25th International Wood Machining Seminar
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Keynote Presentation

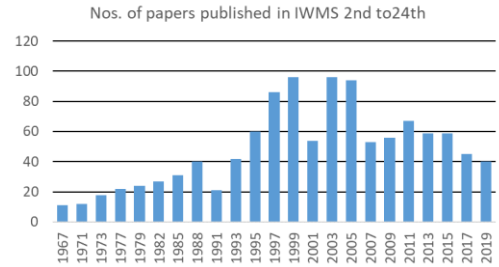
Achievements, present situation and future prospect of wood machining technology

Yoshihisa Fujii
Professor emeritus, Kyoto University, Japan

Achievements, present situation and future prospect of wood machining technology

1. **Short review of R&D 2012-2022**
2. **4 Topics related wood machining**
3. **from "Mokkiten Japan 2023"**

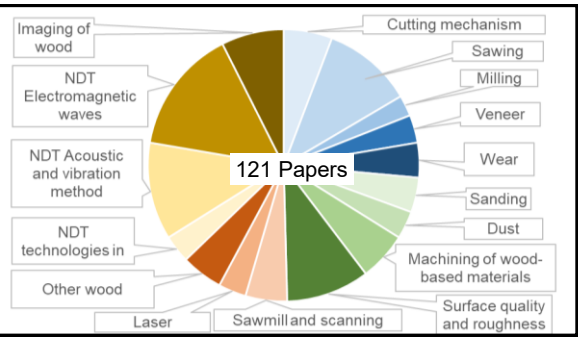
from our bookshelf



"Is research activity really declining?"

Literature related on wood machining 2012-2022

More than 3000 articles published
Holzforschung,
European Journal of Wood and Wood Products
Journal of Wood Science,
121 papers on wood machining 2012-2022 were found



Other resources

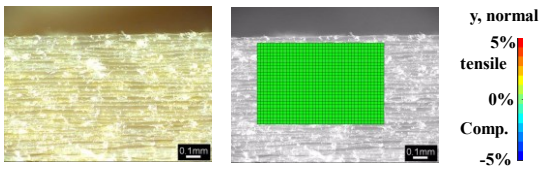
1. **Technical reports**
   from companies, institutions, societies…
2. **On line information**
   Website, SNS, YouTube ….

huge amount of info. produced by researchers and engineers are available.

Topic 1 "cutting" as core subject

1. **Literature survey**
   Wood cutting mechanism [1-7], Sawing [8-20]
   Milling [21-23]
2. **In IWMS25**
   9 orals on "cutting" and "sawing" by
   Orlowski, Mellqvist, Matsuda, Goli, Cool, Jaquemod, Asaka, Shirazi, Hausmann
   4 posters on related topics by
   Fujimoto, Hernandez, Takamura, Sandak

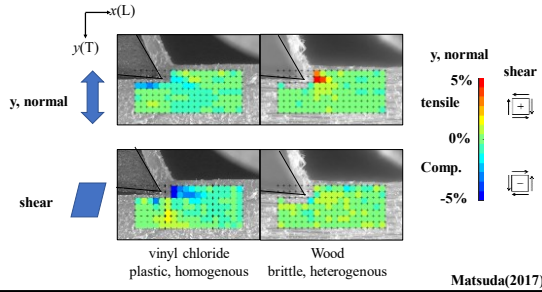
Experimental analysis of cutting process using DIC method



Digital image DIC

Matsuda(2017)

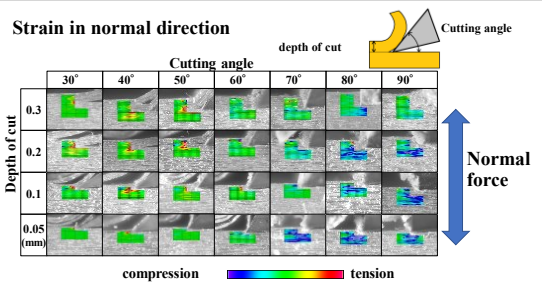
Experimental analysis of cutting process using DIC method



vinyl chloride plastic, homogenous Wood brittle, heterogenous

Matsuda(2017)

Strain in normal direction



Matsuda (2017)

Simulation of cutting process, Previous papers

R. Fischer (2000)

R. Pfeiffer(2015)

Simulation of green wood milling with discrete element method

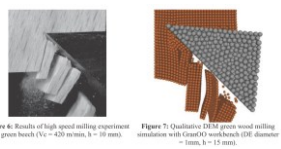
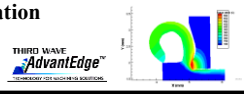


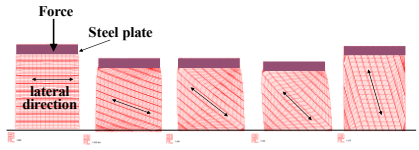
Figure 6: Results of high speed milling experiment on green beech (Vc = 420 m/min, h = 10 mm).

Figure 7: Qualitative DEM green wood milling simulation with GranOO workbench (DE diameter = 1mm, h = 15 mm).

Metal cutting simulation



Simulation of cutting process using FEM
Basic concepts



FE-analysis of lateral compression of wood having annual ring structure

Application of FEM to cutting process

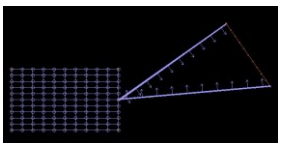
3 phases of analysis

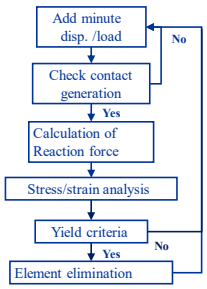
1. Contact analysis between two sub-models, tool and workpiece
2. Chip generation by criteria of fracture, elimination and reproduction of nodes
3. Chip deformation

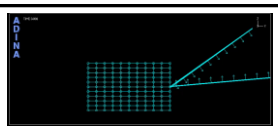
analysis condition

1. Step by step analysis (repetition of calculation)
2. Material property (anisotropic)
3. Non-linear (elastoplastic, large deformation)

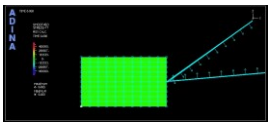
2D Simulation of cutting process by advanced contact analysis with yield criteria



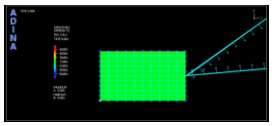




Deformation

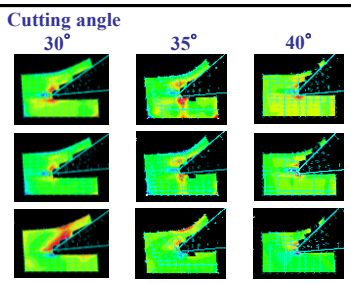


Stress in cutting direction



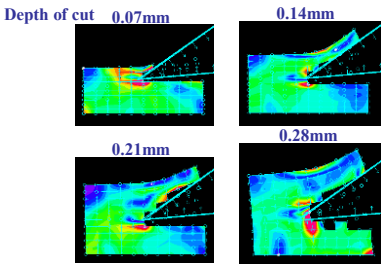
Stress in normal direction

Cutting simulation using FEM



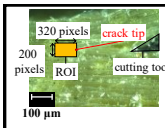
Influence of cutting angle

Depth of cut 0.2mm, Clearance angle 5°

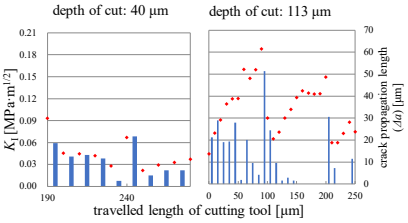


Influence of depth of cut

Cutting angle 35°
Von Mises stress

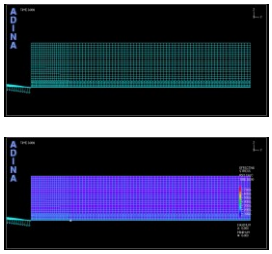


Stress intensity factor and crack propagation at crack tip in cutting using DIC image



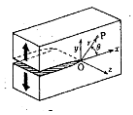
2D Simulation of cutting process based on fracture mechanics

Minute Disp.
↓
Reaction force T
↓
KIc, J-Integral
↓
Stress distribution at crack opening

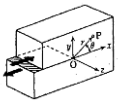


Simulation of cutting process based on fracture mechanics

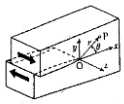
Crack propagation > mode 1



Pressing by rake face > mode 2



3D dimensional cutting > mode 3



Topic 2 "tool wear"

1. **Literature survey [28-32]**
   >wear in process of wood-based materials, such as PB, MDF and laminated wood
2. **In IWMS25**
   3 papers by
   Nasir monitoring of tool
   Iida monitoring by cutting noise,
   Sandak evaluating by optical 3D vision method

Topic 3 "surface quality and roughness"

1. **Configuration by**
   mechanism of processing, knife marks…
   processing conditions, tool wear…
   anatomical features, cellular structure of wood
2. **Should be discussed in relation to**
   next coming processes, adhesion, painting...
3. **As for laminated wood based panels,**
   performance of edge banding machines.
   In IWMS 25, 3 papers by Asaka, Moanda, Binninger

Topic 4.1 "quality control and production system"

1. **Literature survey [61-66]**
   scanning in sawmill,
   yield improvement by dry and rip (SDR) technique,
   log sorting and sawing patterns for large-diameter logs,
   digitalization of small and medium sized sawmills,
   feasibility of log scanning using CT method.
2. **In IWMS 25**
   related 3 papers by Fredriksson, Kortuem, Ji

Topic 4.2 “NDT for quality control”

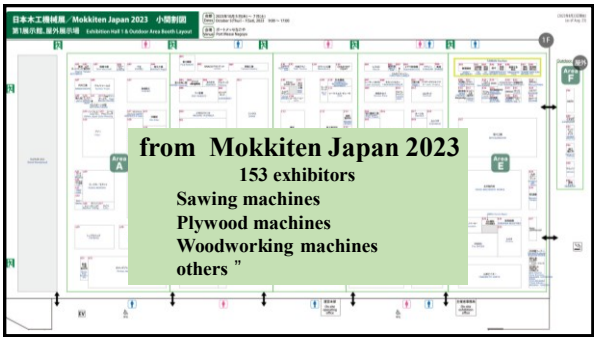
1. **Literature survey**
   NDT technologies in general [77-80],
   acoustic and vibration method [81-94],
   electromagnetic waves [95-112],
   imaging of wood [113-121]
2. **In IWMS 25**
   7 papers by Schajer, Böhm, Zeng, Kobori, Huang, Kurata, Ma,

Inspection and monitoring system in industry

Fagus-GreCon Greten GmbH & Co. KG

ARGOS SOLUTIONS AS

Innovativ Vision AB

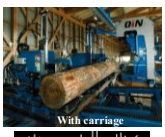


from Mokkiten Japan 2023
153 exhibitors
Sawing machines
Plywood machines
Woodworking machines
others ”

Features of Japanese Woodworking Machines

1. Sawmill machines
2. Plywood production system
3. Pre-cut machines
4. Tools
5. Machines for various woodworking

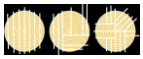
Features of Japanese Woodworking Machines
1. Sawmill machines



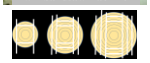
With carriage

Twin bandsaw machine

Twin band saw with log scanner
Kikukawa enterprise, Inc.



Traditional sawing patterns



Sawing pattern for twin band saw

Twin bandsaw machines with log scanning

Features of Japanese Woodworking Machines
2. Plywood production system

Meinan Machinery Works, Inc.

softwood plywood

Rotary lathe peeling small diameter soft wood log

Features of Japanese Woodworking Machines
2. Plywood production system

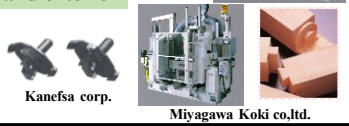
Inspection apparatus using AI

- Veneer, plywood and laminated wood
- Camera and image data processing
- Deep learning
- Detection of knot, check, color…
- High speed of 100-200m/min

- Exhibited by Meinan, Kikukawa, Taihei, Hashimoto

Features of Japanese Woodworking Machines
3. Pre-cut machines

- Pre-process of post and beams
- Mortise and tenon
- CAD/CAM
- For all parts of construction
- For boards interior and exterior



Kanefsa corp.

Miyagawa Koki co,ltd.

Features of Japanese Woodworking Machines

4. Tools
exhibited by Kanefusa, …
also by other companies, involving from abroad

5. Machines for various woodworking
- sawing, planning, boring, turning, sanding,
- molding, routing,
- jointing, adhesion, dowel, press,
- edge-binding , laminating

Future prospect

1. Basic research on wood machining
cutting, sanding, sawing, peeling…
mechanics, machine tools…
efficiency, wear, surface quality…

2. Combination with Info. tech.
IT, IOT, SCM, AI…

3. “Sustainable”
environment, resource, safety, life, economics