AVANT WOOD OY (LTD.)

Valorizing *Hardwoods in Galicia*

RESONATE ***Resilient forest value chains*** *– enhancing resilience through natural and socio-economic responses',*

Native hardwoods, the resilience of the forest sector

2024-02-29

Innovation

TMTM is the only wood modification technology that enables changing the characteristics of the modified wood according to the specifications of the end-product. The vastly different characteristics can be achieved in the same processing equipment.

This is enabled by revolutionary process control technologies that apply:

- Neural Network mathematics and data analysis to solve the correlations and causalities between the initial wood properties, and the characteristics required from the customer/application specific end- product.

- Genetic algorithm and programming to continuously develop new processual parametrisation and configuration to improve the process performance and product quality.

- AI and Digital/ Physical Twin, as well as the latest sensor technologies in timber processing, for the first time.

The TMTM™ control system is first to determine the nonlinear relationship of the new variables impacting the modification process with neural network modelling, and applying the genetic algorithm to optimize lead time, costs, and the end-product characteristics, quality, and material yield accordingly. Acting as a Digital Twin, the genetic algorithms and neural networks based control system is the core innovation of TMTM.

The Problem

Construction Material Manufacturing CO_2 Emission

5-12%
of total GHG emissions

Wood Waste

80%
of wood is wasted or burned

Timber Utilization

Hundreds
unutilized low-value

Current technologies only enable the use of limited, e.g., northern coniferous and tropical hardwood species to be used in construction, but leads to overexploitation of these species.

Wood can fulfil its potential and become the leading sustainable construction material globally only if it is possible to fully utilise low-value softwood and low-density hardwood species, as well as small-diameter timber which is wasted today.

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Solution

TMTM - Modifying low-value wood into sustainable construction material. By improving timber properties through drying, densification, and thermo modification, we can turn even low-value softwood and small diameter wood into a valuable and sustainable construction material.

Integrated Process: all-in-one-line

Patented process control technology

High performance timber with a wide array of applications

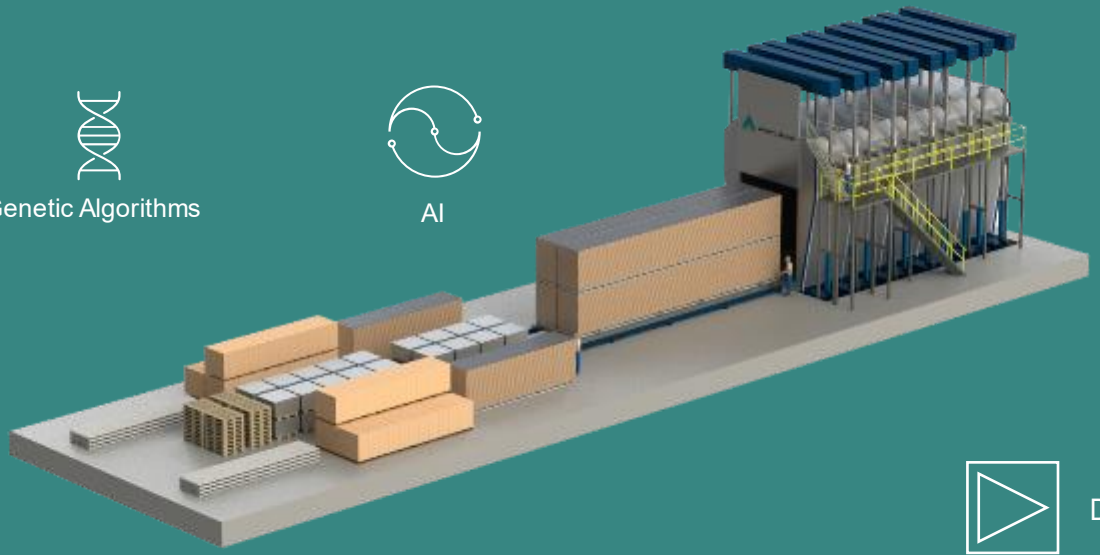
Flexible and energy-efficient process

Sustainability, no chemical impregnation

IoT

Genetic Algorithms

AI



Demo

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TMTM™ Technology

- Avant Wood has developed the TMTM™ – Thermo Mechanical Timber Modification procedure
- Timber is modified by being exposed to heat, steam and mechanical pressure for optimized process conditions to obtain the desired wood properties
- TMTM™ modified wood has

Integrated testing unit-

Easy to operate- short lead time is the key fast new product creation

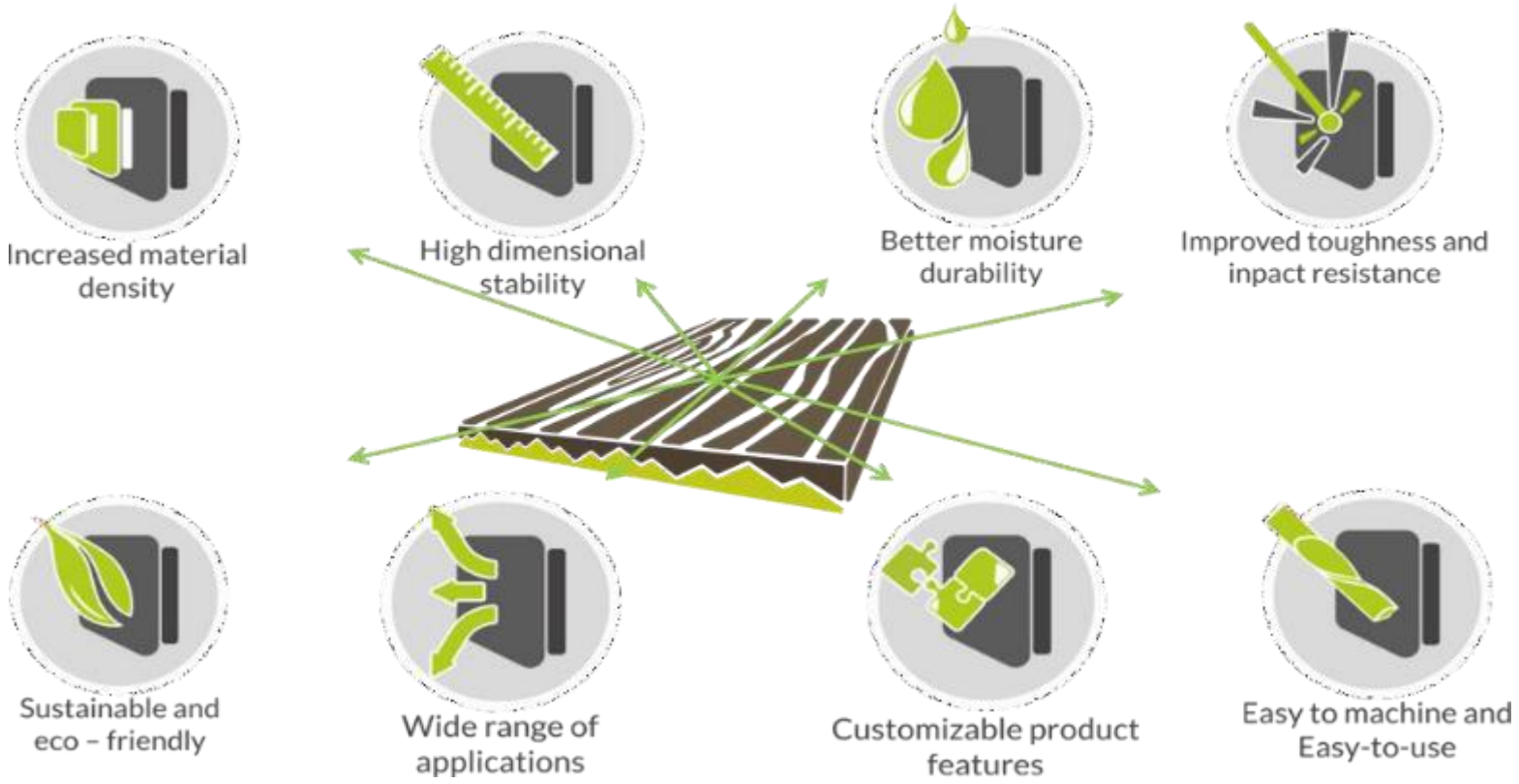
Avant Wood Patented Control System

Benefits of TMTM™ Telemetry

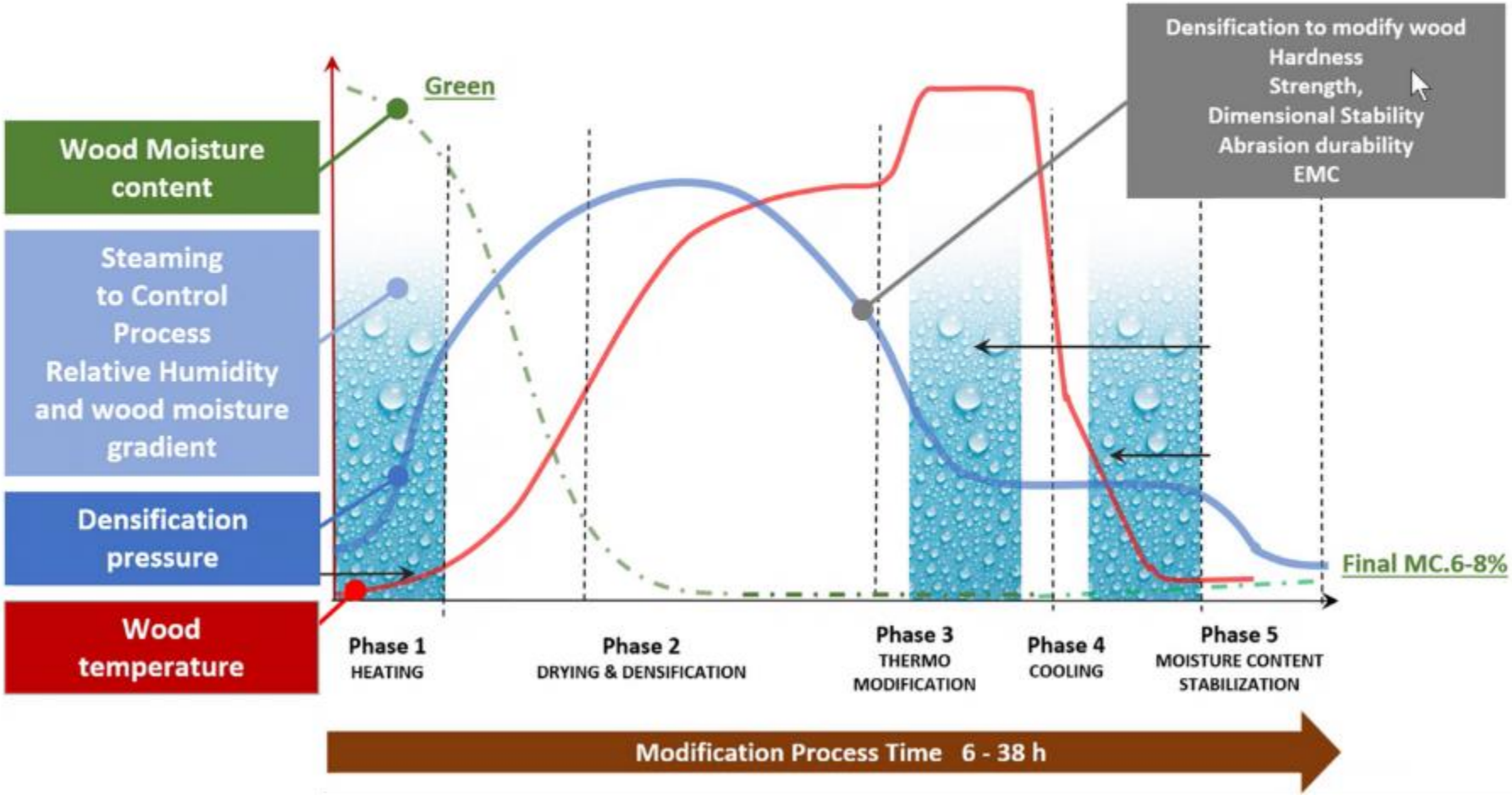
- **A Historical Analysis**: Gain insights into machinery performance over time, helping to spot trends, patterns, and anomalies. E.g., average power consumption, average running time, etc.
- **User Behaviour Insights**: Understand how clients use the machinery. This knowledge allows for tailored guidance, training, or feature enhancements based on actual usage patterns.
- **Predictive Maintenance**: Utilize historical data to identify wear and tear indicators early. Schedule maintenance proactively, reducing unexpected downtimes.
- **Data-Driven Decisions**: By analysing aggregated data, better understand machine performance across various conditions and make informed operational decisions.
- **Enhance Customer Experience**: With an online platform, clients can access their machine data, gaining insights and detailed analytics in the machinery's operations.
- **Foundation for AI**: The amassed data becomes a valuable dataset for training AI models. These models can unlock advanced predictive analytics and optimization opportunities in the future.
- **Cost Efficiency**: Historical insights enable optimization of operational and maintenance costs by understanding when and where resources are best utilized.
- **Expand Services**: With data-driven insights, the company can introduce new services or refinements, further meeting client demands.
- **Basis for Customized Products and New Product Creation**
- **Confirm the actual wood species to verify that the customer is really modifying the material he claims**, The European Union Timber Regulation (EUTR), FSC

Avant Wood Oy
Leväsentie 23, 70780 Kuopio, Finland · +358 40 570 7701 · sales@avantwood.fi · www.avantwood.fi · ID: 2790001-7

TMTM Product advantages



MODIFICATION PROCESS



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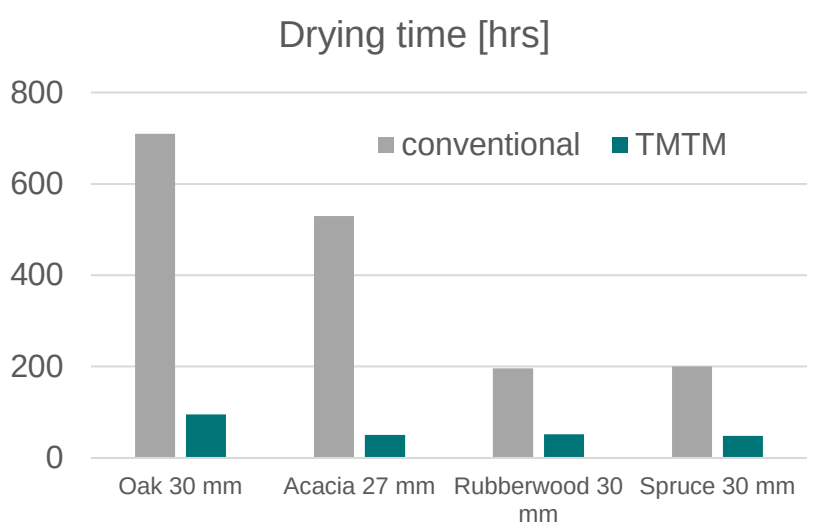
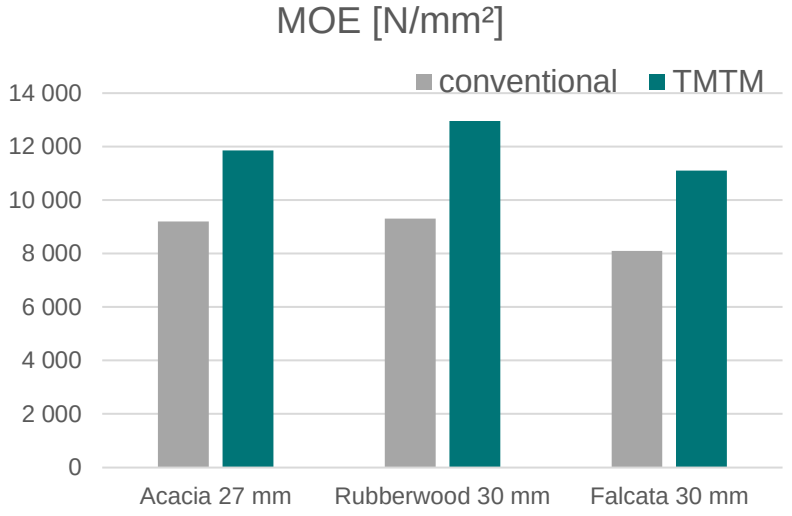
Benefits of TMTM-Technology





- With Avant Wood‘s TMTM-Technology the drying time of most timber species is significantly reduced – by up to 90 %
- Compared to other modification technologies TMTM products have even better product properties
- TMTM-Technology reduces the overall energy consumption

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The Megatrends Analysis Framework

FIRST – the ***most relevant global megatrends*** that affect the business of Avant Wood have been brainstormed and selected to be the following:

- ***Sustainability***
- ***Renaissance of wood as material***
- ***Resource scarcity (e.g. wood, water and energy)***
- ***Digitalisation and artificial intelligence (AI)***

SECOND – the ***impacts of each of the megatrends*** are analysed from four business-critical perspectives:

- ***Society*** – in terms of (a) ***the phenomenon*** of the megatrend, with its manifestations in (b) ***economics and business*** environment, and (c) ***politics***
- ***Customers*** – How each megatrend impacts the customers' needs, expectation and modes of operation, especially concerning our (a) ***immediate customers***, and (b) ***their customers (****i.e.* ***2nd degree customers)***
- ***Technologies, products and services*** – that we shall develop as solutions
- ***Competences*** – which AW shall have in order to be able to develop the products and services as well as to succeed, especially in terms of (a) ***organising and structure*** of the business model (b) ***business competences*** (in "wide" definition of the term "business", incl. e.g. management, law, marketing etc.), and (c) ***technical competences***, which includes e.g. ICT, engineering, wood science, manufacturing know-how and other similar areas

THIRD – a ***concise summary*** of the megatrend analysis is presented as a one-page table (given before the detailed analysis)

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Customer Business Case Examples

- **Main principle** – The presented business cases attempt to differentiate the business advantages of wood processed with AW technology from competitors/substitutes by focusing also on the customer's customer expectations, requirements etc.
  - Described **using numbers and hard facts** – not only with qualitative text/promises
    - Demonstrating the customer's advantages in hard numbers of € and time
    - Show the logic of the business case (current vs. AW deployment)
  - Also emphasise other added value than just dryness and density of processed wood
- The included cases are:
  - Vertically integrated parquet factory
    - NOTE – In most cases the customer's customer wants to have in their multi- layer parquet production only the top layer lamellas. Then TMTM-modify the lamellas sawn from a balk, instead of drying it as whole. Cutting the balk with multi-blade saw
  - Tropical sawmill (focus on acacia and rubberwood)
  - Small-Diameter Wood for Glulam Board Manufacturing

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Customer Business Case Example: Vertically Integrated Parquet Factory

- **Conventional production approach & process**
  1. Green Logs sawing to balks, duration 3 days
  2. Green Balks dried, duration 70 days
  3. Dried balks sawing to lamellae, 2 days
  4. **Total drying lead time** 75 days + 7 days to finalize the multi-layer parquet = **82 days** to have one delivery the customer.

- **In one year**, there are **5 batches** of different wood species available to the market

- Other issues to be taken into consideration
  - The quality and feasibility of the lamellae can be verified only after sawing the balks into lamellae, potential risk to spend time and energy to non-marketable material.
  - Long period of time for capital employed in raw- material and semi-finished goods

- **TMTM™ by Avant Wood**
  1. Green Logs sawing to balks, duration 3 days
  2. Green Balk sawing to lamellae, duration 2 days
  3. Green lamellae TMTM™- modified according the customers specs, duration 3 days
  4. **Total modification lead time** 8 days + 7 days to finalize the multi-layer parquet = **15 days** to have one delivery the customer.

- **In one year**, there are **25 batches** of different wood species available to the market

- Other issues to be taken into consideration
  - Feasible lamellae for the end- product can approved prior to modification, leading to energy savings

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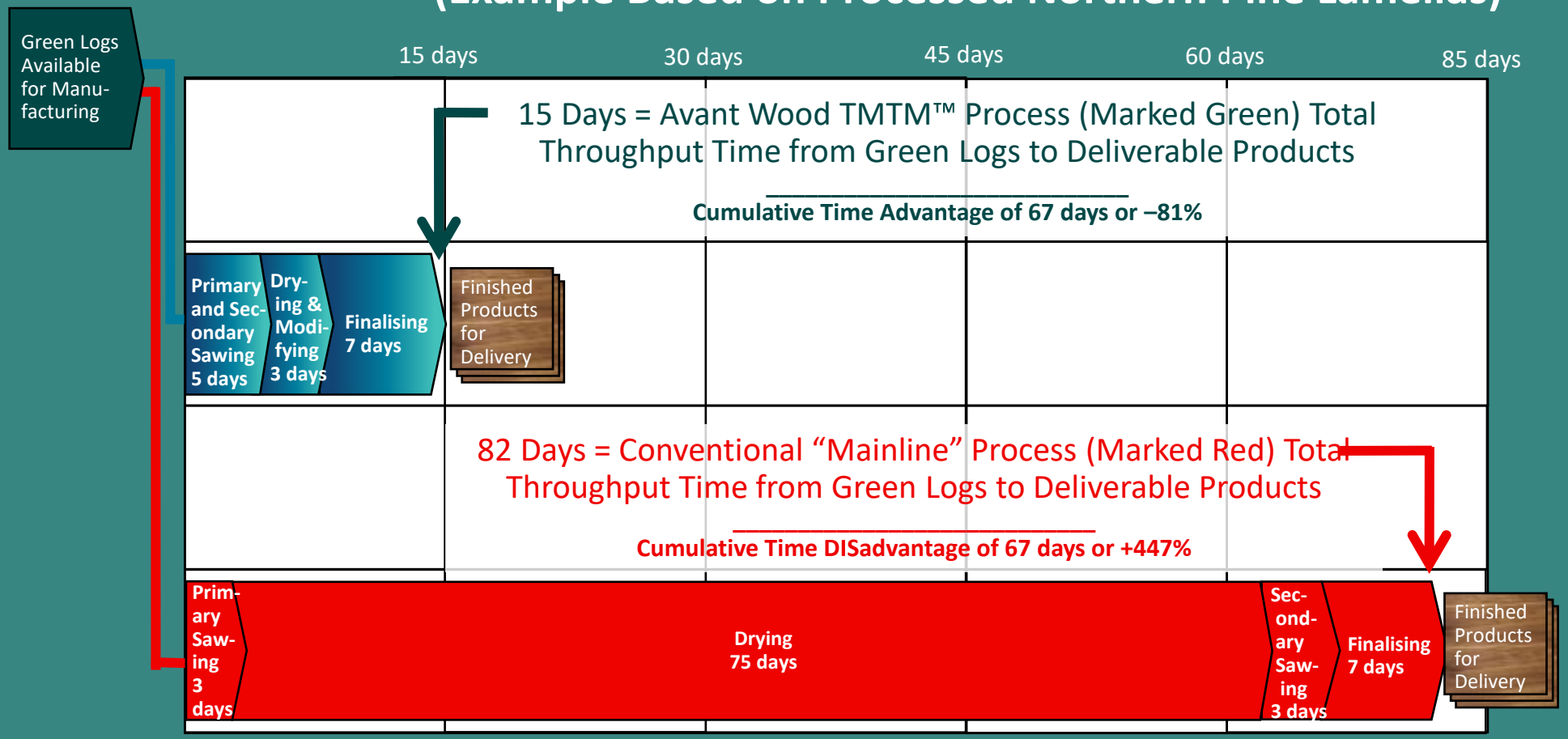
Throughput Advantage of the TMTM™ Process

(Example Based on Processed Northern Pine Lamellas)



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Customer Business Case Example: Tropical Sawmill (Acacia & Rubberwood)

- Acacia and rubberwood grow widely in South-East Asian region.
- However, their utilization in furniture and flooring industry is not common due to long processing time, generally low yield and insufficient mechanical properties.
- Avant Wood demonstrated the advantages of TMTM™ modification in € and time hard numbers to turn low-value timber into valuable, CO_2 neutral construction material.
  - Test results are shown in the table on the next page
- The tests demonstrated that TMTM™ modification reduces the modification by 85- 90 % compared to conventional drying
- Yield from sawn planks to finished products was over 90 %, compared 75% of conventional drying.
- Mechanical properties, MOR, MOE and compression strength of 65- 78 Mpa after TMTM™ are comparable to high density tropical wood, such as teak wood 54.8 Mpa. Teak wood is considered to be a strong and durable wood that is suitable for furniture, interior and exterior joinery, and boat building. TMTM™- modification can convert acacia to match the similar properties of teak
- The price of acacia log is according the Globalwood.org database are on average 120€/m^3, whereas teak is 580€/m^3.
- Yield increase of 15% and the cost advantage of about 80% will establish a potential competitive edge to acacia in various applications

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Customer Business Case Example: Tropical Sawmill (Acacia & Rubberwood)

Test Results Modification Process	Acacia Green	Acacia Dried and Densified	Acacia Termo-Mech. Modified	Rubberwood Green	Rubberwood Dried and Densified	Rubberwood Termo-Mech. Modified	Acacia Conventional Drying	Rubberwood conventional Drying	Reduction/ Improvement	Reduction/ Improvement	Unit
Sample Thickness	30	30	30	30	30	30	30	30			*mm*
moisture content	110 %	110 %	110 %	110 %	110 %	110 %	110 %	110 %			*%*
moisture content	110 %	5 %	4 %	110 %	6 %	5 %	10 %	10 %			
Modification time		48	59		30	53	550	200	**-91 %**	**-85 %**	*Hours*
Max. Temperature		130°	210°		120°	210°	125	210			*Celcius*
Yield		min 90 %	min 90 %		min 90 %	min 90 %					
strength (MOR)	86	89,5	61	86,2	121,2	93	79,5	66	**13 %**	**36 %**	*N/mm²*
elasticity (MOE)	11 591	14 236	11 714	10 645	11 874	13 174	9 307	9 316	**53 %**	**53 %**	***N/mm²***
Compression strength		69,2	78,6		61,3	66,5	52,1	42,1	**33 %**	**64 %**	***N/mm³***

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Customer Business Case Example: Small-Diameter Wood for Glulam Board Manufacturing

CLT Board

- CLT board is made of sawn pine or spruce.
- The price of pine and spruce logs varies from 62 €/m³ to 68 €/m³
- The yield of logs is 2.2- 2.4 (2.2-2.4 m to have one m³ of sawn timber
- Material price varies from 136 €/m³ to 163 €/m³
- The market price CLT as a commodity 500 €/m³, with material margin varying typically from 336 €/m³ to 364 €/m³
- The drying time of pine and spruce in a conventional kiln is 4-6 weeks

Lock Wood

- Lock Wood board is made of small-diameter wood from harvesting, end- cutting or the cores, residues of plywood manufacturing pine or spruce.
- The price of SDM birch, pine and spruce varies from 38 €/m³ to 46 €/m³
- The yield of logs is 2.4 to 2.5 m³
- 2.4 to 2.5 m³ to have one m³ of sawn timber
- Material price varies from 91 €/m³ to 115 €/m³
- The market price of the Lock Wood Board is minimum equal to CLT, material margin being 385 €/m³ to 409 €/m³
  - NOTE – This is 15-20% higher material margin
- The drying time of pine and spruce in a TMTM™ unit is 2-3 days, bringing a substantial saving of energy use and cost
- Combining savings in material and energy costs, TMTM™ modified will bring a 25-30% higher margin compared to conventional CLT board

The story of Löyly

- Hernesaaren Löyly, Helsinki, Finland
- Built v. 2016

The story of Löyly

- In the interior, main material are the cores, residues from the plywood manufacturing. They have been TMTM™- modified, profiled and glu-pressed to Lock-Wood™ – solid wood glulam board.

TMTM™ END PRODUCTS FROM SMALL-DIAMETER WOOD

EXTERIOR CLADDING

Small-diameter pine

Cladding lamellas

Lock-wood structure

Exterior cladding of Sauna building

- Cheap raw material
- Natural wood material with improved visual characteristics, extended colour gamut and full colour penetration
- Less or no swelling & shrinkage in exterior applications
- Improved weather resistance in extreme climates

INTERIOR CLADDING

Small-diameter birch core from plywood production

Gluelam planks

Interior cladding of restaurant

- Cheap raw material
- Cost-effective
- Improved dimensional stability in interior applications
- Easy to machine

INTERIOR FURNITURES

Small-diameter birch core from plywood production

Gluelam boards

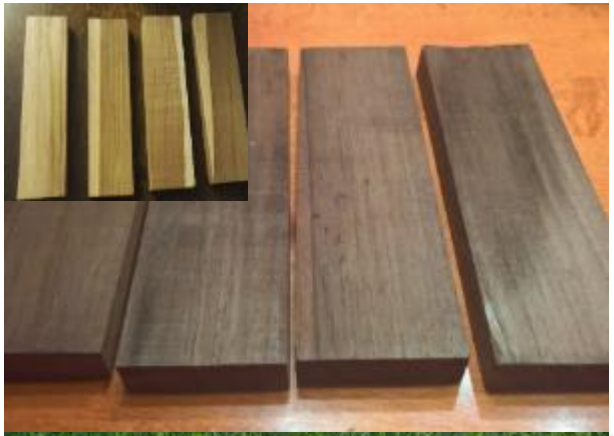
Interior furnitures

- Cheap raw material
- Beautiful look
- Improved dimensional stability in interior applications
- Improved strength and hardness characteristics (Hardness +20-100 %, MOE/MOR +15-30%)

Other applications

- TMTM-Technology of Avant Wood offers high yield and high quality for multi-layer parquet lamella manufacturing
- Deck lamella are typically cut green and then TMTM treated
- The quality and the yield of the deck lamella for the final product is significantly higher than with conventional procedures

Typical results



- Juvenile Teak from plantations
  - TMTM treatment at 210 °C
  - Even colour distribution
  - Homogenous material
- Falcata plantation wood
  - TMTM treatment
  - Improved mechanical strength by 30%
  - Even colour distribution
  - Homogenous material

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Oil Palm Trunks
TMTM™ modified OPT
Green samples

TMTM™ modified OPT

OPT						
	L/mm	W/mm	T/mm	Volume/ m³	Mass/kg	Density/ kg/m³
1	644	154	50	0,00496	4,45	897,4
2	642	153	52	0,00511	4,60	900,6
3	642	155	52	0,00517	4,51	871,6
4	637	154	53	0,00520	5,00	961,7
5	650	150	47	0,00458	3,80	829,2
6	646	152	55	0,00540	4,66	862,9
7	646	153	52	0,00514	4,60	895,0
8	646	154	51	0,00507	4,50	886,9
9	647	153	52	0,00515	5,06	983,0

Final Density of OPT – 340 kg/m3

TMTM™ modified OPT

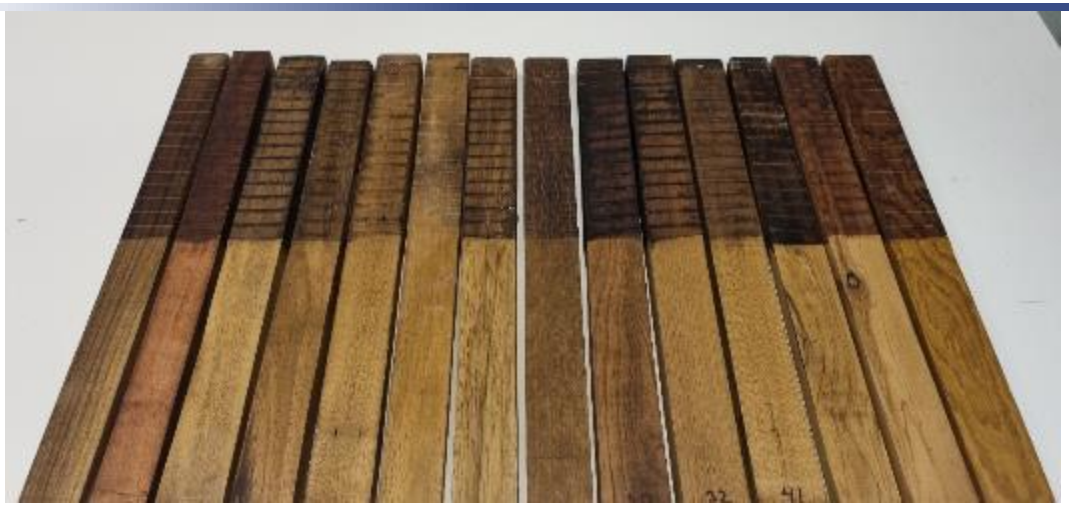
TMTM™ modified OPT

Un- planed surface

Planed surface

TMTM™ modified OPT

Bhutan’s new ‘Mindfulness City’ is massive — with plans showing a city unlike any other in the world



Gelephu mindfulness city project Bhutan

Technical/ Biological Name	Local Name
Populus ciliata	Populus ciliata
Duabanga grandiflora	Lampate
Alstonia scholaris	Alstonia scholaris (B)
Bombax ceiba	Pama Gaser shing (T) Simal (L)
Larix Griffithil	Larch
Picea spinulosa	Spruce
Alnus nepalensis	Gamashing
Tusuga Dumosa	Hemlock
Pinus Roxburghii	Chir Pine
Lagerstroemia hirusta	Jarul (L)
Beil schmiedia roxburghiana	Robtang shing (T)
Engelhardia spicata	Engelhardia spicata (B)
Tectona grandis	Teak
Abies densa	Fir
Quercus glauca	Quercus glauca
Toona ciliate	Rawshing
Chukrasia tabularis	
Albizia fulva	Albizia
Altingia exelsa	Seti
Acrocarpus fraxinifolius	
Quercus lamellose	Quercus lamellose
Schima wallichii	Zalashing
Cmelina arborea	Gamari
Quercus oxydon	Quercus oxydon
Albizia procera	Seto siris
Acacia catechu	Khair
Quercus lanata	Quercus lanata
Quercus semecarpifolia	Quercus semecarpifolia
Castanopsis hysterix	Katus
Castanopsis tribuloides	Castanopsis tribuloides
Rhus chinesis	Robtang shing (T) Bhakmilo (L)

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Grazas polo teu interese e por darme a oportunidade de asistir ao teu seminario.

Gracias- Thank you- Kiitos

Pekka Ritvanen
CTO, Founder, Partner
Avant Wood Oy
+358 40 57 07 701
pekka.ritvanen@avantwood.fi
www.avantwood.fi
www.linkedin.com/in/PekkaRitvanen