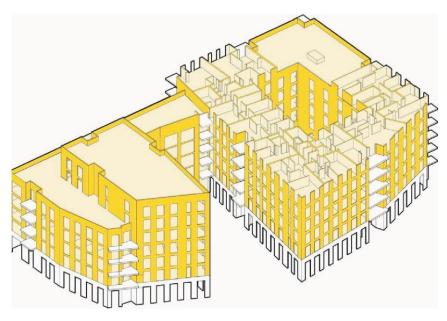
London, UK.

33 m

121 flats

9 floors

2017



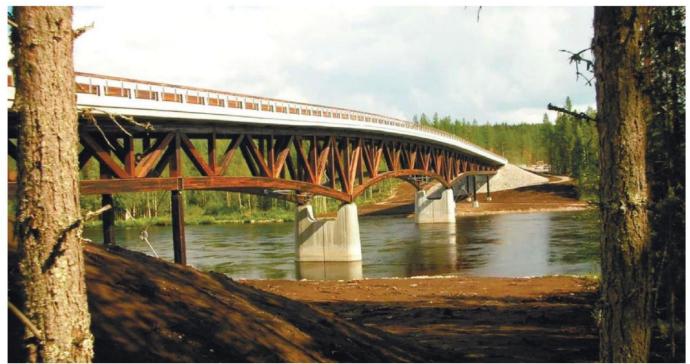
Source: http://waughthistleton.com/dalston-works/

Bridge over the River Rena

NOR.

Military Load Class (MLC) 100 – a convoy consisting of vehicles with a maximum weight of 109 t and moving at a distance of 30 m (STANAG 2021).

2005



Source: http://support.sbcindustry.com/Archive/2008/june/Paper 045.pdf? PHPSESSID = ju29kfh90ovju5o371pv47cgf?



Metropol Parasol

Seville, ES.

Elevation: 26 m

150 x 70 m

2011



Source: http://waughthistleton.com/dalston-works/

Composite Wood Materials

What are composite materials?

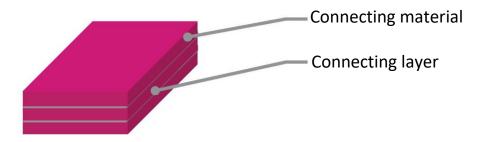
D.:

Composite materials (composites) are materials composed of two or more materials that differ significantly in physical and chemical properties at the macroscopic, microscopic, or nano level.

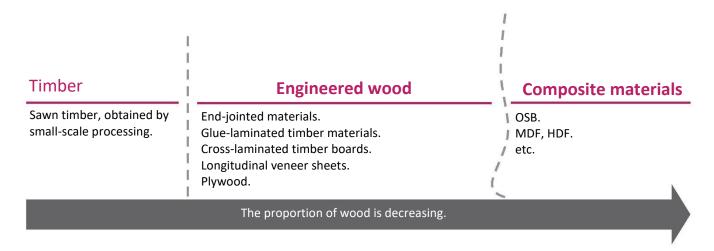
What are composite materials?

D.:

Layered composites are materials composed of layers of different materials of different thicknesses.



What is engineered wood?



The most common composites in building constructions

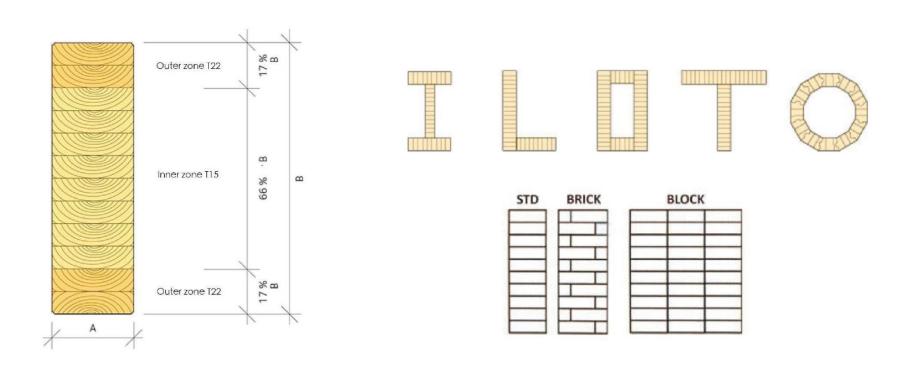
Glue-laminated timber materials.

[glulam]

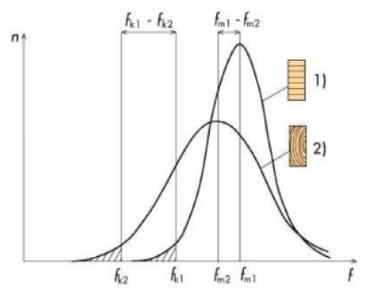
Glue-laminated timber materials.

Manufacturing Process

Structure



Advantages





Dimensions

```
Theoretically - ∞
```

In reality -

Width: 60...250 mm,

Height: 120...2500 mm,

Length: $< \sim 40$ m.

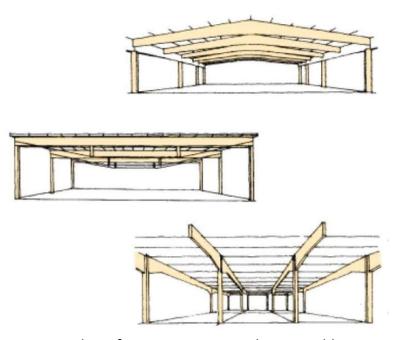


Figure 1 Examples of constructions; column and beam system.





Figure 2 Examples of constructions; continuous beam system.

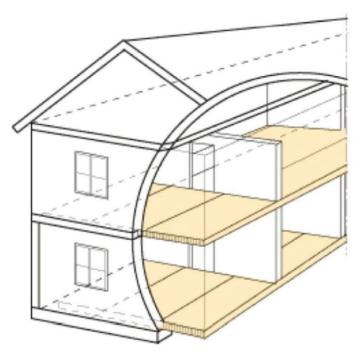


Figure 3 Examples of constructions; floor slabs.

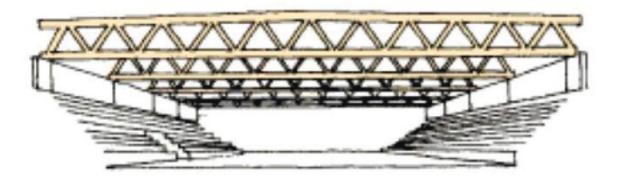


Figure 3 Examples of constructions; girders.

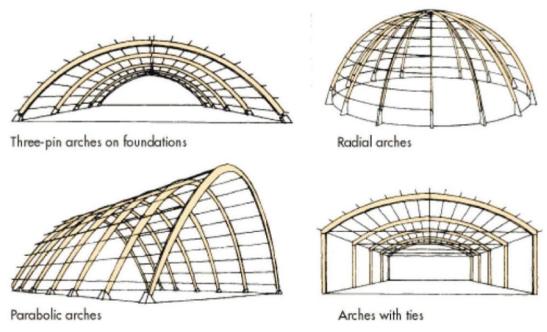


Figure 3 Examples of constructions; curved structures.

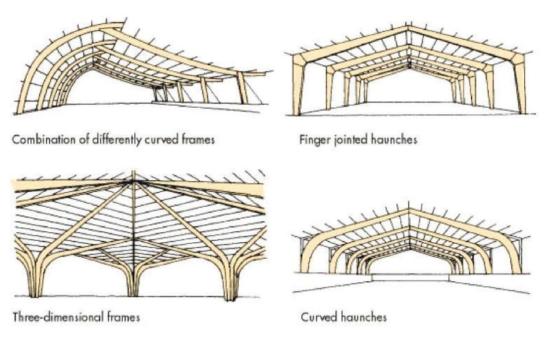


Figure 3 Examples of constructions; portal frames.

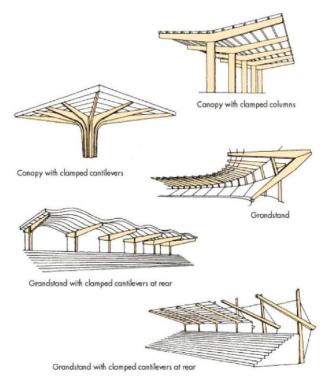


Figure 3 Examples of constructions; consoles.

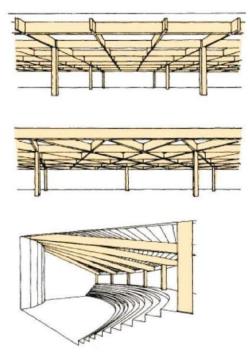


Figure 3 Examples of constructions; grids.

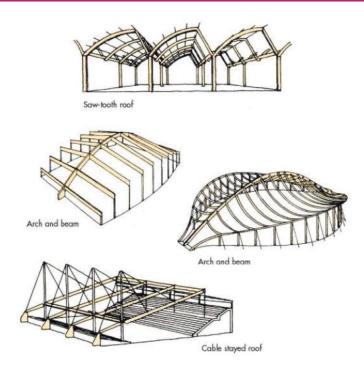


Figure 3 Examples of constructions; combined construction.

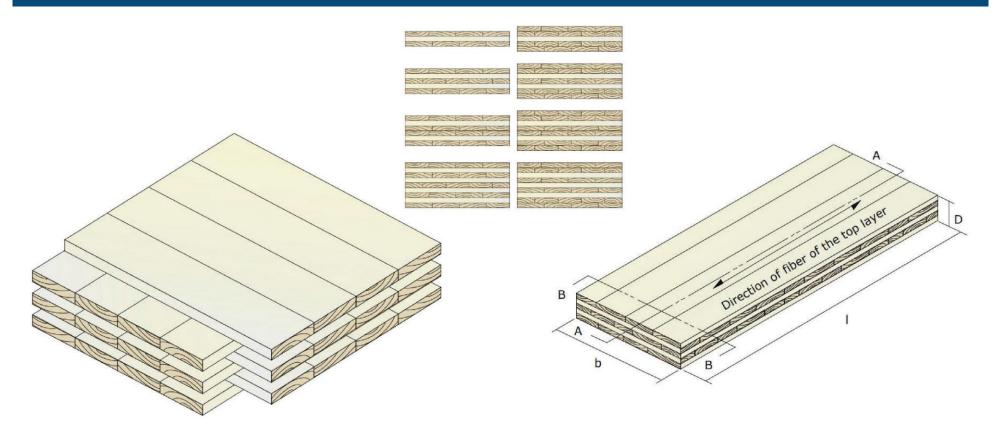
Cross-laminated timber panels.

[CLT, X-Lam]

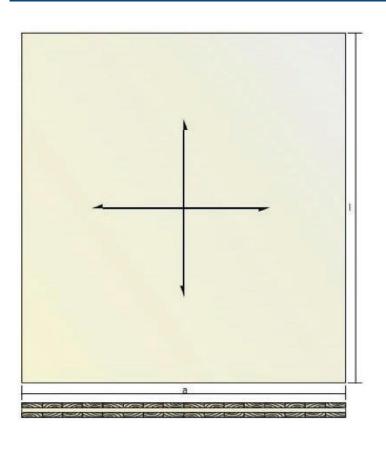
Cross-laminated timber panels.

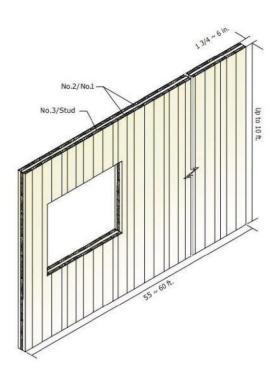
Manufacturing Process

Structure



Advantages





Dimensions

```
Thickness: 75...300 mm;
```

Width: < 5000 m;

Length: $< \sim 30$ m.



Figure 3 Examples of constructions; small private house.

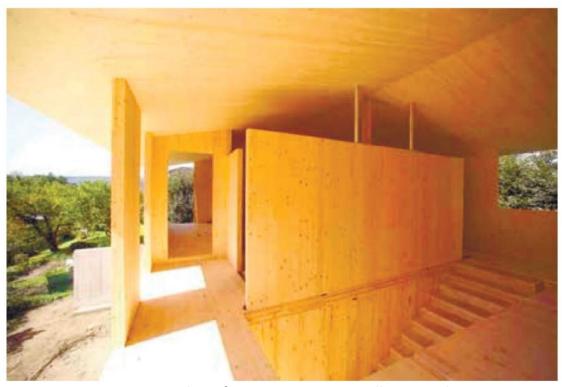


Figure 3 Examples of constructions; small private house.



Figure 3 Examples of constructions; small private house.



Figure 3 Examples of constructions; apartment building.

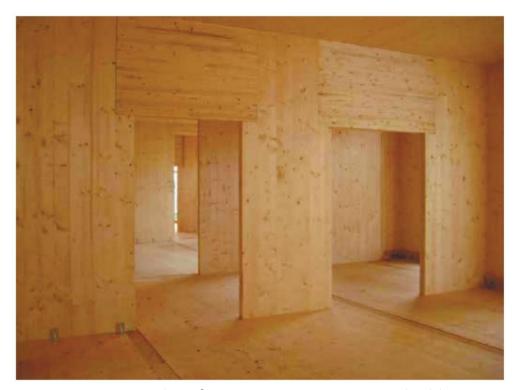


Figure 3 Examples of constructions; apartment building.



Figure 3 Examples of constructions; apartment building, modular system.



Figure 3 Examples of constructions; public building.



Figure 3 Examples of constructions; public building.



Figure 3 Examples of constructions; multi-storey car park.

Longitudinal veneer sheets.

[LVL]

Longitudinal veneer sheets.

Manufacturing Process

Structure



Advantages



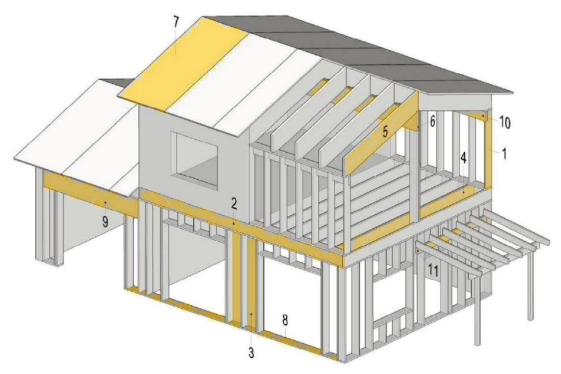


Figure 3 Examples of constructions; private house.

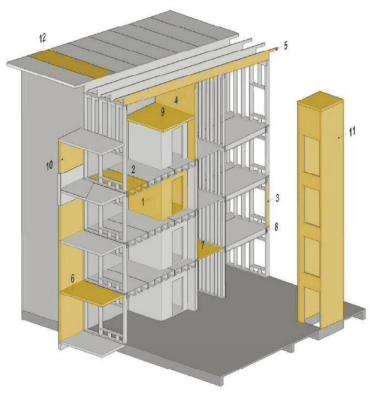


Figure 3 Examples of constructions; apartment building.

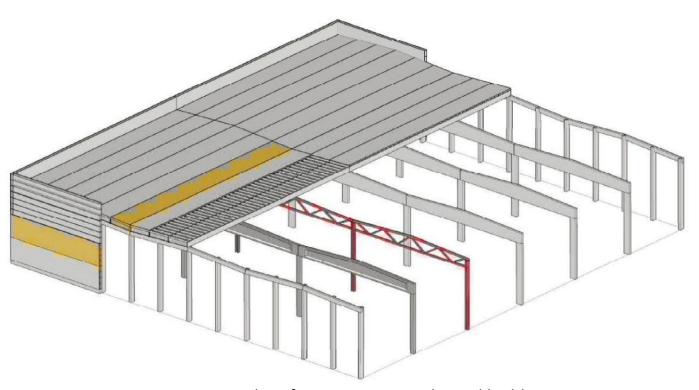


Figure 3 Examples of constructions; industrial building.

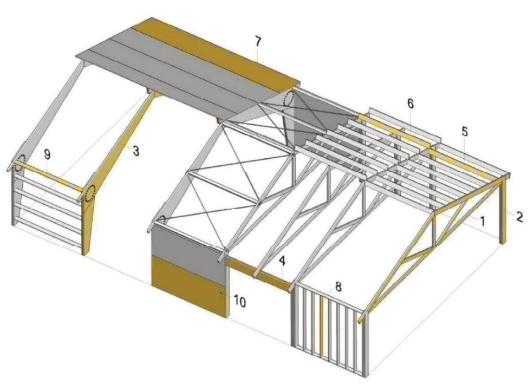


Figure 3 Examples of constructions; industrial building.







Manufacture of Wooden Constructions

Kārlis Pugovičs, Mg.Sc.ing.



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Topic:

"PRODUCTION OF WOOD BASED PANELS: GENERALLY AND THEORY"

Author *Uldis Spulle*

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA







PRODUCTION OF WOOD BASED PANELS Generally and Theory

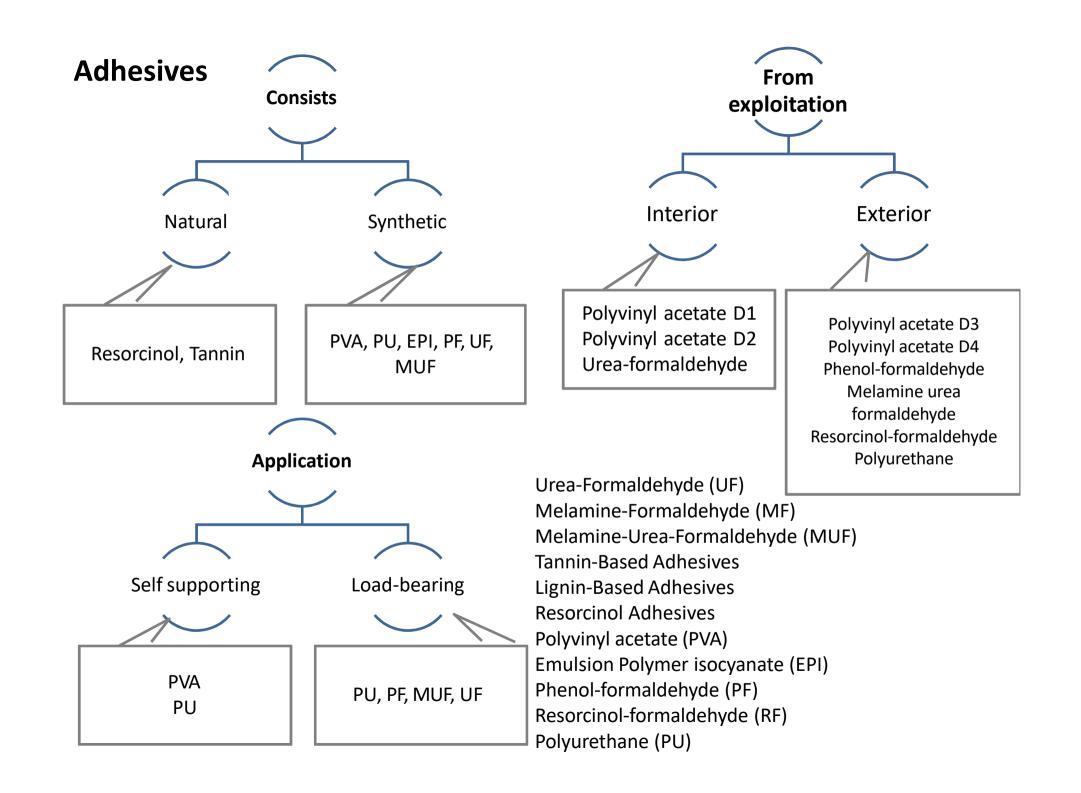
Uldis SPULLE

Latvia University of Life Sciences and Technologies

Solid Wood Base Panels Single or multi layer Cross Laminated Timber (CLT) Beams Glue Laminated Timber (GLT) Panel elements

Material	Yield Strength (MPa)	Density (kg/m³)	Modulus Elasticity (MPa)	Compresion Strength (MPa)	Tensile Strength (MPa)
Steel	350	7800	200,000	400-1000	400-1000
Concrete	N/A	2300	20,000	20-40	2.0-5.0
Structural Timber	N/A	400-600	8,000-11,000	Parallel 30 Perp. 8	Parallel 6 Perp. 1

Adhesives Theories of **Adhesion** Mechanical/ Adsorption/ Diffusion Electronic specific adhesion interlocking **Connection Glue Lines** With glue Without glue Thick > 1mm Thin < 1mm http://www.baublatt.ch/fachbeitraege/bau praxis/wenn-holz-geschweisst-wird http://ibois.epfl.ch/page-20697-en.html



In General



Methods of grading structural timber are employed:

- Visual grading
- Machine stress grading
- **Proof grading**



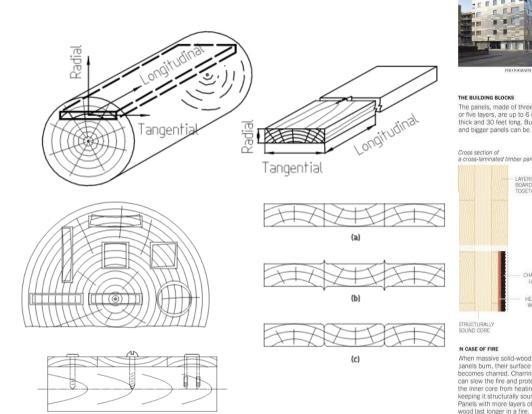








Wood and the Properties



https://www.extension.purdue.edu/extmedia/fnr/fnr-163.pdf http://www.tesseract-design.com/cross-laminated-timberconstruction.html



STRUCTURE OF WOOD Long tubular cells of the tree trunk make wood strongest

Typically walls and ceilings

plasterboard to further reduce risk of the fire.

are covered with

and most stable in the direction of the grain, and weaker and more prone to expansion and shrinkage due to moisture in the cross-grain direction.



MAKING THE PANELS Layers of spruce boards are glued together. To

provide maximum strength and stability, each layer's grain is laid perpendicular to the previous one's.



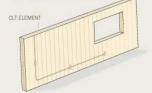
Computer-controlled machinery in the factory trims the panels to exact dimensions, and cuts openings for

screws or nails can

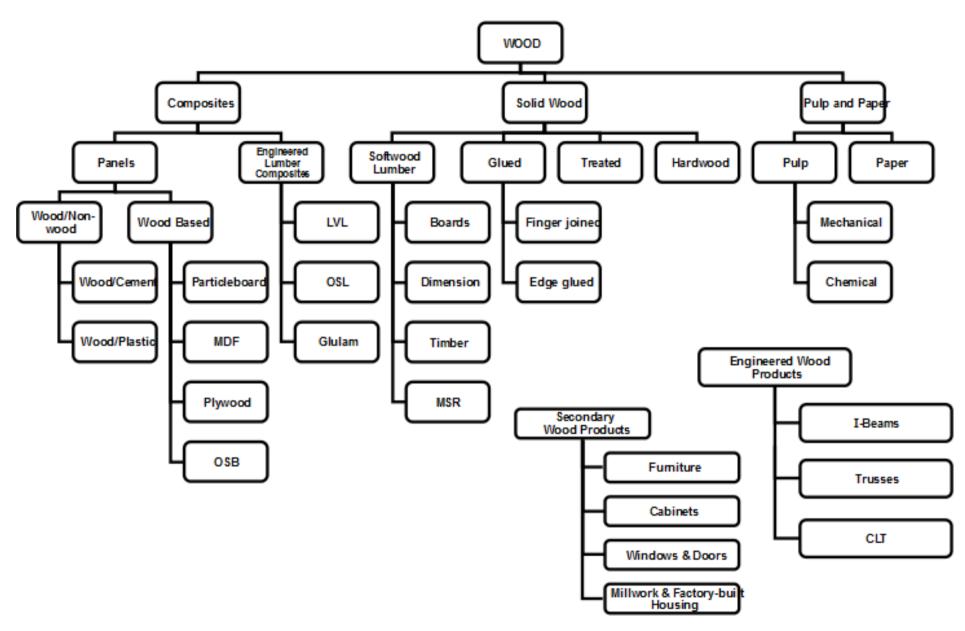
be driven into the

floor to distribute the

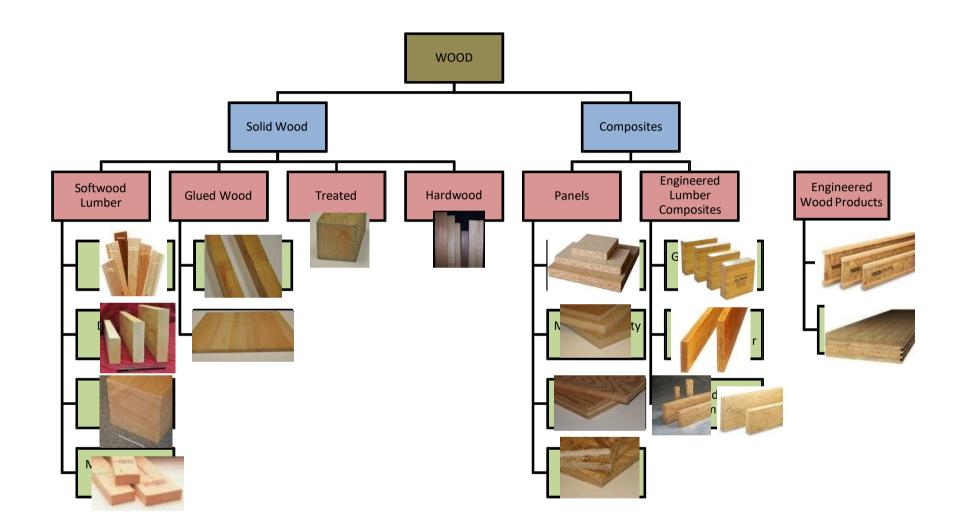
surface load deeper

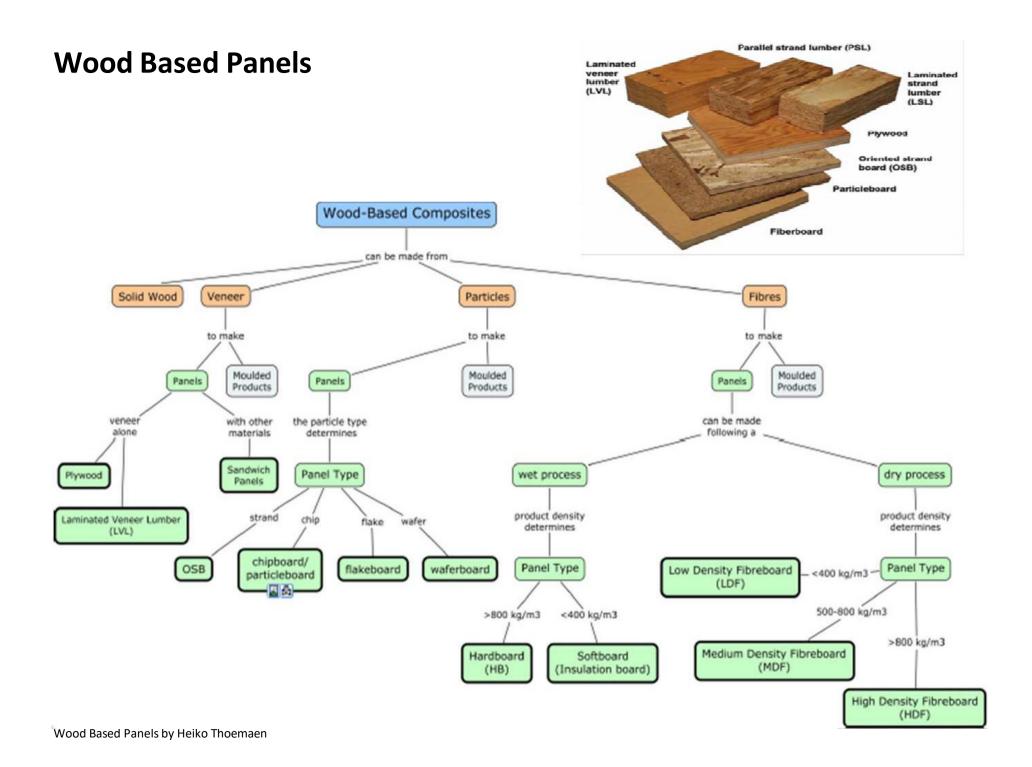


Wood Products Taxonomy

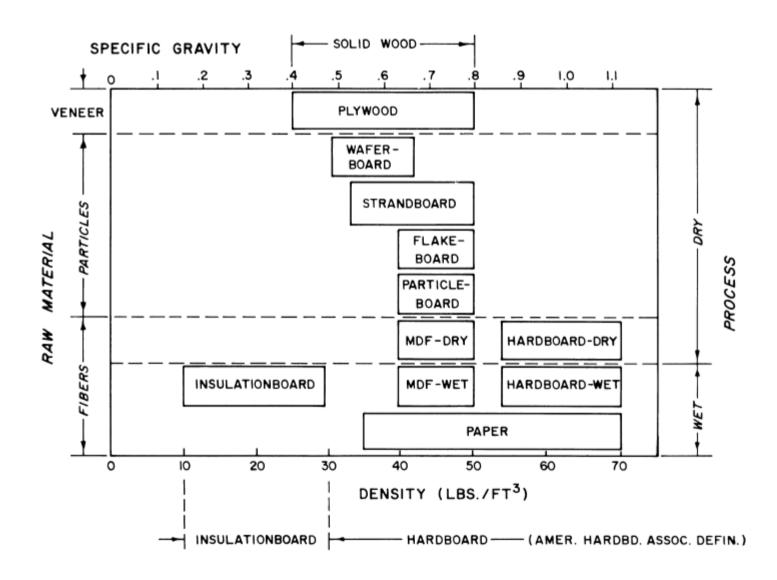


Wood Products Taxonomy





Wood Based Panels properties



Types of Wood Composites

Particleboard

- chipboard
- flake board
- wafer board

Fibreboard

- Soft board (low density)
- MDF (Medium Density Fibreboard)
- Hardboard (high density)

Veneer products

- plywood
- sandwich panels, e.g. blockboard

Wood Based Panels – Why to make?

Economic reasons

- use of low grade logs
- use waste material

Ecological reasons

- efficient use of wood

Performance reasons

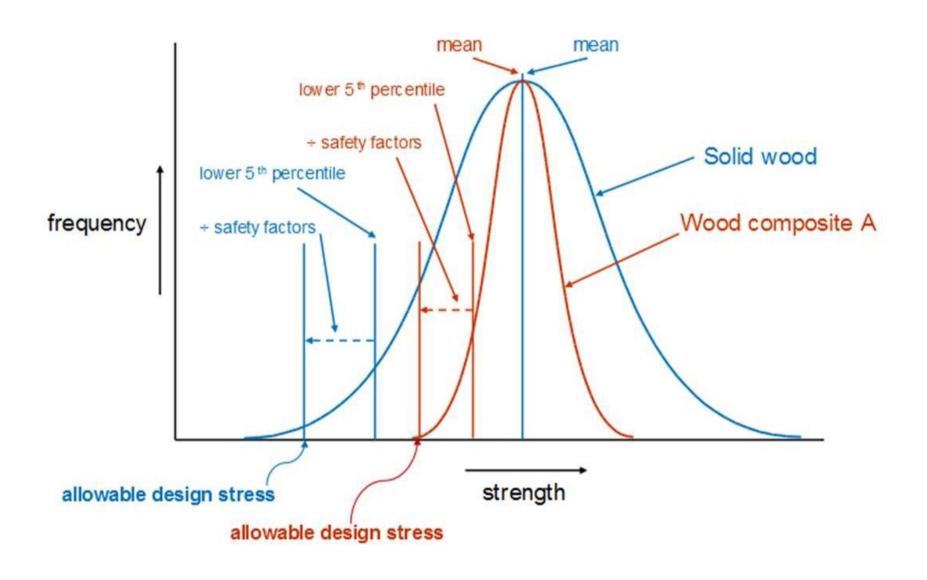
- size
- consistency
 - » dimensional stability
 - » strength
- decay resistance
- fire resistance
- insulation
- machining
- surface quality
- decoration

Wood Based Panels – Dimensionl Stability

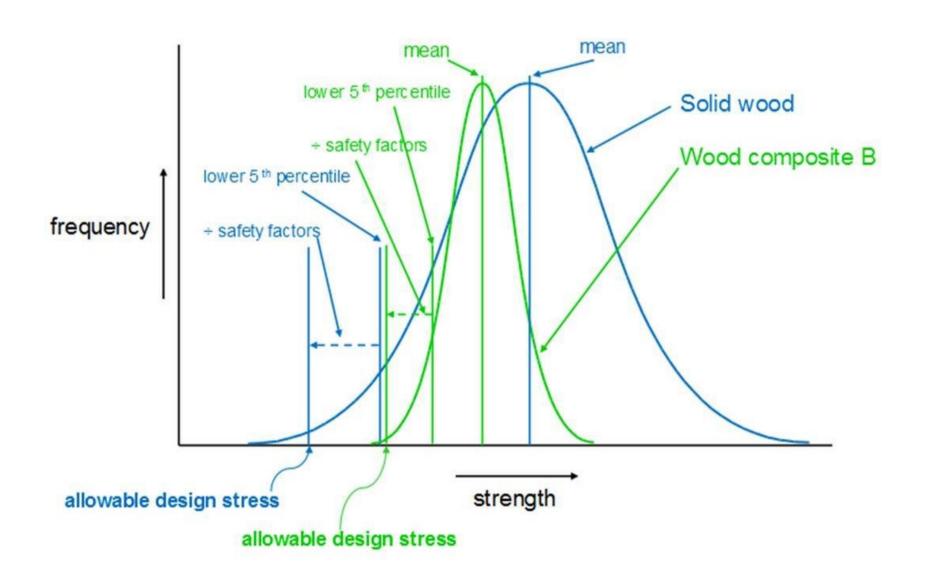
	Direction to grain				
	Parallel	Perpendicular	Thickness		
Solid Timber					
Douglas fir	negligible	2.0-2.4	2.0-2.4		
Beech	negligible	2.6-5.2	2.6-5.2		
Plywood					
Douglas fir	0.24	0.24	2		
Chipboard					
UF	0.33	0.33	4.7		
PF	0.25	0.25	3.9		
MF/UF	0.21	0.21	3.3		
Fibre-building board					
Tempered	0.21	0.27	7-11		
Standard	0.28	0.31	4-9		
Medium density	0.24	0.25	4-8		

Percent change in dimensions of materials moved from 30% to 90% relative humidity, from Dinwoodie (1981).

Wood Based Panels – Why to make?



Wood Based Panels – Why to make?



Wood Based Panels – Strength properties

Strength properties of timber and panel products, from Dinwoodie (1981).

	Thickness	Density	Bending Strength		Bending Stiffness	
	(mm)	(kg/m ³)	Parallel	Perpendicular	Parallel	Perpendicular
Solid Timber						
Douglas fir	20.0	500	80.0	2.2	12700	800
Plywood						
Douglas fir	4.8	520	73.0	16.0	12090	890
Douglas fir	19.0	600	60.0	33.0	10750	3310
Chipboard						
UF	18.6	720	11.5	11.5	1930	1930
PF	19.2	680	18.0	18.0	2830	2830
MF/UF	18.1	660	27.1	27.1	3460	3460
Fibre-building board						
Tempered	3.2	1030	69.0	65.0	4600	4600
Standard	3.2	1000	54.0	52.0	_	_
Medium density	9-10	680	18.7	19.2	_	_

Sources of Informtion

- Wood Handbook Wood as an Engineering Material (Ch10 Adhesives with Wood Materials Bond Formation and Performance; Ch.11 Wood-Based Composite Materials; Ch.12 Mechanical Properties of Wood-Based Composite Materials
- Wood Based Panels by Heiko Thoemaen, Mark Irle and Milan Sernek, Brunel University Press, 152 p.
- Волынский В. Н. Технология клеених материалов. Санкт-петербург, Издательство "Профикс", 2008., 393 с.
- Волынский В.Н. Технология древесных плит и композитных материалов. Архангельск, Издательство "Лань" 2009., 336 с.
- Волынский В.Н. Технология стружечных и волокнистых плит. Таллин Дезидерата, 2004., 192 с.
- Handbook of Finnish Plywood
- A/S «Latvijas Finieris» Plywood Handbook, 2010.
- Suchsland O., Woodson G.E. Fiberboard Manufacturing Practices in the United States, 270 p.
- Panel World <u>www.panelworldmag.com</u>
- http://www.apawood.org/







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Topic:

"PRODUCTION OF WOOD BASED PANELS: FIBERBORDS"

Author Uldis Spulle

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA







PRODUCTION OF WOOD BASED PANELS Fiberbords

Uldis SPULLE

Latvia University of Life Sciences and Technologies

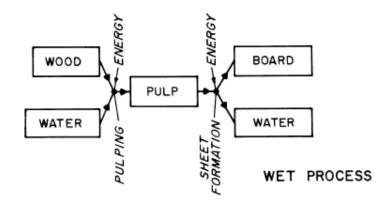
Terms and Defenitions

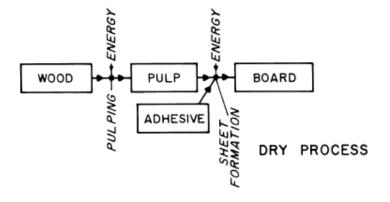
MDF composed of ligno-cellulosic fibres

EN 316:2009 Wood fibre boards. Definition, classification and symbols EN 622-5 Fibreboards. Specifications. Requirements for dry process boards (MDF)

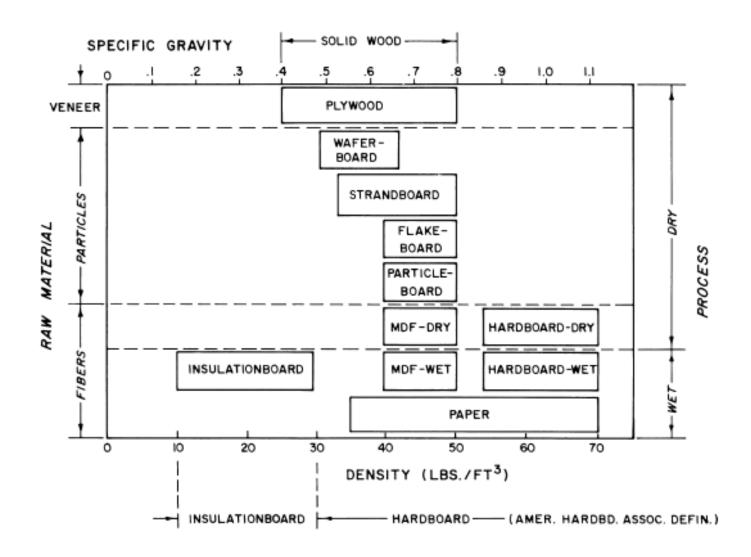
MDF – general purpose MDF.H - general purpose, humid MDF.LA – load-bearing, dry MDF.HLS – load-bearing, humid

Thickness: 2 to 100 mm Density: 500 to 900 kg m⁻³

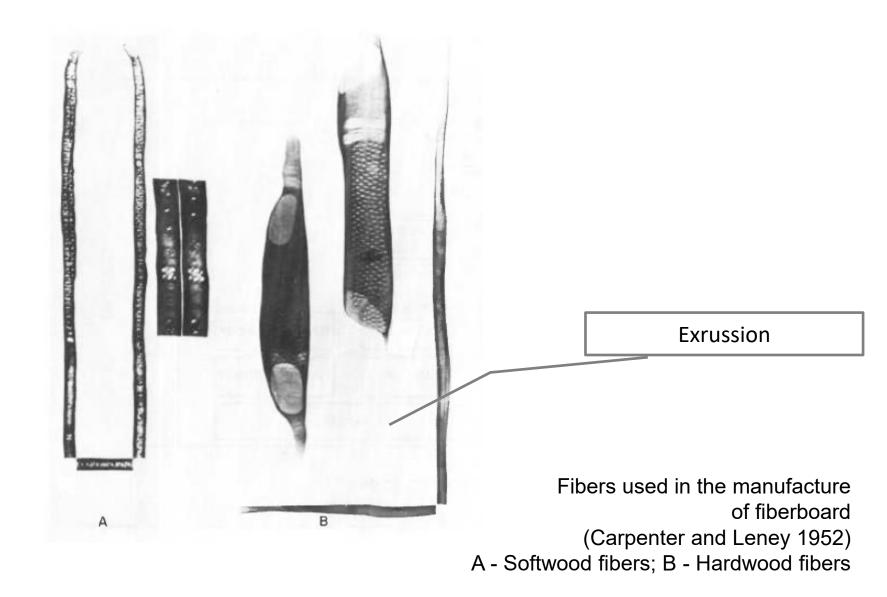




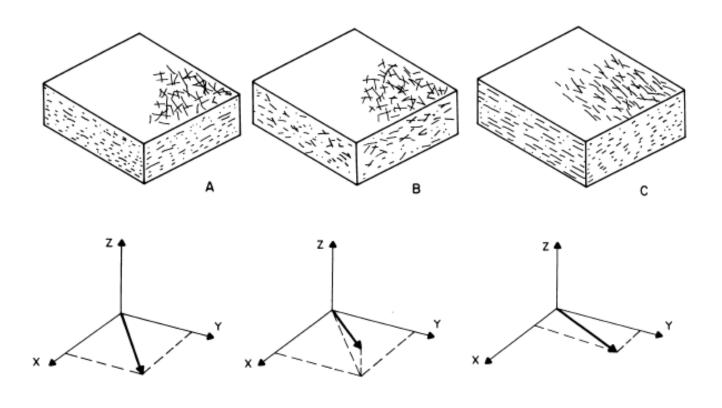
MDF properties



Wood Fibres used

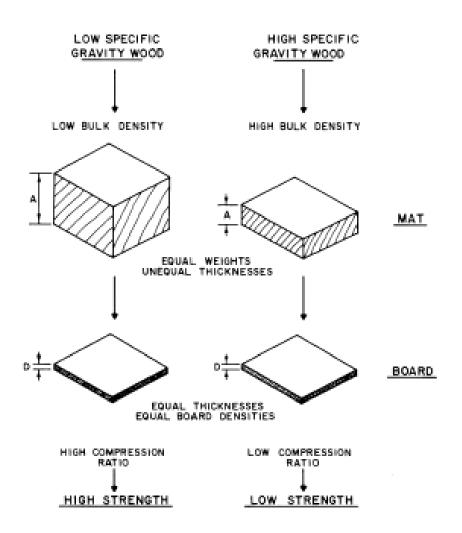


Orientation of fibres

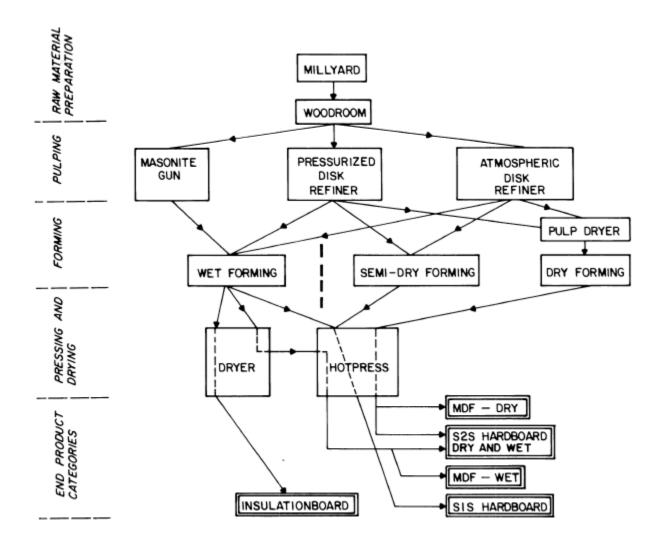


A—Random orientation in plane of board, no vertical components; B—Random orientation in plane of board, small vertical component; C—Oriented in y-direction, small x-component, no vertical component.

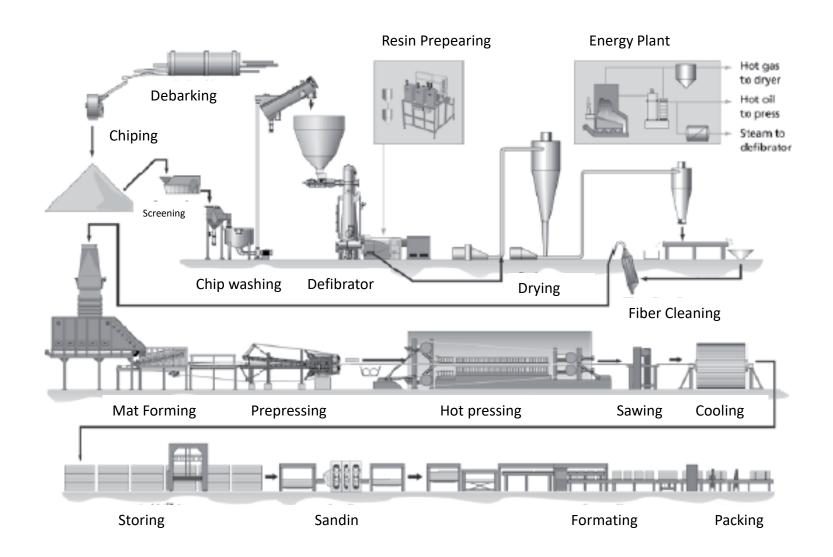
Influence of Raw Material



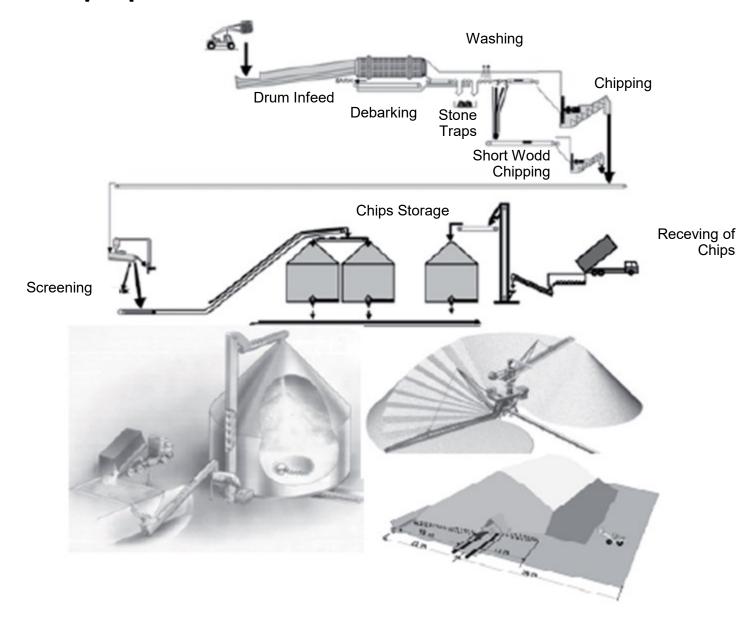
Summary scheme



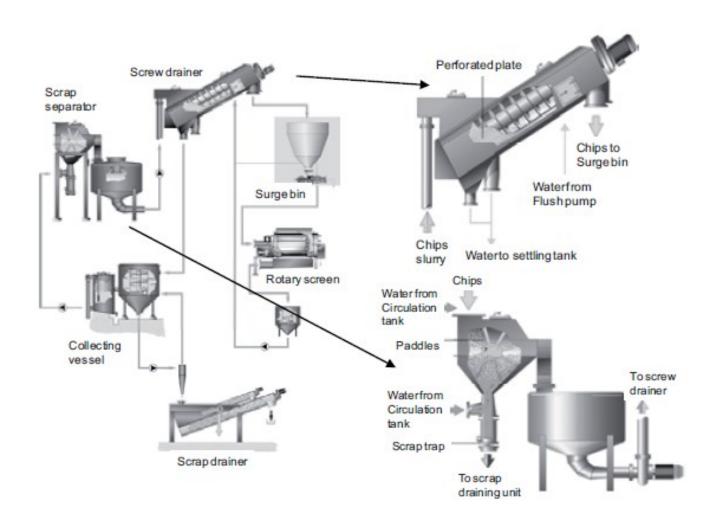
Technology overview



Raw material preparation



Chip washing

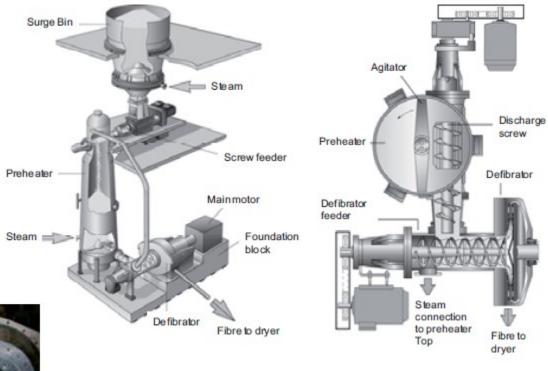


Defribrator



a- tube; b- window; c- pluging screw; d- main engine; e- blow pipe; f- resin injection

Defibrator







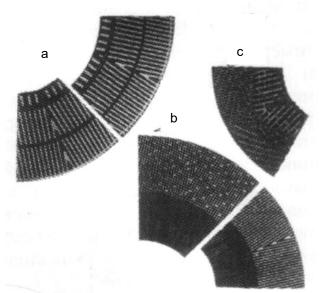




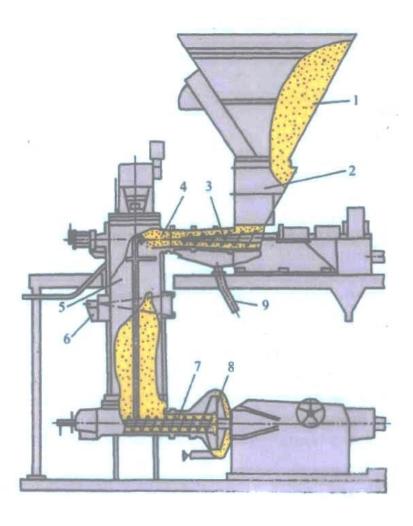
A – softwoods

B – hard hardwoods

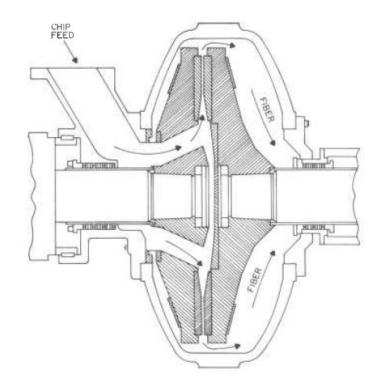
C – soft hardwoods



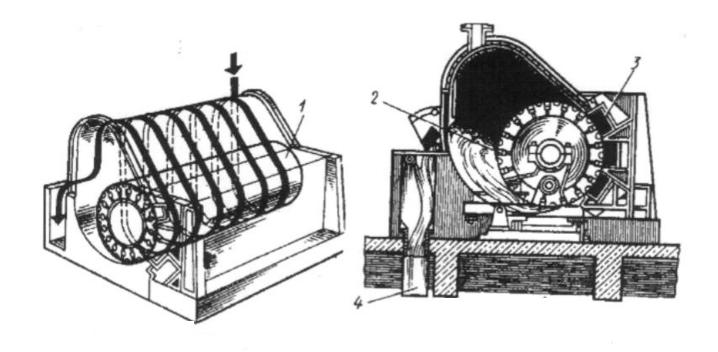
Refiner



- 1 Chip chute
- 2 Vibrator
- 3 Plug screw feeder
- 4 Chips plug
- 5 Steam inlet
- 6 Level controler
- 7 Feed screw
- 8 Refiner
- 9 Water transporter



Holender



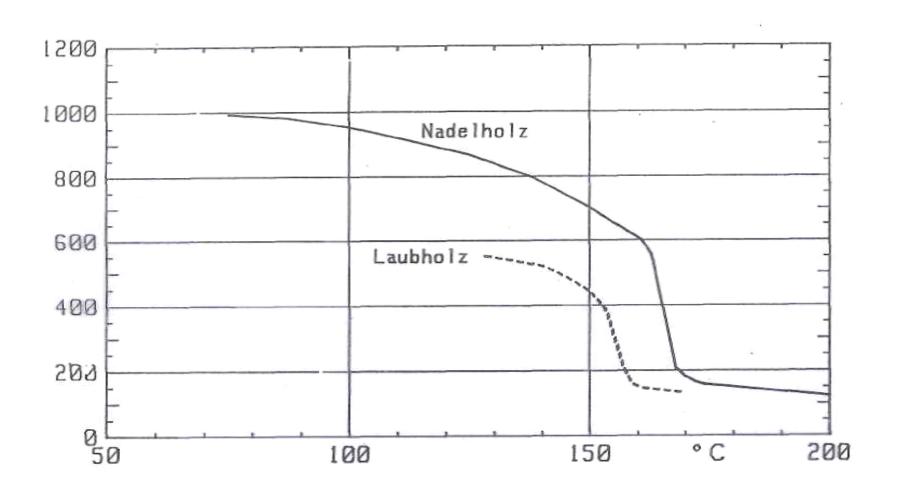
1- cylinder; 2- abrasives; 3 - basalt elements; 4- fibre outfeed.

Dry Fibre Blender

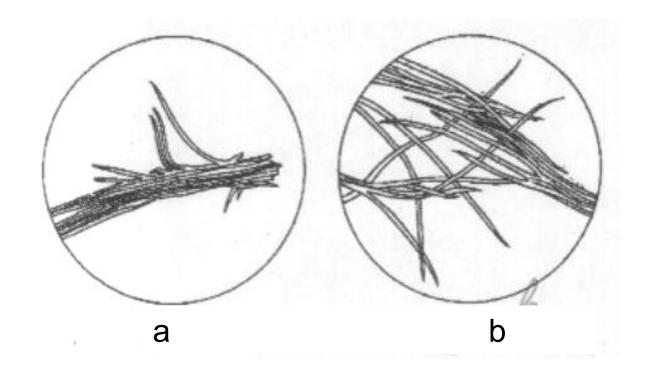




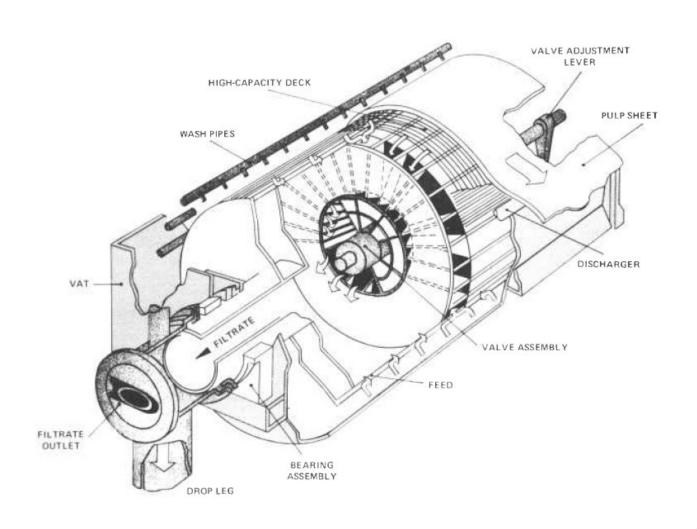
Energy Consuption



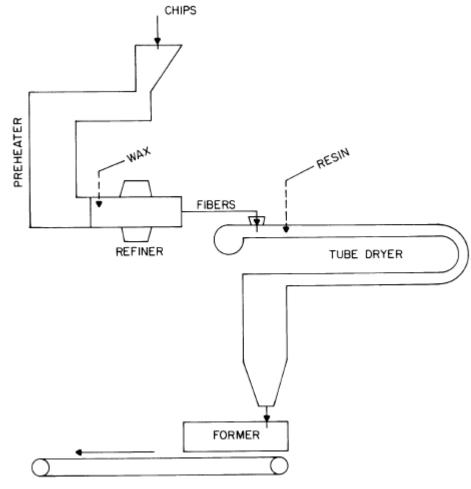
Fibers by Method



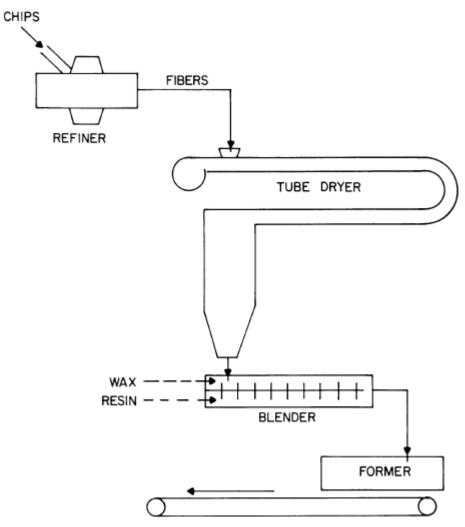
Pulp Washer



Addition of Resin

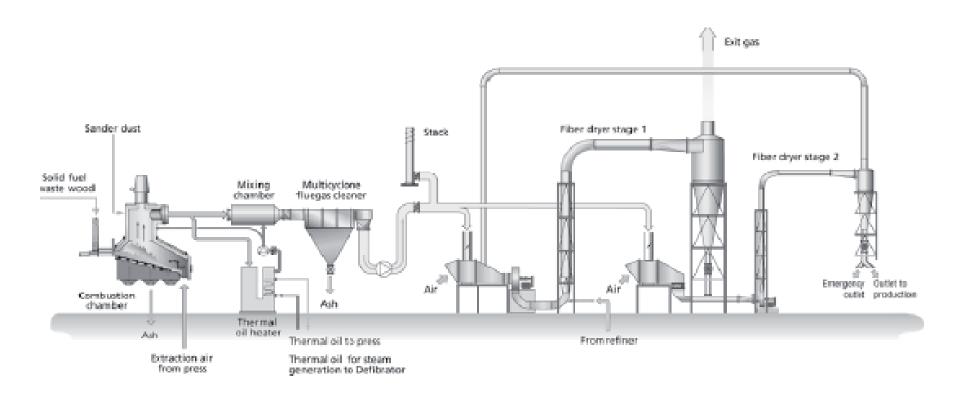


MDF (dry process) addition of urea resin in short retention blender after drying of fiber in tube dryer

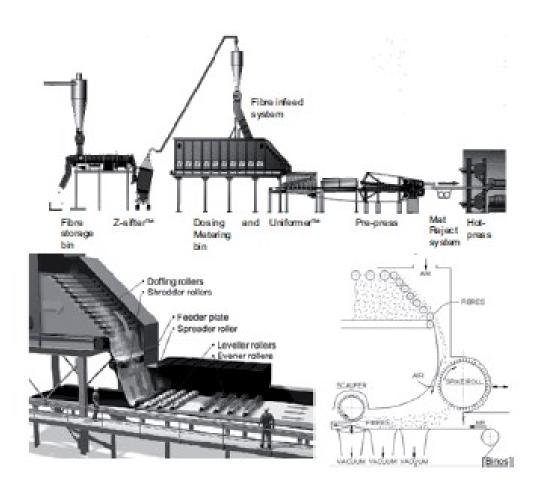


HDF(dry-process) addition of phenolic resin prior to drying of fiber in tube dryer

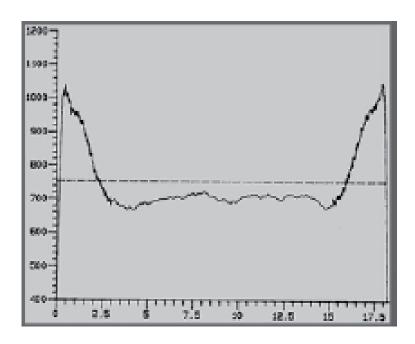
Two Stage Dryer



Fibre Eighing, Sifting, Mattress Forming

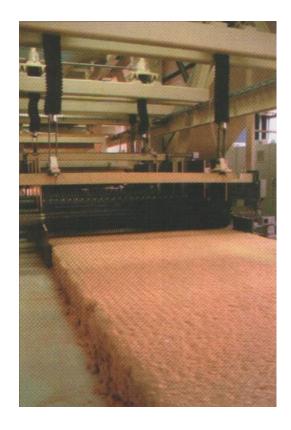


Density Profile of MDF

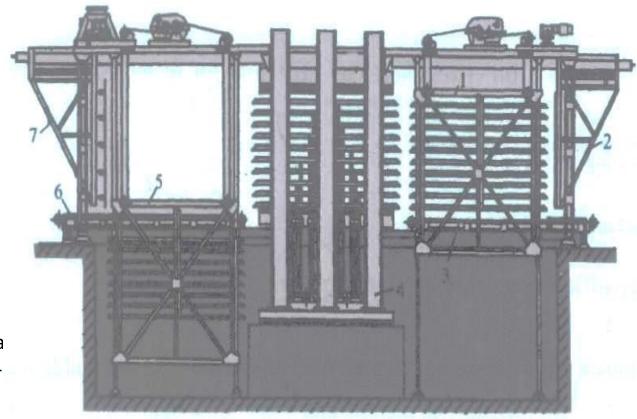


Mattress Former (Siempelkamp)



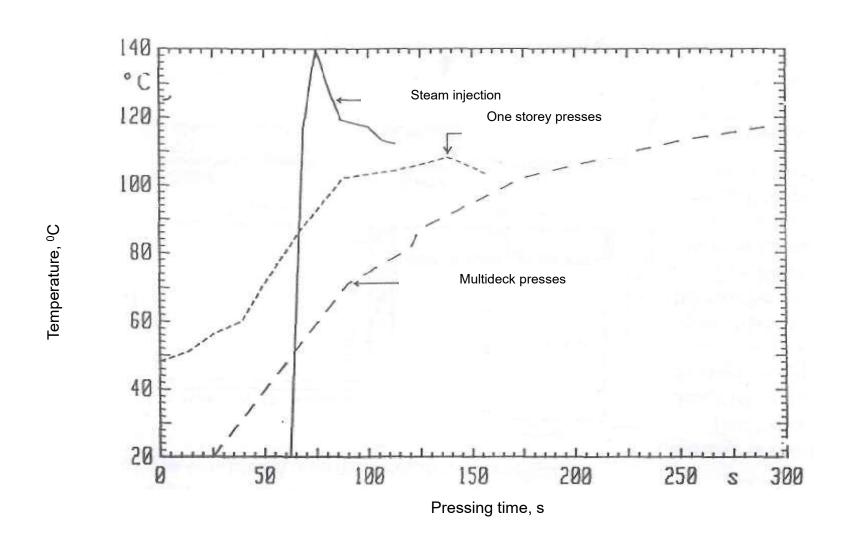


Multideck Press

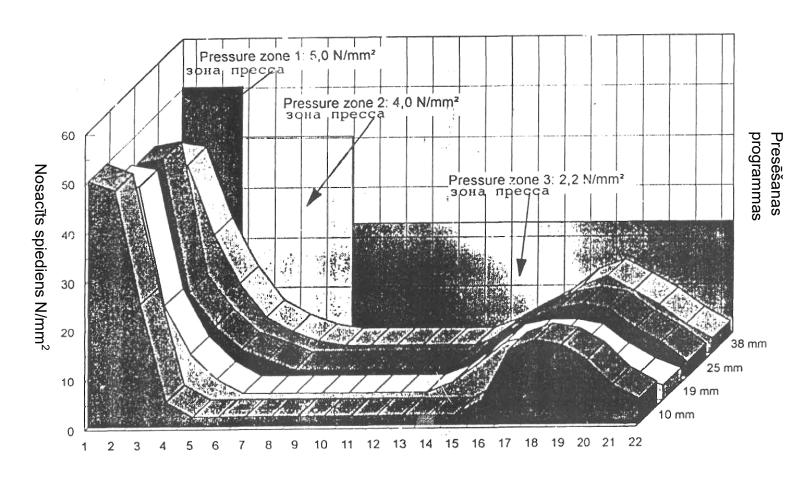


- 1 In feeder
- 2 In feeder mecha
- 3 Belt transporter
- 4 Hot press
- 5 Outfeed mechanism
- 6 Belt transporter
- 7 Outfeed

Pressing Time and Temperature

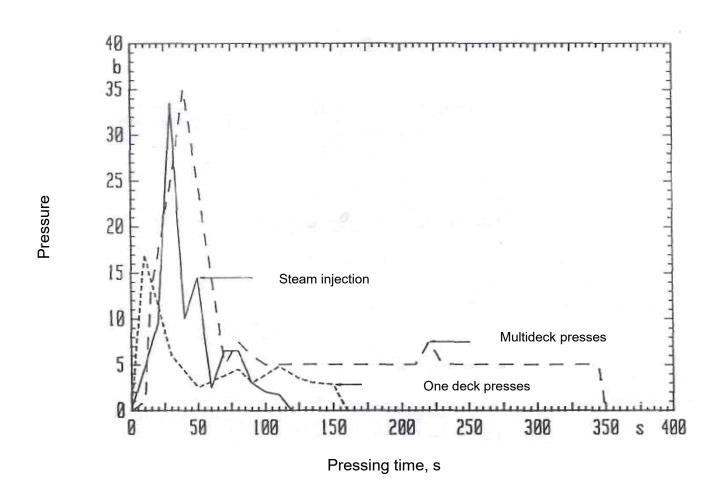


Pressing Preasure by Thickness

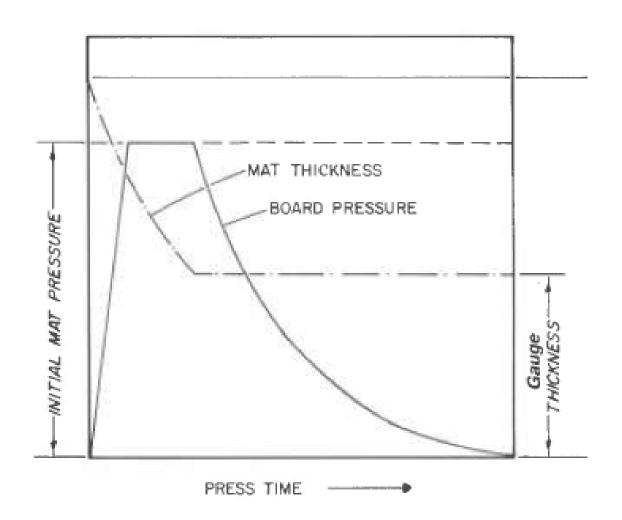


Rāmju (vidējais attālums 1200mm) Kopējais presēšanas garums 28000mm

Pressing Pressure



Holender



Properties of MDF.LA – load bearing, dry

Properties		Unit	Nominal thickness, mm									
	Tetsts		1,8 līdz 2,5	> 2,5 līdz 4,0	> 4 līdz 6	> 6 līdz 9	> 9 līdz 12	> 12 līdz 19	> 19 līdz 30	> 30 līdz 45	> 45	
Swelling in thickness, 24 h	EN 317	%	45	35	30	17	15	12	10	8	6	
Inter bond quality	E319	MPa	0,70	0,70	0,70	0,70	0,65	0,60	0,60	0,55	0,50	
Bending strength	EN310	MPa	29	29	29	29	27	25	23	21	19	
Modulus of Elastictity	EN310	MPa	3000	3000	3000	3000	2800	2500	2300	2100	1900	

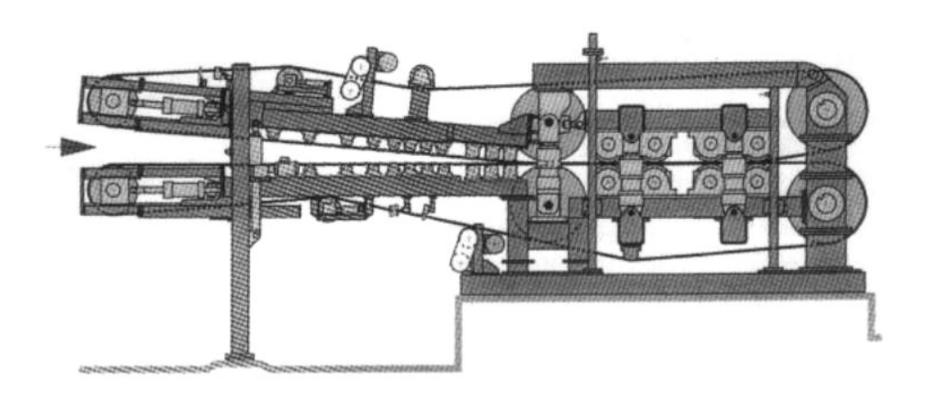
Properties of MDF.HLS – load bearing, humid

	Tetsts		Nominal thickness, mm								
Properties		Unit	1,8 līdz 2,5	> 2,5 līdz 4,0	> 4 līdz 6	> 6 līdz 9	> 9 līdz 12	> 12 līdz 19	> 19 līdz 30	> 30 līdz 45	> 45
Swelling in thickness, 24 h	EN 317	%	35	30	18	12	10	8	7	7	6
Inter bond quality	E319	MPa	0,70	0,70	0,70	0,80	0,80	0,75	0,75	0,70	0,60
Bending strength	EN310	MPa	34	34	34	34	32	30	28	21	19
Modulus of Elastictity	EN310	MPa	3000	3000	3000	3000	2800	2700	2600	2400	2200

Properties of MDF.H – general purpose, humid

Properties			Nominal thickness, mm								
	Tetsts	Unit	1,8 līdz 2,5	> 2,5 līdz 4,0	> 4 līdz 6	> 6 līdz 9	> 9 līdz 12	> 12 līdz 19	> 19 līdz 30	> 30 līdz 45	> 45
Swelling in thickness, 24 h	EN 317	%	35	30	18	12	10	8	7	7	6
Inter bond quality	E319	MPa	0,70	0,70	0,70	0,80	0,80	0,75	0,75	0,70	0,60
Bending strength	EN310	MPa	27	27	27	27	26	24	22	17	15
Modulus of Elastictity	EN310	MPa	2700	2700	2700	2700	2500	2400	2300	2200	2000

Prepressing of Continous Press



Wood Consumption

	Production	by process
Property	Wet	Dry
Wood consumption in dry condition tons by tons	1,15	1,10
Wood consumption in m³ by 1 ton of fiber board	2,3 – 2,9	2,1 – 2,2







http://www.siempelkamp.com/index.php?id=732&L=0





http://www.dieffenbacher.de/en/wood-based-panels/wood-based-panels.html





http://www.imalpal.com/en/plants.php











Thank You For Your attention!



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Topic:

"PRODUCTION OF WOOD BASED PANELS: PARTICLEBOARDS AND ORIENTED STRAND BOARDS"

Author Uldis Spulle

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA







PRODUCTION OF WOOD BASED PANELS Particleboards and Oriented Strand Boards

Uldis SPULLE

Latvia University of Life Sciences and Technologies

Terms and Definitions

TERMS: Particleboard or chipboard and Oriented Strand Board

STANDARDS:

EN 312:2010 Particleboards. Specifications

P1: general purpose boards for use in dry conditions.

P2: boards for interior fitments (including furniture) for use in dry conditions.

P3: non load-bearing boards for use in humid conditions.

P4: load-bearing boards for use in dry conditions.

P5: load-bearing boards for use in humid conditions.

P6: heavy duty load-bearing boards for use in dry conditions.

P7: heavy duty load-bearing boards for use in humid conditions.





EN 300 Oriented Strand Boards (OSB) – Definitions, classification and specifications

OSB/1 - general purpose boards and boards for interior fitments (incl.furniture) for use in dry conditions.

OSB/2 - load-bearing boards for use in dry conditions.

OSB/3 - load-bearing boards for use in humid conditions.

OSB/4 - heavy-duty load-bearing boards for use in humid conditions.

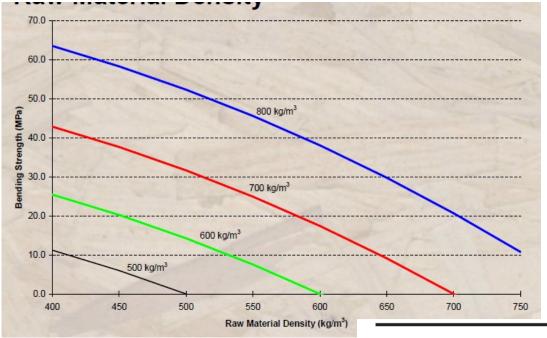








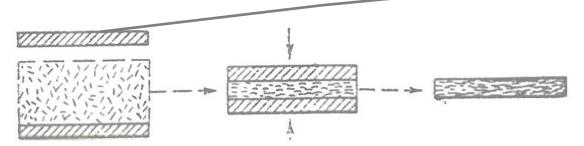
Overview of Properties



Thickness (mm)		Density (kg/m³)	Bendi	ng Strength (MPa)	Bending Stiffness (MPa)		
	(111111)	(kg/iii)	Par.	Perp.	Par.	Perp.	
Solid Timbe	er						
Douglas fir	20	500	80	2.2	12700	800	
Plywood							
Douglas fir	4.8	520	73	16	12090	890	
Douglas fir	19	600	60	33	10750	3310	
Chipboard							
UF bonded	18.6	720	11.5	11.5	1930	1930	
PF bonded	19.2	680	18.0	18.0	2830	2830	
MF/UF bonded	18.1	660	27.1	27.1	3460	3460	
Fibre-build	ing board						
Tempered	3.2	1030	69	65	4600	4600	
Standard	3.2	1000	54	52			
MDF	9-10	680	18.7	19.2			

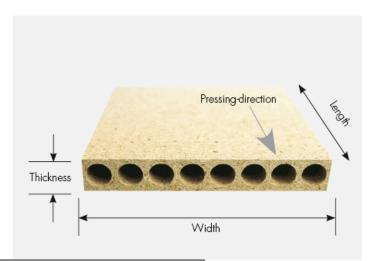
Overview of Processing

Flat Press Plates



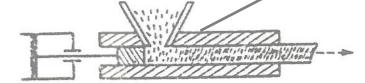
http://www.sauerland-spanplatte.de/en/product/product-data/structure-of-extruded-particle-board.html



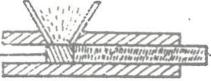


Extrusion process



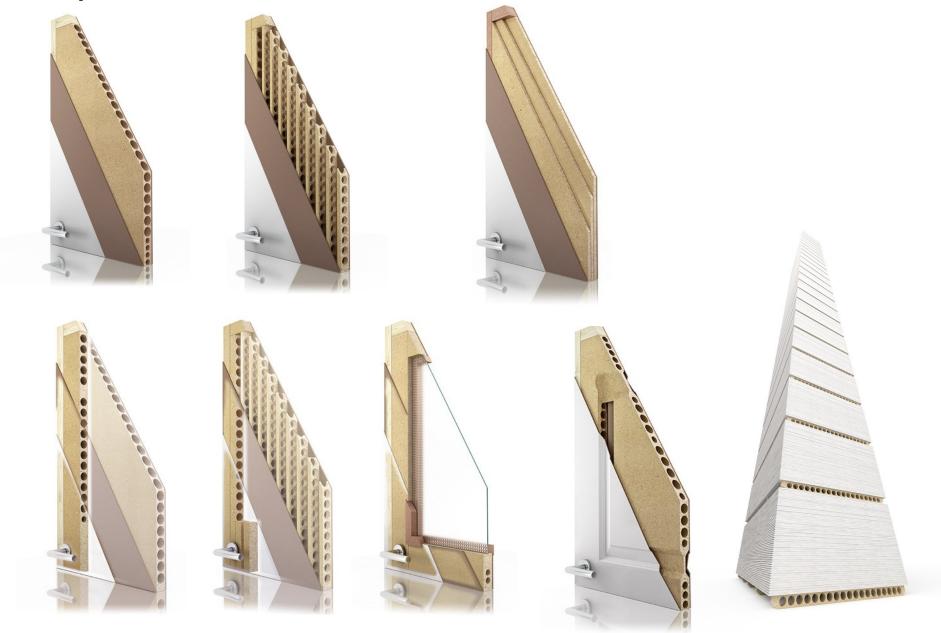




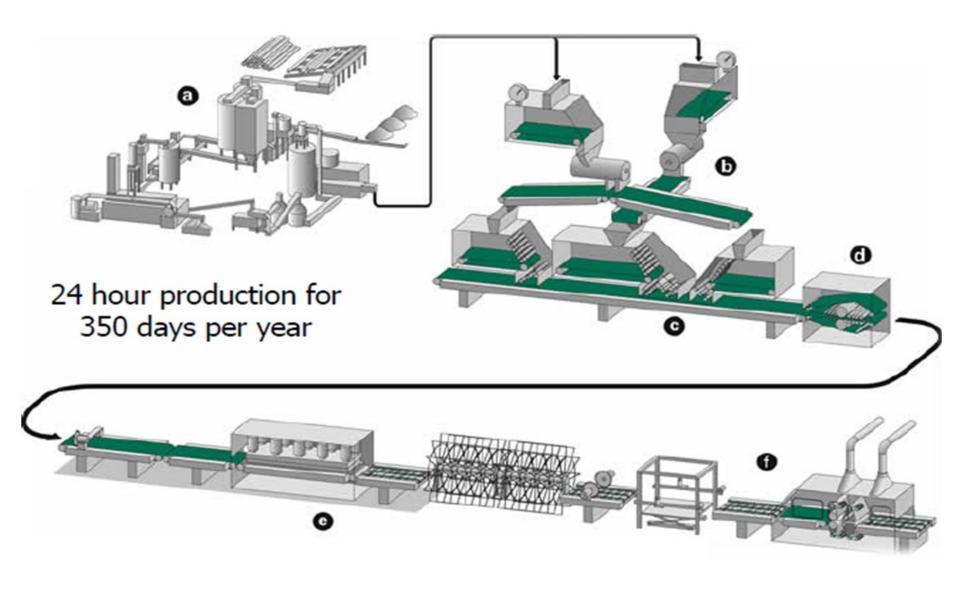




Example of Extruted Particleboard



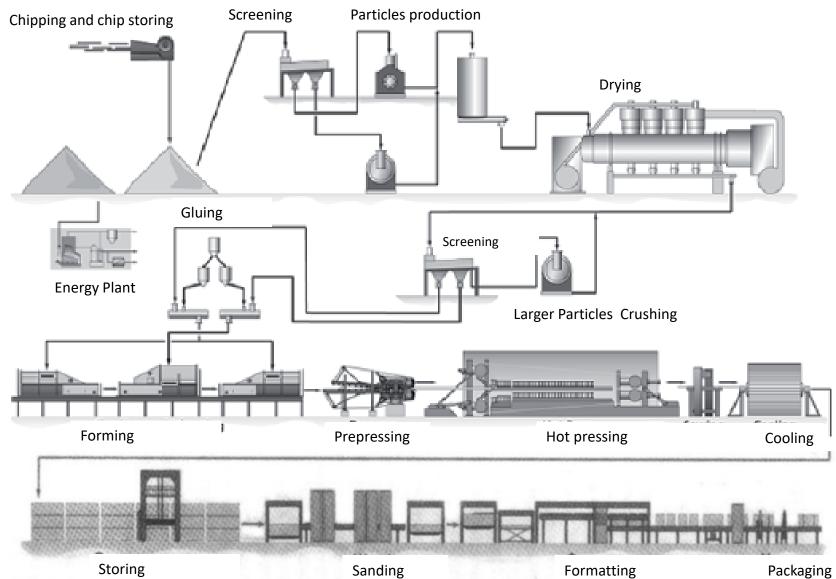
Production Line Overview



a – preparation of raw material; b- applying of adhesives; c- mattress making; d- pressing; e- splitting; f-finishing

Production Line Overview





Raw Material - Chips

Wood Residues

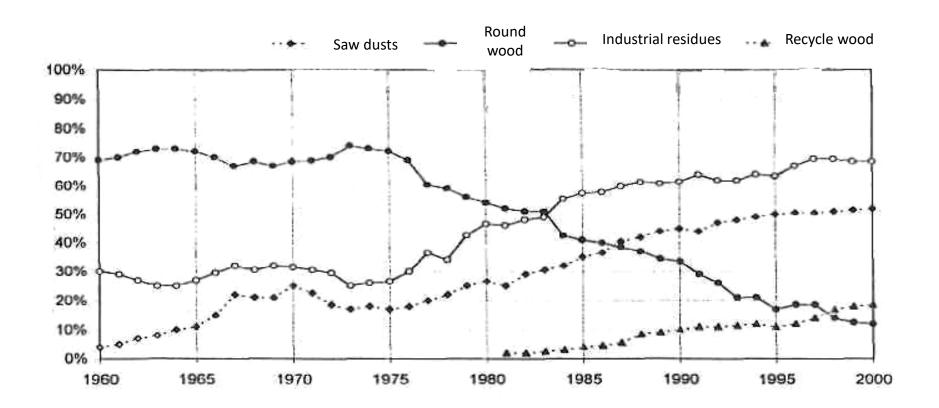
- Forest Residues
 - » Thinnings,tree tops, branches
- Sawmill Residues
- Plywood mill Residues
- Timber Processor
 Residues
- Recycled wood "Urban Forest"
 - Pallets & boxes
 - Demolition timbers



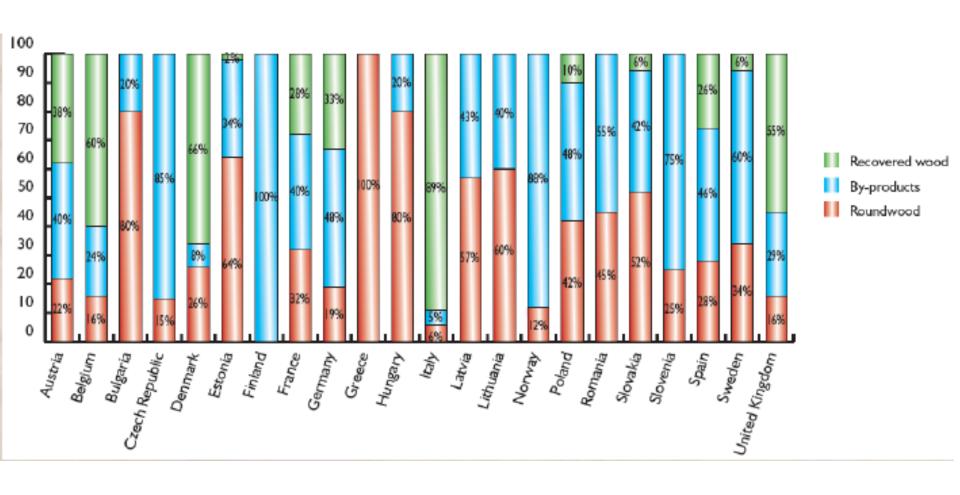


Source: G.I. Hadfield & Son Ltd.

Overview of Raw Material



Raw Material – for Particleboard Production in EU



Raw Material - Chips Properties

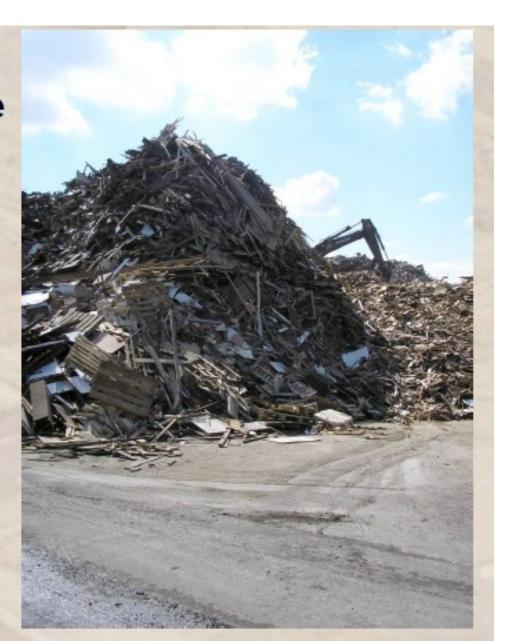
Heterogeneous

Very variable moisture content

 Generally drier than virgin wood

Contaminants

- Minerals: stones, concrete, soil, etc.
- Ferrous metals: iron, steel.
- Non-ferrous metals: aluminium, lead, etc.
- Organic: plastics, paints, rubber, fabric, etc.



Quality Check of Recycled Wood

- Documentation check
- Visual inspection
- Sample
 - particle size distribution
 - moisture content
 - grit content
- Chemical analysis is rare

Initial Processing of Recycled Wood

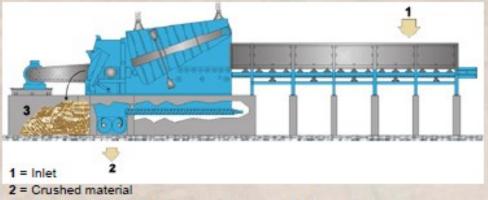
Coarse shredding

- Low speed
- High speed

Tiger Family (PAL)

- Inlet
 - » width 1.8 m
 - » height 1.4 m
- Capacity 15-20 t/h





3 = Reject of non-crushable material Source: PAL website

Low Speed Shredding

* Rotor:

- Diameter 1000 mm
- Length 3500 mm
- Rpm 13
- Capacity 5-25 t/h





Source: Klinkert Maschinen GmbH

Cleaning Recycled Wood

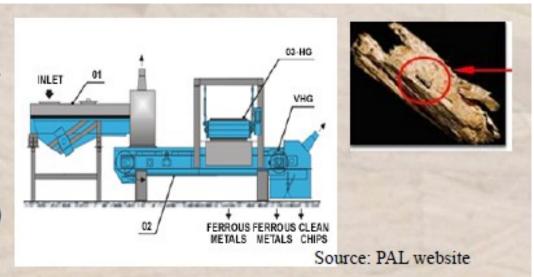
- Ferrous metals: magnet
- Non-ferrous metals: Eddy current drum
- Heavy mineral particles: vibrating tables with air sifting
- Fine inorganic particles: sieve
- Plastic particles: air sifting

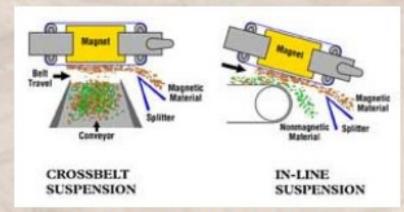
Ferrous Metal Separation

Magnets

- 01 Vibrating channel for chip spreading
- 02 Wide horizontal belt conveyor equipped with Very high gradient (VHG) front magnetic pulley
- 03 High gradient overbelt magnet

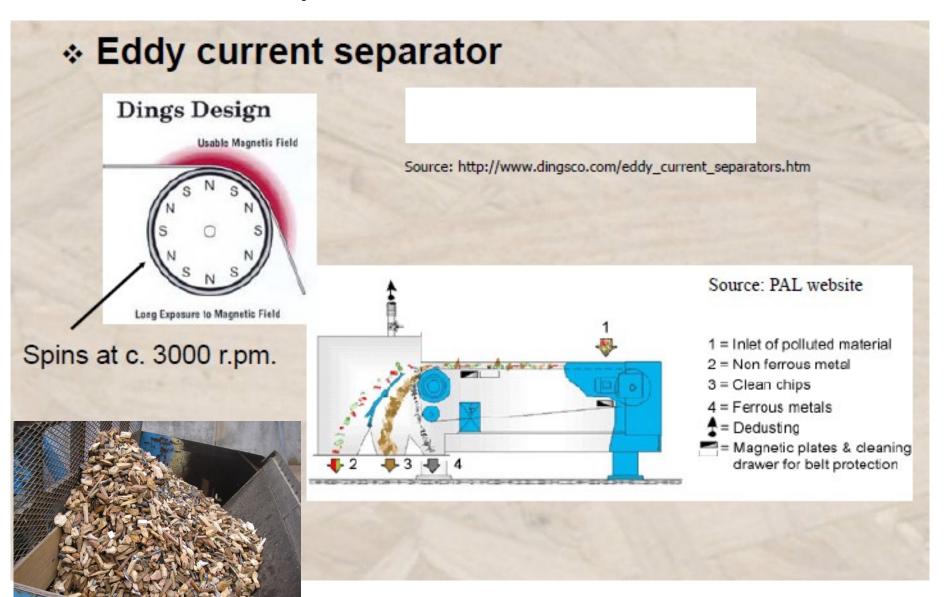






Source: http://www.dingsco.com/overhead_magnetic_separators.htm

Non- ferrous Metal Separation



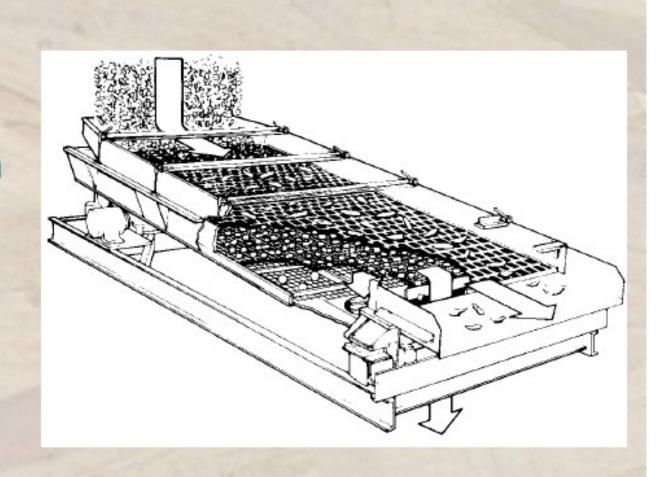
Particle Sorting: Sieve

* Motion

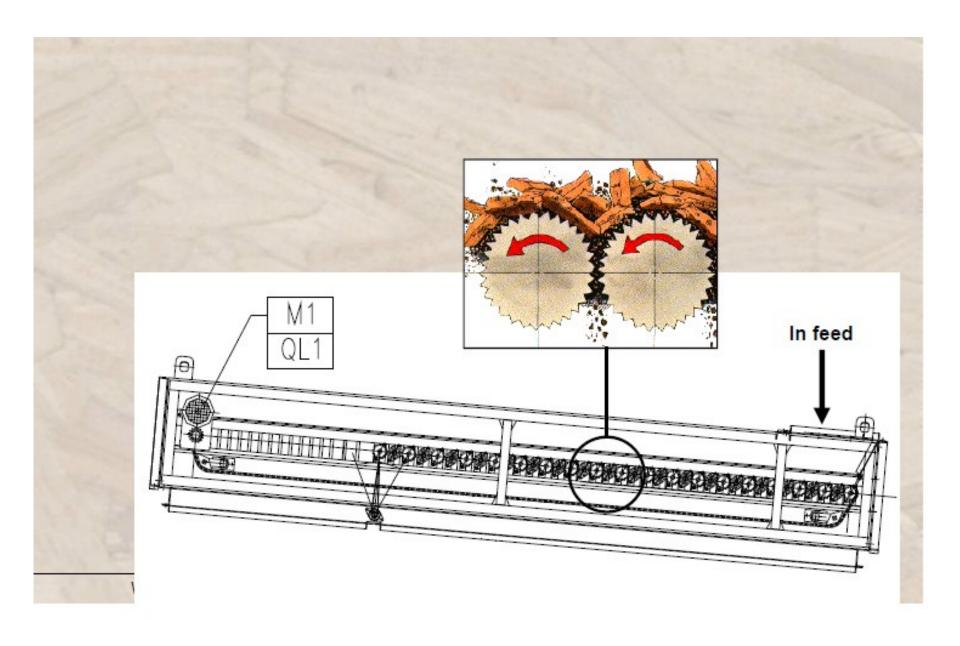
- vibration
- gyratory

Orientation

- horizontal
- inclined



Particle Sorting: Rolls



Screening

· W-Rolls

To separate very fine,
 short and dusty particles



· V-Rolls

 To separate thin particles and micro-chips



* D-Rolls

- To remove oversize

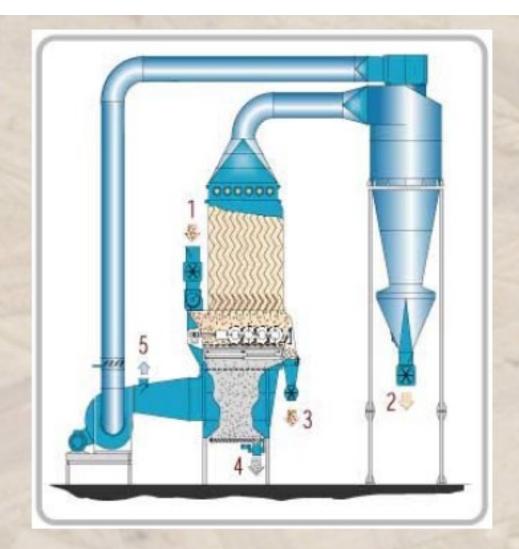


Source: PAL website

Sifting

Wind sifter

- Separating sand and grit
 - 1 Polluted particles
 - 2 Accepted [thin]
 - 3 Rejected [thick]
 - 4 Heavy pollutants
 - 5 Exhaust air



Source: PAL website

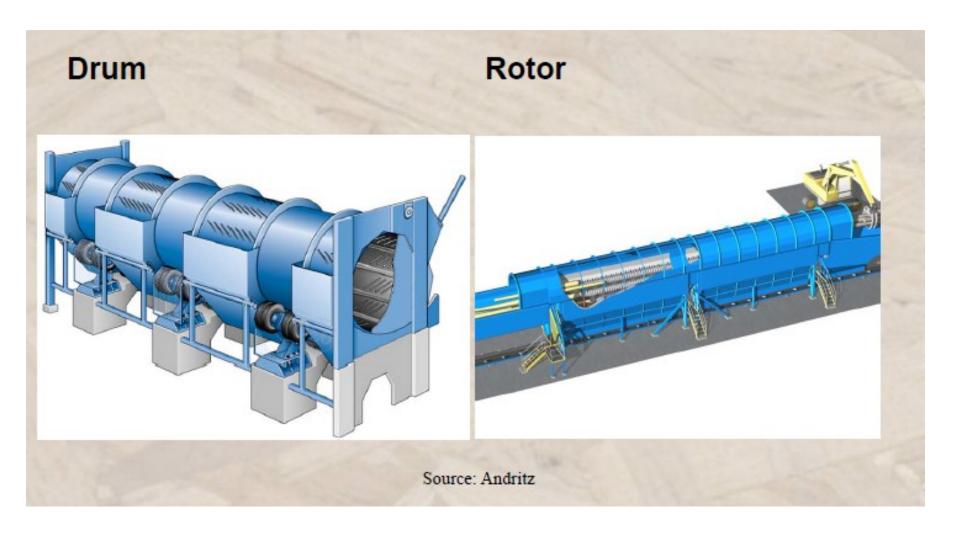
What Cleaning is Possible?

- Cleaning by physical property
 - metallic
 - density
 - size
- Removal of isolated contaminants
 - except plastic
- Solid contaminants associated with wood
- Cannot separate treated wood

Raw Material - Solid Wood



Log Debarking



Ideal Raw Material Properties

Workability

- smooth surfaces and a minimum of end grain
- dependent on anatomy

Density

panel density = wood density × 1.5

⋄ pH

- adhesive cure
 - » acidity and buffer capacity

Permeability

- difficult to prove

Wood Acidity

There is great variation in acidity and buffer capacity between species and within trees.

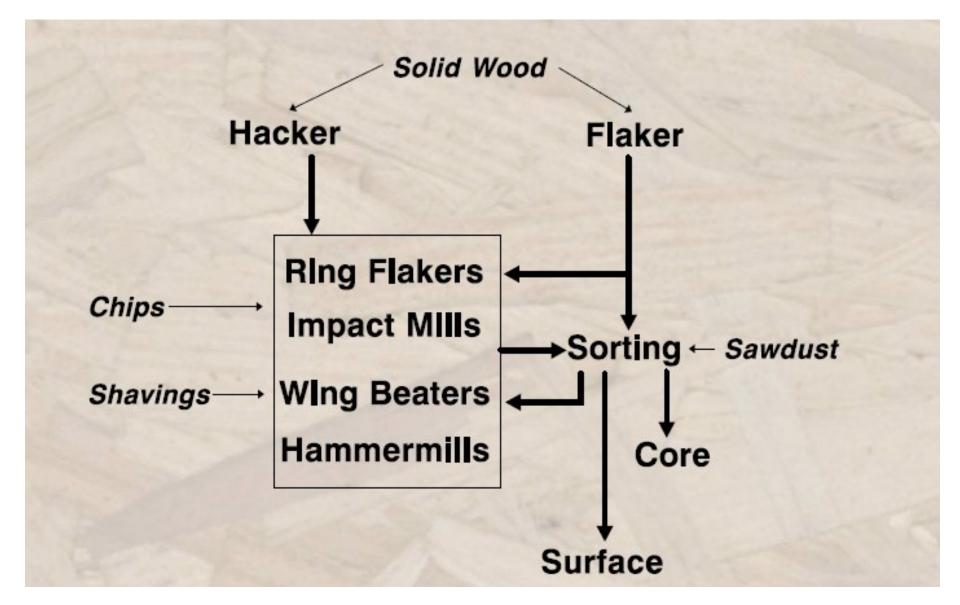
Wood Source	рН
Larix decidua (European Larch)	4.3
Picea abies (Norway Spruce)	5.3
Pinus sylvestris (Scots Pine)	5.1
Pseudotsuga menziesii (Douglas Fir)	3.3
Betula verrucosa (European Birch)	4.8
Quercus alba (White Oak)	4.1
Araucaria angustifolia (Parana Pine)	5.2 - 8.8

Source: Fengel & Wegener (1989)

Raw Material – Solid Wood Economics



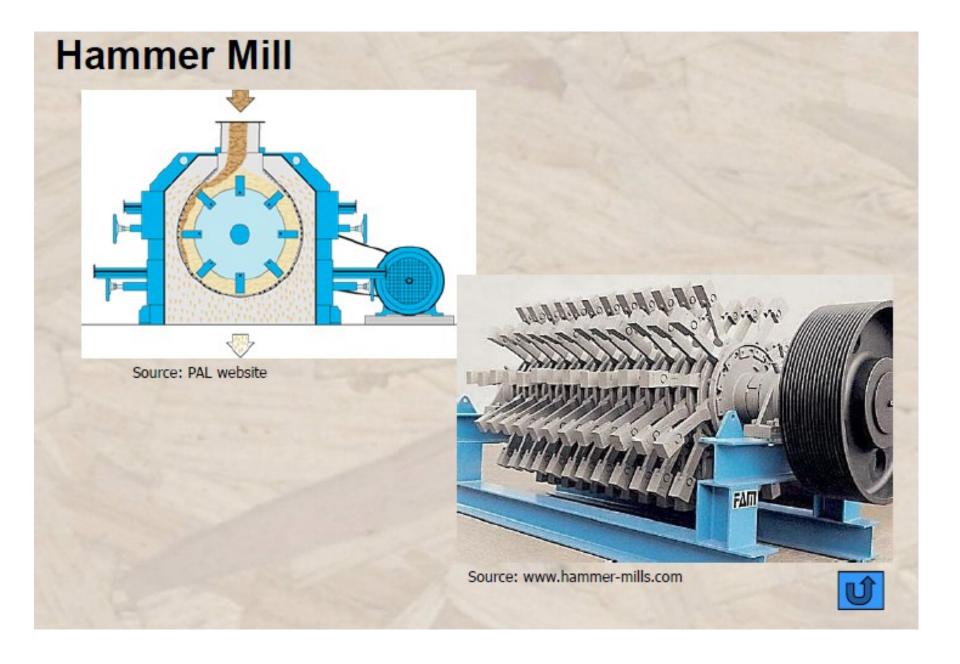
Chipping Wood



Hacker



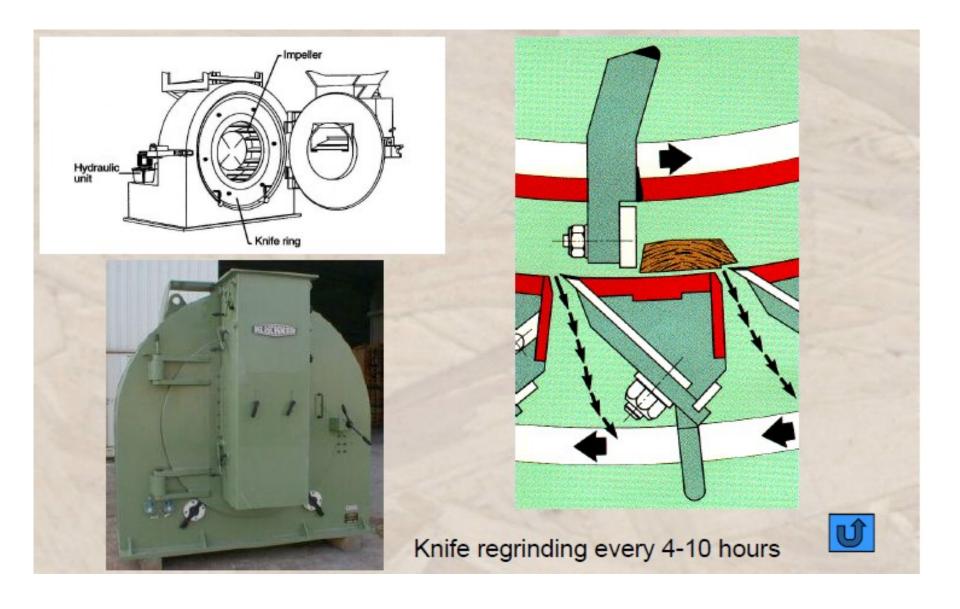
Hammer Mill



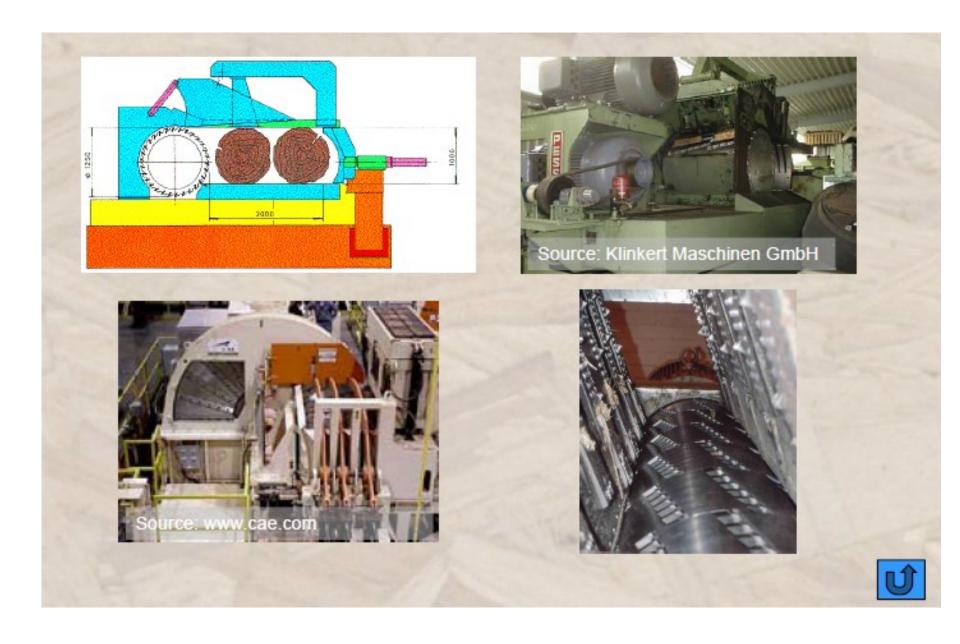
Impact Mill



Knife Ring Flaker



Round Wood Flakers



Wing Beater



Particle Size

Typical for chipboard:

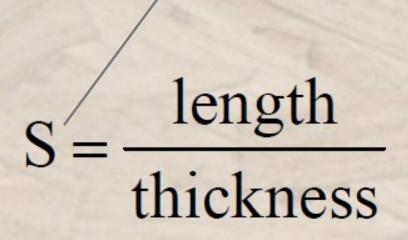
- length: 10 to 50 mm
- thickness: 0.2 to 0.5 mm

Typical for OSB and waferboards:

- length: 50 to 100 mm
- thickness: 0.4 to 0.8 mm

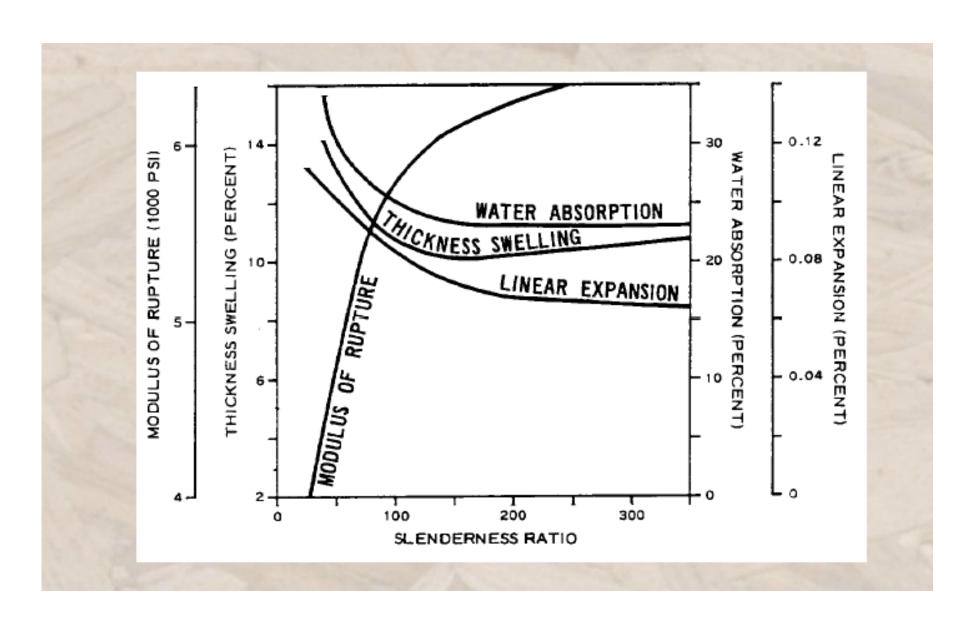
Slenderness Ratio

Longer and thiner is better



- S is independent of width
- Does not take into account:
 - density of timber
 - cross section of particle
- Long thin particles:
 - impact resistance, bending properties
- Short, small particles:
 - internal bond, surface smoothness, permeability

Slenderness Ratio vs. Panel Properties



Particle Drying

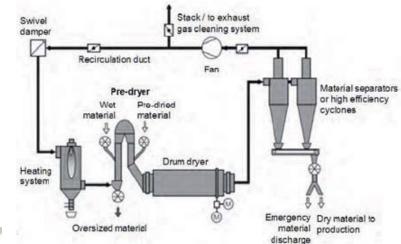
- Particle moisture content reduced to 2 8% because
 - steam generation during hot pressing
 - water added with adhesives
- Initial moisture content may exceed 100%
 - high energy input
 - 66% of total energy input used for drying
 - lots of steam generated
- Moisture content measured by infra-red sensors

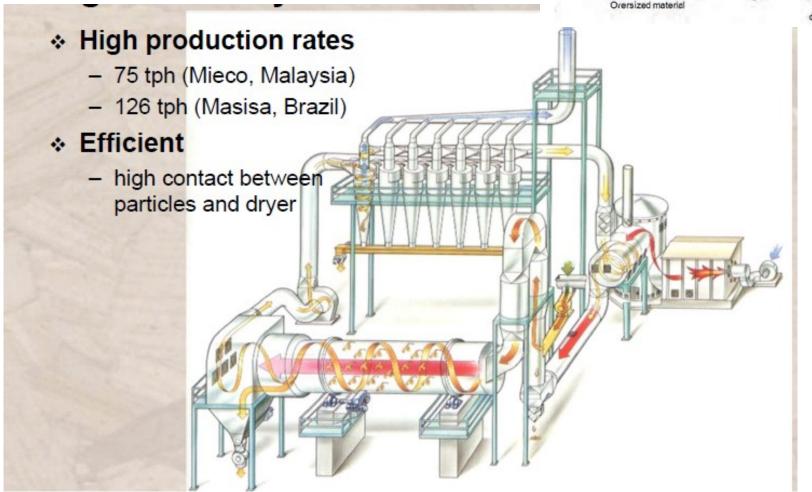


Technical Parameters of Dryers

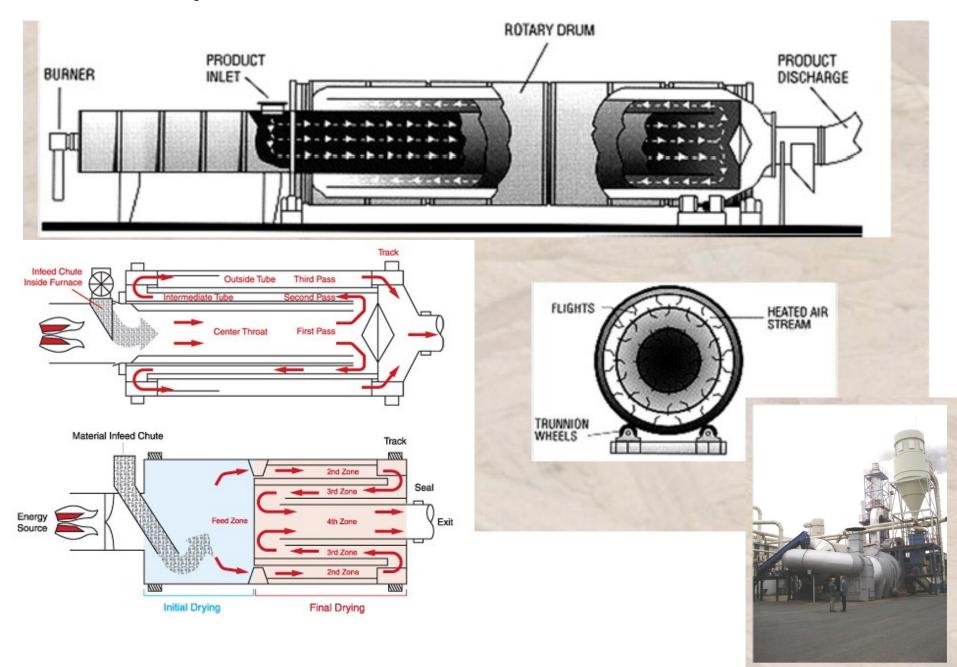
Dryer type	Scheme	Temp. range	Drying time	Drying capacity
Rotary bundle dryer		up to 200°C	≤ 20 min	1 9 t/h
Tube bundle dryer		up to 160°C	n.a.	10 18 t/h
Single-pass drum dryer		up to 450°C	20 - 30 min	≤ 40 t/h
Three-pass dryer		up to 400°C	5 - 7 min	≤ 25 t/h
Flash tube pre-dryer		up to 500°C	≈ 20 s	2 14 t/h
Jet tube dryer	-	approx. 500°C	≈ 0,5 - 3 min	≤ 10 t/h

Single Pass Dryer





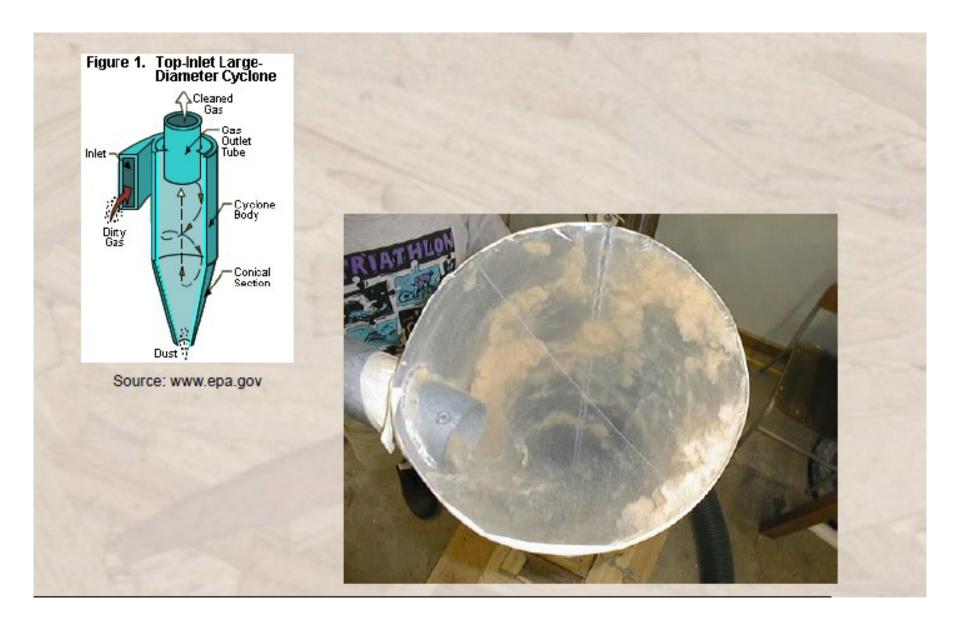
Three Pass Dryer



Industrial Cyclones



Cyclones



Dryer Legislation

❖ European Directive 2010/75/EU

- WBP factories producing more than 600 m³/day

Limits set:

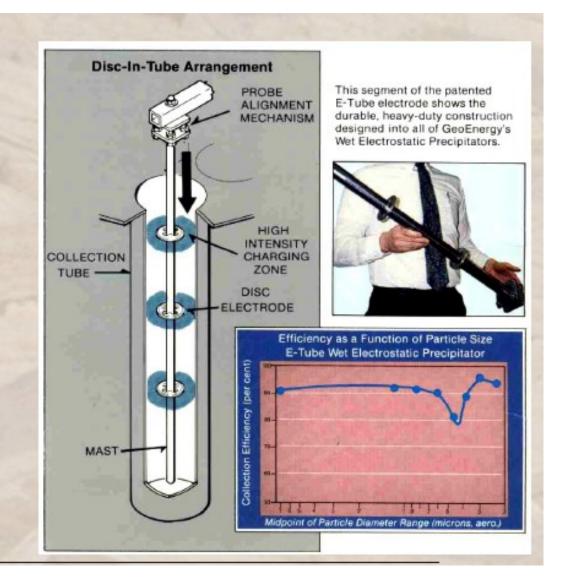
- Particulate matter 50 mg/m³
 - » values often quoted as x mg/Nm³, where the N refers to "normal", i.e. a m³ at a given temperature and pressure
- VOCs 50 mg/m³

* Also specifies:

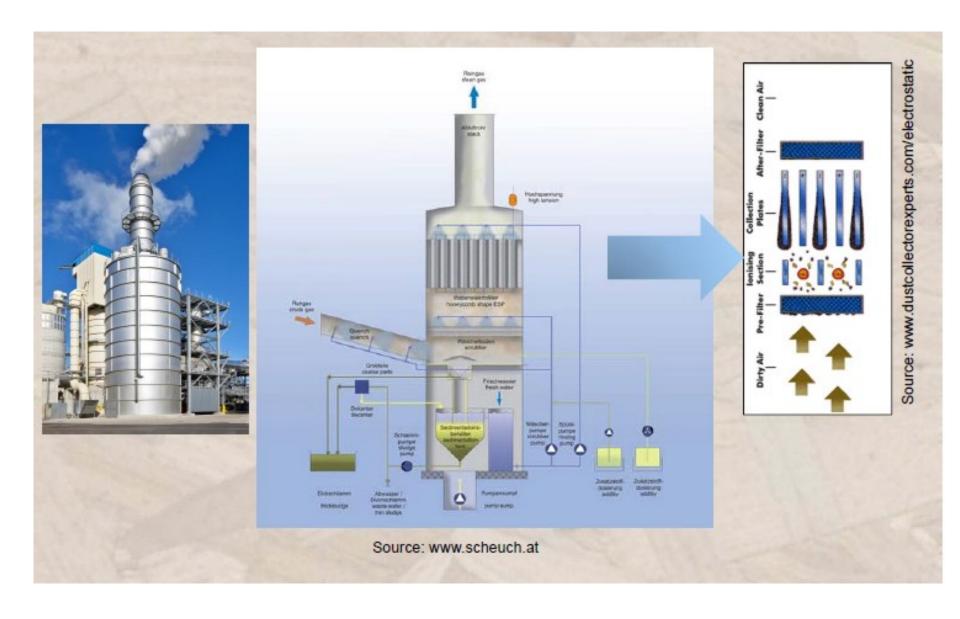
- Monitoring procedures
- Record keeping

Reduction Dryer Emissions

- Cyclones
- * Filters
- * WESP
 - Wet electrostatic
 precipitators
 - High reduction of VOCs and particulates



A Wet Electrostatic Precipitator (WESP)



Particle Sorting

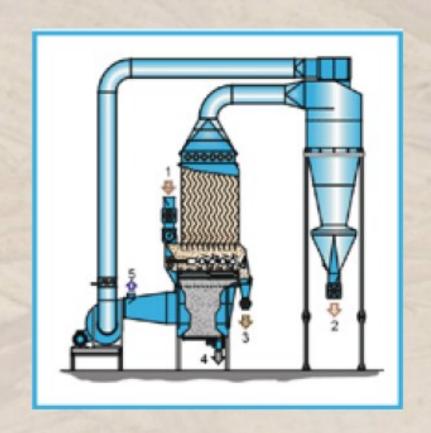
Common sequence:

- Air sorting
 - » Remove fine material
- Mechanical sorting
 - » Sieves
 - » Diamond rolls

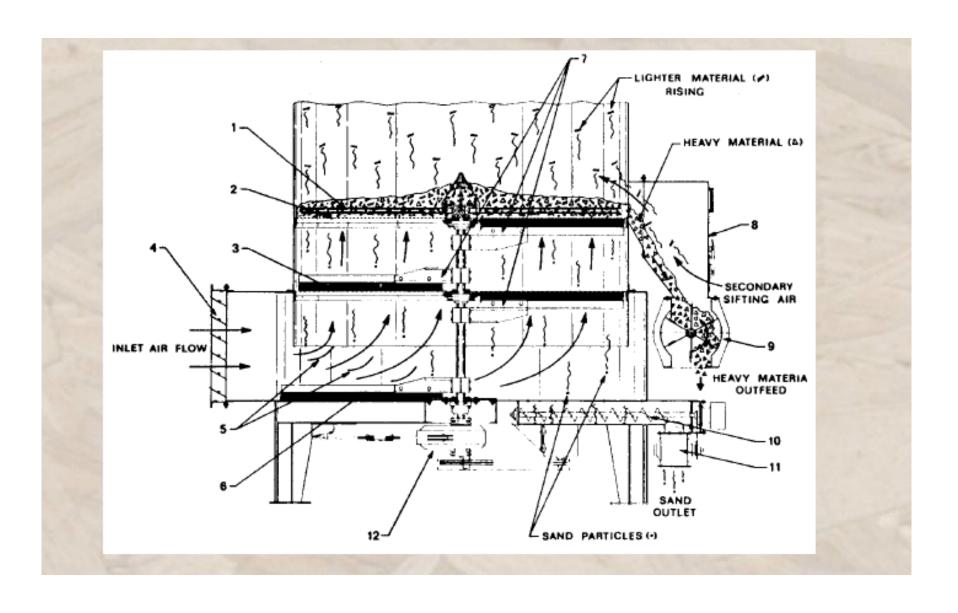
Sifting

Wind sifter

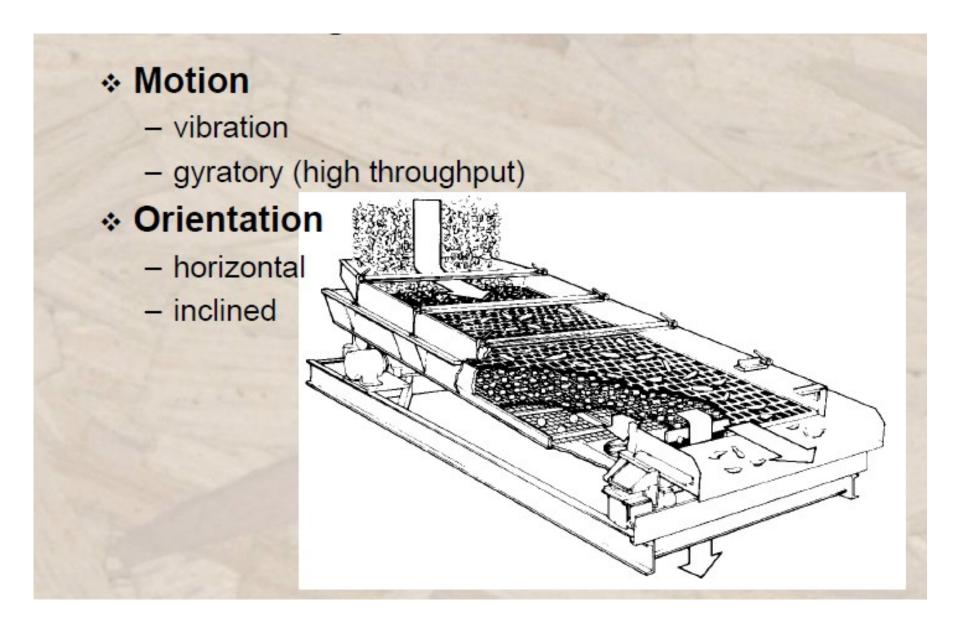
- Separating sand and grit
 - 1 Polluted particles
 - 2 Accepted [thin]
 - 3 Rejected [thick]
 - 4 Heavy pollutants
 - 5 Exhaust air



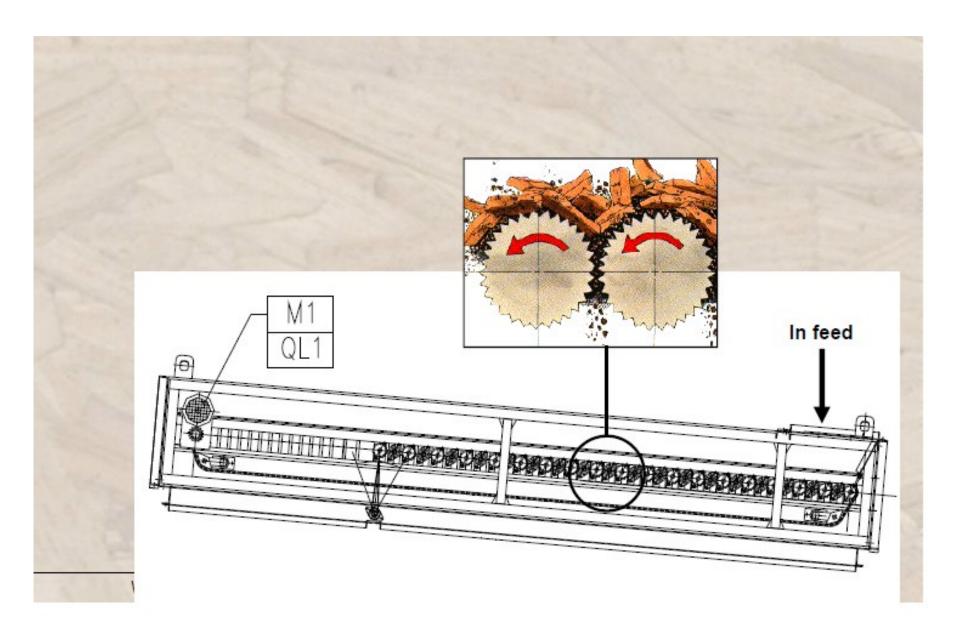
Particle Sorting: Air classification



Particle Sorting: Sieve



Particle Sorting: Rolls



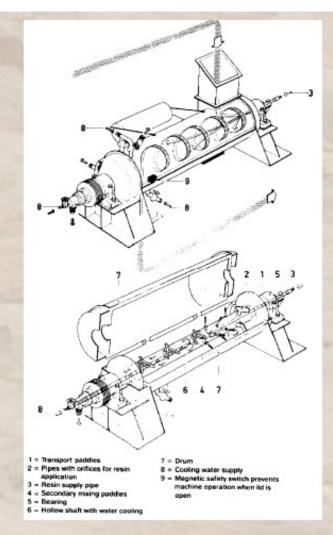
Blending



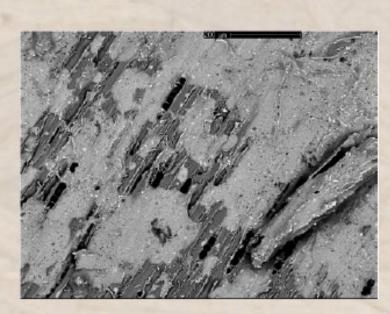
- Adhesives, water repellents and colour are often added
- Spray nozzles
 - air
 - hydraulic



PAL ASS 120

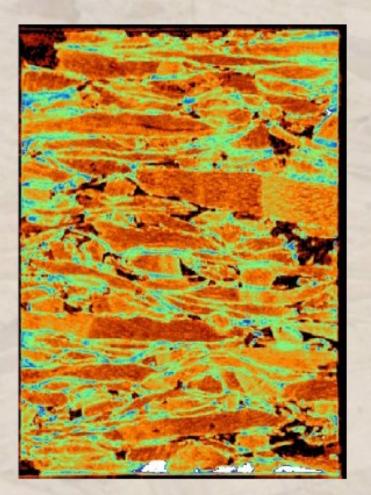


Resin Distrubution



UF resin labelled with copper sulphate to increase X-ray opacity. Furnish properties: 12.5% adhesive, 0.7% wax

Blue = resin, black = void, orange = wood



Source: Evans et al (2008) Pacific Rim Bio-Based Composites Conference

Urea Formaldehyde (UF)

- * versatile
- * clear
- * strong
- * cheap
 - (c. €380/t in 2009)

$$H-N-CH_2OH$$
 $C=O$
 $H-N-H$

Poor weather resistance Formaldehyde release

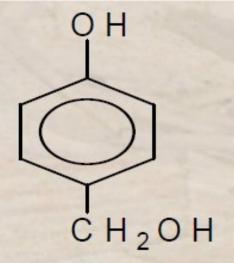
Melamine Formaldehyde (MF)

- reasonably versatile
- clear
- strong
- moisture resistant

Expensive (x2 UF)
Formaldehyde release

Phenol Formadehyde (PF)

- * strong
- weather resistant
- no formaldehyde release



Expensive (x2 UF)

Dark Colour

Production Problems

Isocyanate (MDI)

Isocyanate

- * strong
- * weather resistant

WOOD-O-H + O=C=N-R
$$\longrightarrow$$
 WOOD-O-C-N-R

OCC N-R + OH₂ \longrightarrow HN-R + CO₂

OCC N-R + HN-R \longrightarrow HN-R

- no formaldehyde release
- light/yellow colour

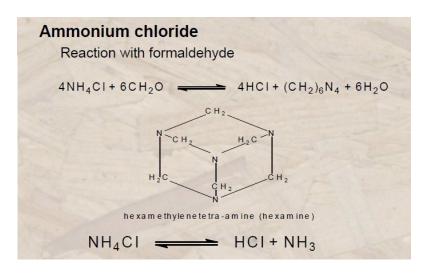
Very Expensive (x4 UF)
Production Problems

Latent Hardeners and Proportions

Particle board	UF	4 % - 10 %	→ surface layer	8 % - 14 %		
			→ core layer	4%-8%		
	PF	6%-8%	→ surface layer	8 % - 12 %		
			→ core layer	6%-9%		
	MDI	2%-6%	→ surface layer	6%-8%		
			→ core layer	2 % - 4 %		
OSB	PF	6%-8%				
	MDI	2 % - 6 %				
MDF	UF	8 % - 14 %	→ in blow-line res	in application		
	UF	6 % - 10 %	→ resin application	n to dry fibres		
	MUF	8 % - 12 %	→ for HDF as floo	ring quality		
	MDI	≈ 4 % - 10 %		, , , ,		
all panel types	wax	0,3 % - 2 %	applied as micro-crystalline wax emulsion or liquid paraffin			

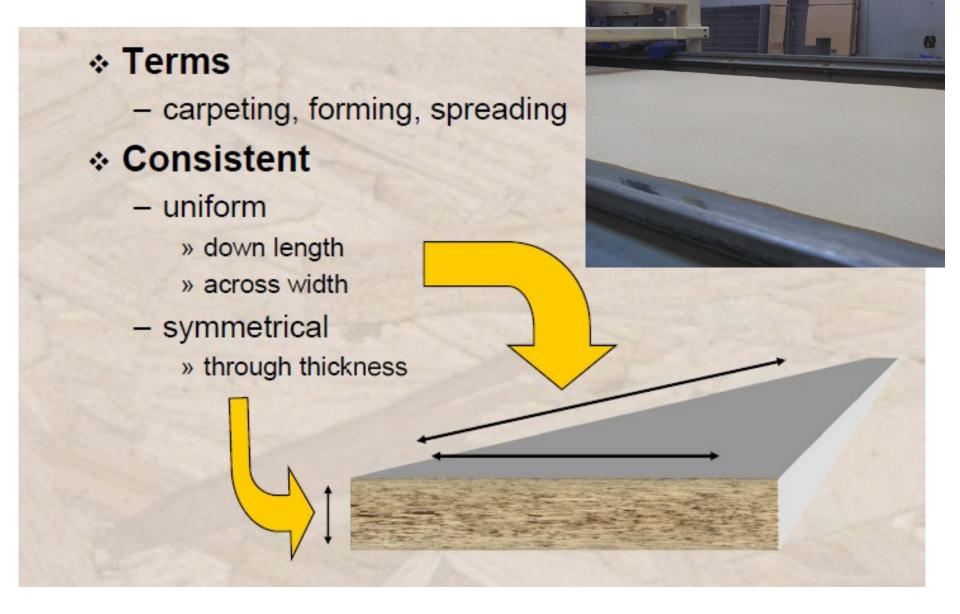
UF bonded particleboard for interior application						
UF resin (66 % solid content)	100 kg	Hardener solution				
Hardener (15 %)	10 kg	SL 5 % (NH ₄) ₂ SO ₄				
Paraffin emulsion (50%)	10 kg					
Water	12 kg	85 % H₂Õ				
		CL 10 % (NH ₄) ₂ SO ₄				
Adhesive solution	132 kg	5 % NH ₃				
Adilesive solution	102 kg	85 % H ₂ O				

PF bonded particleboar	d for exte	erior application
PF resin (45 % solid content) Hardener (50 %) Paraffin emulsion (50%) Water	5 kg	Hardener solution SL none CL 50 % K ₂ CO ₃ 50 % H ₂ O
Adhesive solution	120 kg	



UF - Urea Formaldehyde
PF - Phenol Formaldehyde
MUF - Melamine Urea Formaldehyde
MDI - Isocyanate

Mattress Laying



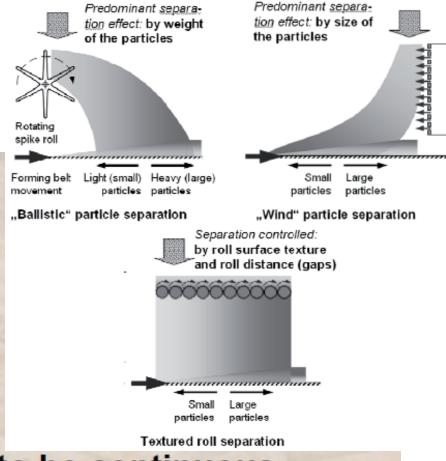
Mattress Formers

Particle sorting

- Non-segregating
- Segregating

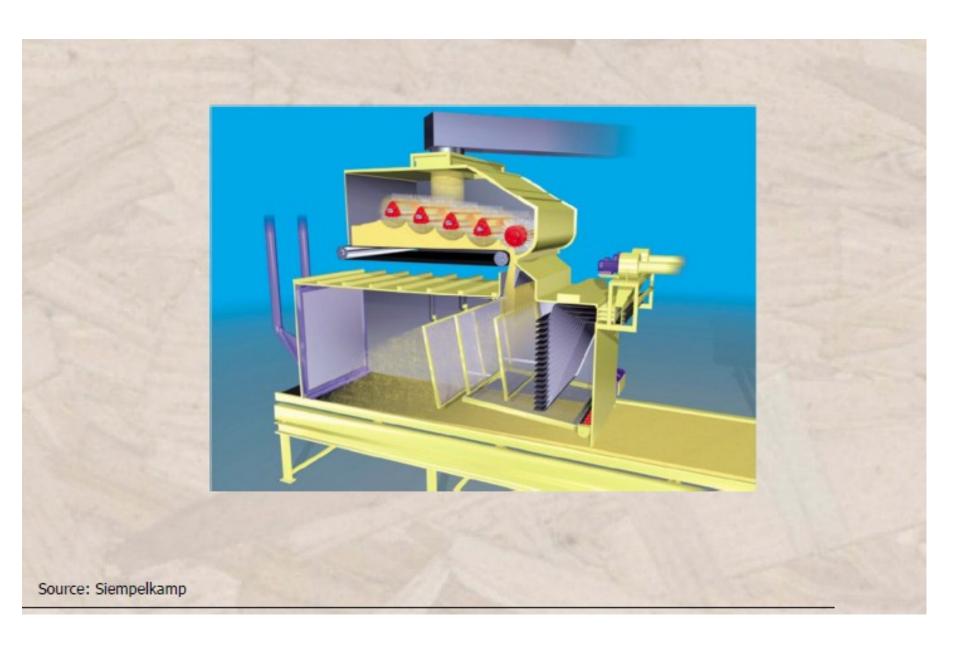
Operation

- Batch
- Continuous

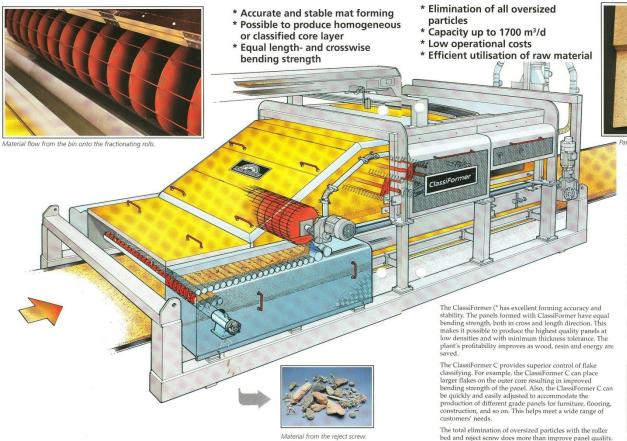


 Modern systems tend to be continuous, segregating formers

Internals of an Air Segregating Former



Internals of an Mechanical Former





Particleboard formed with the ClassiFormer.

The risk of damage to the press platens or steel belts is virtually eliminated

The unique, self-cleaning DiamondRolls¹⁸ (** together with the ClassiFormer dosing bin which feeds a constant uniform mass flow to the forming head, ensures high forming accuracy without daily or weekly cleaning. As a result production capacity and productivity are maximised.

No mats are lost during forming line stop/start phases, as the long forming section maintains accurate forming.

The ClassiFormer design simplifies width adjustment and material return techniques.

The low height and space requirements of the ClassiFormer makes it ideal for rebuilds and retrofits. There is typically sufficient space available to easily replace an existing forming machine. Installation and start-up is simple and fast. As a result, lost production time is minimised when installing the new ClassiFormer.

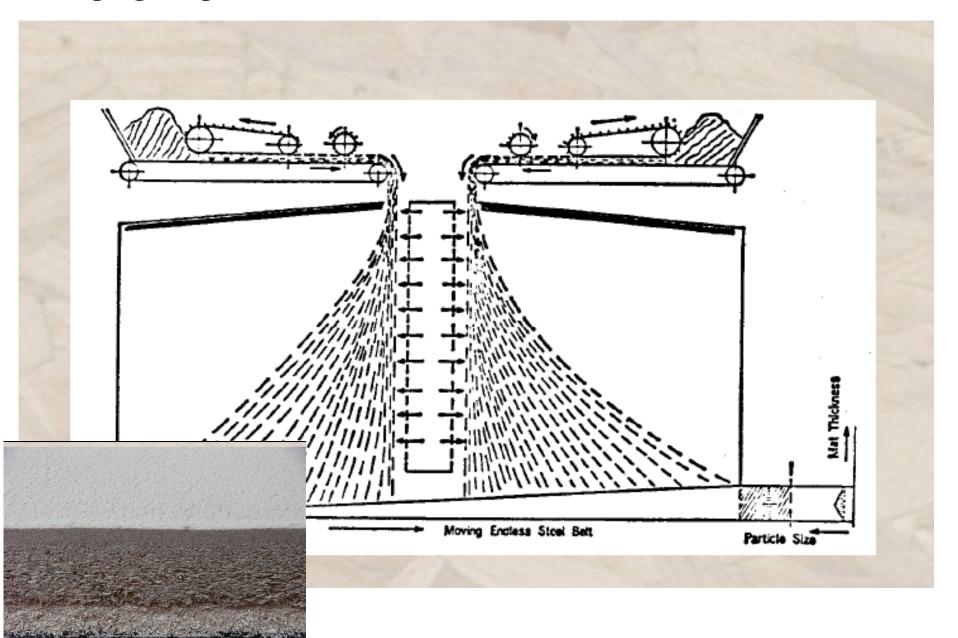
- *) The ClassiFormer™ is patented by Sunds Defibrator in several countries and it is a trade mark of Sunds Defibrator.
- **) The DiamondRollsTM are manufactured under the license of Acrowood Corp. and patented (U.S. pat. nos. 4903845, 5012933, 5058751, 5109988)

Particleboard Production m³/d

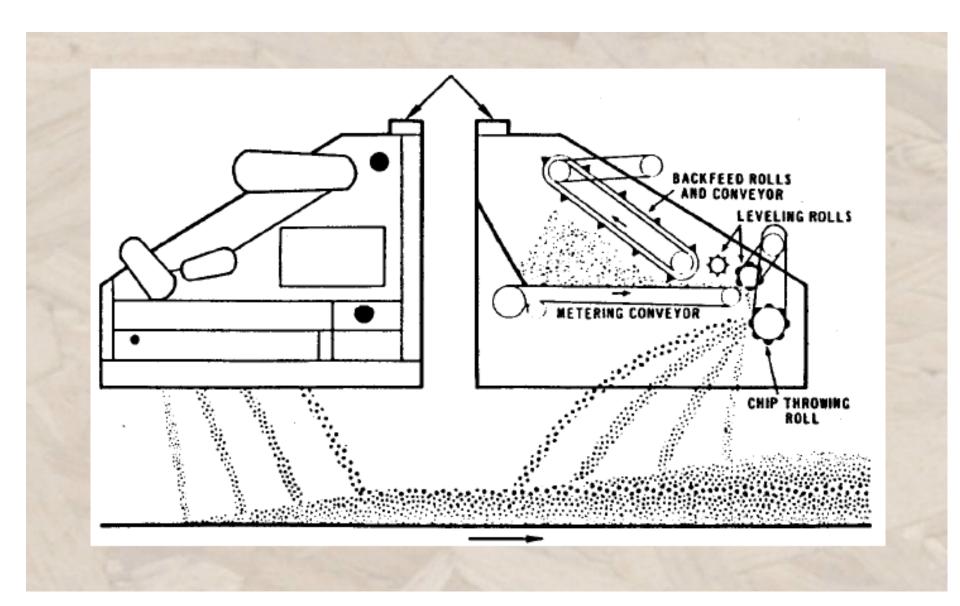
Line width		ClassiFormer™C type				
mm	feet	C2	C3	C4	C5	C6
1220	4	330	500	640	800	940
1830	6	470	700	900	1130	1320
2135	7	530	790	1000	1270	1490
2440	8	600	900	1150	1450	1700

Capacity is subject to raw material testing.

Air Segregating Former



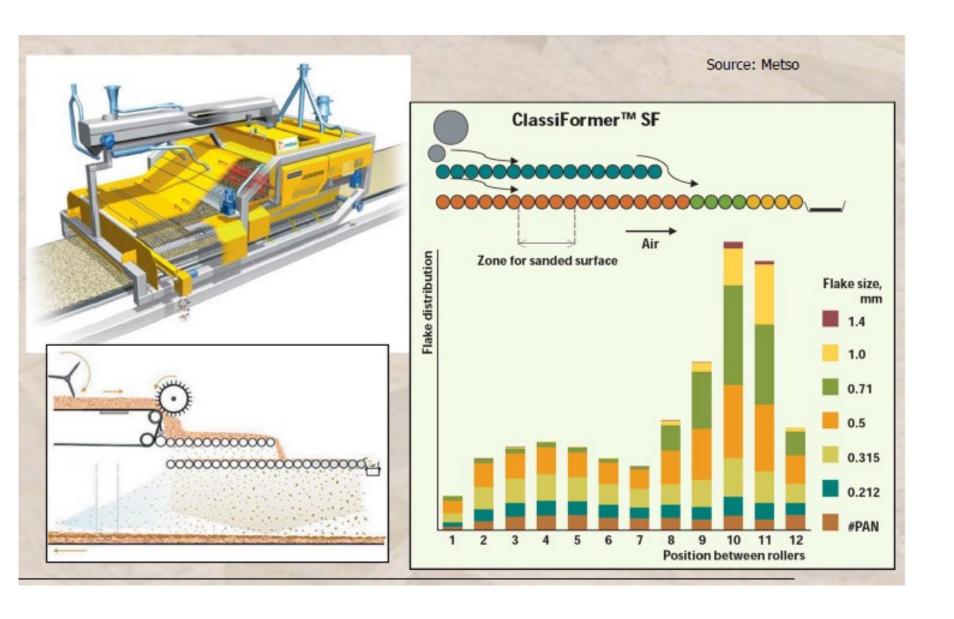
Mechanical Segregating Former



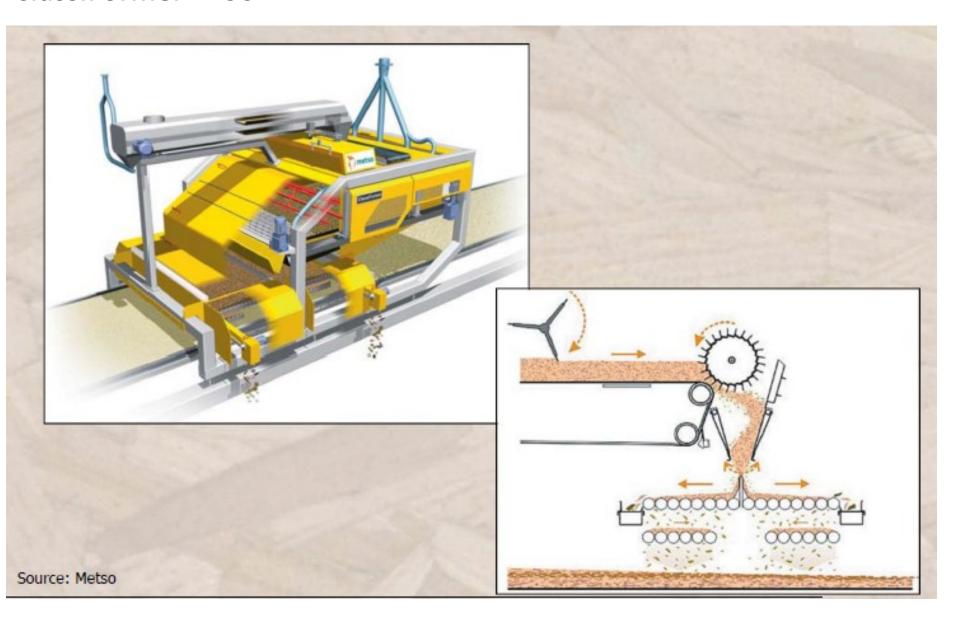
$ClassiFormer^{TM}$



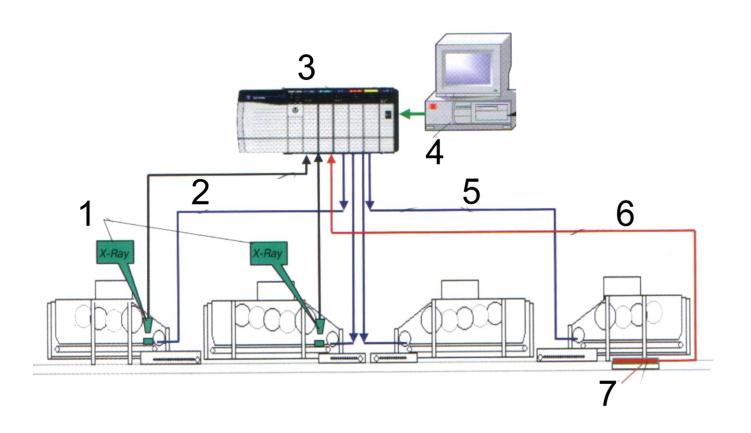
ClassiFormer[™] SF



ClassiFormer[™] **CC**



Forming Machines and control



1- x-ray apparatus for density and mass control; 2 and 5 – speed control of applying sawdust's; 3 and 4- control panel; ; 6 and 7- mass control

Caulless Systems

Advantages

- larger boards can be made
- less investment/ton of board produced
- less thickness and density variation
- no caul plate maintenance
- no board warping due to caul cooling
- no heat wastage from heating cauls
- no power needed to cool them

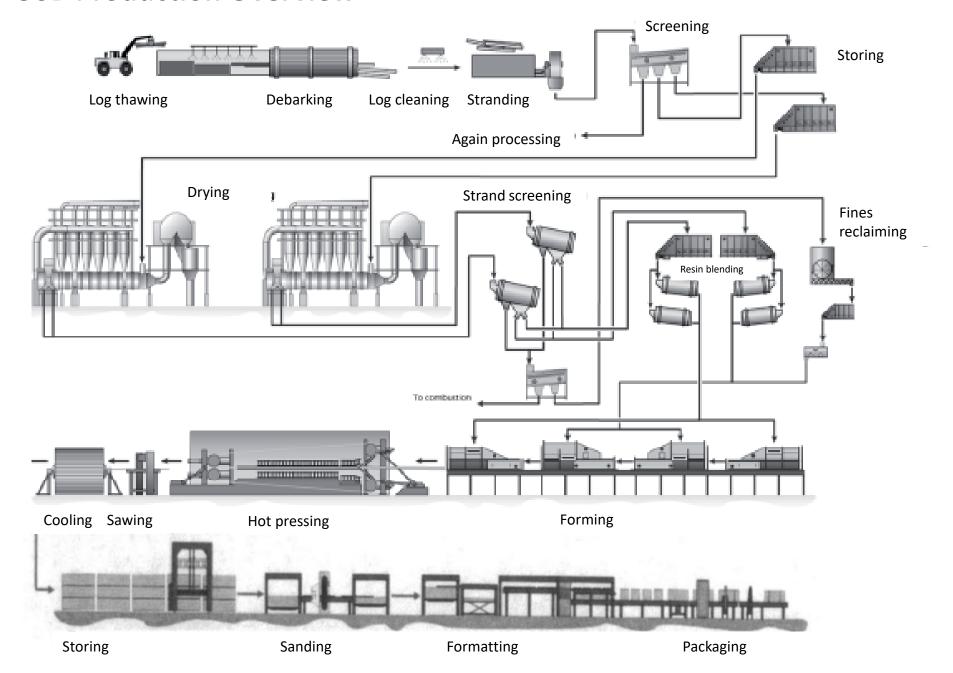
Disadvantages

- potential precure
- mattress dislocations

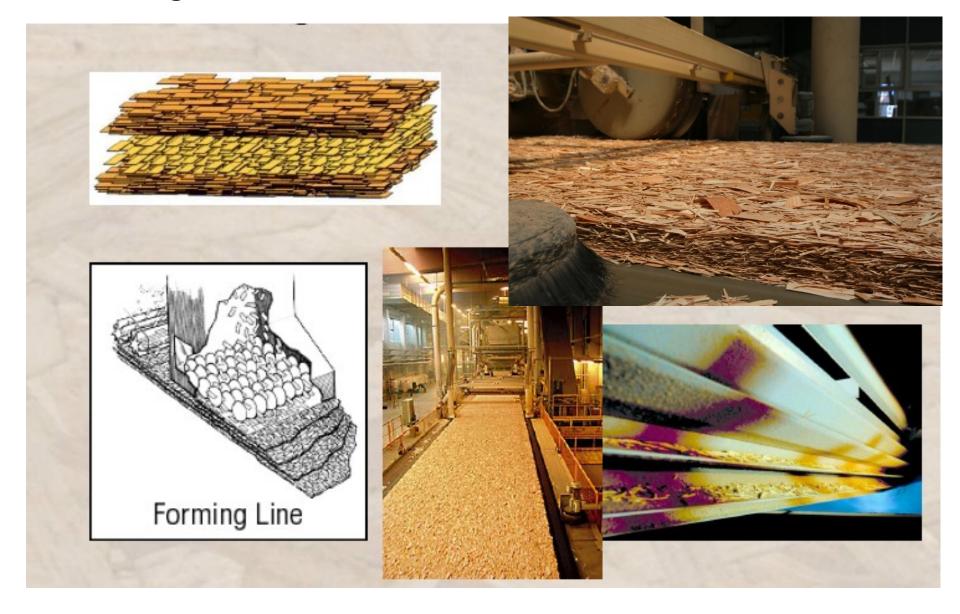
Definition

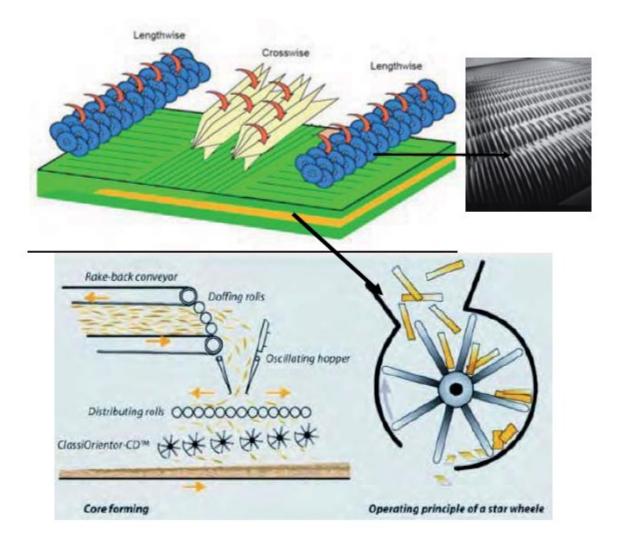
Precure: cure of surface layer adhesives before press fully closed.

OSB Production Overview



OSB Forming

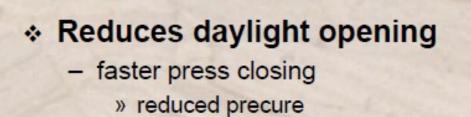






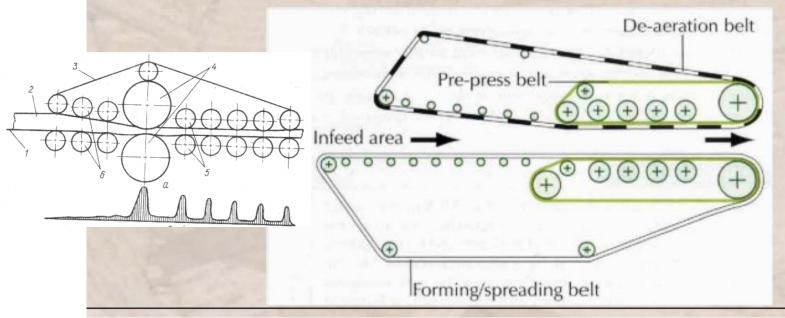


Pre-pressing



- Reduces mat dislocations
 - blow-out
 - conveyor transition

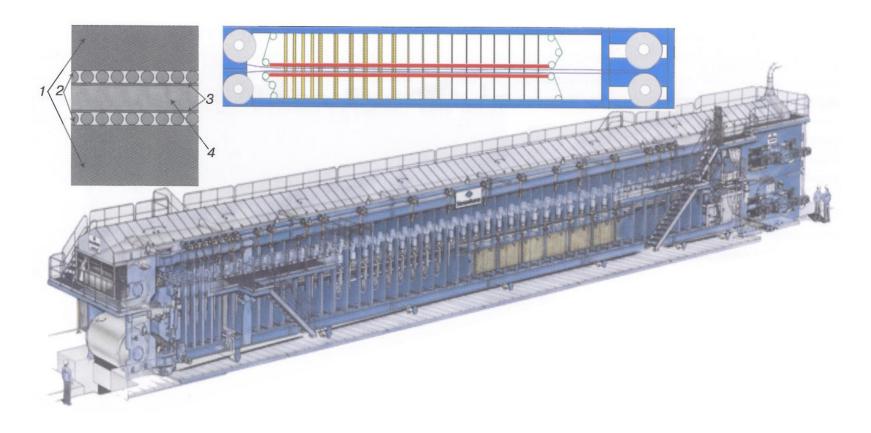




Hot Pressing



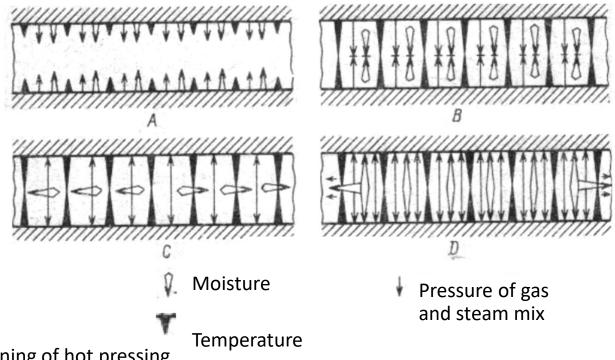
Contiroll Press



1– hot plates; 2– rollers; 3– steel belt; 4– pressing mattress



Migration of temperature and moisture at pressing time



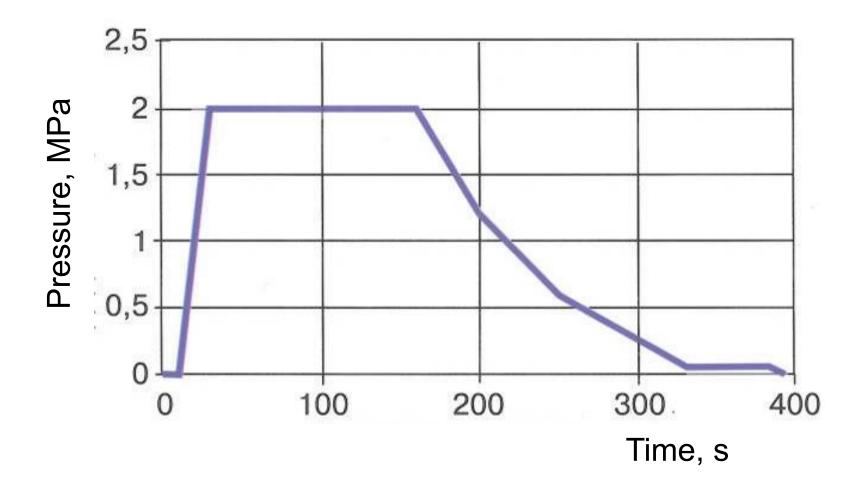
A – beginning of hot pressing

B – moisture and temperature increasing beginning time at middle layer

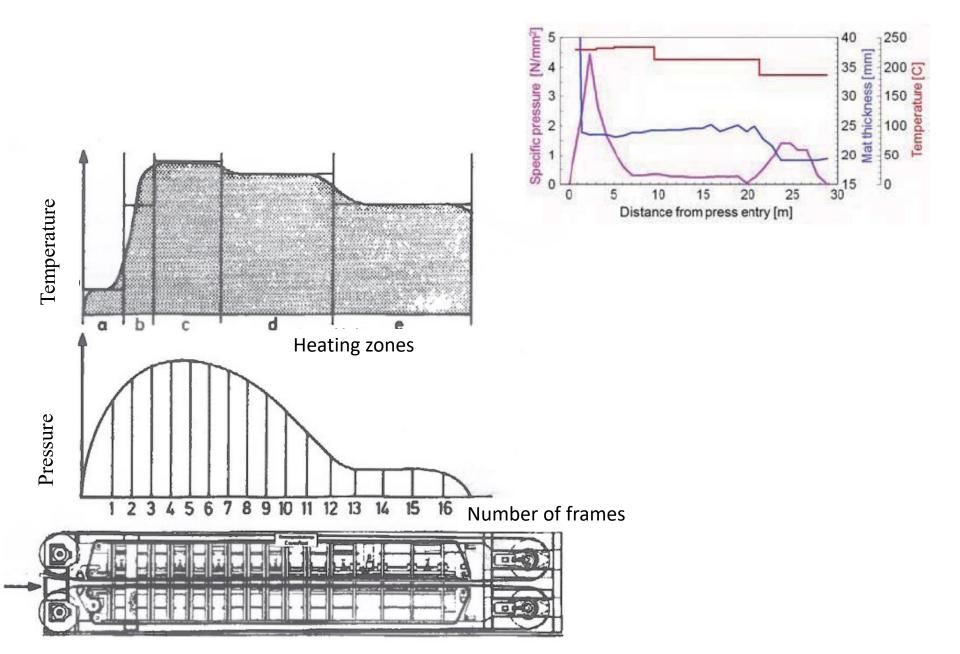
C – temperature at middle layer equal or more 100°C

D – when pressure push down till 0,35 MPa

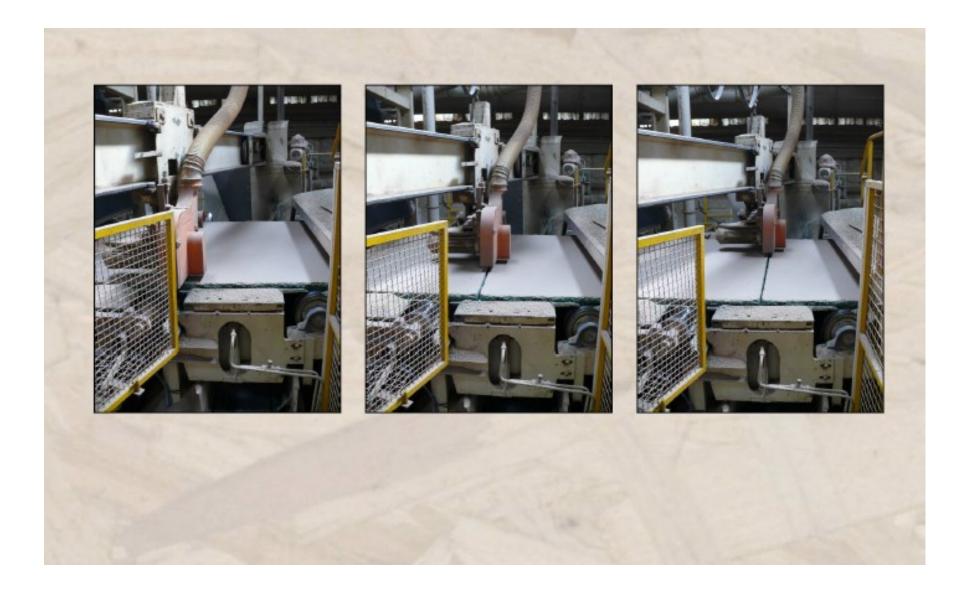
Pressing Line



Temperature and preasure in the press



Mattress Cutting



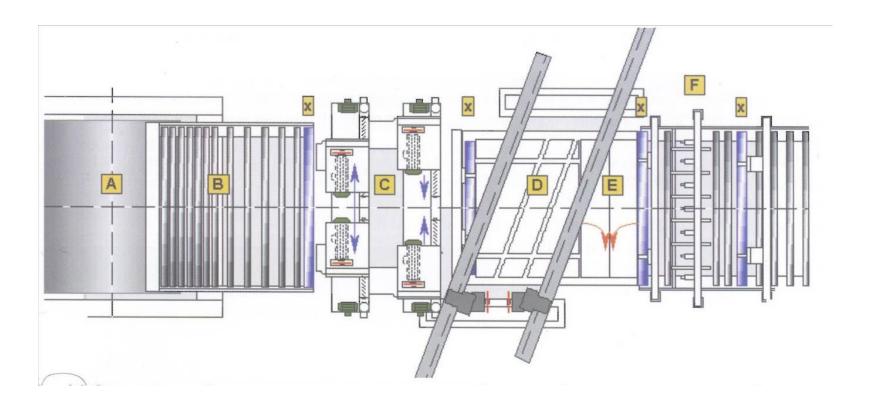
Mattress Separation

 Continuous mat must be cut to panels for single and multi-daylight presses



Source: Siempelkamp

Mattress Separation



A – Roll of the press; B – roller conveyer; C – side cutting saws; D – diagonal saws; E – Sawdust residues F – Thickness ccontrol; X– Rollers

- Temperatures up to 210°C
- Pressures c. 3 MPa
 - 400 × 400 mm board needs 50 tonnes
 - 52 × 2.5 m board needs 39,700 tonnes
- Press factor between 4 and 6 s/mm
- Single daylight
 - large (up to 52 m)
- * Multi-daylight
 - 6 to 8 mattresses pressed at once
- * Continuous
 - product size determined after pressing

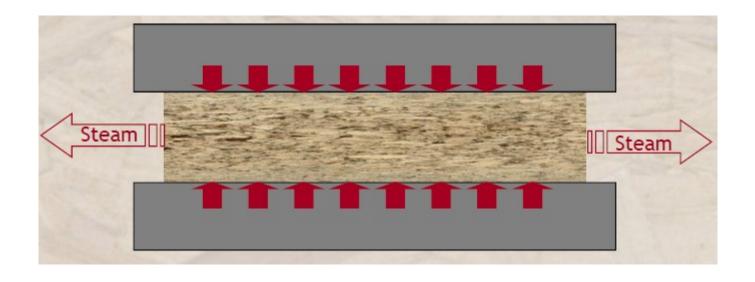




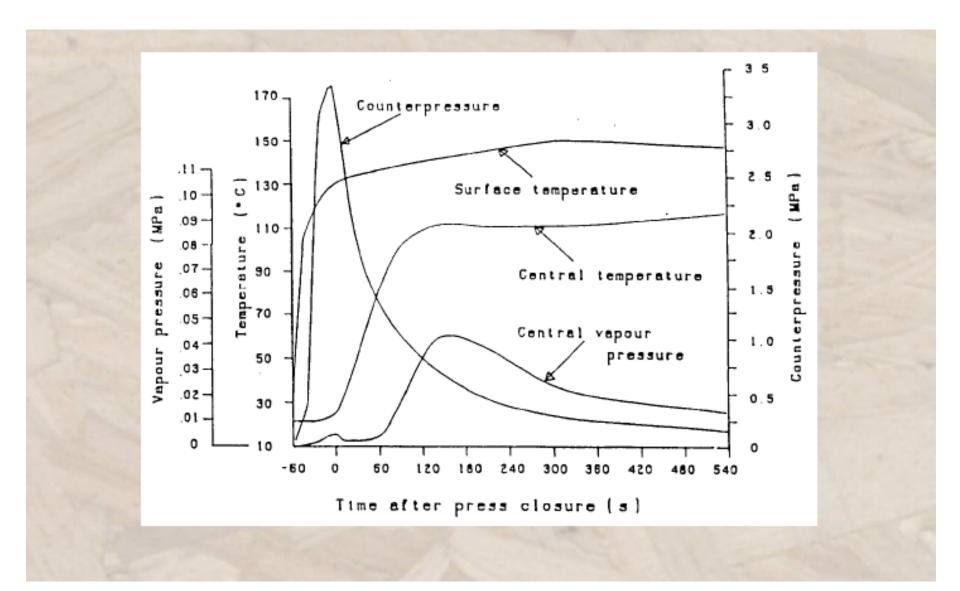








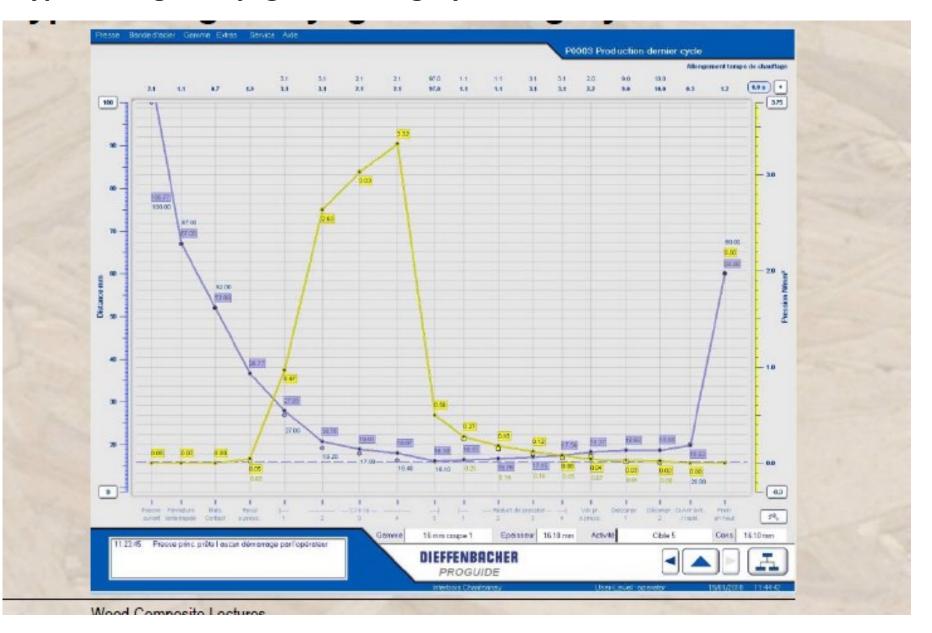
Changing Conditions



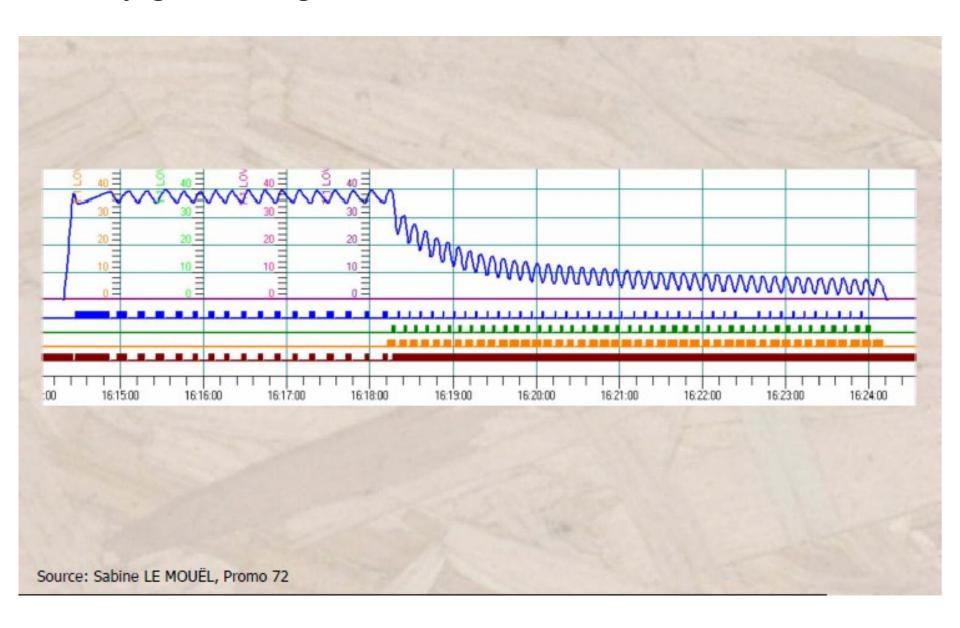
Blown Boards



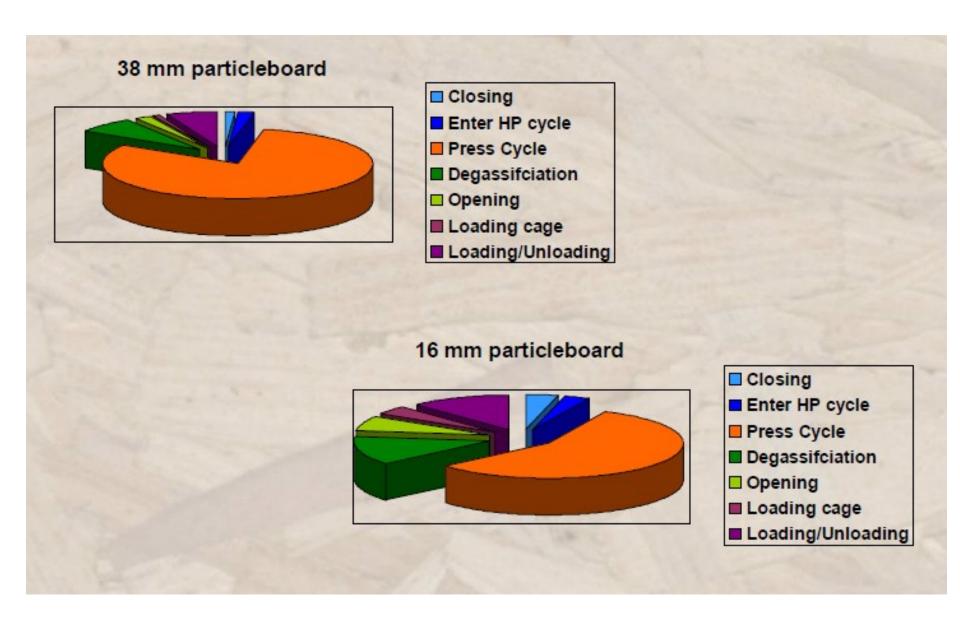
Typical Single Daylight Pressing Cycle



MultiDaylight Pressing Schedule



Comparing Cycles



Mattress Conditions During Pressing

Through thickness

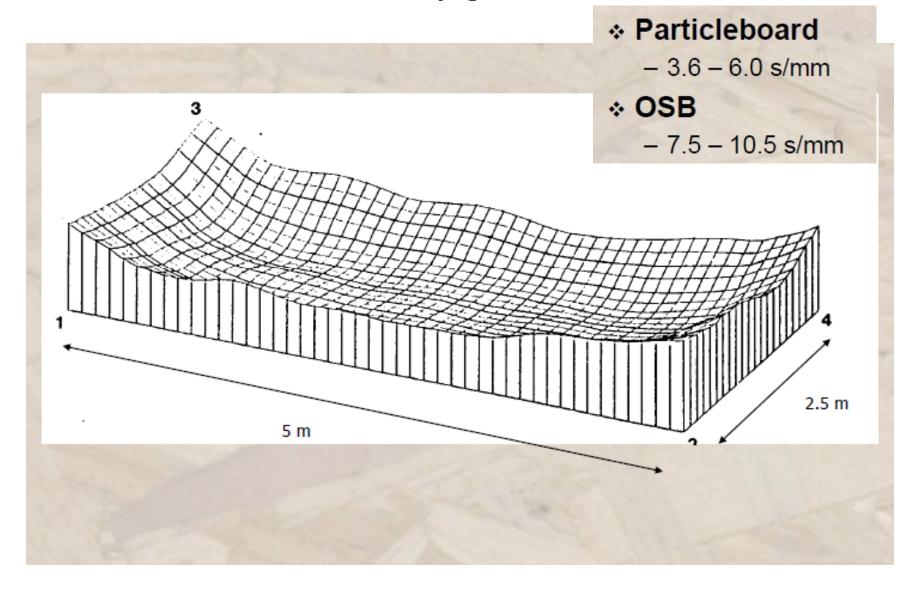
- surface
 - » rapid heating
 - » moisture loss
- core
 - » lower heating rate
 - » lower temperatures
 - » moisture gain/loss

In plane variation

- Middle
 - » steam pressure
 - » high temperature
- Edge
 - » low pressure
 - » low temperature

A complex 3D problem

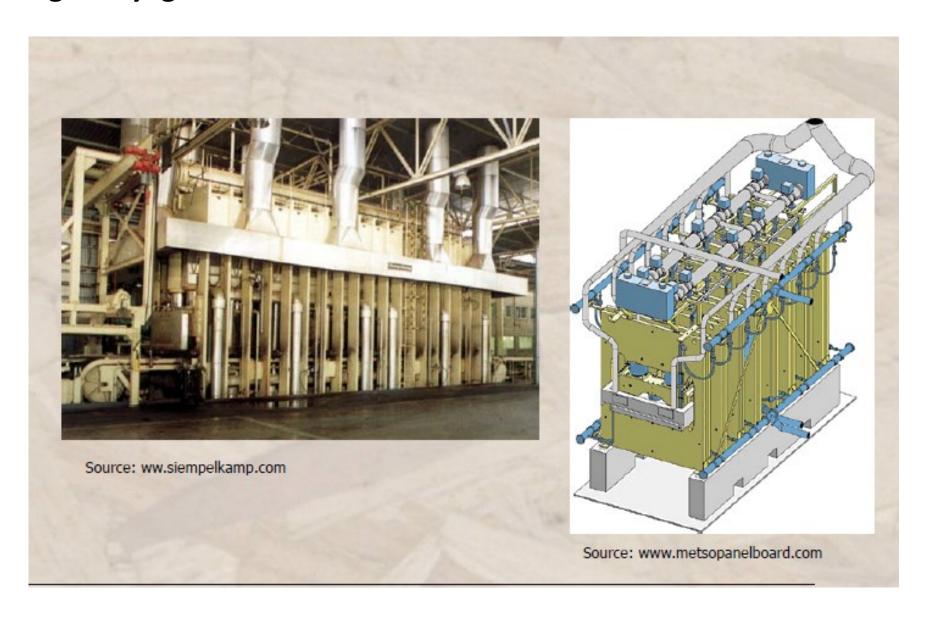
Thickness Swell Across an OSB Daylight



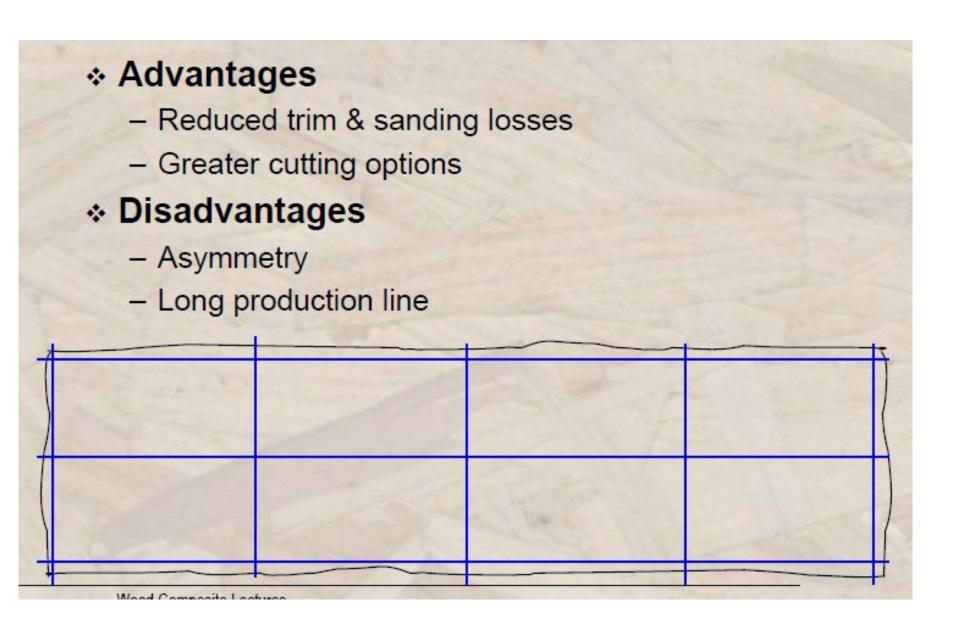
Release Agents

- Build-up of material on plattens can slow pressing
- Sticking to the plattens is a major problem for some adhesives like isocyanates
- The use of release agents reduces this problem
 - internal mixed with glue
 - external sprayed on line
 - » http://www.fusoni.es/flash/aplicacionmadera_eng.swf

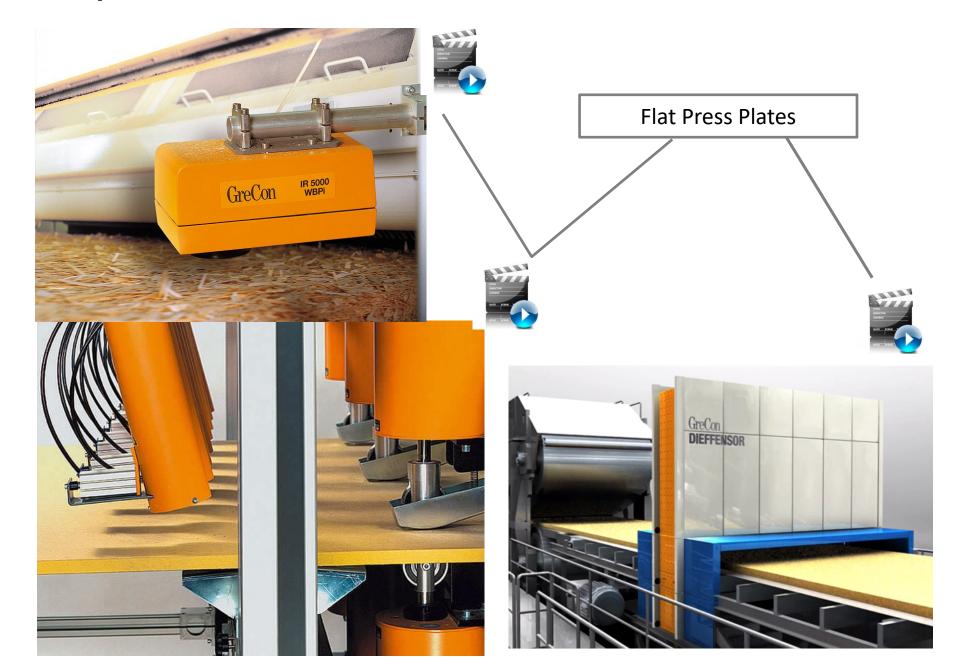
Single Daylight Presses



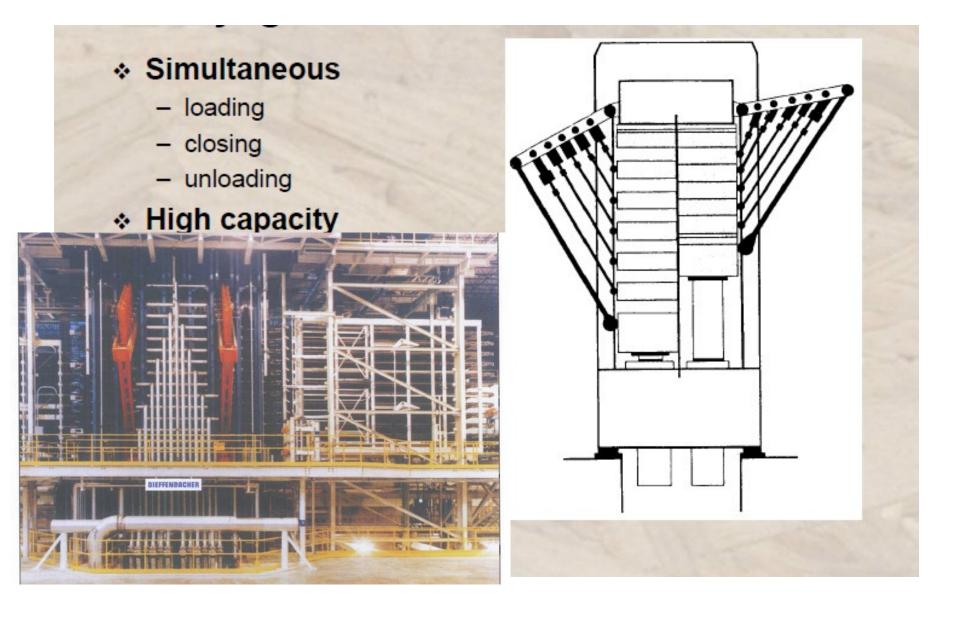
Single Daylight Presses



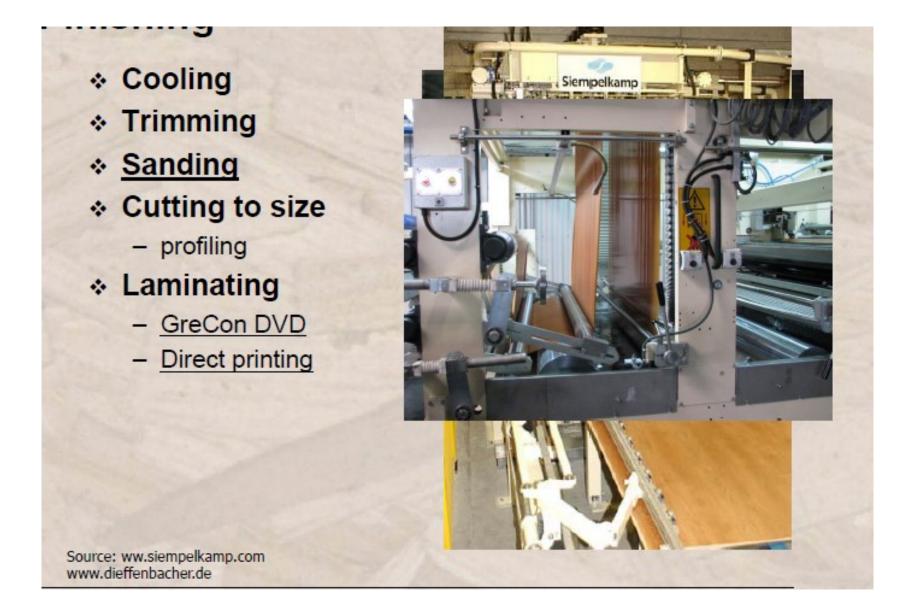
Quality Control



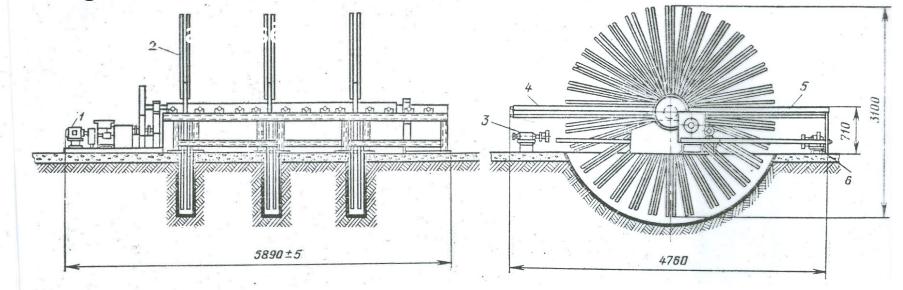
Multi Daylight Presses



Finishing



Coolling

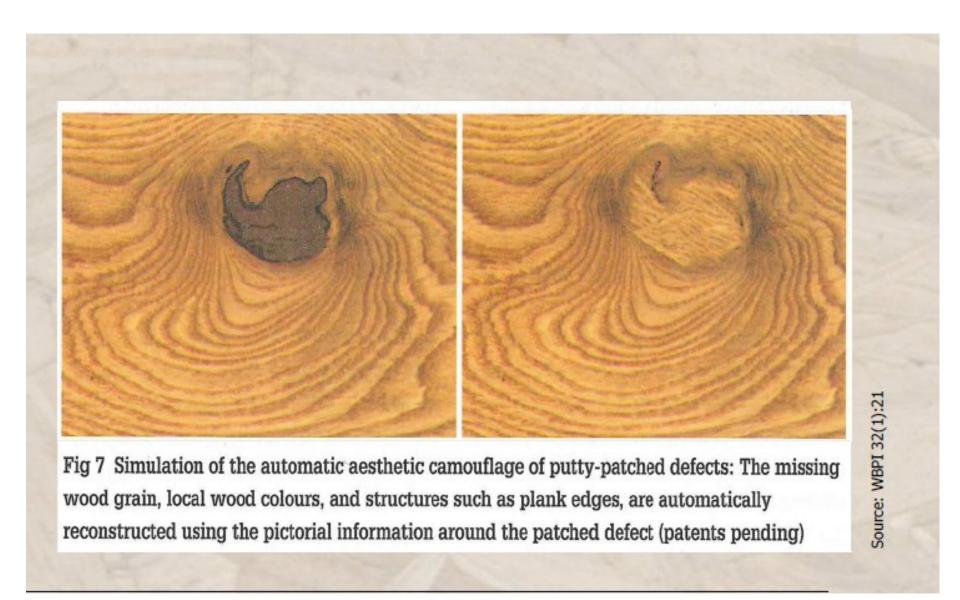






http://www.dailymail.co.uk/news/article-2357216/IKEA-uses-staggering-1-worlds-wood-year.html

New Patching Techniques



Sanding



- Opposing-head sanders
- Endless belts
 - angle spliced to prevent chatter
- Grit
 - silicon carbide for MDF and particleboard
 - aluminium oxide for plywood
- Backing
 - paper (not coarse grades)
 - cloth
 - combination
- Anti-static coating

Finishing sanding



Storing





Other products

- Non-wood particleboards
- Extruded particleboards
- Moulded products
- The SCIENCE behind the product







Source: www.engelvin-bois-moule.com







http://www.siempelkamp.com/index.php?id=732&L=0



http://www.dieffenbacher.de/en/wood-based-panels/wood-based-panels.html



Thank You For Your attention!



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Topic:

"PRODUCTION OF WOOD BASED PANELS: PLYWOOD"

Author Uldis Spulle

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA







PRODUCTION OF WOOD BASED PANELS Plywood

Uldis SPULLE

Latvia University of Life Sciences and Technologies

Production of Plywood - History



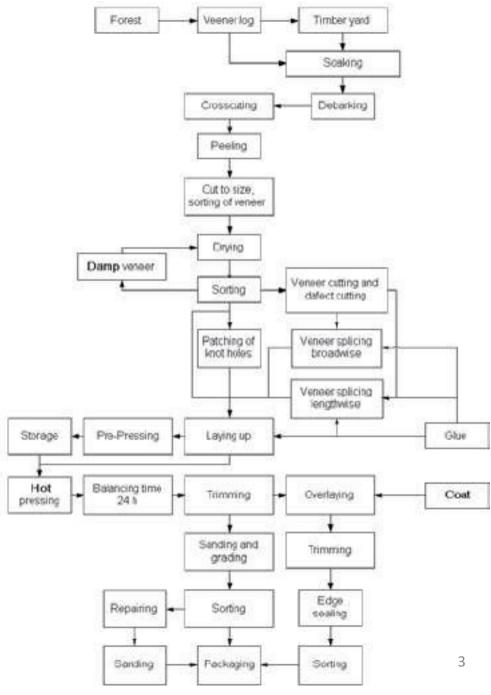


Ancient Origins of Plywood - laminated wood was found in the tombs of the Egyptian pharaohs, Chinese shaved wood and glued it together for use in furniture, English and French first time used at 17th and 18th centuries, Czarist Russia made forms of plywood at 20th century. Early modern plywood was typically made from decorative hardwoods and mostly used in the manufacture for desk tops and doors.

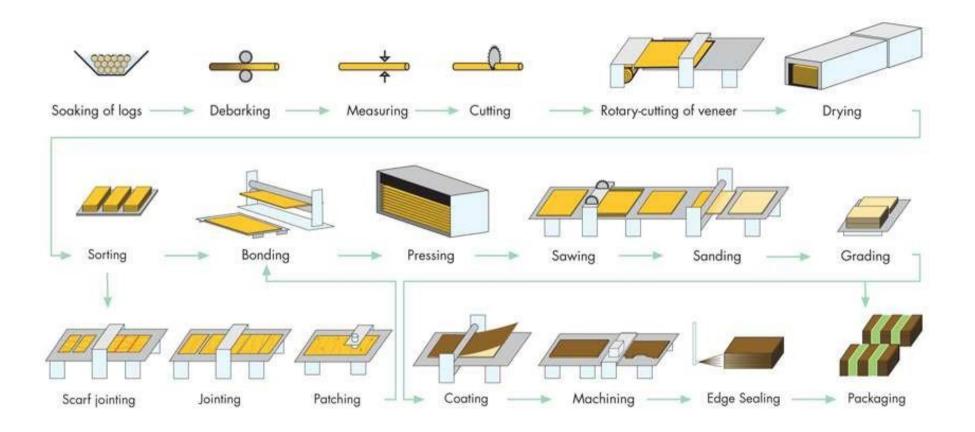


- Plywood Patented, Then Forgotten was issued December 26, 1865, to John K. Mayo of New York City., later, August 18, 1868, Mayo's developed had a vision of construction, but not business idea.
- An Industry is Born in 1905, Portland, called "3-ply hardwood veneer work", by 1907, Manufacturing had installed an automatic glue spreader and a sectional hand press. Production soared to 420 panels a day. And an industry was born.
- From Doors to Running Boards: The First Plywood Markets first 15 years plywood industry produced mostly door panels, but 1920, developed for automobile industry.
- A Technological Breakthrough: Waterproof Adhesive in 1934 Dr. James Nevin developed a waterproof adhesive.
- Founding of the Douglas Fir Plywood Association on June 13, 1933 the Douglas Fir Plywood Association had first meeting in Washington.
- Standardization and Improved Quality Testing Boost Sales exterior plywood was performed Commercial Standard started to use in construction industry.
- Plywood Goes to War plywood barracks was built, navy used plywood for boats. The Air Force flew reconnaissance missions in plywood gliders. The Post-War Boom - in 1944 the 30 mills produced 0,9 billion square meters, in 1954 the 101 mills produced 2,7 billion square meters. In 1975 U.S. production alone exceeded 10,5 billion square meters.
- **Technology now days -** often called engineered wood product because it was one of the first to be made by bonding together. In 1970-80s the plywood principle gave idea to developed oriented strand board (OSB).

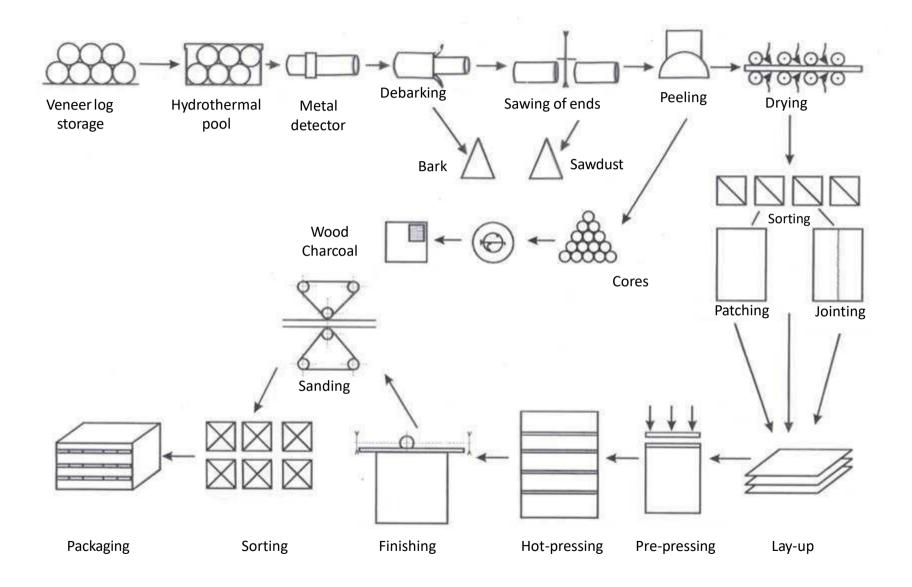
Principle of Plywood Production



Technological Flow

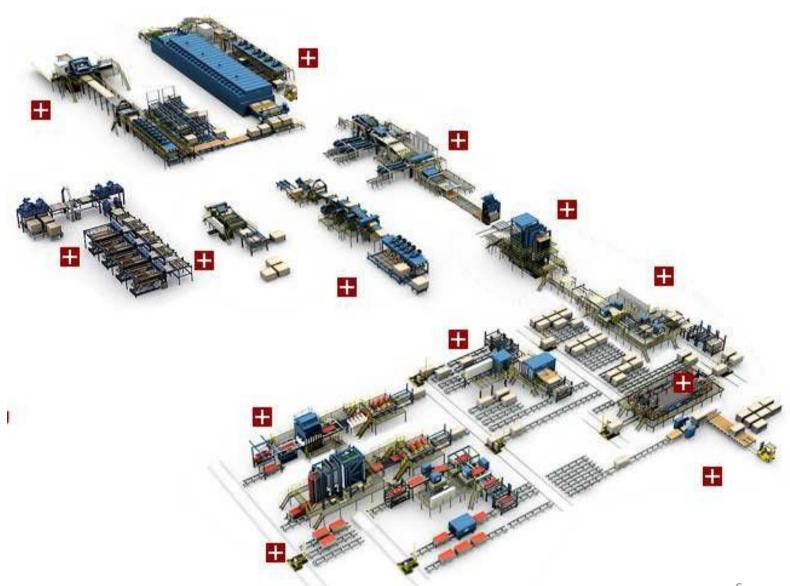


Technological Flow

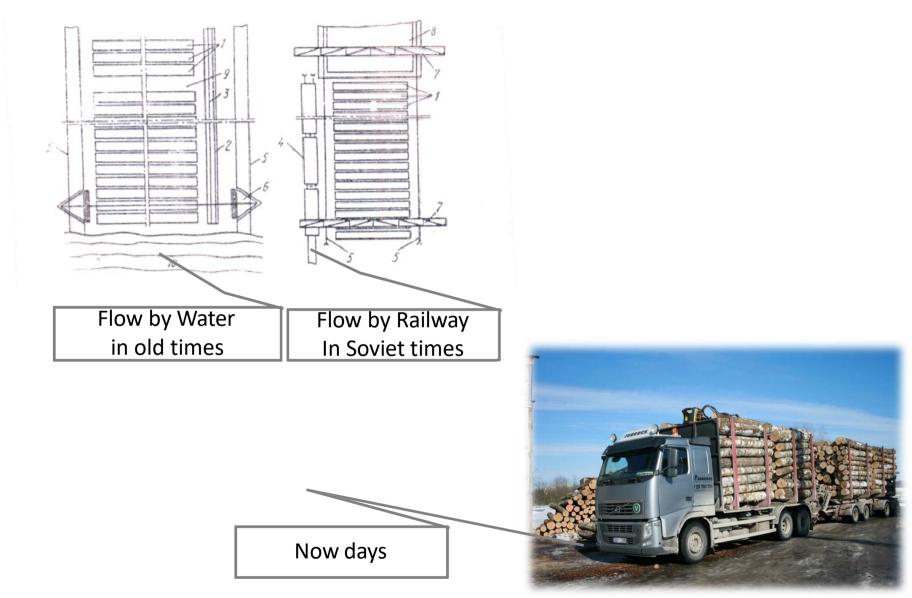


Plywood Factory Virtually

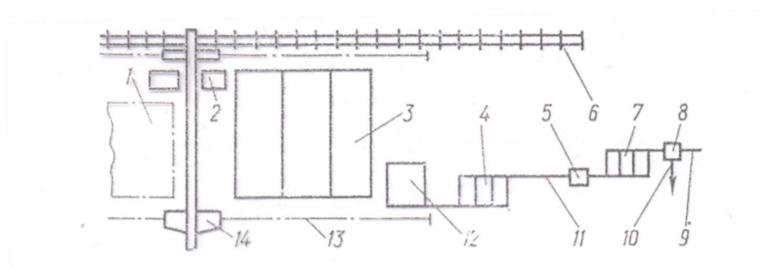




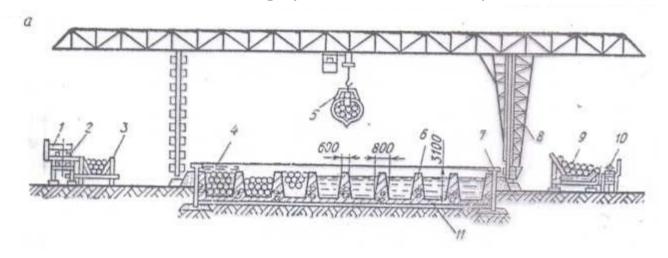
Transporting of Veneer Logs



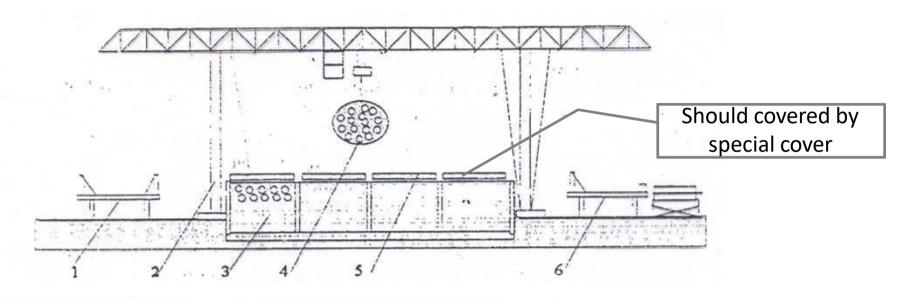
Veneer Logs yard



1- veneer log yard; 2- storage place; 3- hydrothermal pool; 4,7cross conveyor; 5- debarker; 6- transporting line; 8- end sawing machine; 9veneer log transporter to peeling line; 10- transporter of residues; 11- transporter to debarker; 12- storage place; 13- crane way; 14- crane

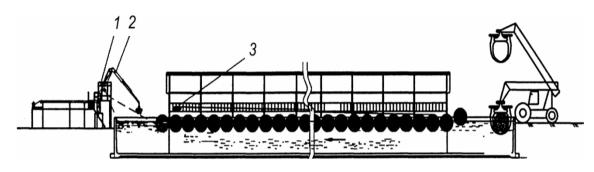


Veneer Logs Hydrothermal Open «pool»



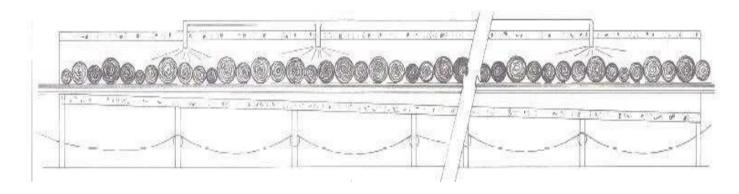


Veneer Logs Hydrothermal Close «pool»





1 – operator cabin; 2 - handling, 3 – belt, (Волынский, 2008)



Veneer Logs Hydrothermal «chamber»

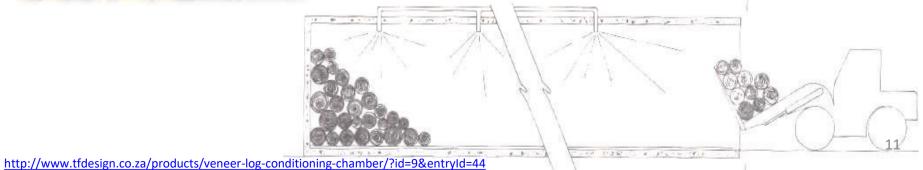




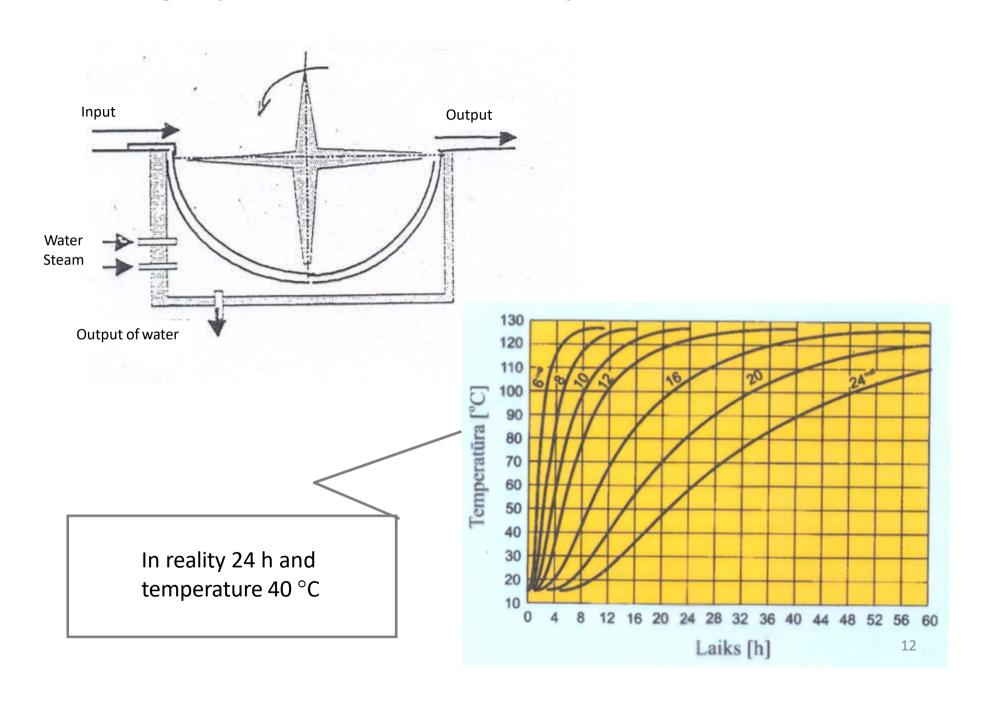








Veneer Logs Hydrothermal Pool With Dispenser



Natural Durability and Temperature Requirements

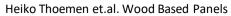
Species	Surface temperature, °C		
	Core, min	Cylindered veneer log, max	
Aspen and Linden	10	25 30	
Birch and Alder	20	4050	
Pine	20	40 50	
Spruce	30	50 60	
Larch	30	50 60	
Beech	30	50 60	

Durability	Outdoor conditions		
	Insects attack	Fungus attack	Splitting
Durable	birch, alder, poplar	oak, ash	spruce, pine, aspen, linden, poplar, birch
Endurable	Spruce, pine, oak, ash	Spruce, pine, poplar, birch, alder, aspen, linden	oak, ash

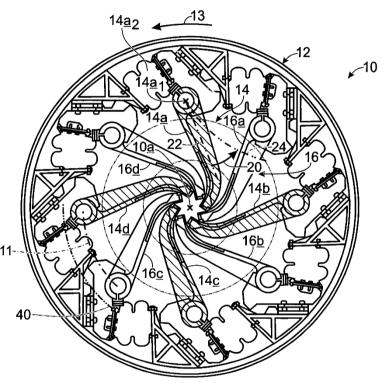
Debarker







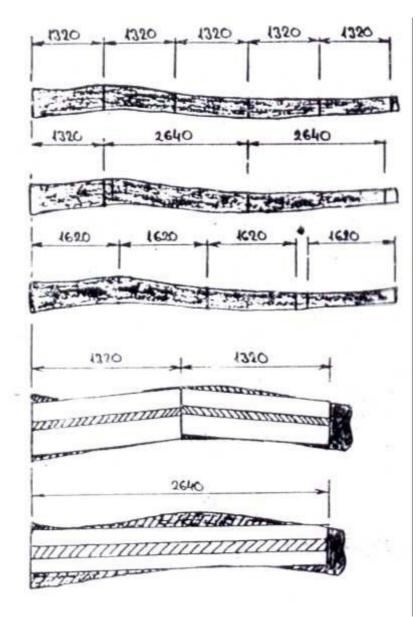


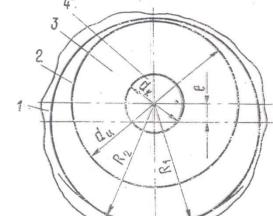


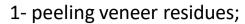
http://www.morbark.com/industries/sawmill/

https://www.google.com/patents/US614457499

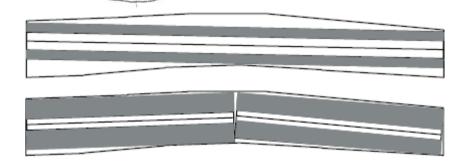
Optimization of Length of Veneer Logs







- 2- inner veneer sector;
- 3- outer veneer sector;
- 4- core





Centering, Peeling and Veneer Effective Outcome



Peelingclipping line

> Veneer log feeder



Frame of Peeling Machines



For large dimensions, diameter max 1,2 meters



www.raute.com

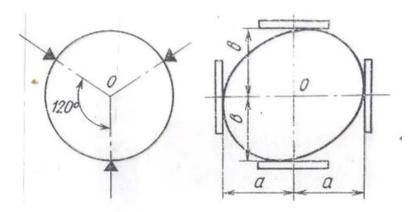
Monolithic frame

Part frame

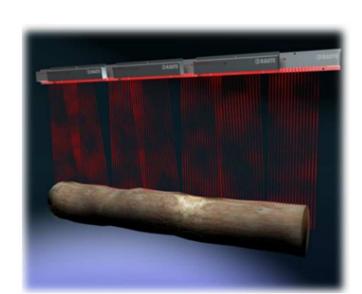
For small dimensions, diameter max 0,6 meters

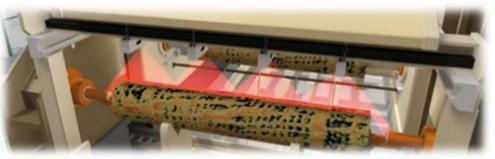
17

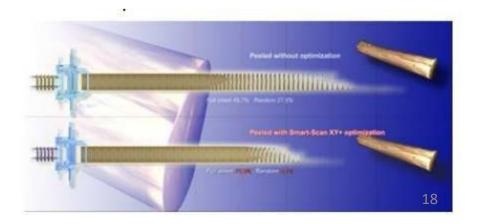
Measuring and Centering



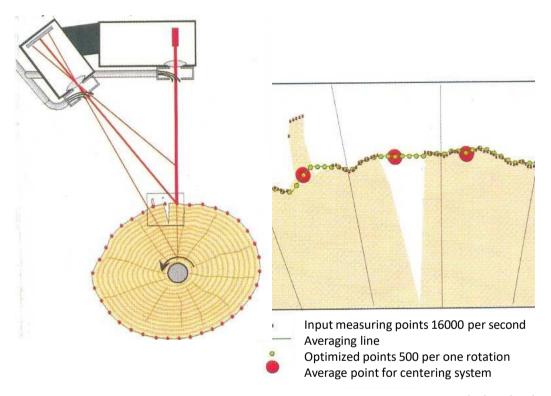








Measuring, Centering and Peeling



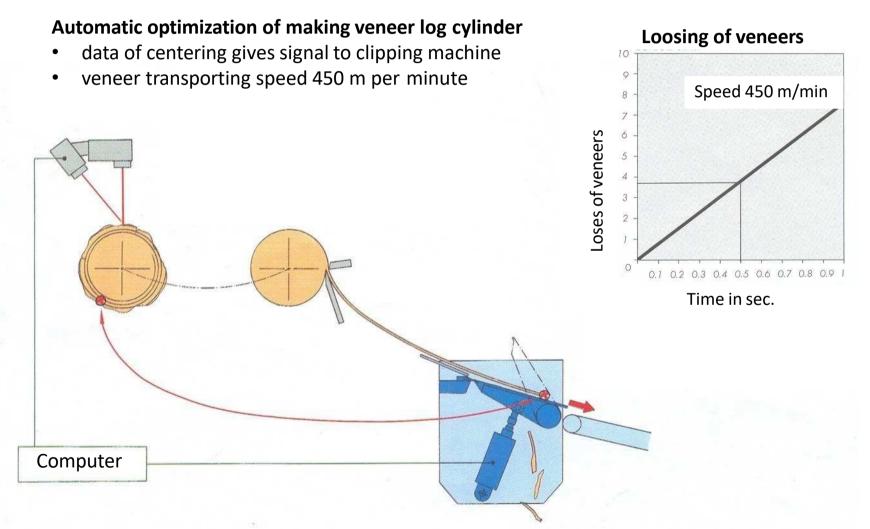
Positive outcomes:

- Precise measuring laser
- Veneer recovery increase 2-15%
- 5-15% more full sheet
- The amount of random drops 20-50%
- Improved veneer loss- excessive veneer handling decreased
- More full face veneer sheets higher value of plywood

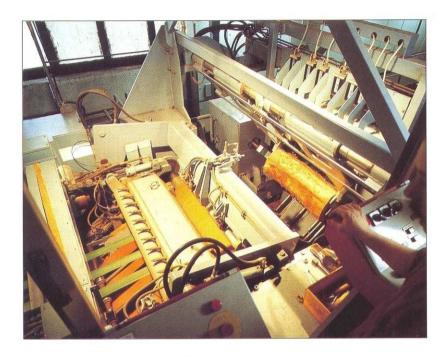
Modular lathe:

- Servo hydraulic feed of knife carriage
- Small spindles (∅ 60 mm)
- Chuck movement 1000 m/s
- Spindle rotation speed 600 rpm

Importance of Centering System

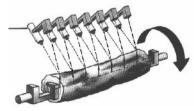


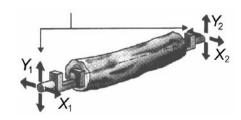
Centering Hydrolic System

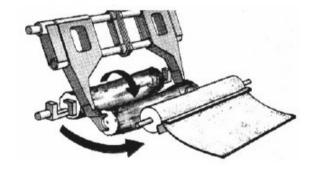


Modular lathe

- Servohydraulic feed of knife carriage (rapid movements and stepless setting of veneer thickness)
- Small spindles (diameter 60 mm)
- Rapid chucking movements of spindles (1000 mm/s)
- High spindle rotation speed (600 r/min)
- Long back-up device with damped bogie or alternatively CORE-MIZER (powered back-up rolls)
- Freely programmable dynamic curve for setting of the cutting angle
- Hydraulic fastening of the knife







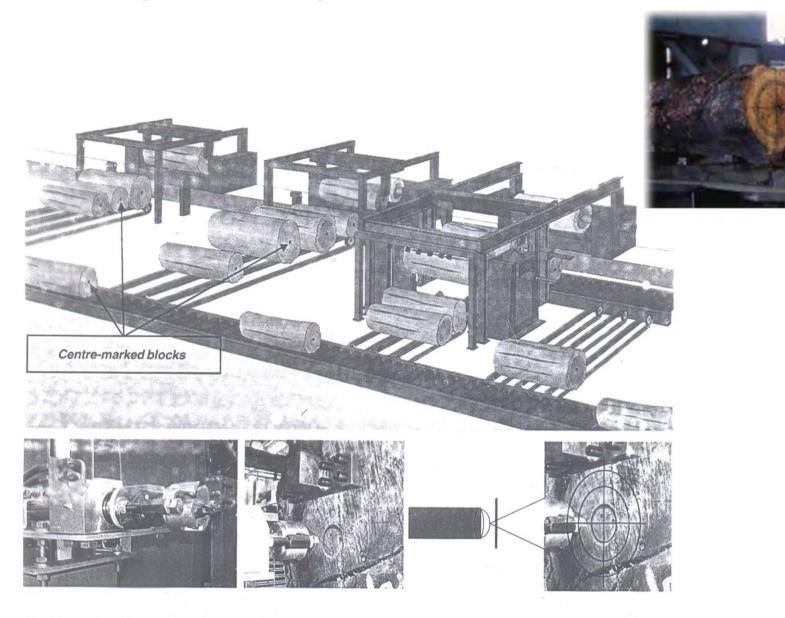








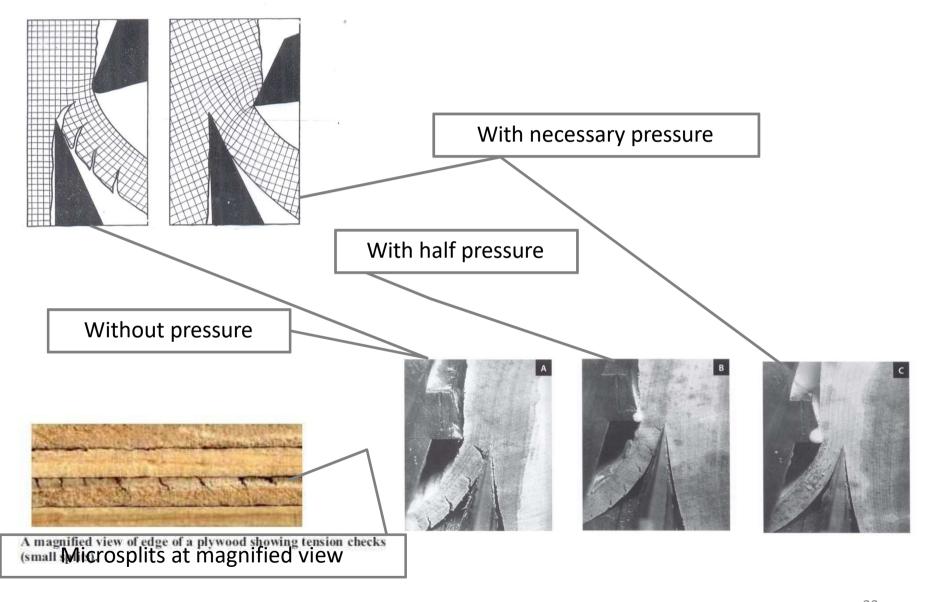
Centering and Marking



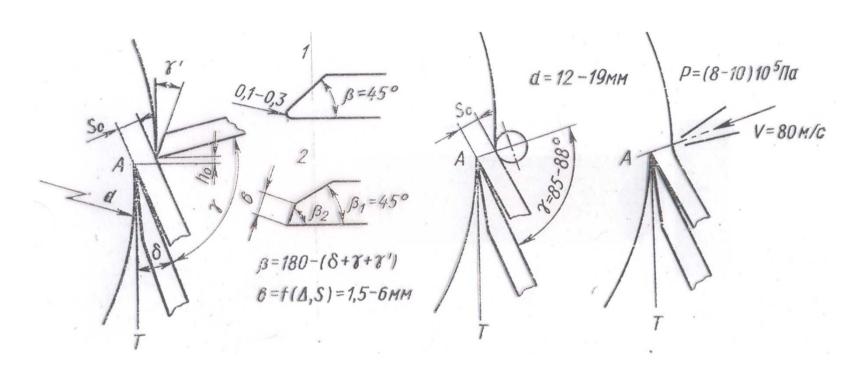
Marking of optimum center

Re-centering according to the centre mark

Peeling Microsplits

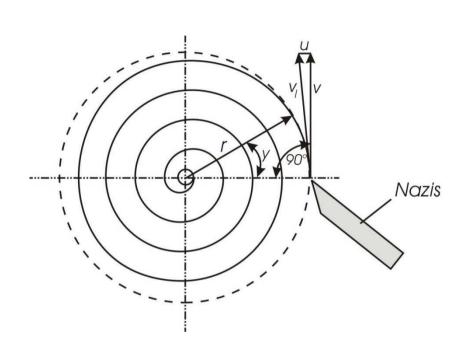


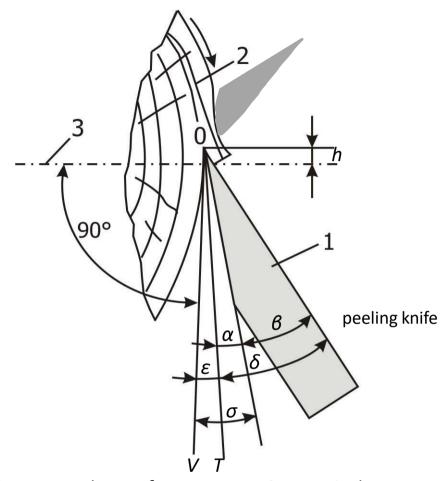
Veneer Pressing Systems



1 – with mechanical pressing element; b – with mechanical roller; c – with air flow

Veneer Cutting Principle

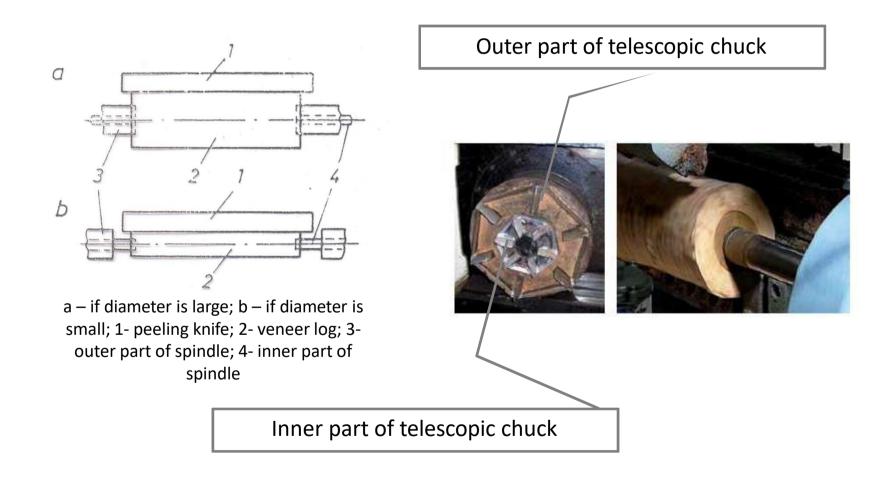




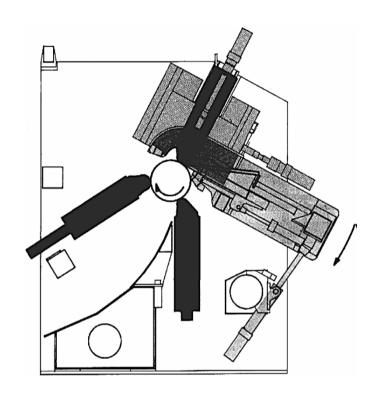
1- peeling knife, 2- veneer log; 3- symmetric axis; OT- veneer log surface tangent; OV- vertical; α -back angle; β - sharpening angel; δ - sum of back and sharpening angel; ϵ - additional angel; σ - installation angel

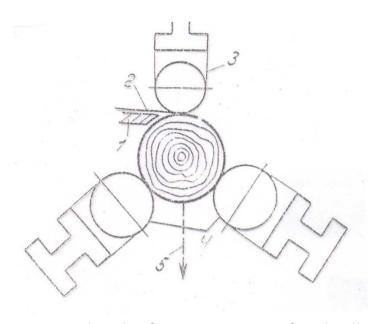
Wood	Sharpening angle β , ° depending of veneer thickness, mm		
	< 2,5	> 2,5	
Birch, ash	18-21	21-23	
Pine	20-22	22-24	
Spruce	225	25	

Telescopic Spindle of Peeling Machine



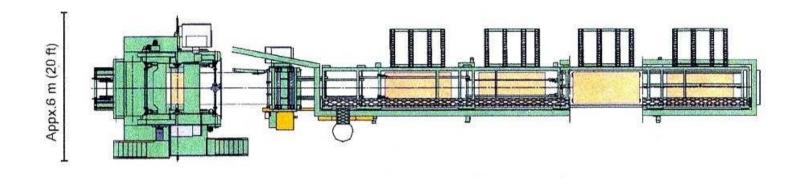
Spindleless Peeling Machine Overview

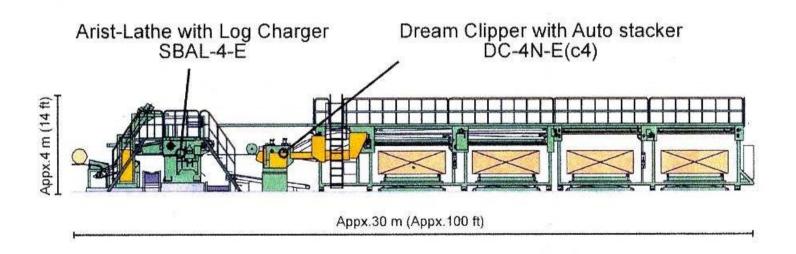




1- peeling knife, 2- veneer; 3- fixed roller;4- moved roller; 5- output of core

Spindleless Peeling Machine





Spindleless peeling machine – specification and result

Line consists of:

New Arist-Lathe with log charger
 Dream Clipper with Auto Stacker

SBAL-4-E DC-4N-E(c4) 1

New Arist-Lathe with log charger

Peeling speed
Spindle chuck diameter
Maximum rotational diameter
Minimum log diameter available
Minimum peeled log core diameter
Available range of log length
Available range of veneer thickness
Available range of spar knife span
Maximum charger capacity
Knife length

Type: SBAL-4-E

90 m/min 95 mm 600 mm 150 mm 32 mm 930 to 1,450 mm 1.30 to 4.00 mm 920 to 1,305 mm approx. 7 pcs/min 1,500 mm

Dream Clipper with Auto Stacker

Feeding speed
Working veneer length
Minimum veneer width
Range of working veneer thickness
Thickness detecting point
Working format width
Maximum stacking height

Type: DC-4N-E (c4)

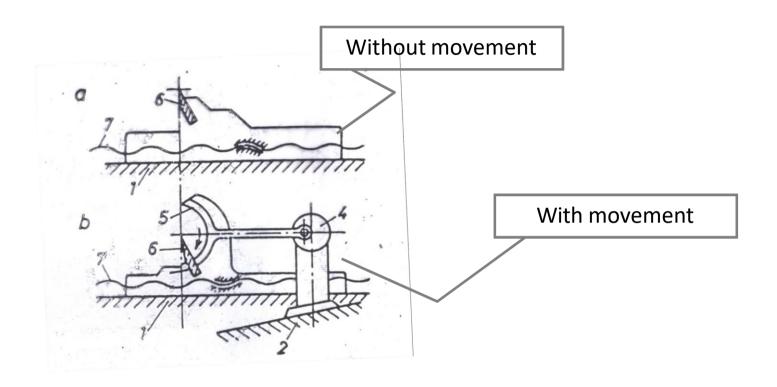
80 to 100 m/min 920 to 1,285 mm 120 mm 1.30 to 4.00 mm Maximum 9 points 2,200 to 2,700 mm 950 mm



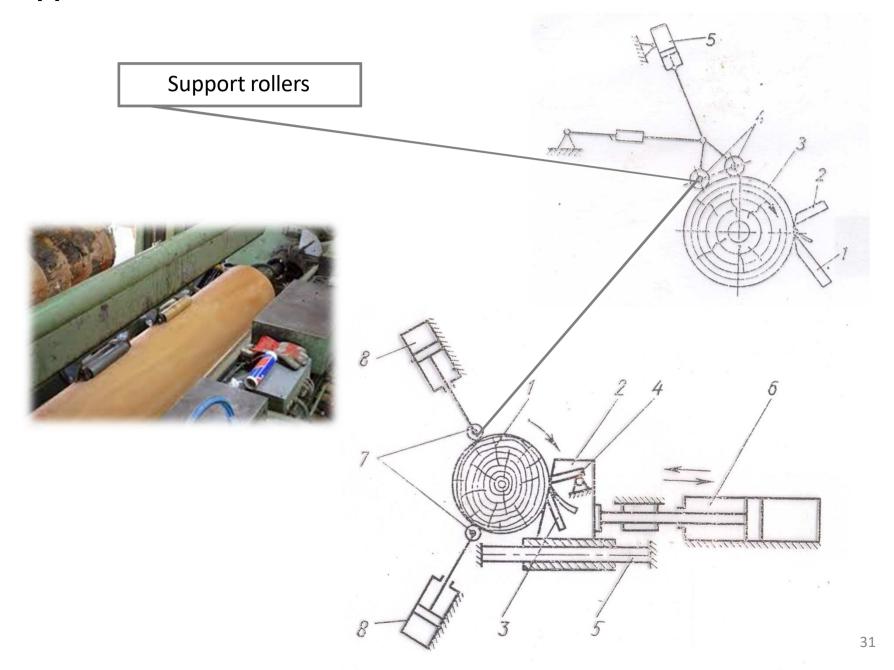




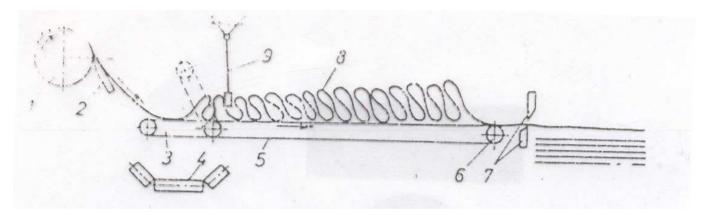
Peeling Support Movement



Support Rollers for Bend Exclude



Japanese Centering and Veneer Clipping System

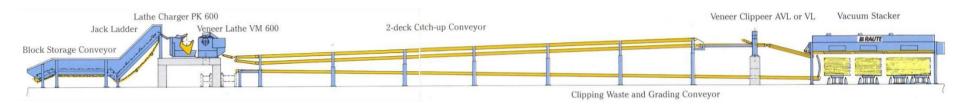


1- Log; 2- peeling knife; 3-trasporter; 4- transporter of residues; 5- belt transporter; 6- speeder roller; 7- clipper; 8- veneer loops; 9- loops turner

Peeling Line Examples

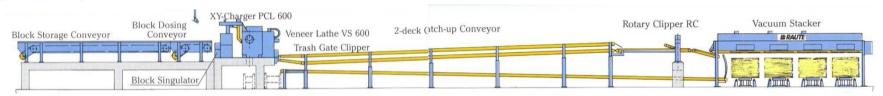
Semi-automatic line

(5 blocks/min)



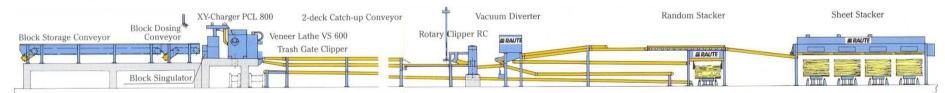
Fully Automatic Line

(7 blocks/min)



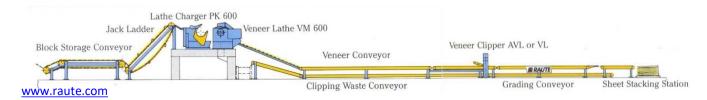
High-Tech Line

(10 blocks/min)



Basic Line

(3 blocks/min)

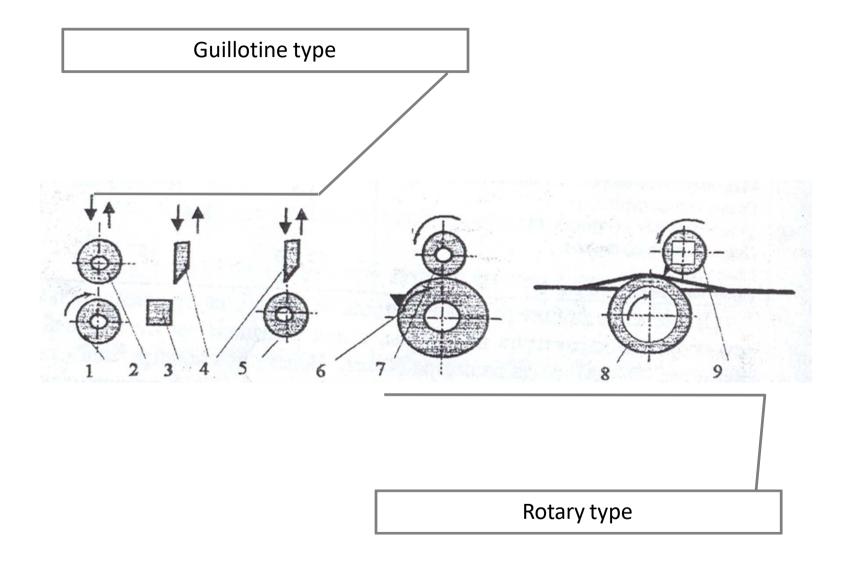


Continuous Veneer Ribbon and Clipper





Type of Veneer Clippers

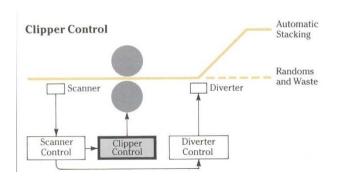


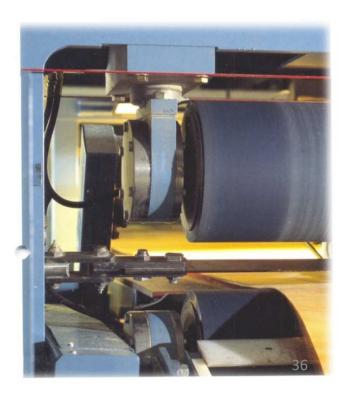
Rotary Clippers



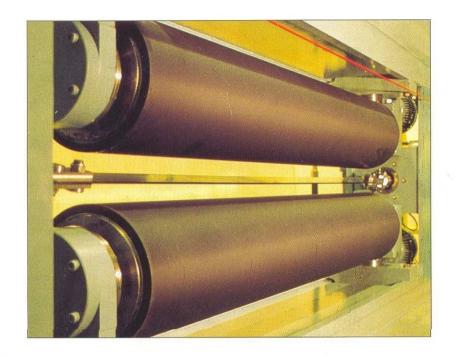






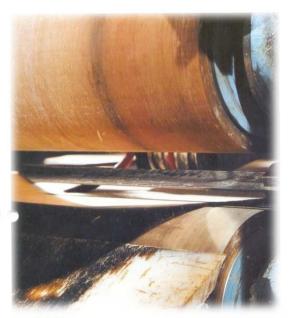


Rotary Clippers

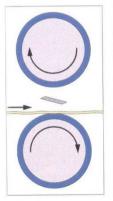


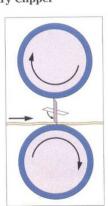
Rotary clipper

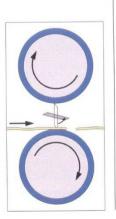
- At a running speed of 200 m/min the clipping accuracy is $\pm/-5$ mm
- Exactly rectangular, straight-edged sheets
- Knife replacement 15 minutes
 Knife sharpening interval abt. 2 weeks
- Clipping speed adjustable to wood species









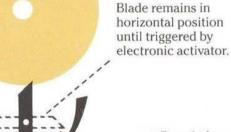




Veneer travelling at over 150 m/min. through Rotary Clipper.





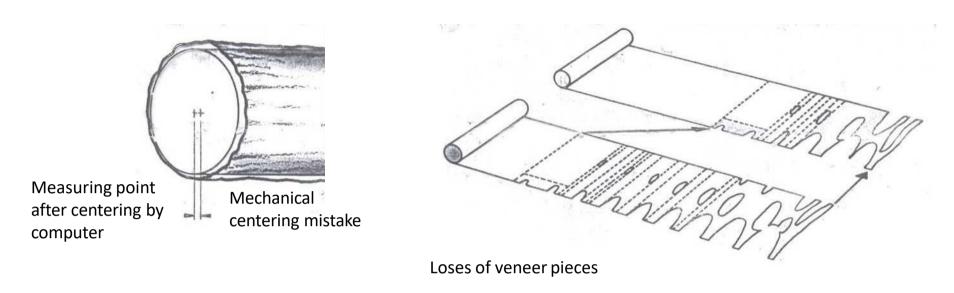


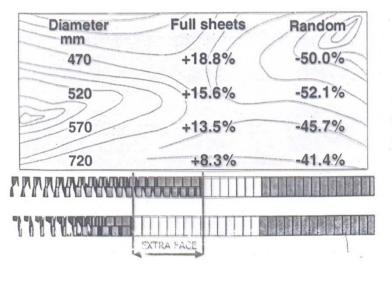
✓ From lathe...

Veneer is transported from lathe on belt conveyors.

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Importance of Centering – Optimization System

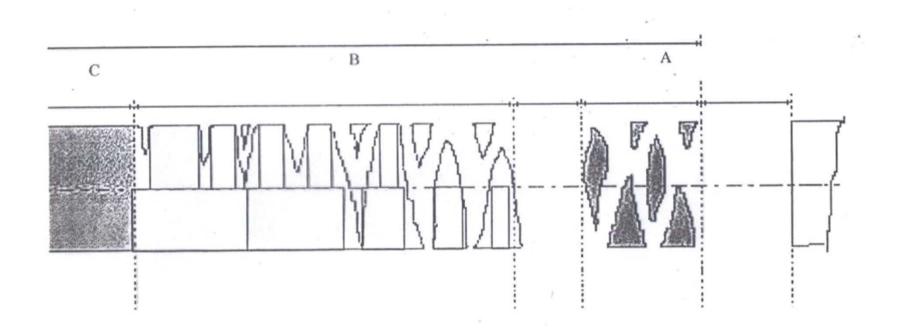




More full sheet face veneers with Raute's Laser XY charger

Test results of the comparison between a conventional optical projector charger and a Raute Laser XY charger clearly show the improvement of full face sheet recovery and the reduction of the amount of randoms.

Japanese Centering and Veneer Cliping System

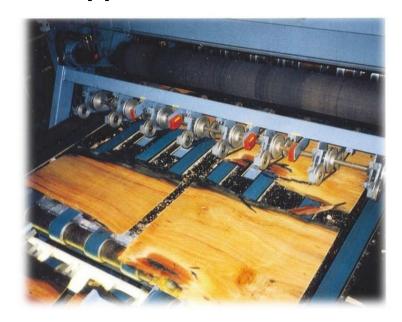


A- surf area, became smaller and it shift to chipper machine

B- if veneer logs length are 2620 mm veneer ribbon splits into 2 parts, and from each are getting more and different number of veneer pieces into special loading «packets»

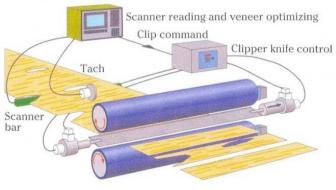
C- full format veneer

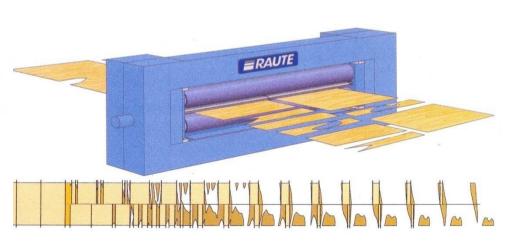
Twin Clipper





Principle of Clipper Control





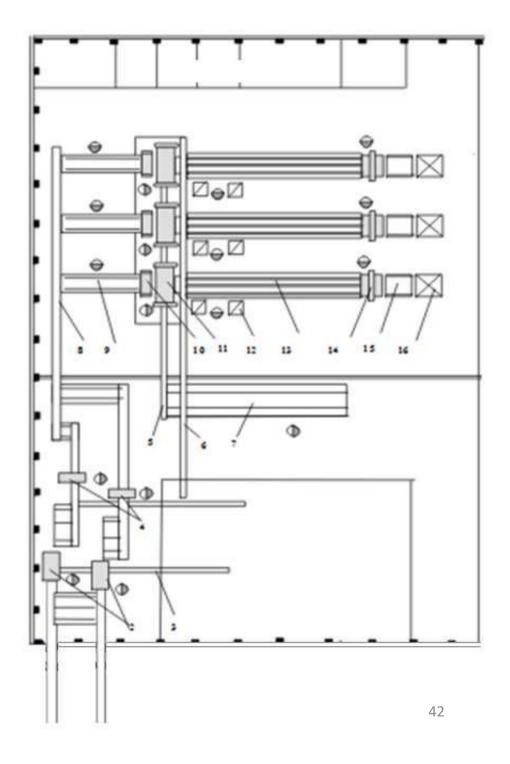
Trasporting Mechanism



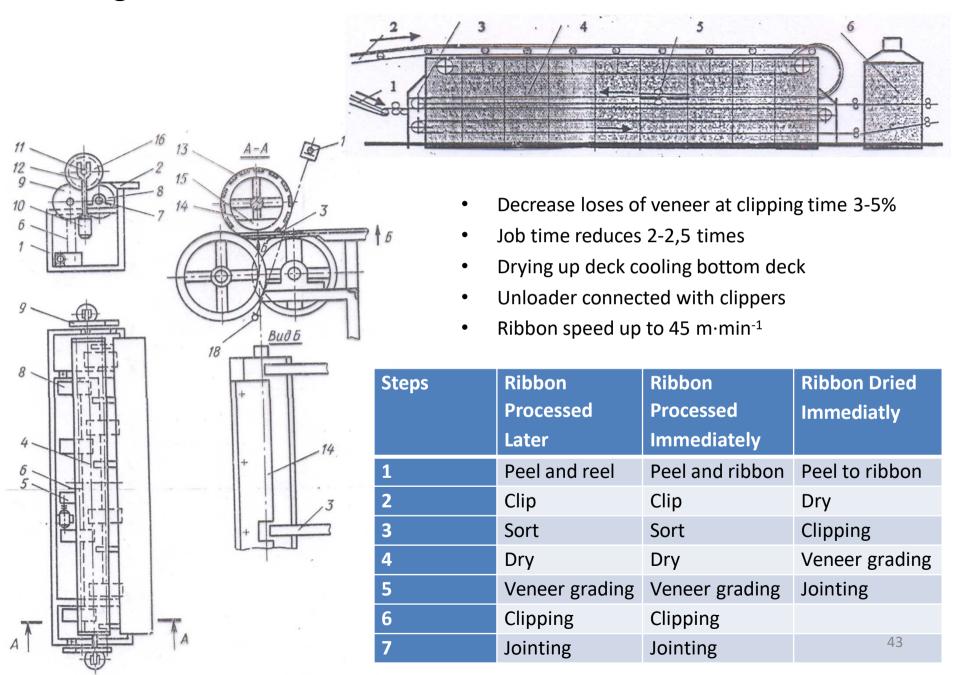


Peeling-Clipping- Stacker Line

1- chain transporter; 2- splitting logs; 3saw dust transporters; 4- end sawing; 5belt transporter of cores; 6- belt transporter of surf; 7- crosstrasnporter of cores; 8- chain transporter of veneer logs; 9- logs separator; 10; centering system; 11peeling machines; 12- stackers of veneer pieces; 13- belt transporter of continuous veneer; 14- clipper; 15- stacker; 16- sorted veneer «pockets»

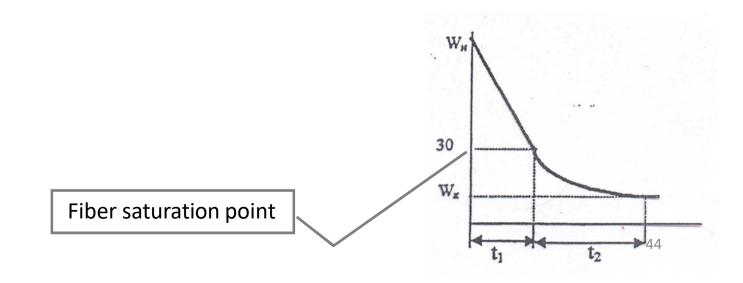


Peeling- Ribbon Roller



Veneer Drying

- Reducing moisture to 4-6%
- Process takes a lot of energy
- Wood is very weak perpendicular to grain
- Temperatures of drying is high up to 250 °C, later steps 180-200 °C.
- Time of drying short
- Dryers are sorting by: type of heating agent; type of applying agent; type of transporting of veneers



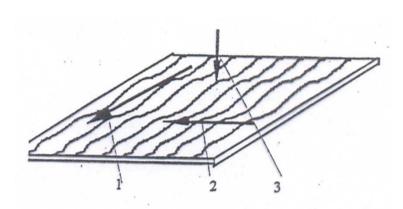
Veneer Drying

- type of heating agent: hot air; flue gas; steam
- type of applying agent:

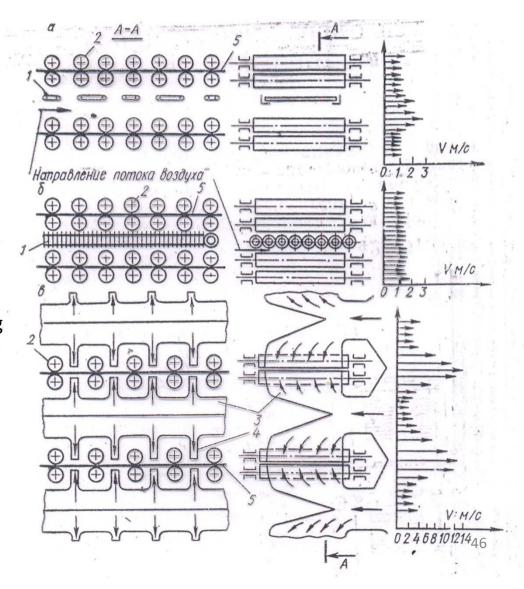
```
convection- by air
```

with contact- by flat plates
wave- micro, infrared, electromagnetic
combined- of above mentioned

Veneer Drying



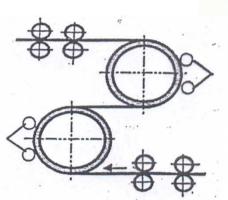
- 1. Speed of agent 1...3 m·s⁻¹;
- 2. Speed of agent 2...4 m·s⁻¹;
- 3.Speed of agent 10...14 m·s-1 (reduces drying time 2...2,5 times)

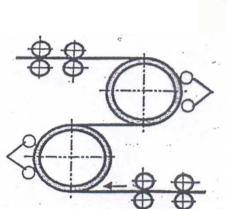


Veneer Natural and Contact



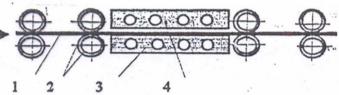






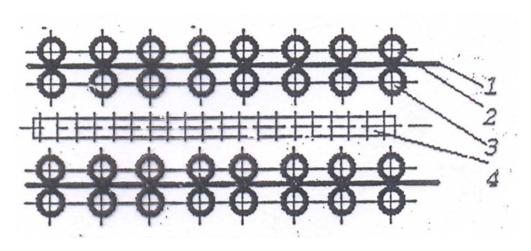








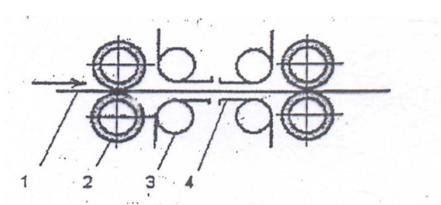
Veneer Drying Roller Systems







- 1- veneer; 2- upper rollers;
- 3- bottom speed apply rollers; 4- heaters



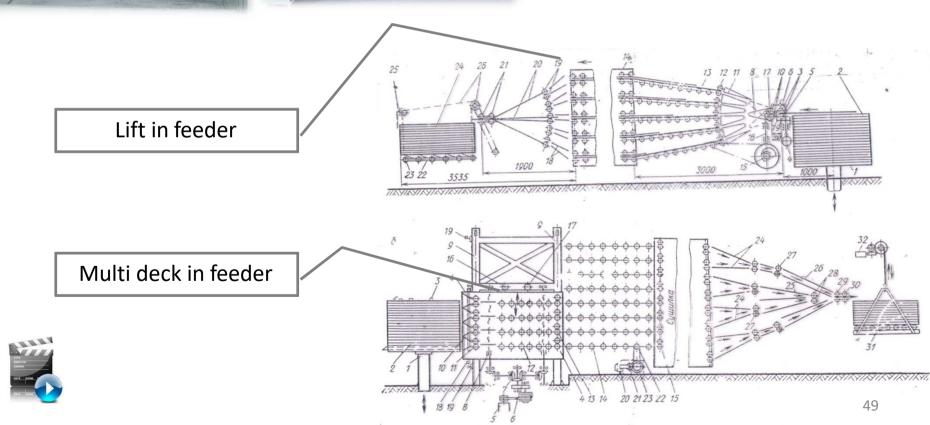


- 1- veneer; 2- upper rollers;
- 3- bottom speed apply rollers; 4- intensive heater jets

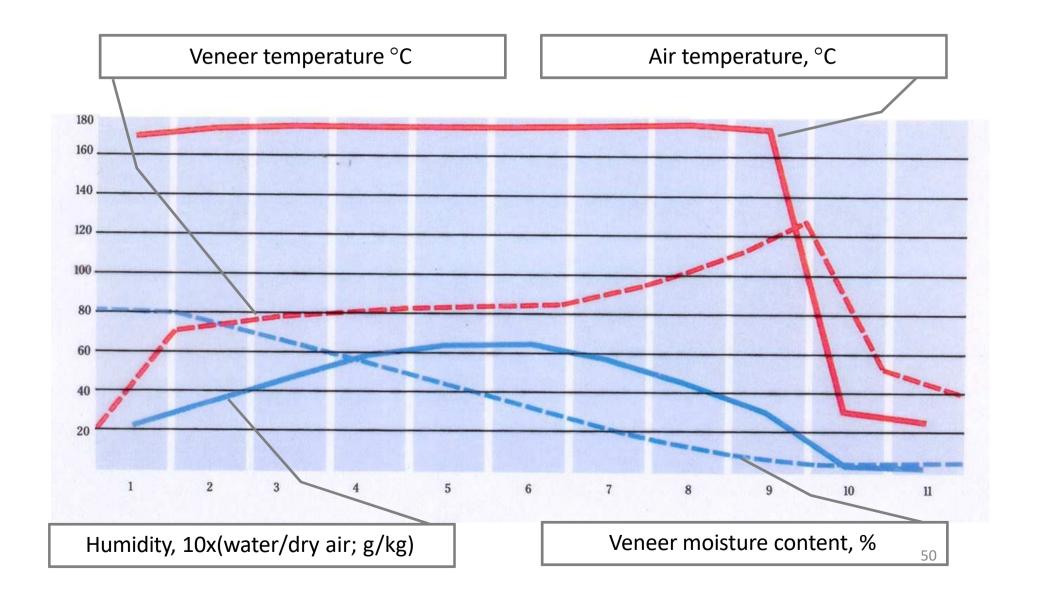
Veneer Drying Mesh Systems



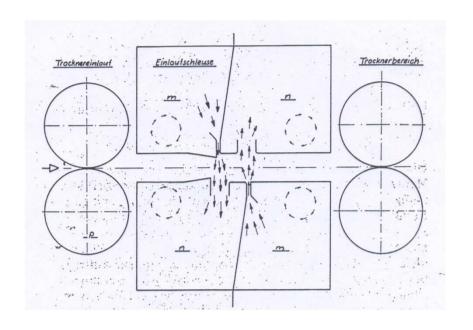
- Multi deck veneer dryer
- Multi veneer lines in one deck
- Automatic speed
- Veneer in feeder and unloader
- Combination with grading conveyor.

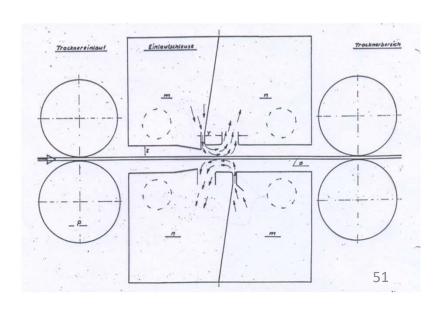


Drying Temperature and Moisture

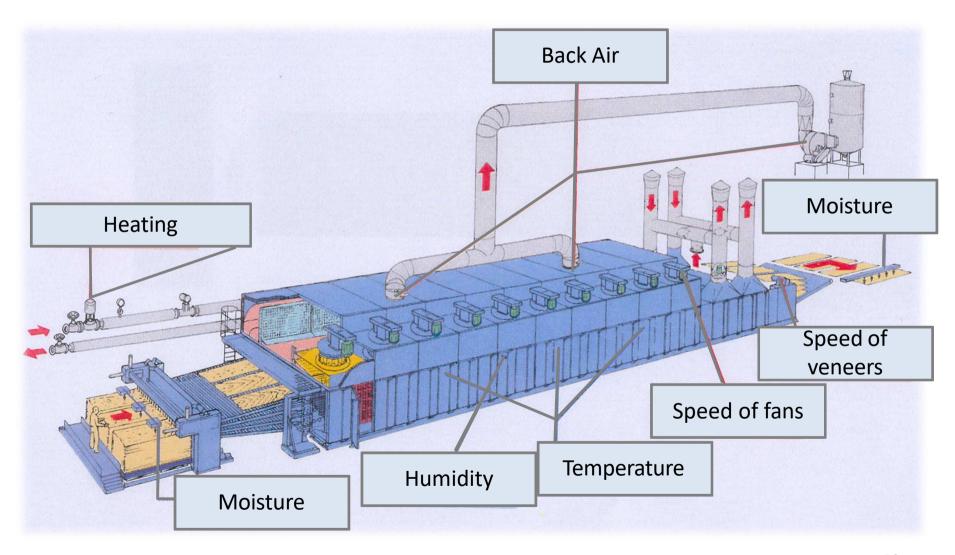


Wave Drying Systems

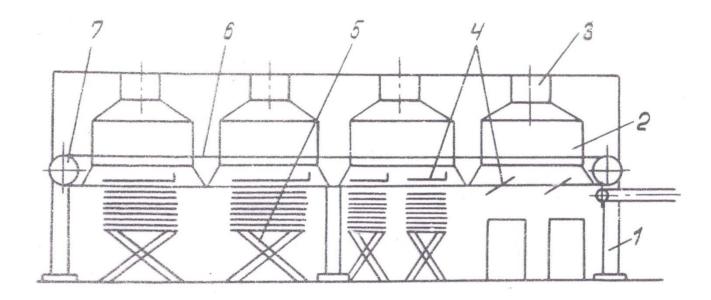




Controlling Systems



Sorting of Veneers

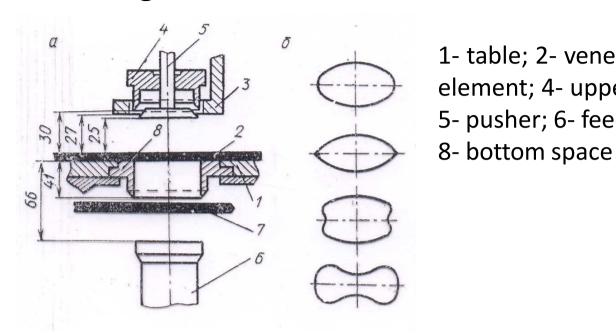


1- frame; 2- vacuum area; 3- fans; 4- loader; 5- lift; 6- perforated vacuum belts; 7- speed roller





Patching of Veneers

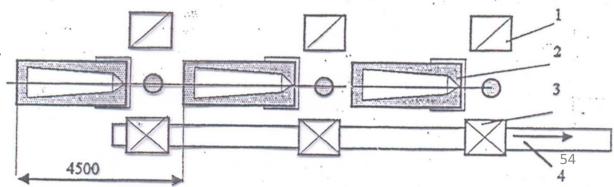


1- table; 2- veneer sheet; 3- pressing element; 4- upper patching element;5- pusher; 6- feeder; 7- veneer belt;

 Patching knot, bark, dark stain with in patch (bigger 0,1-0,2 mm then hole);

 Patch the same thickness, moisture 3-5%;

 ~ 30% of total dry veneer volume



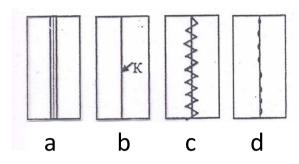
New Methods of Patching



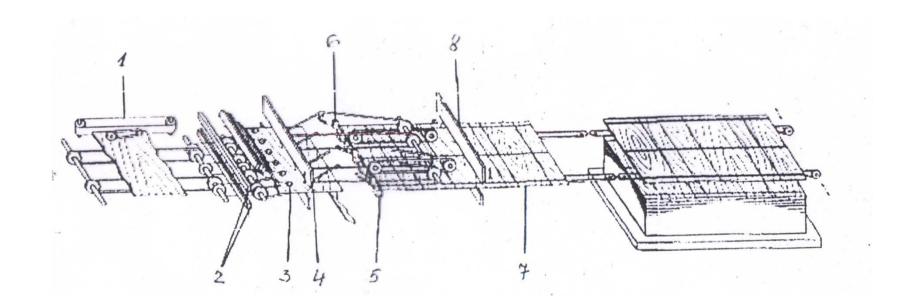




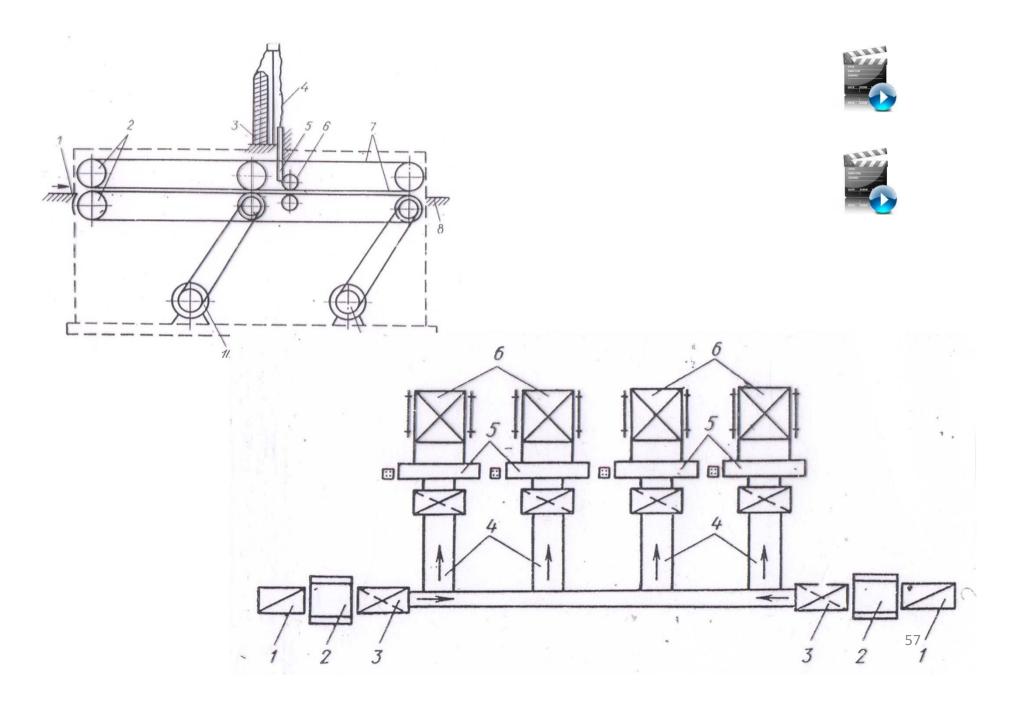
Veneer Composing



a- with tape (paper, other);b- without tape(contact);c- with glue thread (thermoplastic);d-with contact (glue points



Veneer Composing



Scarf jointing veneer saves valuable raw material

To an increasing extent wood is harvested from tree plantations. With Plytec technology the maximum use and benefit is obtained from the thinnest trees. They are cross cut and peeled in short blocks and the core is very small. The peeled veneer is lengthened and widened by scarf jointing and splicing respectively to form sheets of a more practical size.

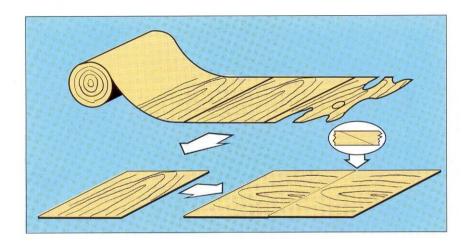
Large plywood panels and panels with nonstandard dimensions are made by scarf jointing and splicing the veneer. Thus, the length of a panel and the length of the block from which the veneer came have nothing in common.

Scarf jointing veneer

At their leading and trailing edges the peeled veneer sheets are scarfed in the direction of the grain and glue is spread on the upper bevel. Then the upper and lower bevelled edges are pressed together to form a continuous ribbon of veneer which is then cut to the required size. This is the whole idea of scarf jointing.

A durable joint is vital

The bevelling itself, control of the raw veneer, glue spreading and pressing are central and vital in the preparation of quality veneer and, by definition, quality plywood. Prime objectives in the development work behind PLYTEC's bevelling saw were to design and produce the best bevelling saw available anywhere. Only when the bevelling, gluing and pressing is carried out properly, can the scarfed joint be just as strong as the adjacent material.



Veneer handling machinery one of PLYTEC's areas of special expertise

PLYTEC has gained most of its experience in the Finnish-plywood industry, which uses thin and often knotty trees as raw material. PLYTEC is rightly famous for its tailor-made solutions which adhere to the individual requirements of its plywood factory clients in new plant investments and in the modernization of older production units.

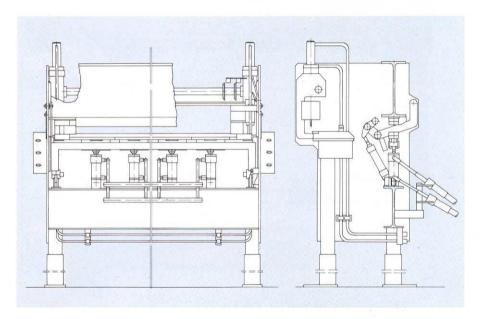
Technical data		1600	1700	2600
Max. distance between blades (max. length of scarfed veneer)	mm	1600	1700	2600
Min. distance between blades	mm	850	950	1250
Sawing thickness	mm	1.23.6	(2.54.2)	
Feed speed	m/s	0.8	0.8	0.8
JVP 1450, JVP 1700				
JVP 1450, JVP 1700 Technical data		1450	1700	
	mm	1450 1450	1700 1600	
Technical data	mm mm	-theodistants		
Technical data Max. width of veneer	923335	1450	1600	
Technical data Max. width of veneer Max. thickness of veneer Min. thickness of veneer	mm	1450 3.2	1600 3.2	
Technical data Max. width of veneer Max. thickness of veneer	mm mm	1450 3.2 1.5	1600 3.2 1.5	

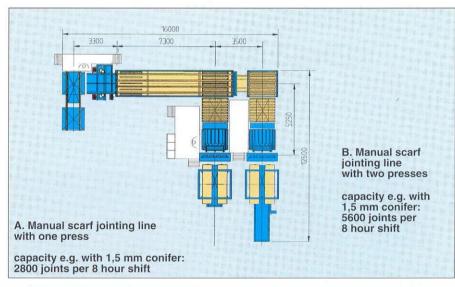
JVP scarfing presses

RAUTE's JVP presses incorporate a wide range of adjustments, which facilitate and improve production.

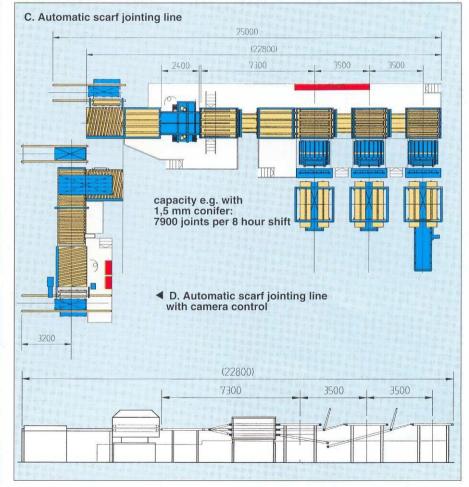
Pressing pressure and time, as well as clipping length, are measured







Technical details					
Scarfing saw	Jointing press				
Max. length of veneer sheet 1600 mm Min. length of veneer sheet 700 mm Veneer thickness range 1.23.5 mm Speed, max. 0.75 m/s Weight 3200 kg	Max. width of veneer Min. width of veneer Pressure maxsurface pressure Temperature of the pressing beam max. Pressing time	1650 mm 900 mm 1,5 MPa 300°C 3 - 8 seconds			



Operation and use

Feed speed up to 25 sheets/min. in grain direction.

Camera control

- for monitoring of veneer dimensions to determine the suitability for joint-

Calibration of veneer width

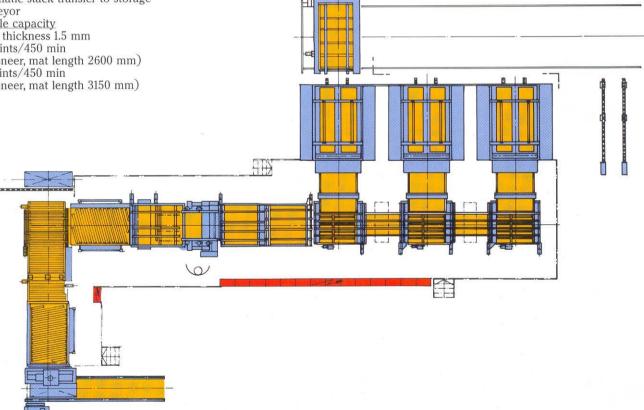
- sheets of equal width
- square sheets after scarf sawing
- straight and even mat edge after jointing

Control features

- full microprocessor-control and high automation
- Supervision of the line requires one operator, camera monitoring of veneer
- high capacity
- the line is intended for veneer of standard size, with 3 pre-selectable alternatives

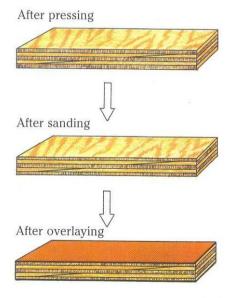
- automatic adjustment for different product dimensions
- automatic clipping of mats
- stepless clipping length adjustment separately on each press
- optimized operation and control Stack handling
- selectable auto/manual operation
- automatic pallet feed
- minimum stack removal time
- automatic stack transfer to storage conveyor



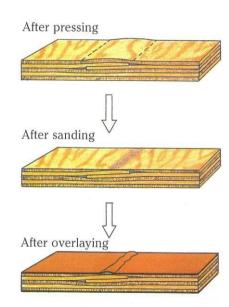




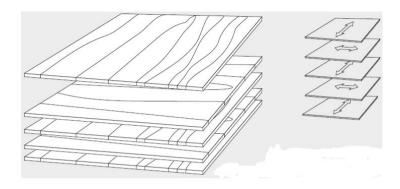
Examples Panel made of scarf-jointed veneers:



Panel with overlapping veneers:



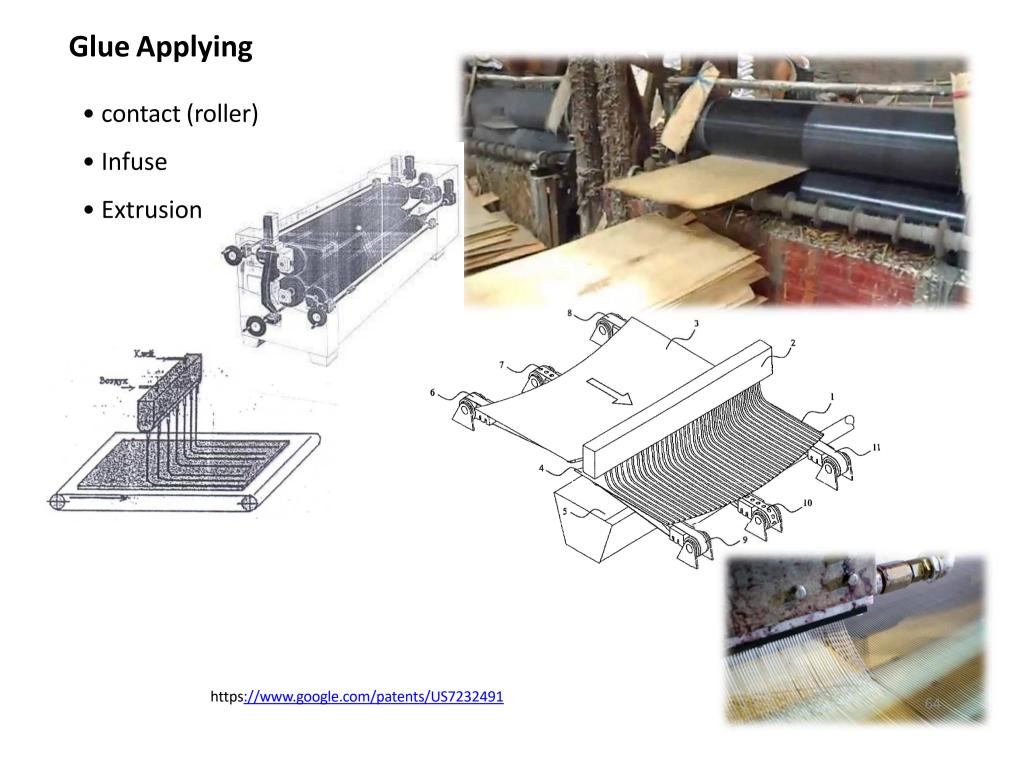
Plywood Lay-up



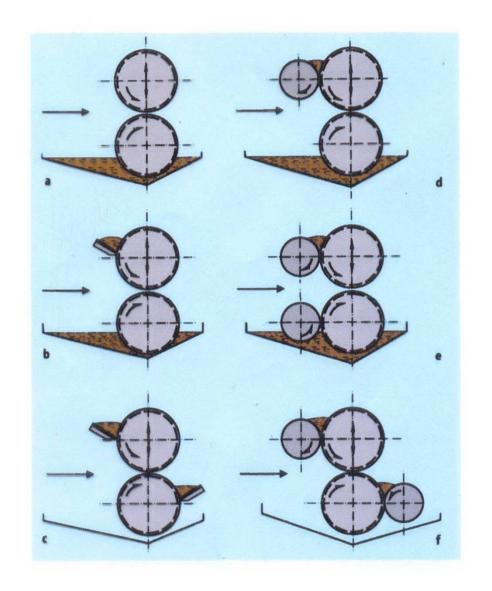


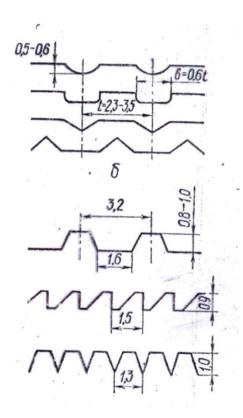




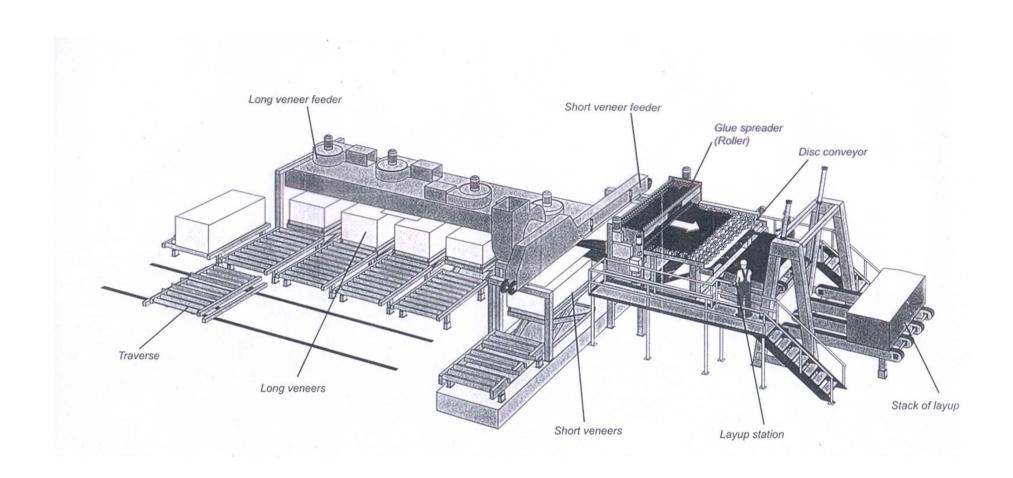


Glue Applying With Roller

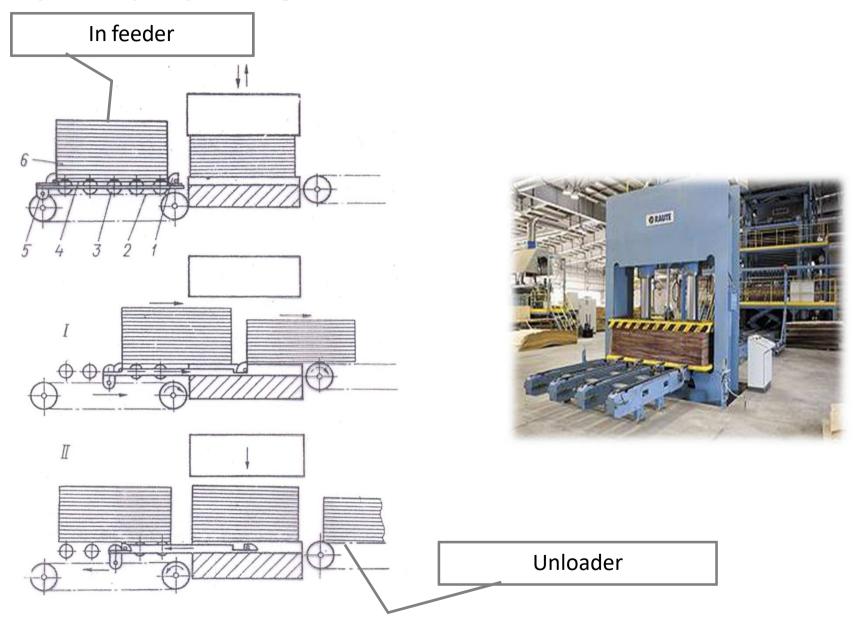




Semi- Automacic Glue Applying Line – With Roller

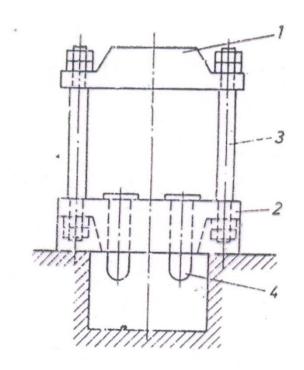


Plywood pre-pressing



Plywood pressing

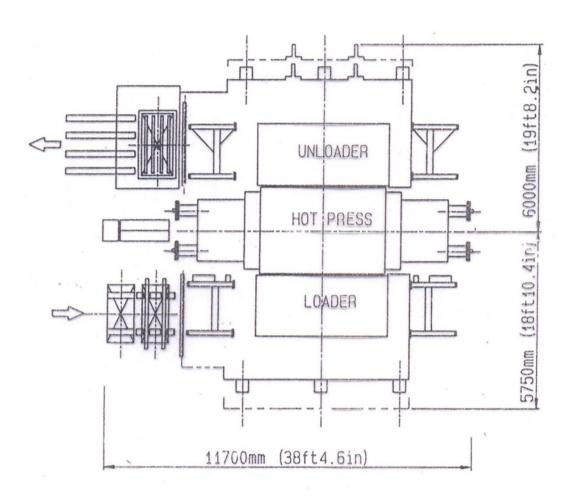
- By construction columns, frame other
- By number of deck 1, 2 or multi
- By applying pressure periodic or continuous
- By adding pressure hydraulic, pneumatic and vacuum
- By press type by temperature (cold or hot)
- By heater of deck plates steam, water, electricity, high frequency, thermo oil



- 1 upper travers;
- 2 lower travers;
- 3 column;
- 4 cylinder



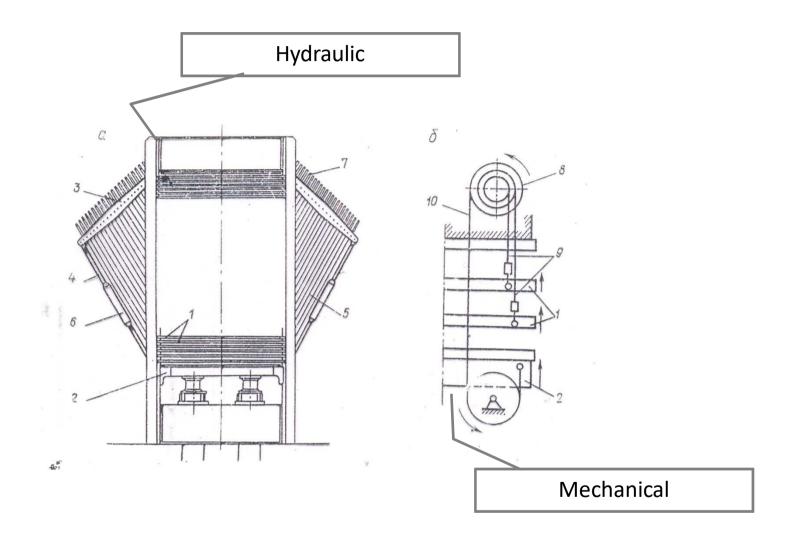
Pressing Organization





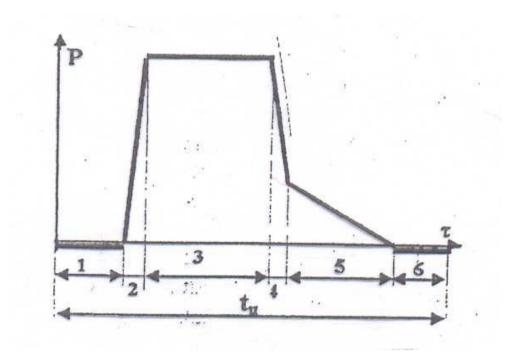


Pressing – Applying Force



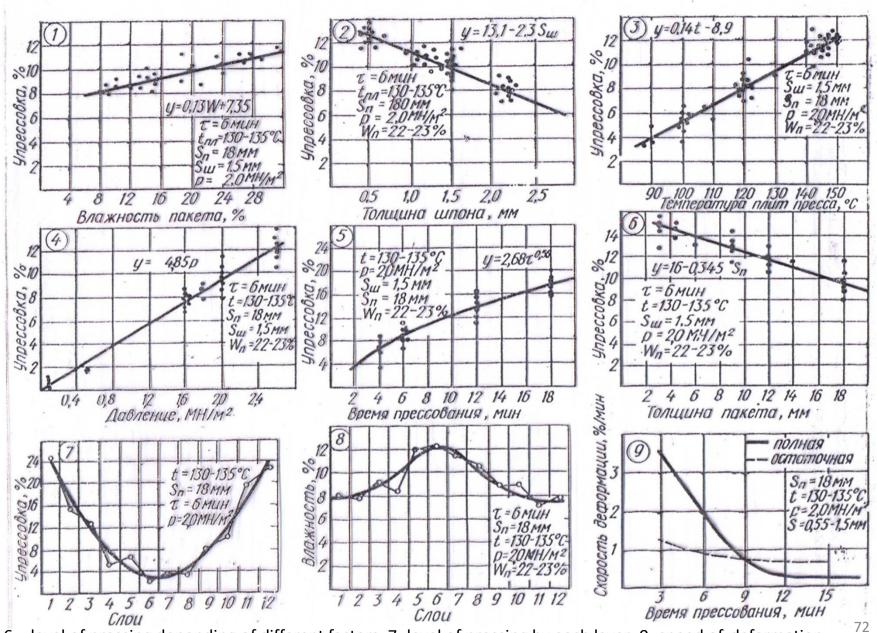


Pressing Diagram



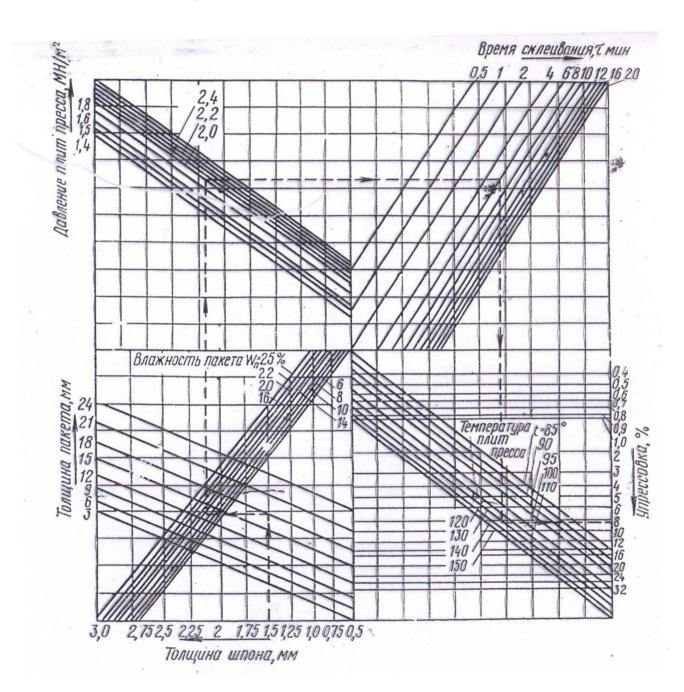
- 1- load of plywood; 2- closing of deck plates;
- 3- under the pressure; 4- reduction of pressure (1st step); 5- reduction of pressure (2nd step); 6- open deck plates and unload of plywood

Pressing Level

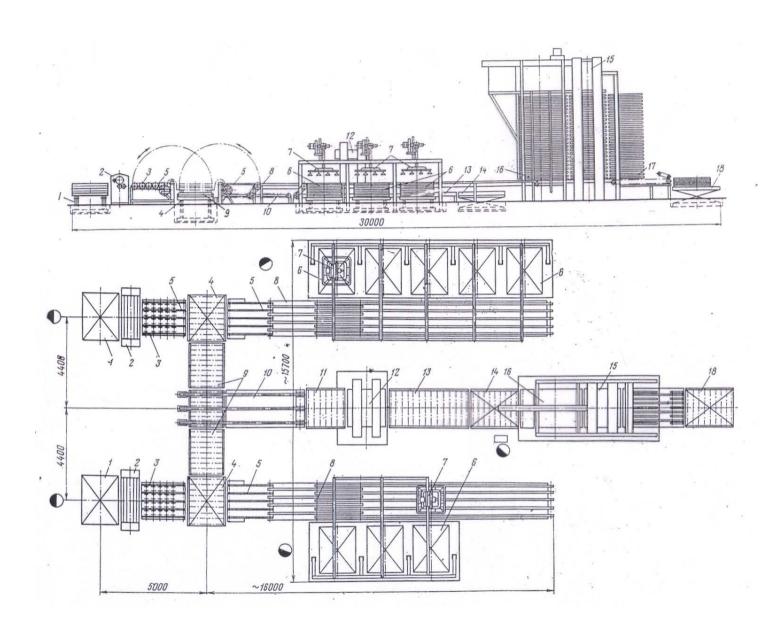


1-6 – level of pressing depending of different factors; 7- level of pressing by each layer; 9- speed of deformation

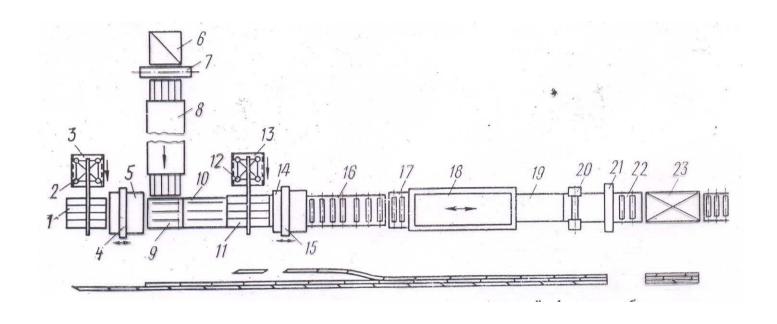
Pressing Level of Birch Plywood



Pressing Line (40 decks)

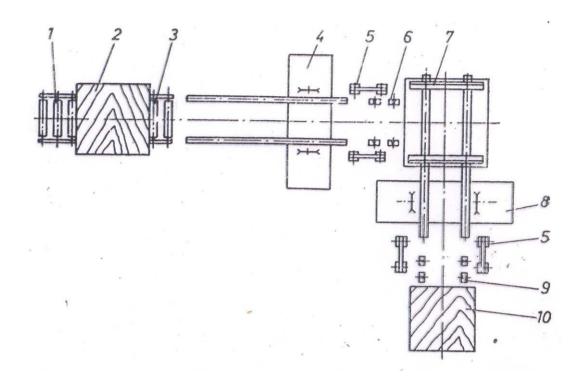


Pressing Line (continuous)



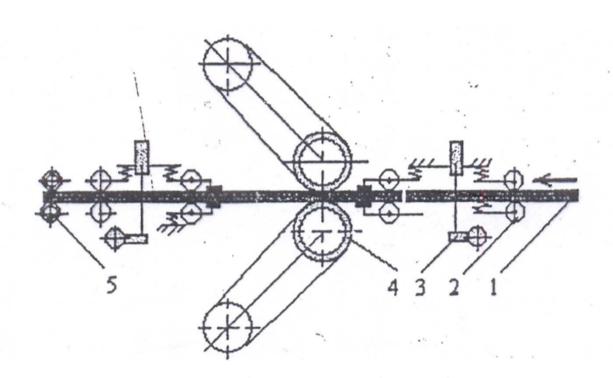
1-16 – lay-up of veneers; 17-20- press; 21- splitter; 23 –ready pack

Finishing - Sawing



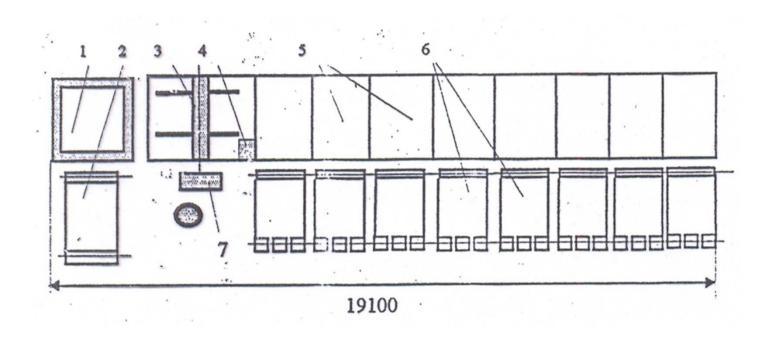
1-3 – preparation of plywoods; 4 and 8 both sides cutting; 5- transporting mechanisms; 6- loader; 7 and 9 unloader

Finishing - Sanding



1 – plywood; 2- speed roller; 3- lifting element of upper frame; 4- sanding belts; 5- dusters

Finishing - Sorting



1 – loader; 2- transporter; 3- turning element; 4- marker; 5- stacker; 6- unloader transporter; 7- operator

Finishing – Sorting Classes (birch)



- B (I) for high quality painting, staining and lacquering.
- S (II) for good quality painting, staining and lacquering.
- BB (III) standard grade (plugged), for interior paint finish and coating with transparent and non-transparent thicker overlays and films, and also veneering.
- WGE plywood of WG grade without open defects (repaired with epoxy filler), for coating with non-transparent finishing material.
- WG (IV) for use where surface appearance is not important, reverse grade.



Veneer GradeScan

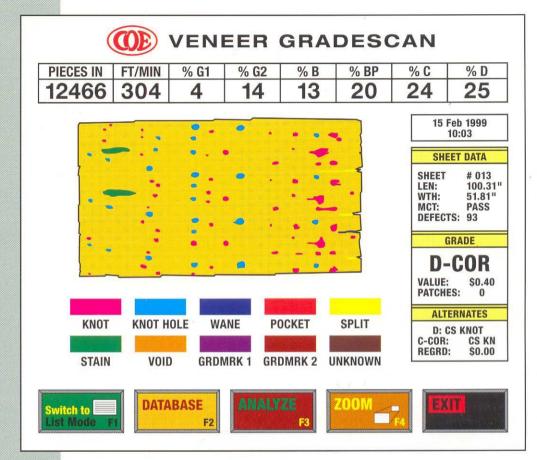
GradeScan Technology:

A unique image processing technique:

- **■** Efficiently defines defects
- Filters out grain pattern
- Automatically adjusts for variation in color

Veneer Grading Software:

- Type-classifies and names each defect
- Considers patching vs. downgrading
- Evaluates critical knot sections as well as defect sizes — faster and more accurately than an operator



High-speed image processing logic extracts and identifies defects that are plotted on-line for every piece. Color codes indicate defect type. A production window at the top shows grade distribution, line speed and additional data.

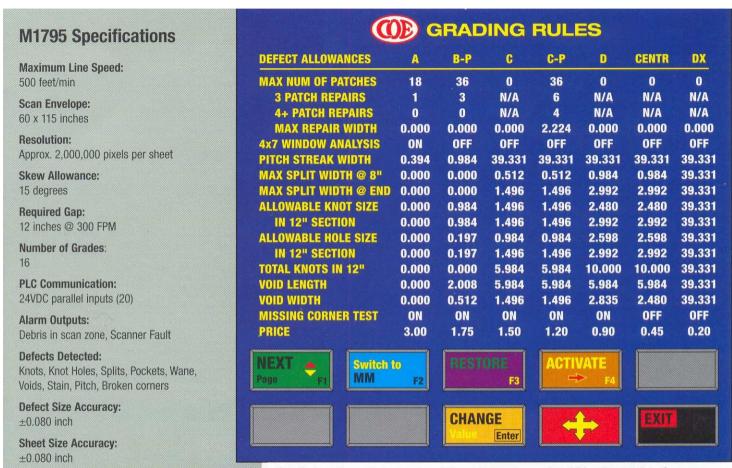


Several man years in development, Coe presents the Veneer/Lumber Grade Scanner for automatic sorting and stacking. It inexhaustibly monitors your sorting line and makes accurate grading decisions piece by piece.

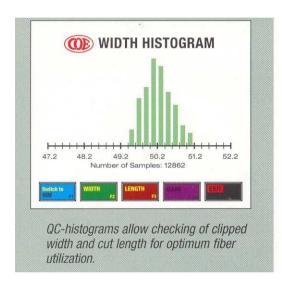
Grading software evaluates the optimum grade based on your grading rules. High-speed image processing provides the means to automatically achieve maximum value for each piece processed.

Protected by United States Patent 4,803,371 and foreign patents. Other patents pending.





Detailed grading rules are entered through an advanced and friendly user interface. The Grading software evaluates patching vs. downgrading, critical knot sections and tests for missing corners and required sheet size.



The Veneer GradeScan system consists of a scan frame located three to five feet above the grading conveyor. The scan frame employs two high-speed CCD line array cameras and a halogen illumination system to detect the defects in the veneer. A shaft encoder monitors conveyor movement. High-speed image processing computers extract defects in the veneer and identify their types. Grading software evaluates the optimum grade based on entered grading rules. A PC-based graphical user interface allows plotting of defect data and changing of the grading rules. Outputs from the system are passed to a PLC for control of the stacker.

Bonding Classes

Plywoods comply with the European standards EN 314-1 and 2, establishing three designations for use in dry, humid or exterior conditions

- Class 1 dry conditions: this classification is adapted for internal uses sheltered from water and humidity.
 In such a case bonding type class 1 is relevant.
- Class 2 humid conditions: this classification is adapted for use in wet applications (e.g. under roofing underlayments) when the level of relative humidity is not supposed to exceed 85% or only very occasionally. This category of products is also suitable for use in exterior sheltered conditions or in case of short-term exposure to bad weather conditions (e.g. during work on site). In such a case, bonding type class 2 or 3 relevant.
- Class 3 exterior conditions: these products are designed for use in unprotected external applications with prolonged exposure to the elements.
 - In such a case, bonding type class 3 is relevant.

Service Class

The service class specifies the end uses for which plywood is suitable, in accordance with EN 636.

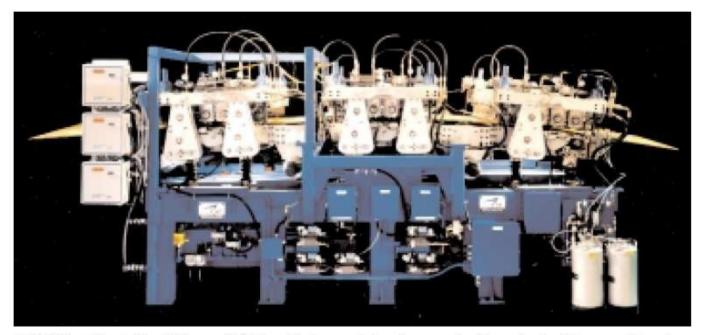
- Class 1 IAW EN 636 -1: Use in dry conditions, bonding type class 1
- Class 2 IAW EN 636 -2: Use in humid conditions, bonding type class 2
- Class 3 IAW EN 636 -3: Use in exterior conditions, bonding type class 3

Plywood manufactured to technical specifications which exceed the requirements for plywood for exterior use such as defined in EN 636-3. Their bonding type conforms to class 3 in accordance with EN 314-2.

In case of uncertainty regarding the precise final end use of the plywood, it is recommended to presuppose that the plywood is going to be used in construction for a structural load bearing application.

In such a case the panels must demonstrate compliance with the Construction Product Directive (CPD) and EN 13986. CE marking is required in accordance with annex ZA of EN 13986 and characteristic values must be supplied for use in accordance with EN 1995 -1-1 Eurocode 5.

Mechanical Grading of Veneers



LightWave Computing Tech. used National Instruments hardware and software to develop a wood panelbend machine to test stiffness and elasticity.

Finnish Plywood Handbook



A/S "Latvijas Finieris" Plywood Handbook



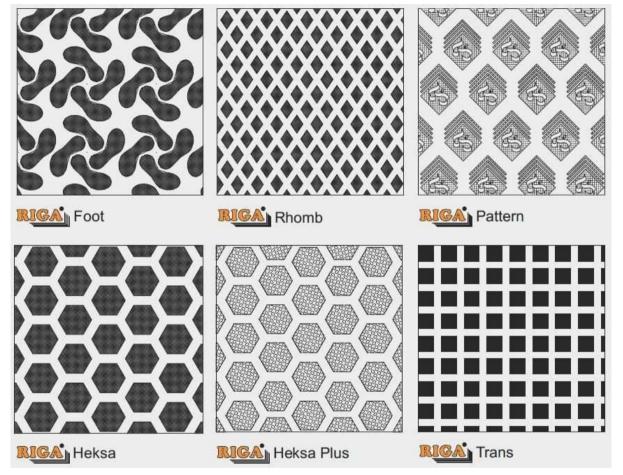
Canadian Plywood Handbook



USA Plywood Handbook



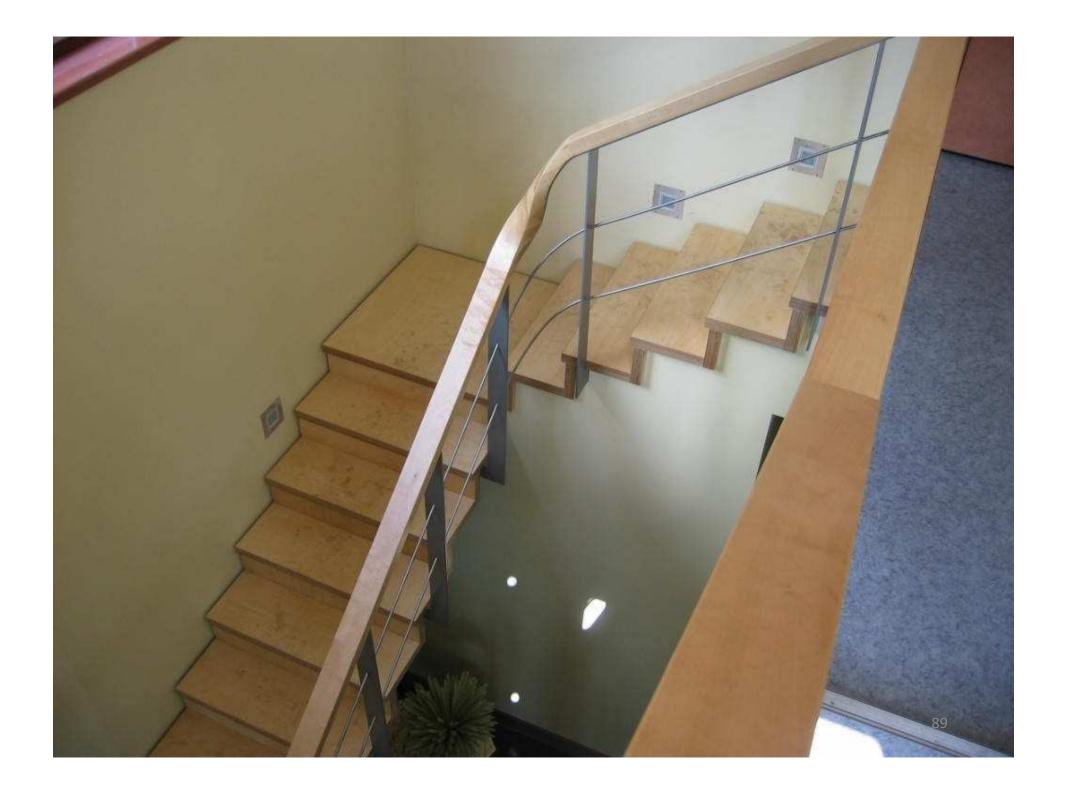
Plywood Lamination

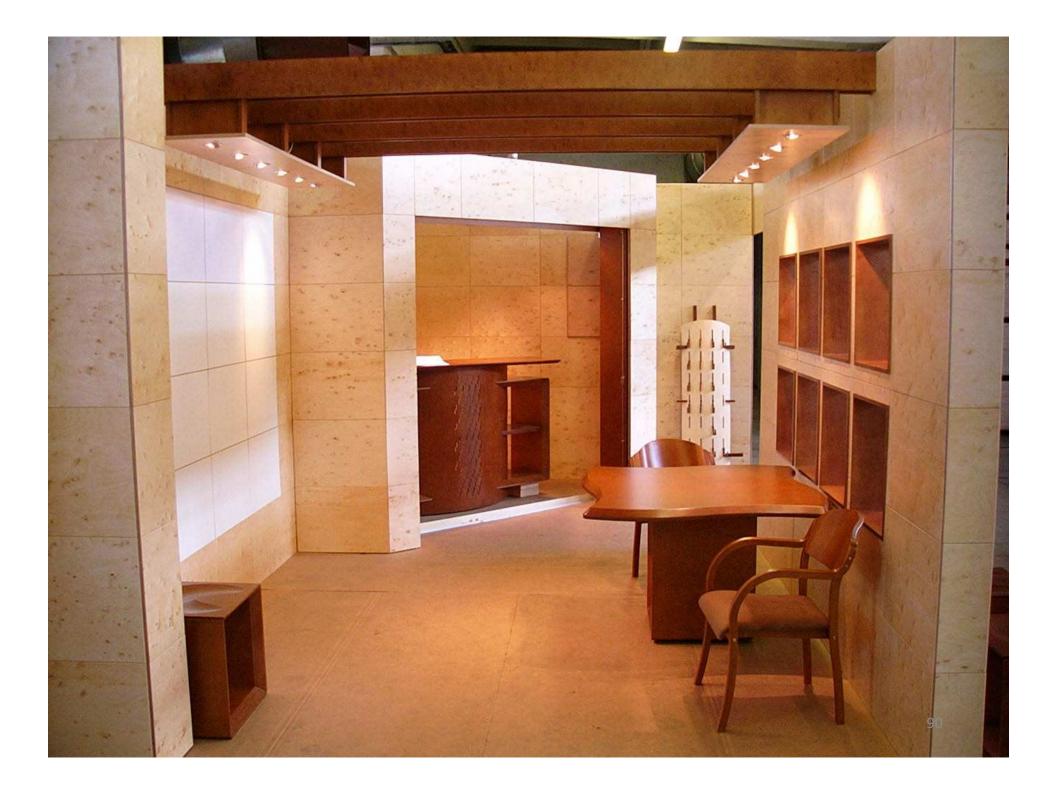


ISSA SERVICES

http://www.finieris.com/en/products/birch-plywood

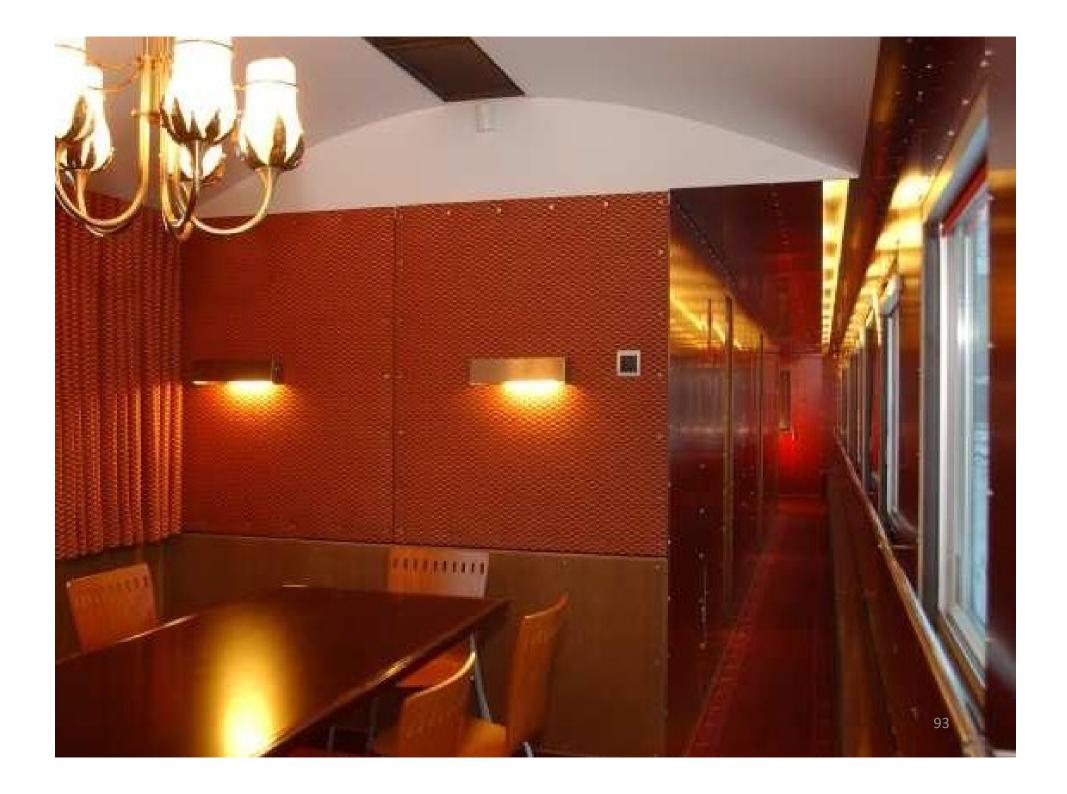


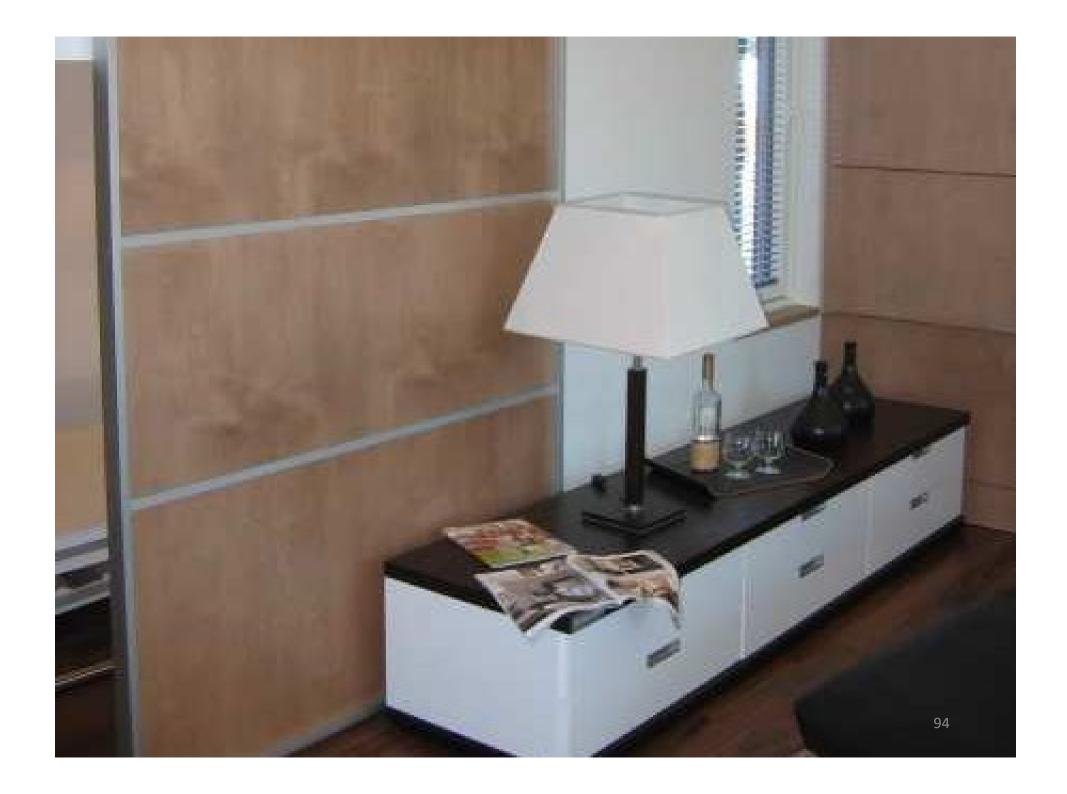






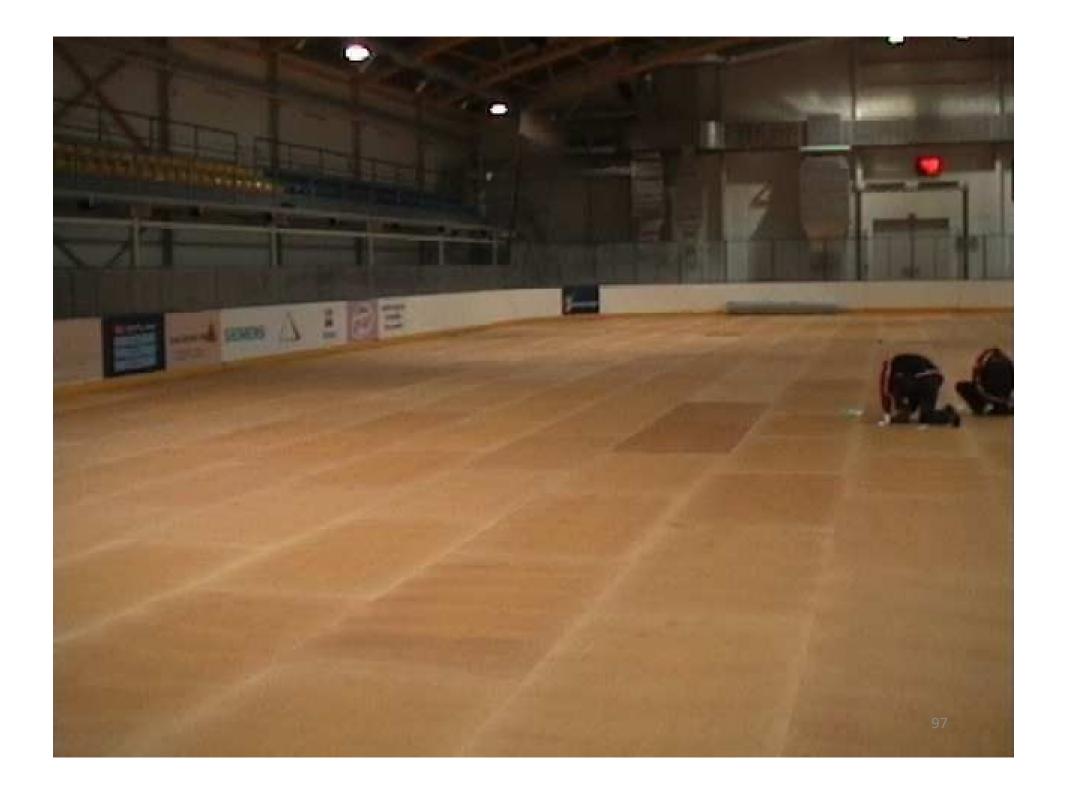






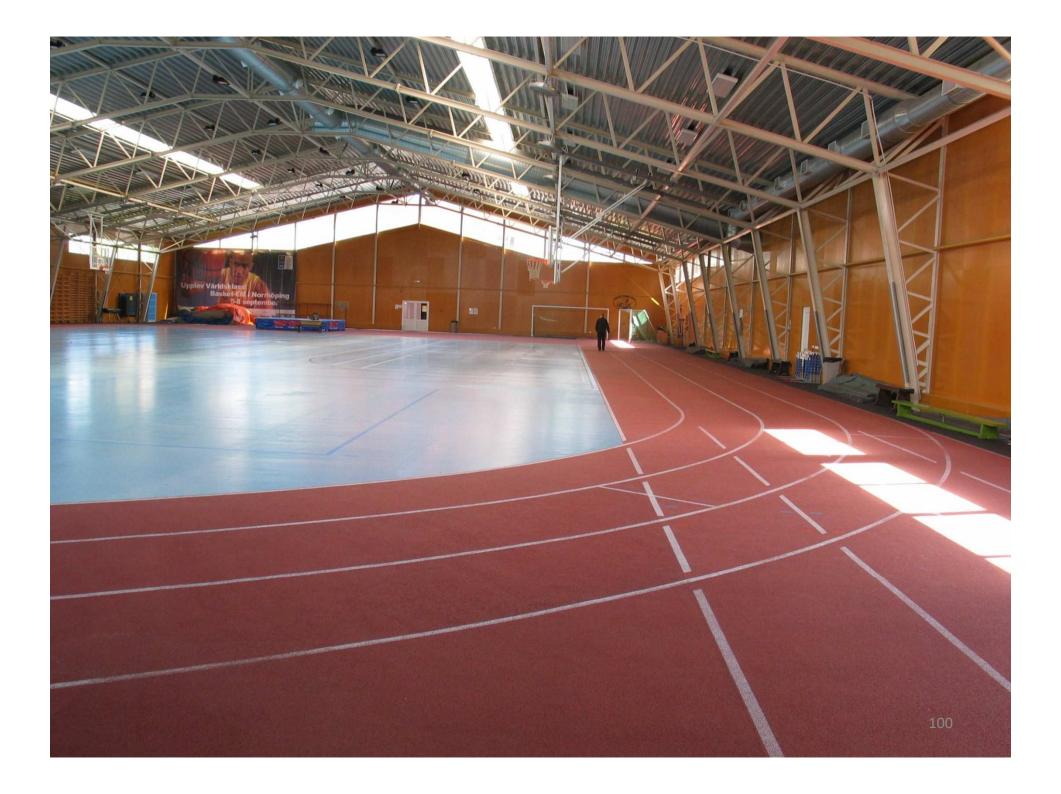








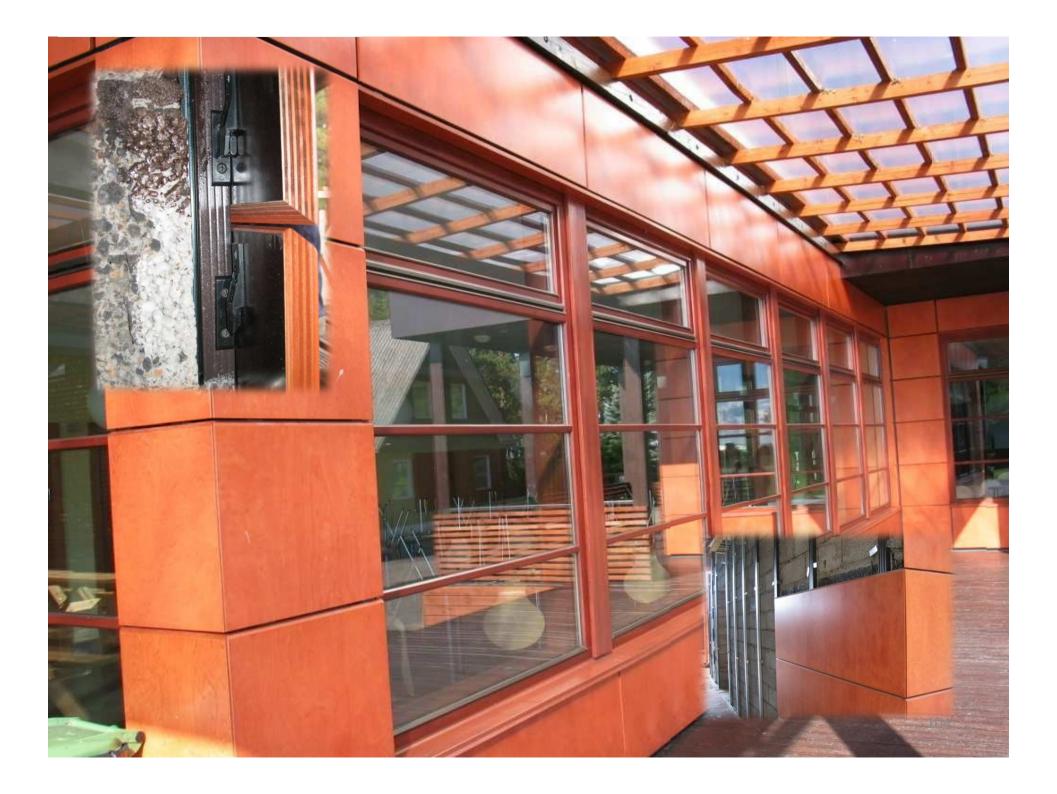




























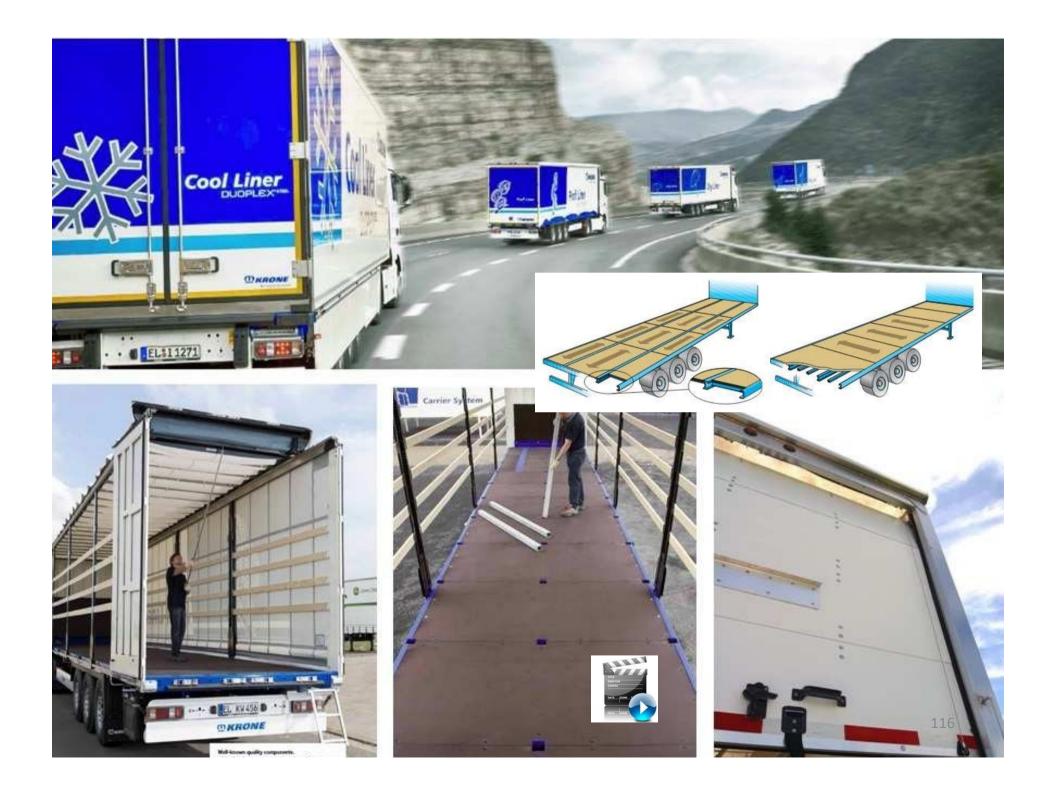






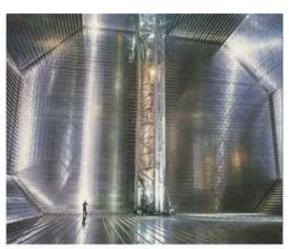




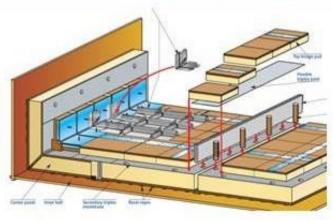




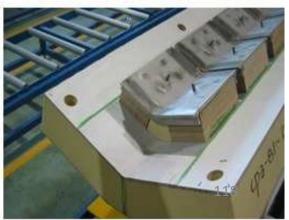


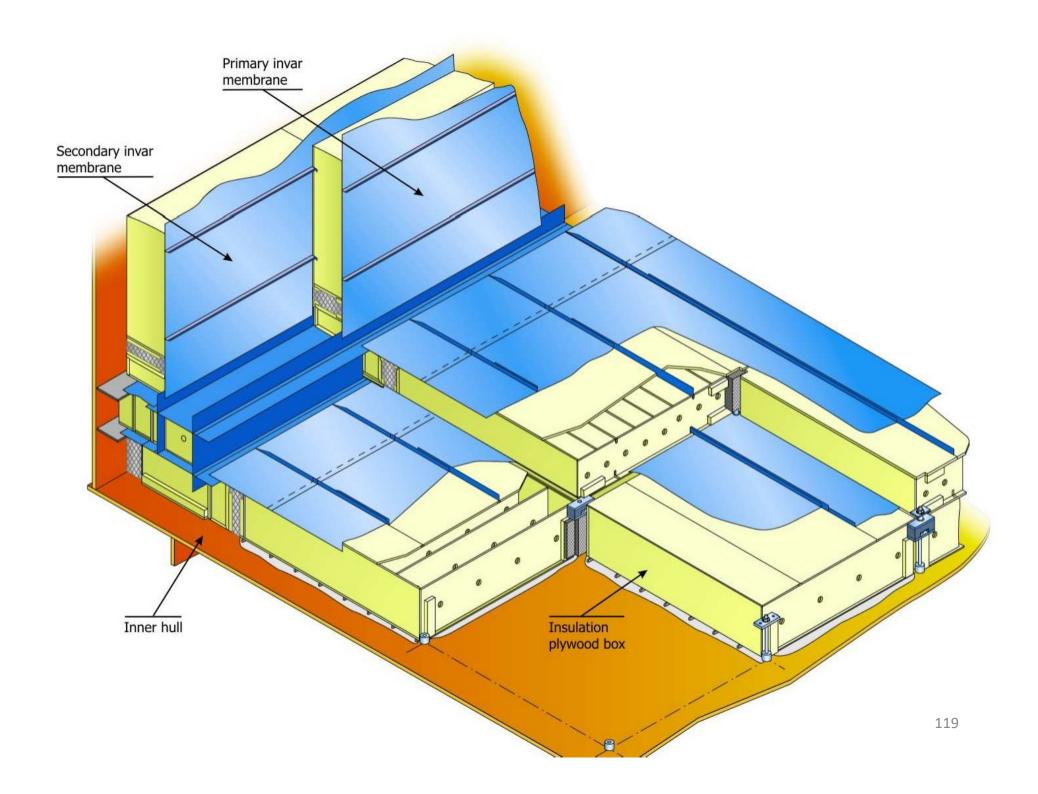






















New Technologies and Totaly and Big Producers





http://www.raute.com/





http://www.wisaplywood.com/Pages/default.aspx

Marine Plywood production





http://www.finieris.com/en/about-latvijas-finieris

Plywood production BIELE



http://www.metsawood.com



Curved plywood elements



http://www.sveza.com/











Exotic timber Plywood (underlayer)

Thank You for Your Patient and Attention!



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Topic:

"NEW RENEWABLE MATERIALS: SOME EXAMPLES AND TRENDS"

Authors Andrejs Domkins

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA



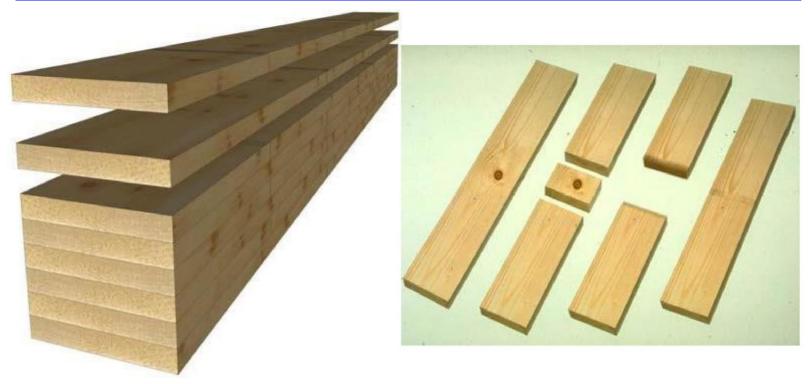




New renewable materials

Some examples and trends

Currently, glued timber dominates





Jointing wood and concrete in bridge construction







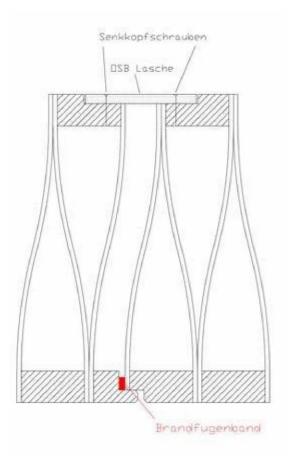
XLamConcrete



Magnum plates



Structural panels







Further development?



Light boards



IKEA Boboard

Functional adopted boards & lightweight

- Focus in carrier materials

Standard particleboard and standard MDF



- Board on stiles and board on frames
- 2. Boboard and lighter particle board

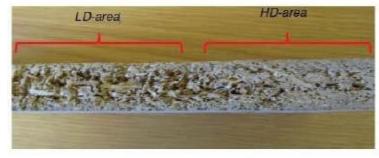
Boboard

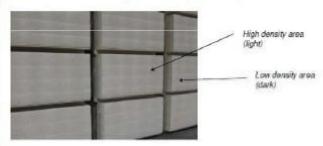
- 2009
- · 4 mills producing
- -100kg/m3



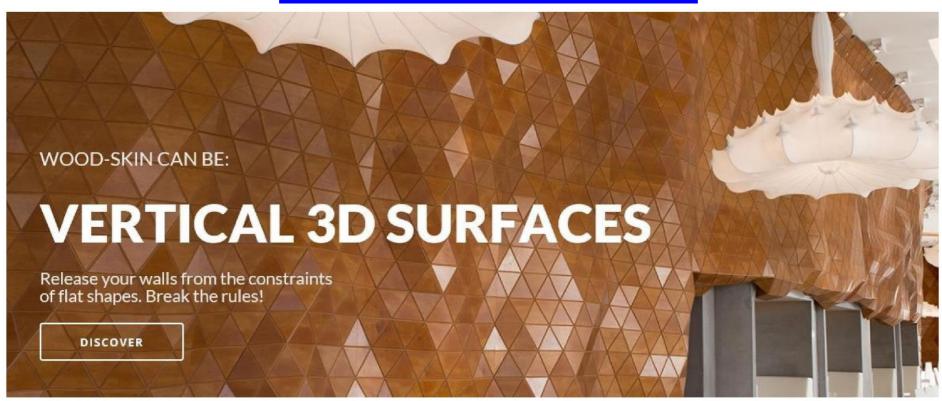
BOBOARD definition

Dual density particleboard is a three-layered, function adapted wood based panel with defined high- and low density areas over the whole board area. The idea of dual density board is to adjust all necessary physical properties while spreading the mat individually on different parts of the panel.





Wooden "leather"



Paper cell boards



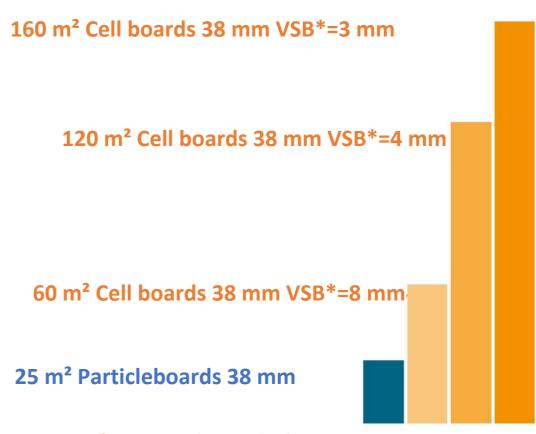
VMG board factory in Akmene



Lightweight boards – the main trend in furniture constructions

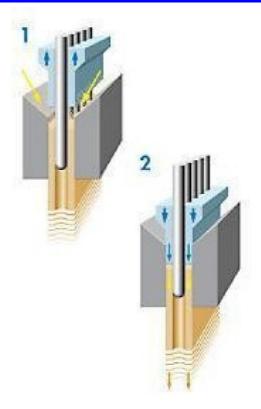


From one cubic metre of wood the following can be made:



* VSB top layer thickness

Extrusion particle board



Wiggle Side Chair

Frank Gehry Design: 1972

Production time: 1972

The Producer: Easy Malas, Inc., New York

Size: 85 x 42.5 x 60; seat height 45.5 cm

Material: corrugated [card]board,

hardboard, wood



Donna, arch. Gaetano Pesce

Design: 1969

Production time: 1970-3

The Producer: C & B Italia (Cassina &

BUSNELLI), Italy

Size: 92 x 117 x 137; seat height 40 cm,

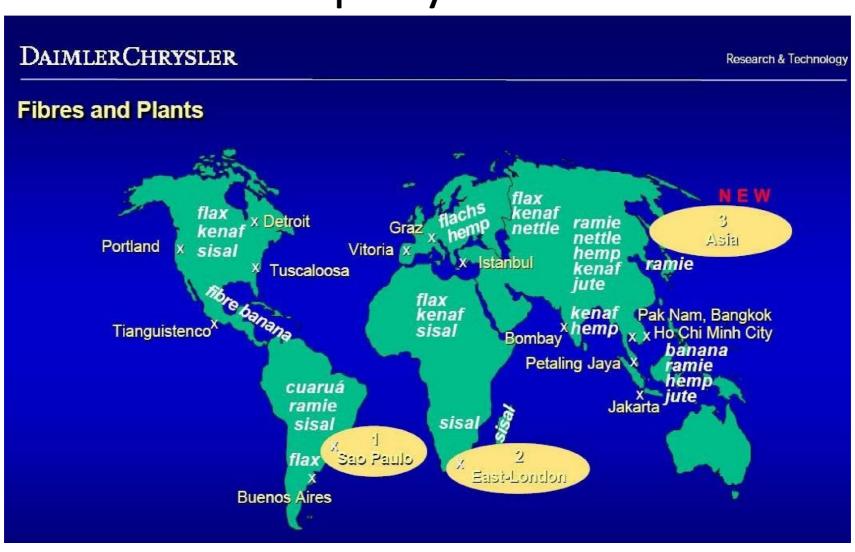
UP6 circumference 60 cm

Material: polyurethane foam, nylon

fabric



Europe consumes 1 million tonnes of fibre per year





Bicycle 1896 and today







Car parking in Leipzig Zoo







Bamboo furniture





Bamboo in the exterior





Comparison of properties

Eigenschaften:	Bambus	Bongossi	Eiche	Fichte
Rohdichte in g/cm³	1,11	0,94	0,67	0,47
■ Formstabilität	mittel-hoch	gering-mittel	mittel-hoch	gering-mittel
■ Brinell-Härte	9,84	5,50	3,7	1,3
Druckfestigkeit in N/mm²	176	108	52	40
 Biege-Elastizitätsmodul in N/mm² 	17.000	15.000	13.000	10.000

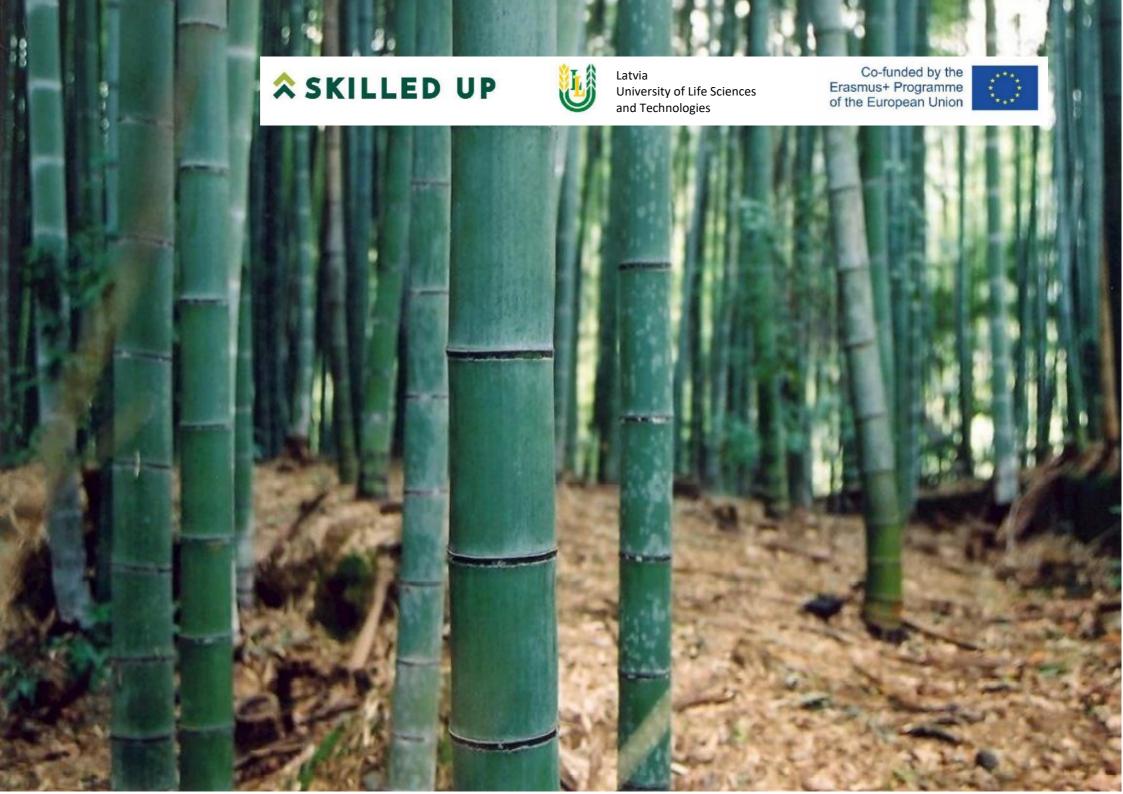
Bamboo pre-treatment





Bamboo window







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Topic:

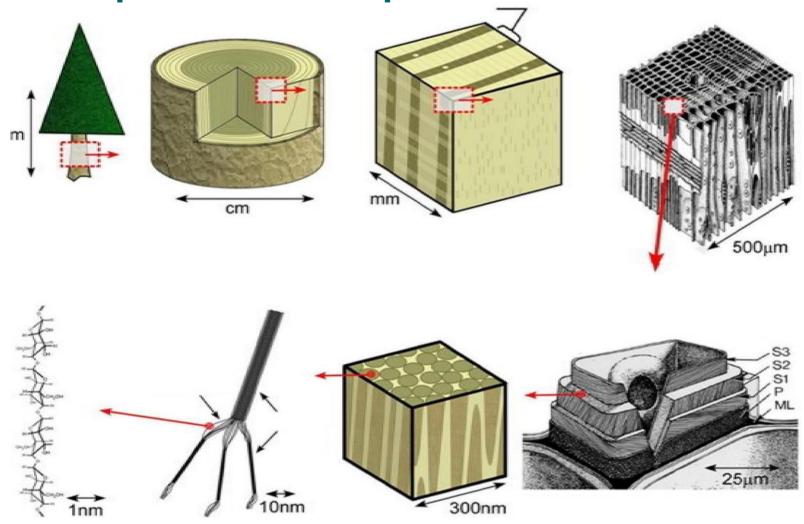
"WOOD FURTHER PROCESSING OPTIONS"

Author Andrejs Domkins

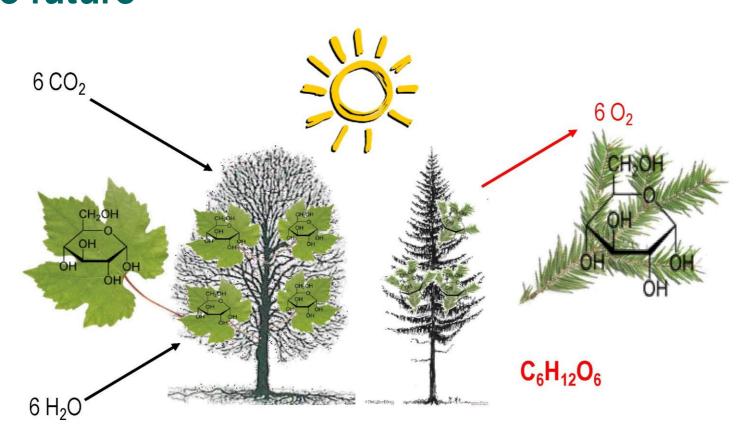
Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA



The structure of wood offers unique opportunities for future product development



Photosynthesis converts CO₂ into the material of the future



Input
1.46 kg CO₂
0.60 kg H₂O
18.5 MJ Solar energy

balance of 1 kg wood

Output

1 kg Wood 1.06 kg O₂

18.5 MJ Chemically related energy

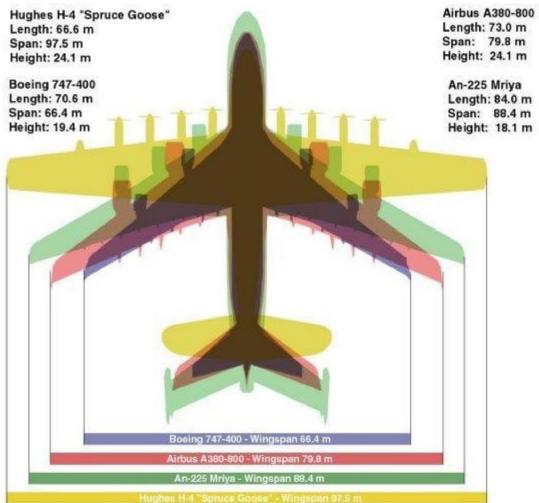
1 m³ = ~0.7 t CO₂ + Substituted materials and green energy Increase in value in wood use/processing chain Wooden construction Sawn timber Structural timber Glued solid wood Sawlogs Particle board Fibreboard Wood in the interior Chips Peeled veneer Furniture Plywood Paper fibre Regenerated fibres Paper/Cardboard Textile fibres/Fabrics Industrial wood Logs/Fiber

Biorefining

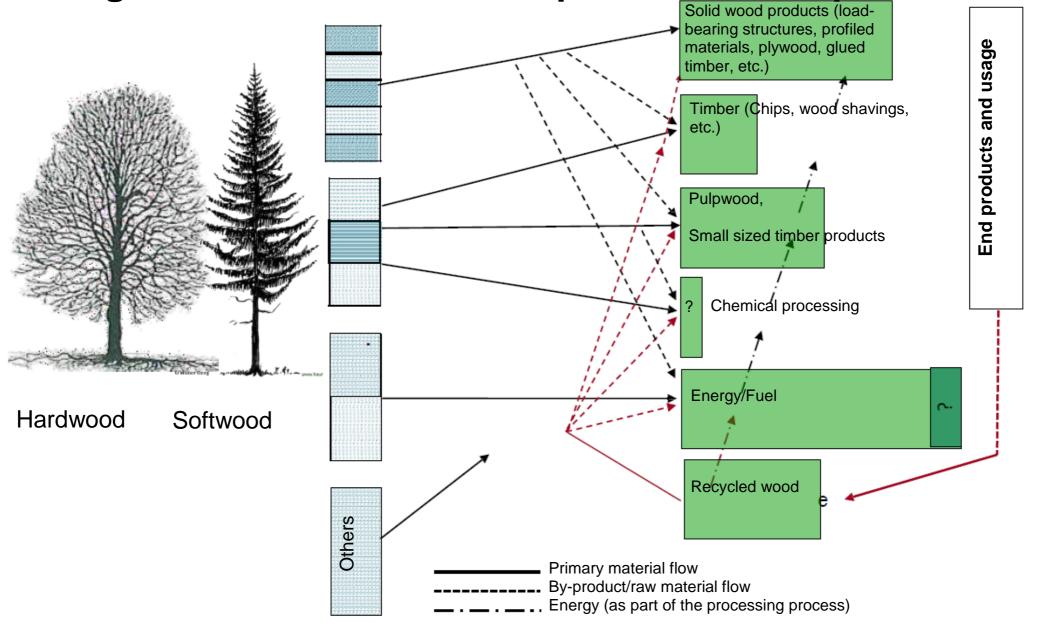
The tree can also fly!

Spruce Goose/Hughes HK1 1942-1947





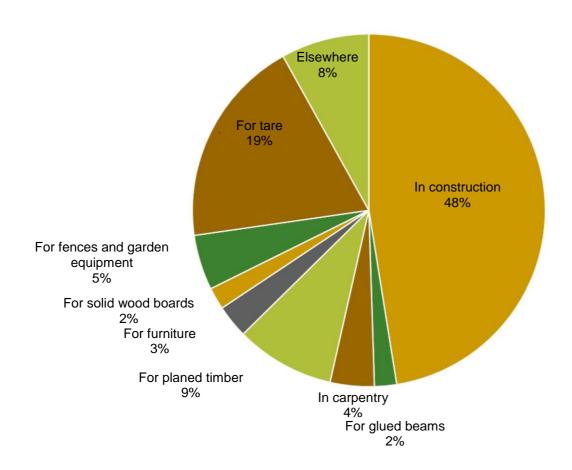
Competition in the flow of wood raw materials – the driving force behind the development of wood products



Valuable wood is processed in Latvia, less valuable wood still lacks local capacity

	Species/assort ment	Conifer	Birch	Aspen, white alder
Firewood {	firewood	Very modern pellet and slab industry.	Firewood producers	Local furnaces; export
Pulpwood	Pulpwood/techn ological wood	Very modern pellet and slab industry. A large proportion of it is exported to the Nordic pulp mills	Most of it is exported to the Nordic pulp mills	Part of the aspen pulpwood is exported; the rest is used in local furnaces
Sawlog	Sawlog/veneer block	> 95% of sawlogs are processed in Latvia. ~ 80% of sawlogs are processed in sawmills that meet the best Nordic standards	> 90% of veneer blocks are processed in Latvia. World-class veneer production; manufacture of furniture components f	> 90% of sawlogs are processed in Latvia. Aspen sawlogs are processed by manufacturers of the sauna and furniture components; white alder and damaged aspen – to produce tare

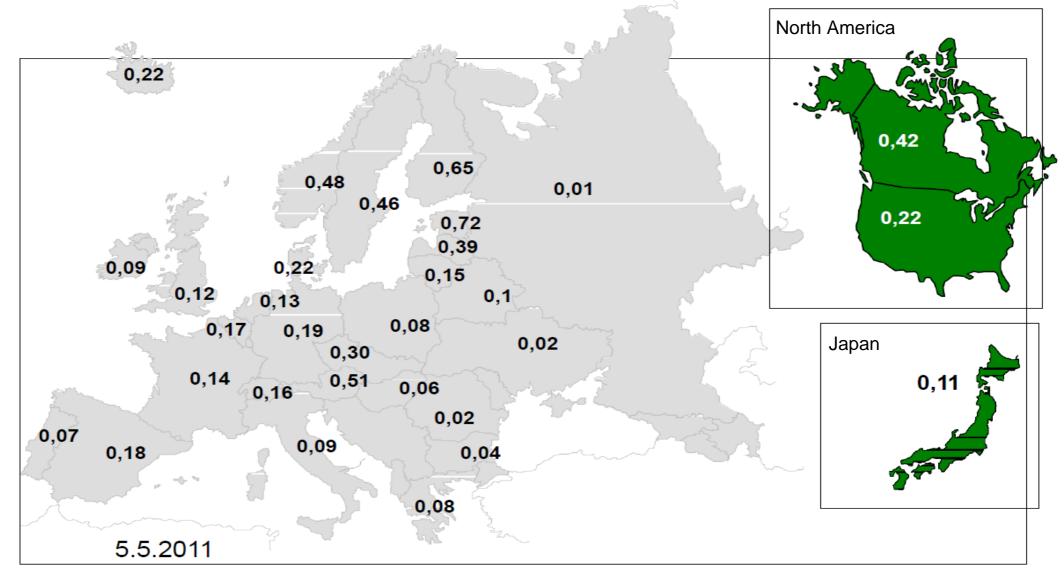
Use of converted coniferous timber in the main importing countries in Europe



Source: Jaakko Poyry Consulting

Consumption of converted coniferous timber per capita. In 2009

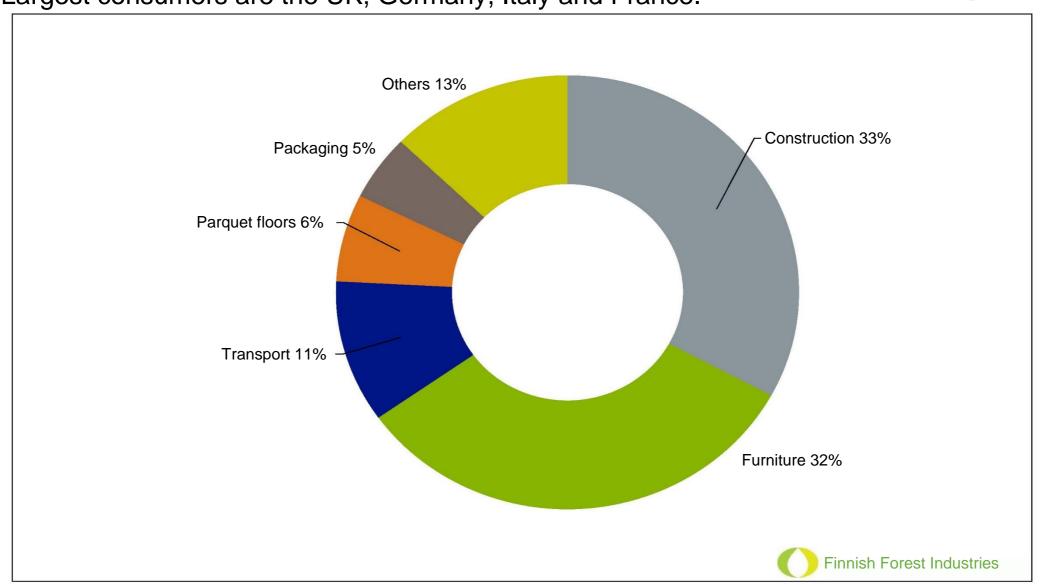




End users of plywood in Europe





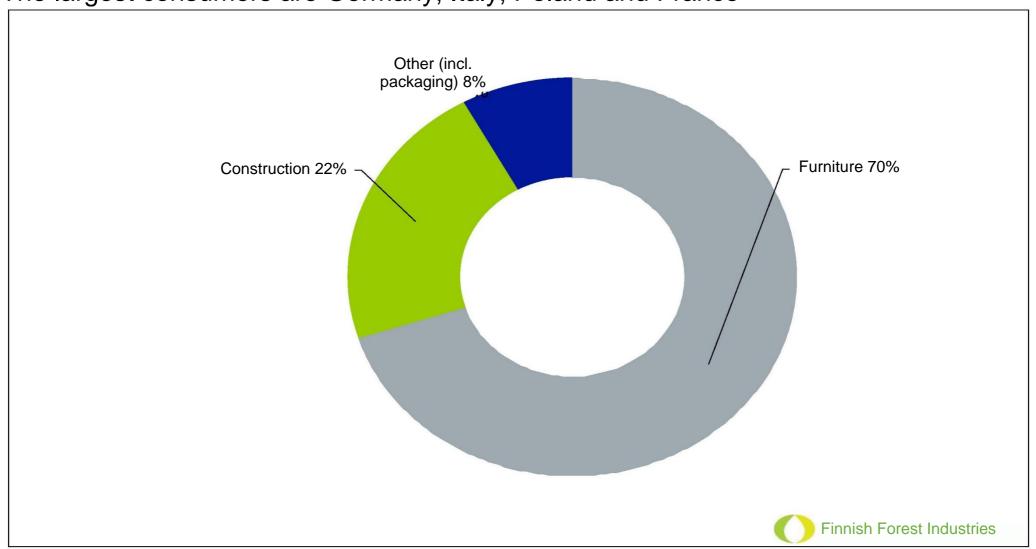


End users of particle boards in Europe

The total consumption of particle boards in Europe in 2010 was 28 million m³.



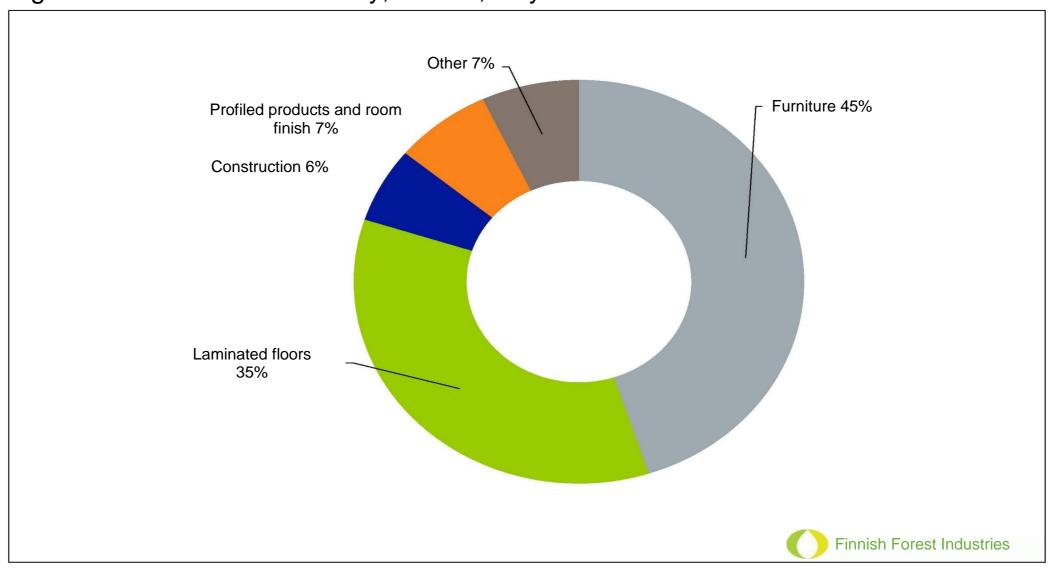
The largest consumers are Germany, Italy, Poland and France



End users of MDF in Europe



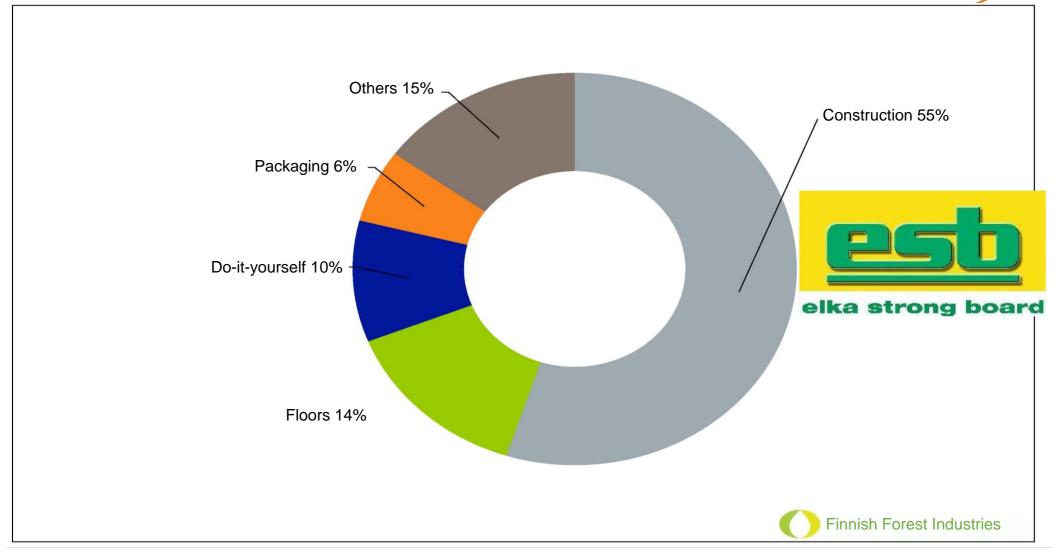




End users of OSB in Europe

The total consumption of OSB in Europe in 2010 was 3.6 million m³.

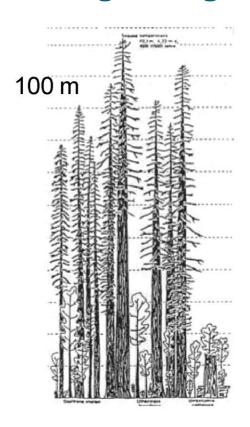




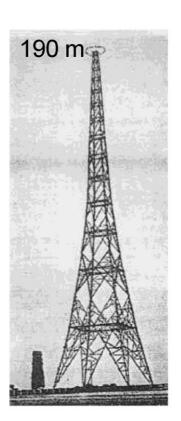
Wood has an aroma



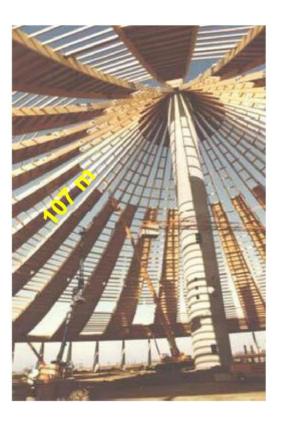
From growing wood to industrial construction



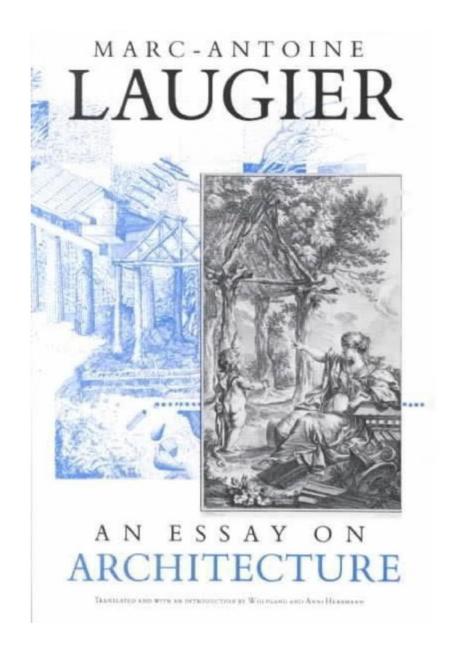
Sequoia forests



in 1934



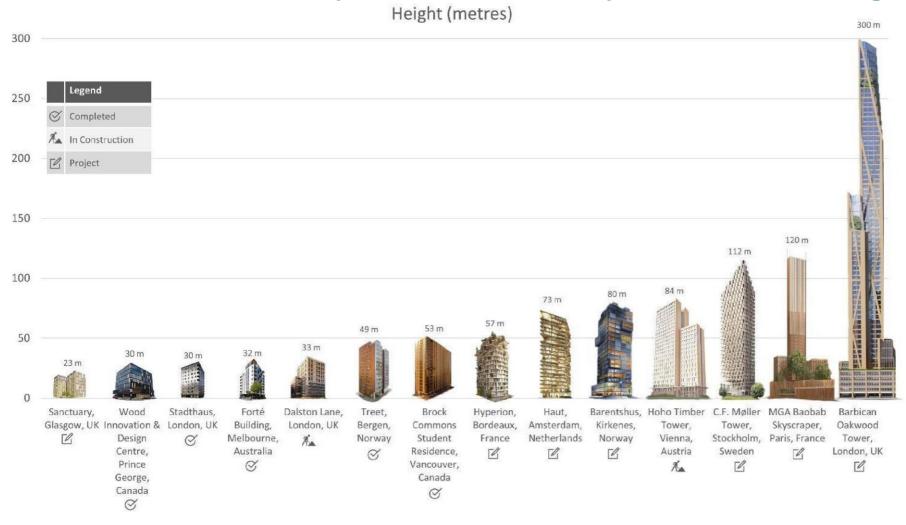
Radio tower in Germany Roof of a waste incinerator in Vienna



Book published in 1753 on 'Construction of Wooden Buildings'

Wooden construction Renaissance began 10–15 years ago

In 2008, there was only one new 8-storey wooden building



trends

- ★ Urban planning
- ★ Priority of structures safety and health

Wood has convincingly returned to modern construction

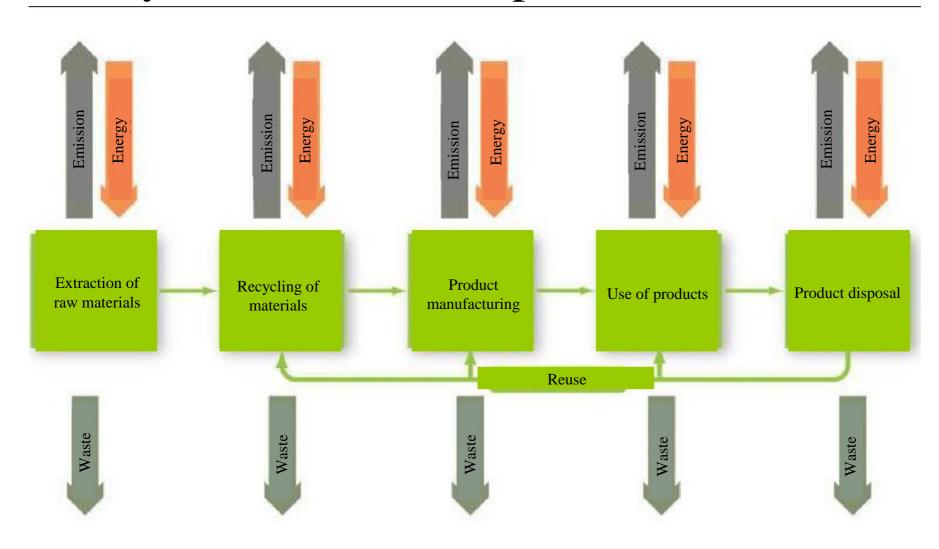


Keywords of sustainable construction

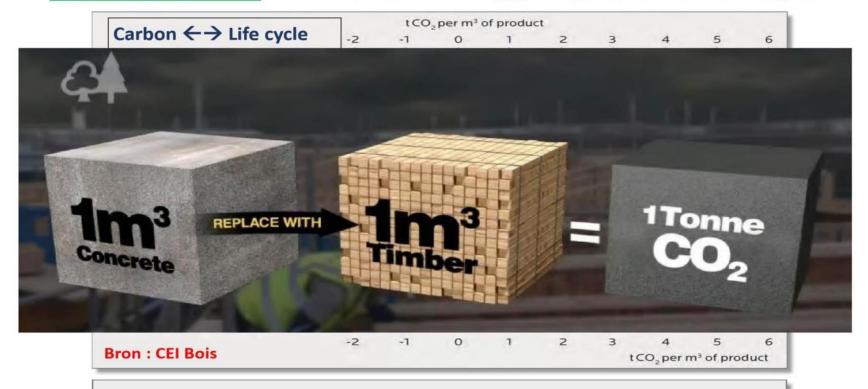


- Reduces climate change
- Reduces waste
- Consumes less energy
- Less material is required
- Healthy for people and the environment

Life cycle assessment step



1. **Embodied C**: emission during production and disposal



WOOD IS THE NEW CONCRETE

Innovation in the Hedmark region (Norway) 1



The Research Centre on Zero Emission Buildings (2009 – 2017)



Zero Emission Buildings Pilot Projects

Pilot building/project	Level of ambition	
1. Skarpnes, Arendal	ZEB-O	
2. Powerhouse Kjørbo, Sandvika	ZEB-O → ZEB-OM	
3. ZEB Pilot House, Larvik	ZEB-OM + electric car	
4. Ådland, Bergen	ZEB-O	
5. Visund, Haakonsvern Bergen	ZEB-O-EQ	
6. Powerhouse Brattøra, Trondheim	ZEB-O → ZEB-OM	
7. ZEB Living Lab, Trondheim	ZEB-O	
8. Heimdal VGS, Trondheim	ZEB-O + 20%M	
9. Campus Evenstad	ZEB-COM	

















University campus Evenstad

Faculty of Applied Ecology, Agricultural Sciences and Biotechnology



Innovation in the Hedmark region 2.



ZEN pilot projects

Bodø: Airport area

Steinkjer: Residental area

Trondheim: Knowledge Axis (NTNU Campus & Sluppen)

Evenstad: Campus

Elverum: Ydalir

Bergen: Zero Village Bergen

Oslo: Furuset

Bærum: Oksenøya, Fornebu

30 000

m2 > 1 million















ZEN pilot project – school, gym and kindergarten











RDI2CluB



Design and production in the 21st century open up new possibilities for the use of wood

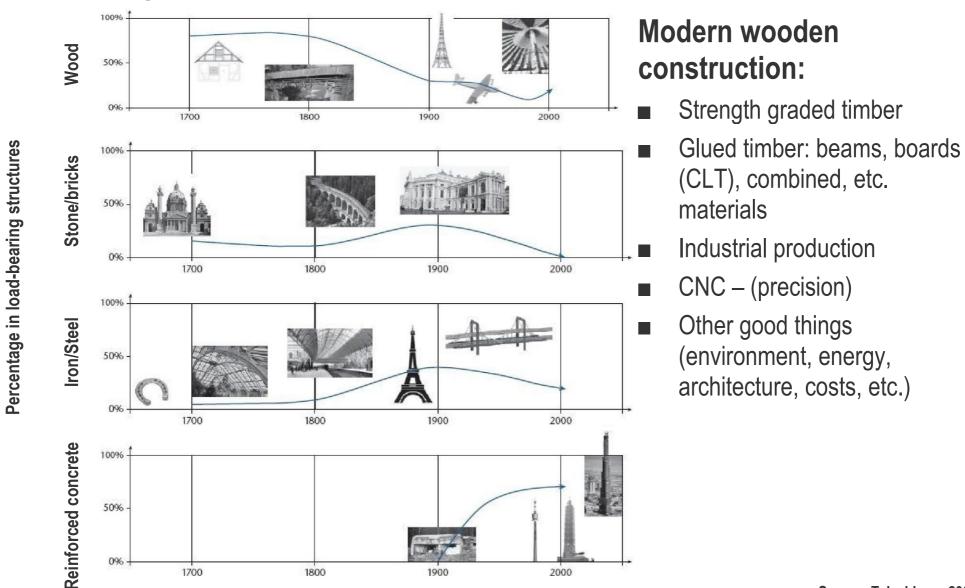
- Digital design tools allow you to create complex geometric shapes regardless of material and static constraints.
- The mechanisation and CNC process allows the material to be processed with a high degree of precision.







Evolution of building materials with the development of technologies



Source: Teischinger 2009

21st century trends

Solid wood construction

- Simple structure
- A combination of load-bearing and enclosing functions
- High flexibility no lattice structure
- Fast and economical assembly

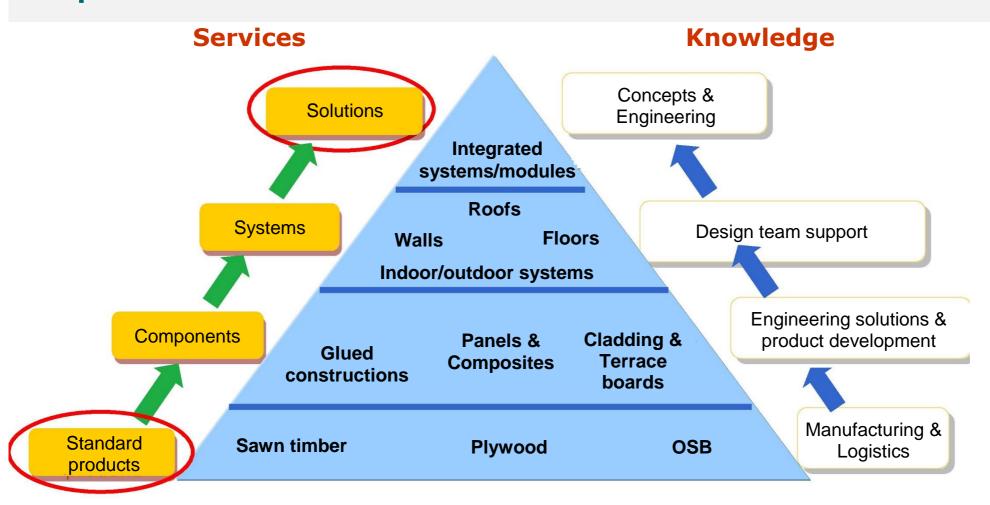
Complex structural design

- Away from simple lines and plane elements
- Curved, 3 dimensional structures
- Individuality, creativity, extravagant design

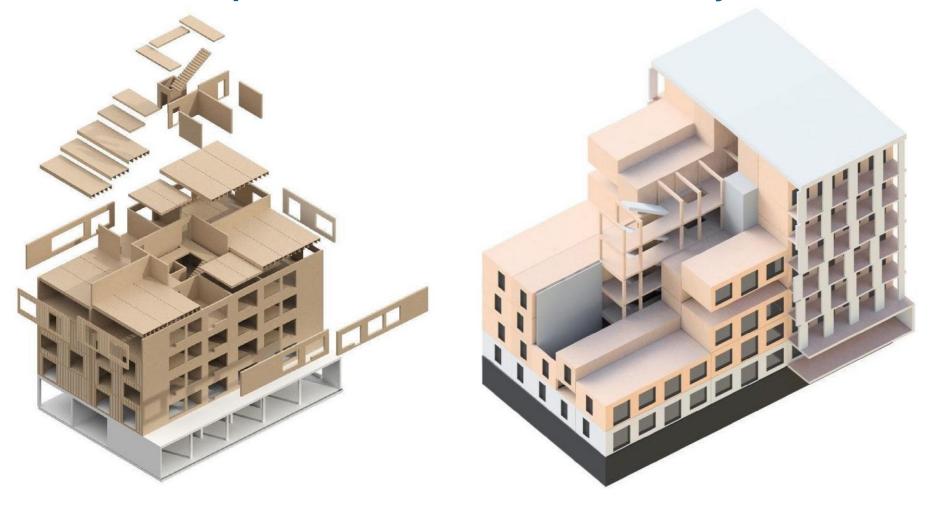




Wooden construction is moving from standard products to complex solutions



An example of a solution is a multi-storey wooden house



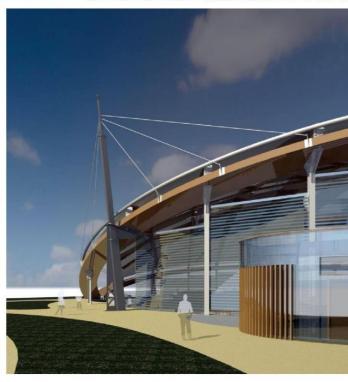
Stage roof of Post Island in Jelgava



From idea to reality:









Benefits of added value to wood



- More jobs/m³
- Higher value/m³
- Value is created in regions
- Smaller companies are emerging
- Less costs/m³ in transportation

In the competition 'Latvian Construction of the Year Award', the newly developed wooden pedestrian bridge of Tervete Nature Park, the laboratory won 3rd place in the nomination 'Wooden Building of 2015'



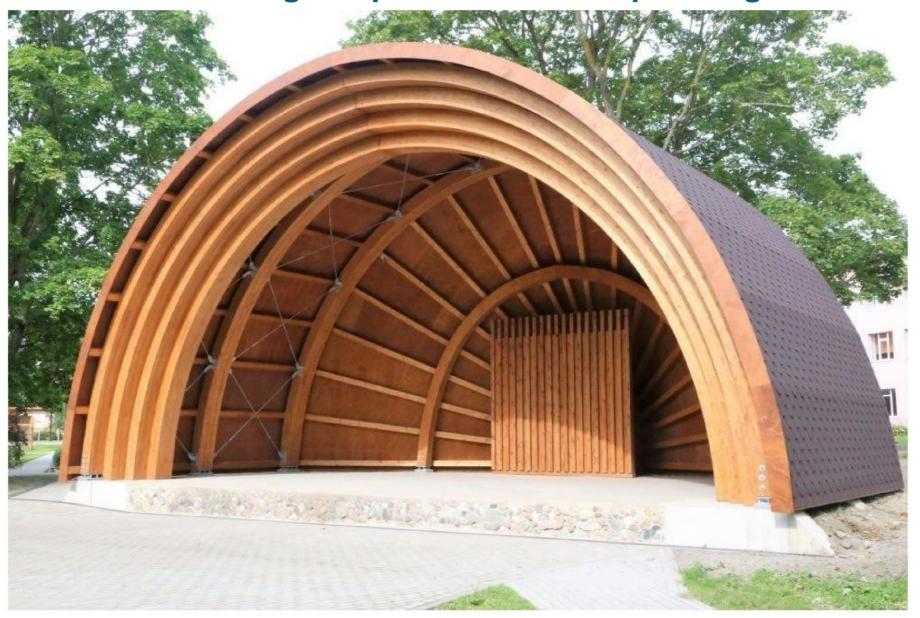


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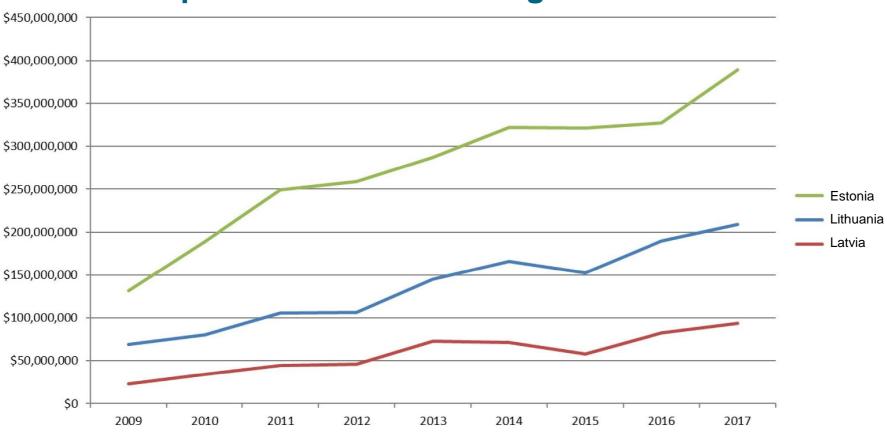
Wooden building - 1st place for customer centre in Dundaga, 2016



Wooden building. 2nd place. *Krimūnu* open stage 2017.



Export of wooden buildings from the Baltic states



Forest Green Rovers football stadium





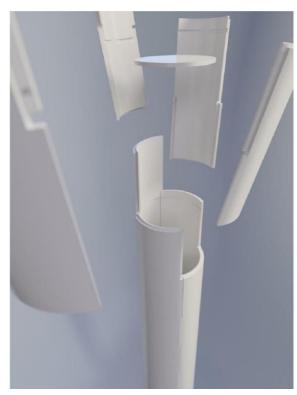




240 m high wind generator towers

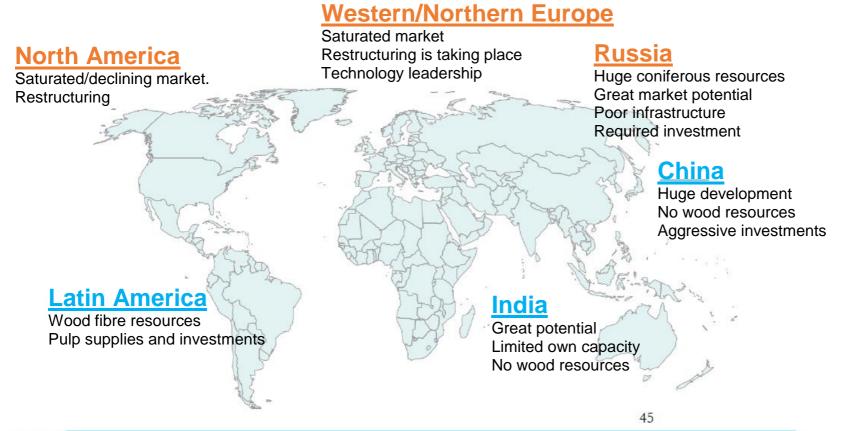






Global market trends





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China today





India tomorrow?





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Topic:

"Final Examination"

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA

Final Examination

Topic of presentation: Production Technologies in the Production of Various Wood Products

Conditions for the Final Examination:

- Each team must prepare a presentation on the topic, and all team members must participate in the presentation.
- The team members start preparing the materials necessary for the presentation by the day of the examination. On the day of the examination, 3 hours will be available to prepare for the presentation and specify the final version of the presentation.
- The teams are divided at random.
- The format of the presentation is not limited, it can be ppt, video, or other information, but the slides of the presentation should not be read. We want to see your story and your thinking!
- Each team prepares a presentation (up to 20 minutes), which includes:
 - 1. Describe the interaction of different technological processes and the impact on production efficiency. Various literature sources, research, and blogs (reliable sources) shall be used for the theoretical part.
 - 2. **Two examples from different areas of production technology implementation shall be chosen.** Good practices on how to manage and supervise production, how to ensure an efficient and high-quality production cycle of various products, how to ensure the quality of the product and the corresponding process, as well as how to prevent risks of quality discrepancies, shall be demonstrated. Obstacles to implementation or the things, which have not been implemented can be identified. The organisation can be a representative's workplace or some other freely chosen organisation, blogs (reliable sources).
 - 3. Reasoned proposals shall be made 1) What other improvements and efficiency measures are in these examples that have not been eliminated? 2) What methods should be used to implement the improvements mentioned in the previous paragraph in the organisation? 3) What does the organisation need to start implementing your proposed methods?
 - 4. It shall be explained how roles and responsibilities were divided in the team for presentation development, and what methods learnt in the programme were used in this task.