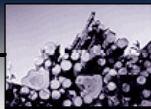


Strength grading by log grading

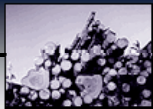
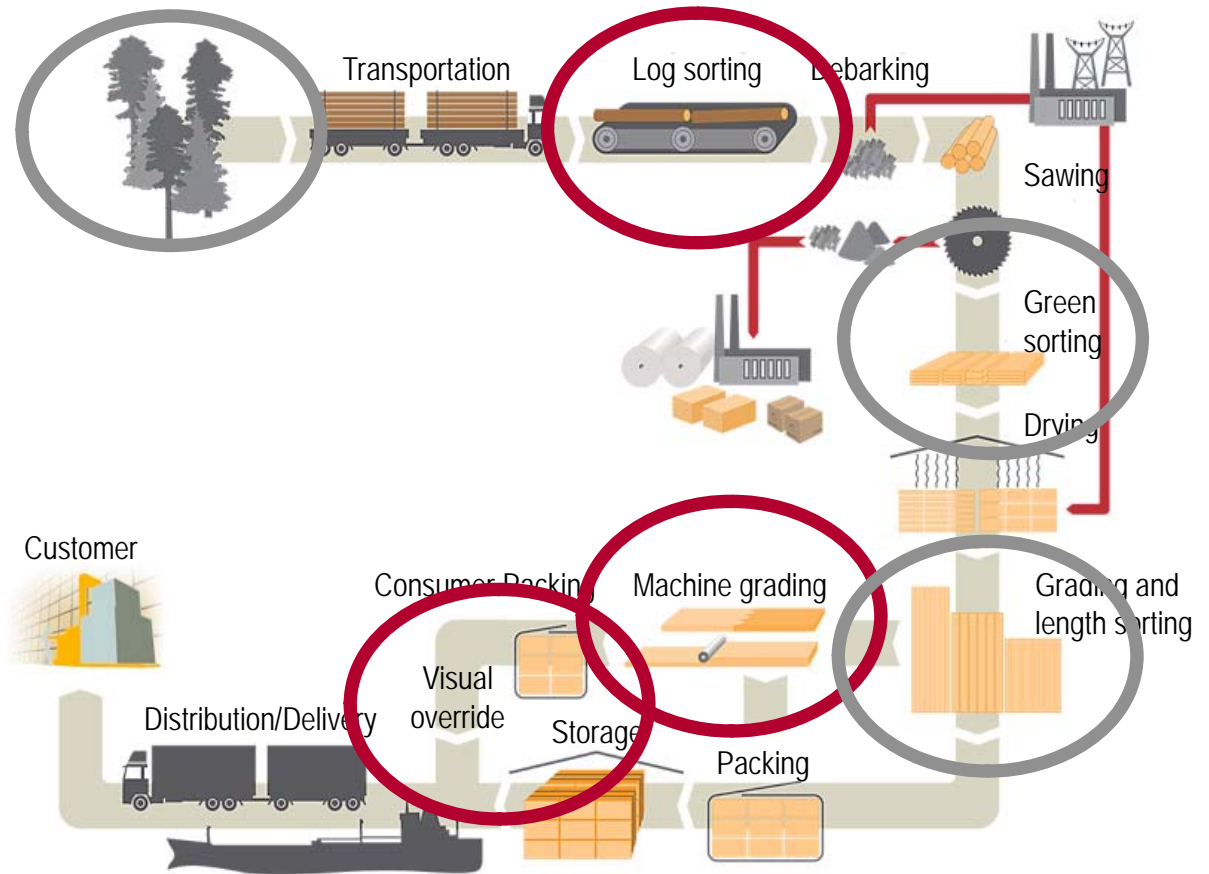
COST E53 – Bled
21 April 2009
Mattias Brännström



Integrated strength grading

Process including sub-processes

- Harvesting
- Log grading (LG)
 - Pregrading
 - Machine control
- Green sorting
- Dry-grading
 - Pregrading
 - Machine control
- Machine grading (MG)
 - Machine control
- Visual override



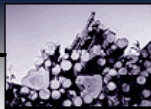
Materials & Methods

Some of the equipments used

X-ray log scanner

Using several sources and detectors to scan the internal features of a log.

When used in combination with resonance analysis,
= **“Log grading” LG**



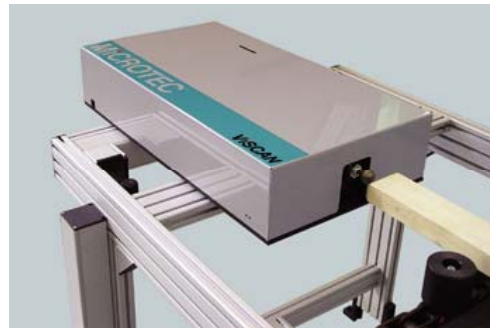
Materials & Methods

Reference equipment

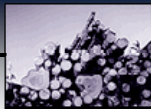
Strength grading machine

=“Machine grading” MG

Using X-ray in combination with resonance frequency



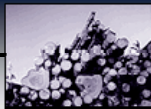
Article IV + Article V



Methods

Overview - Log grading

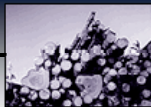
- Use different scanning technology
- Develop scanner variables/use existing ones
- Test boards in laboratory
- Model laboratory results by developed variables (create IPs)
- Develop settings for modelled results according EN14081
- Analyze yield, properties and financial result



Materials

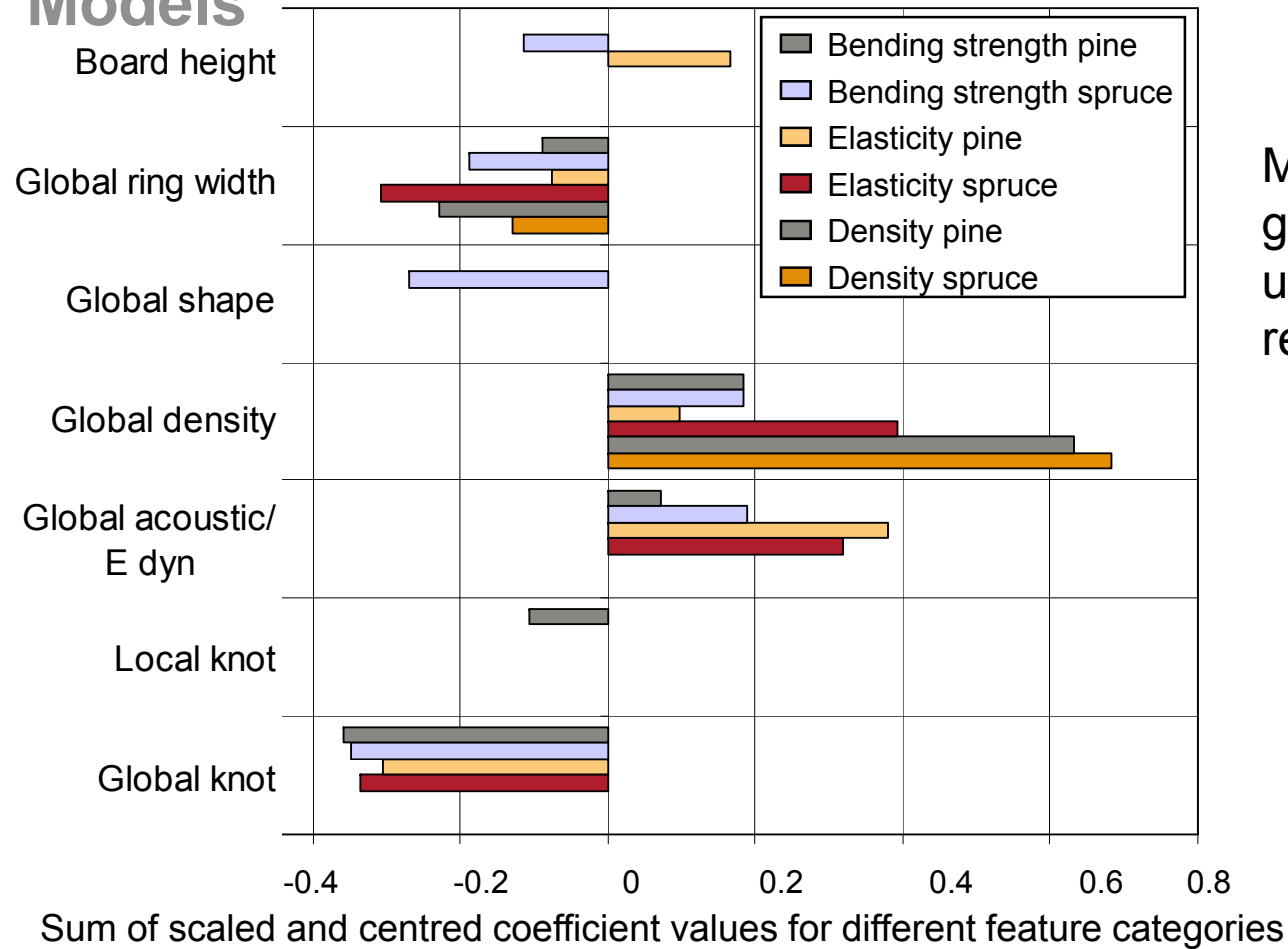
Wood sample used

Sample name	Species	Log size (mm)	N	Sawn size span (mm)		N
				Thickness	Width	
Pilot sample	Spruce	195–210	120	50	150	234
Combigrade 2 (Hanhijärvi <i>et al.</i> 2008)	Spruce	154–398	828	38-63	100–200	828
	Pine	152–364	897			897

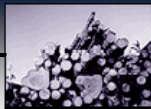


Results

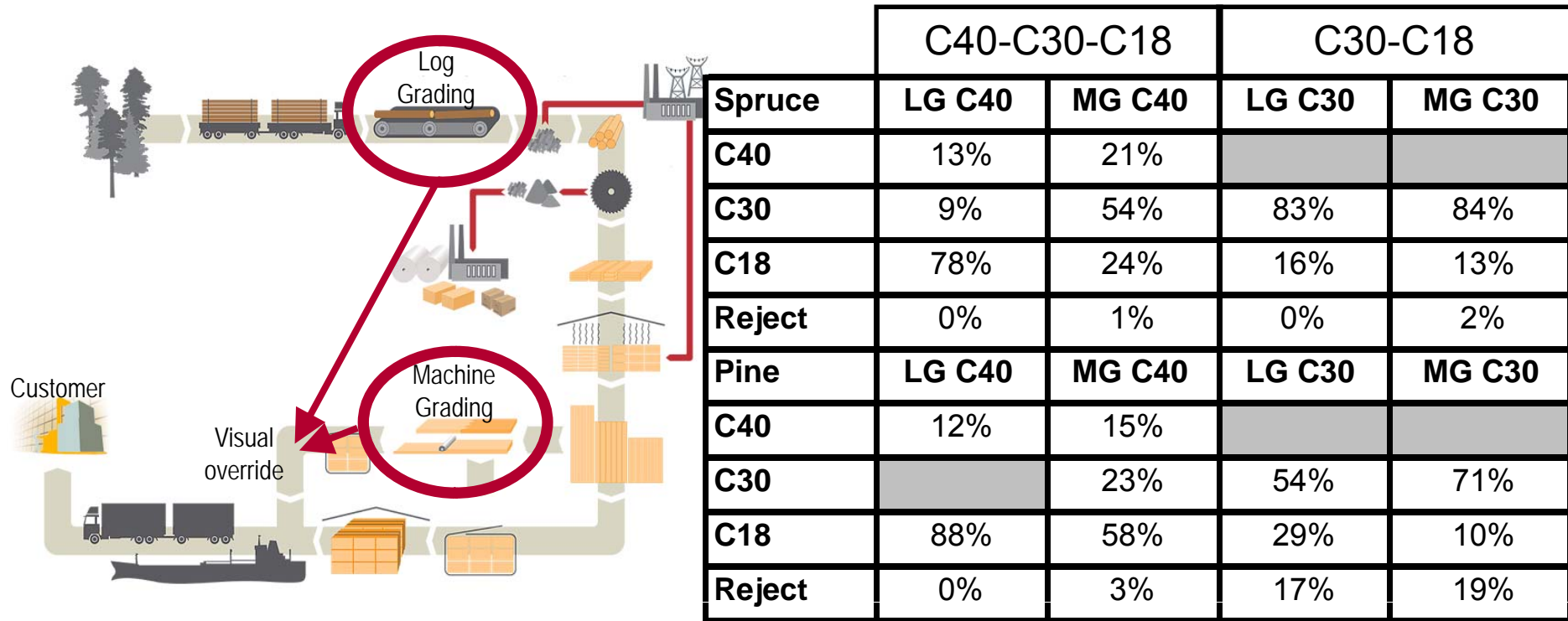
Models



Models for a log grading equipment using x-ray and resonance frequency



Yield by machine control – Without Visual override

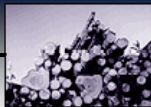


Grading result

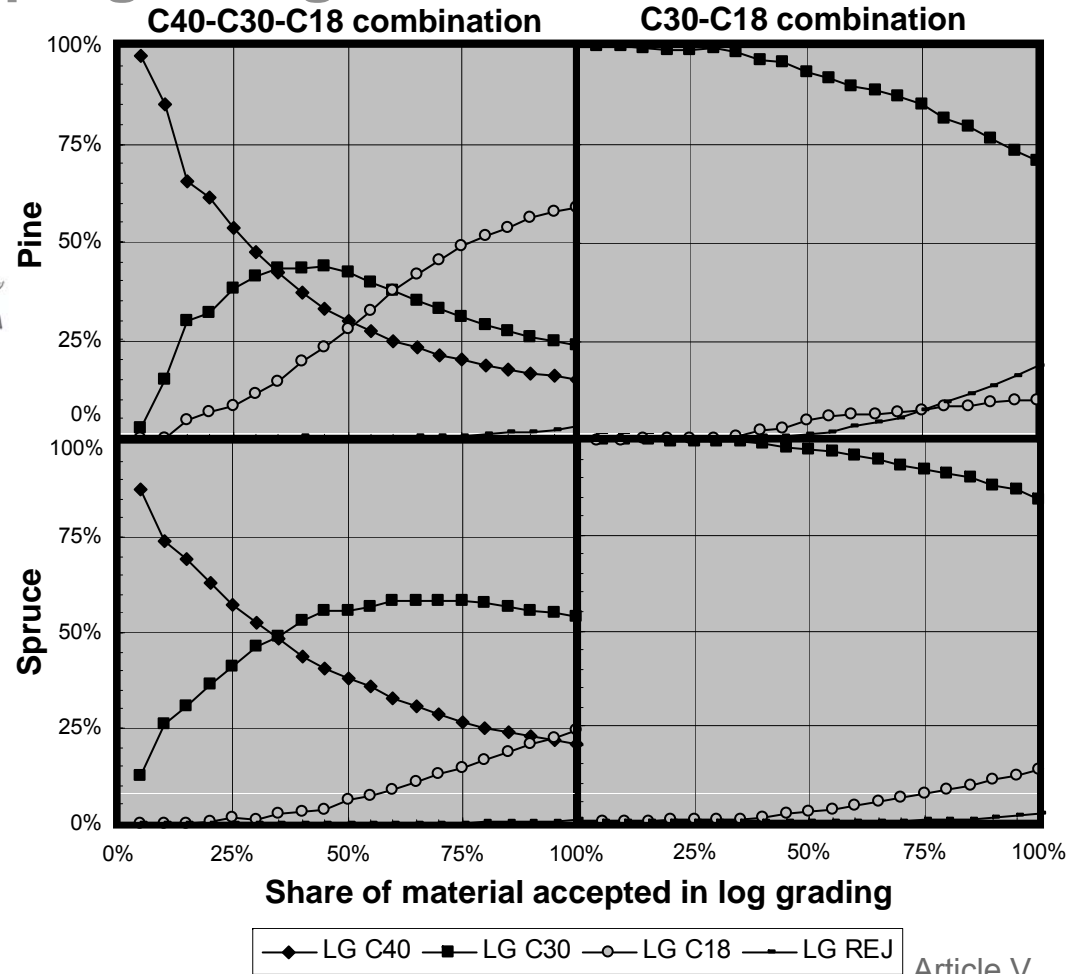
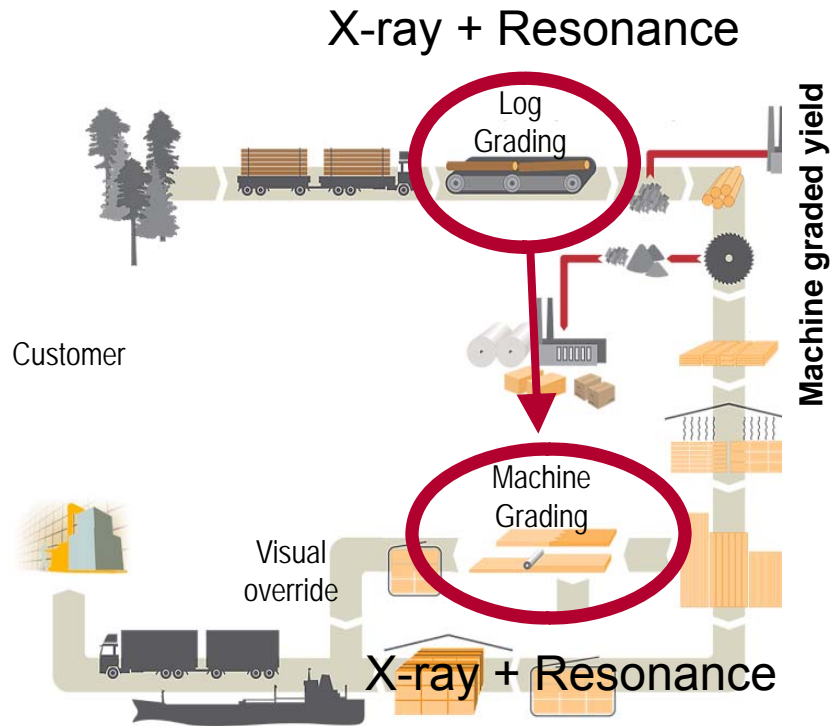
Agreement between different process steps

Spruce

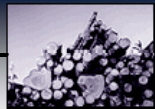
Pieces	LG		
	C30	C18	Reject
MG			
C30	623	72	2
C18	61	50	0
Reject	5	14	0



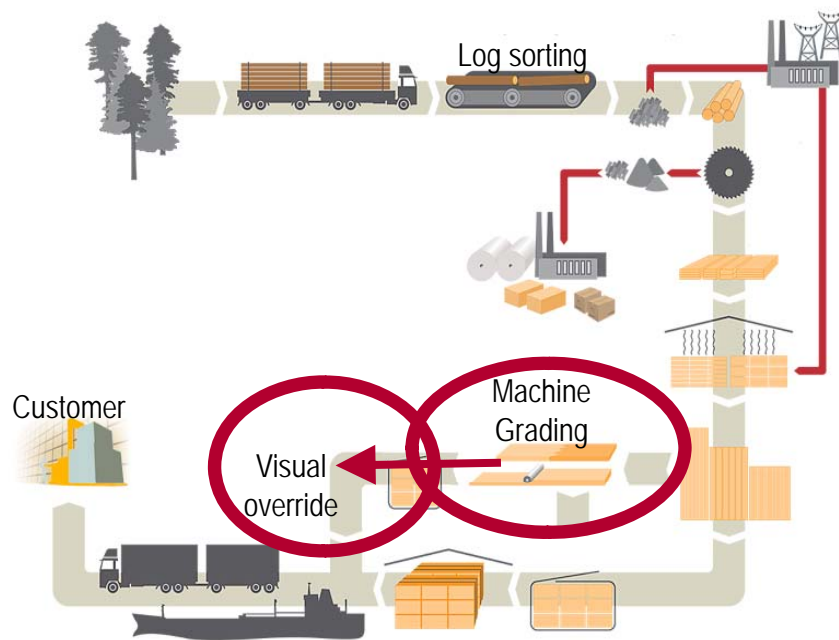
Grading result - Yield by pregrading



Article V

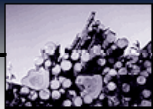


Visual override

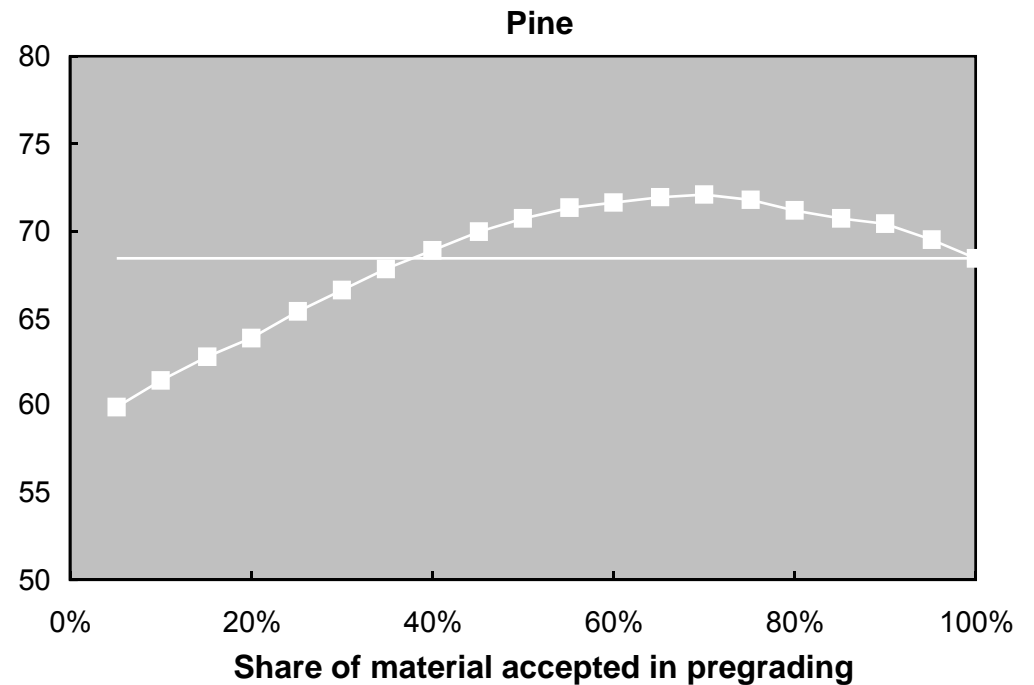
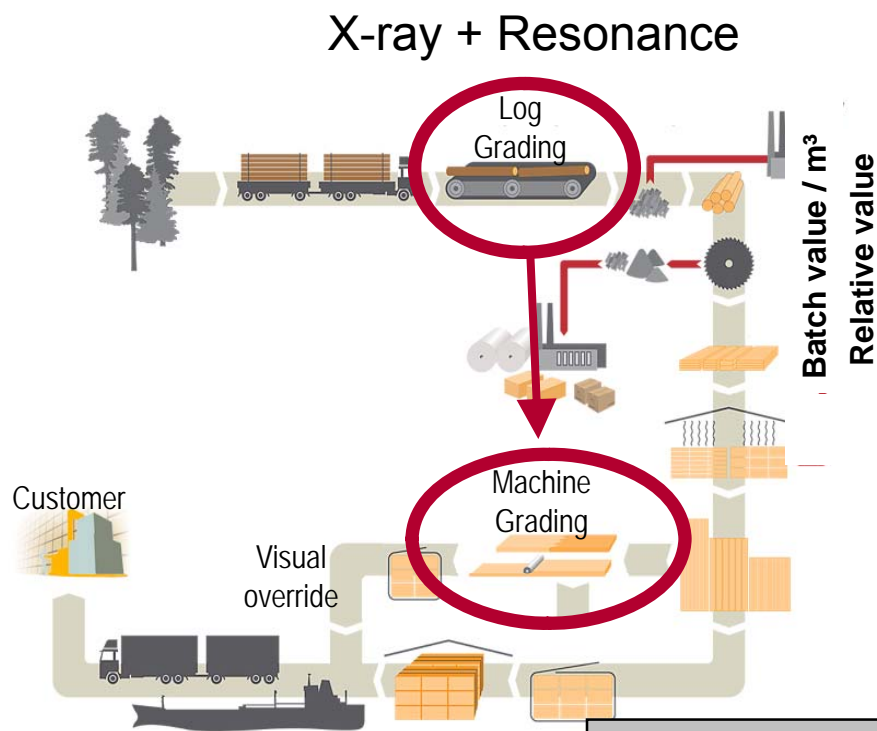


Visual override **only on deformation** before planing – less deformation after planing

	Machine Grading	Visual override
C40		
$f_{m,k}$ (MPa)	41.9	45.8
$E_{m,g}$ (GPa)	14.9	14.9
ρ_k (kg/m ³)	423	419
Yield	21%	10%
C30		
$f_{m,k}$ (MPa)	31.4	31.5
$E_{m,g}$ (GPa)	12.2	12.3
ρ_k (kg/m ³)	385	382
Yield	54%	24%



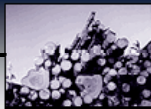
Value by pregrading – One example w/o Visual override



— No pregrading. MG C30 combination.
 ■ Pregrading by LG. Accept to C grades, MG C30 combination. Reject to Nordic timber.

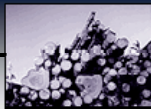
Most important results from thesis

1. Shown the possibility and feasibility of log strength grading
 - Machine control settings & pregrading
2. Given examples of integrated strength grading
 - Combining log & dry & machine grading
3. Proposed a method for adapting classification algorithms to EN14081
 - General method for all classification algorithms
4. Proposed a method for developing settings for multiple indicating properties
 - Enabling structured pregrading & development of settings



Thank You for your attention!

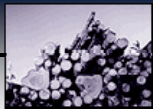
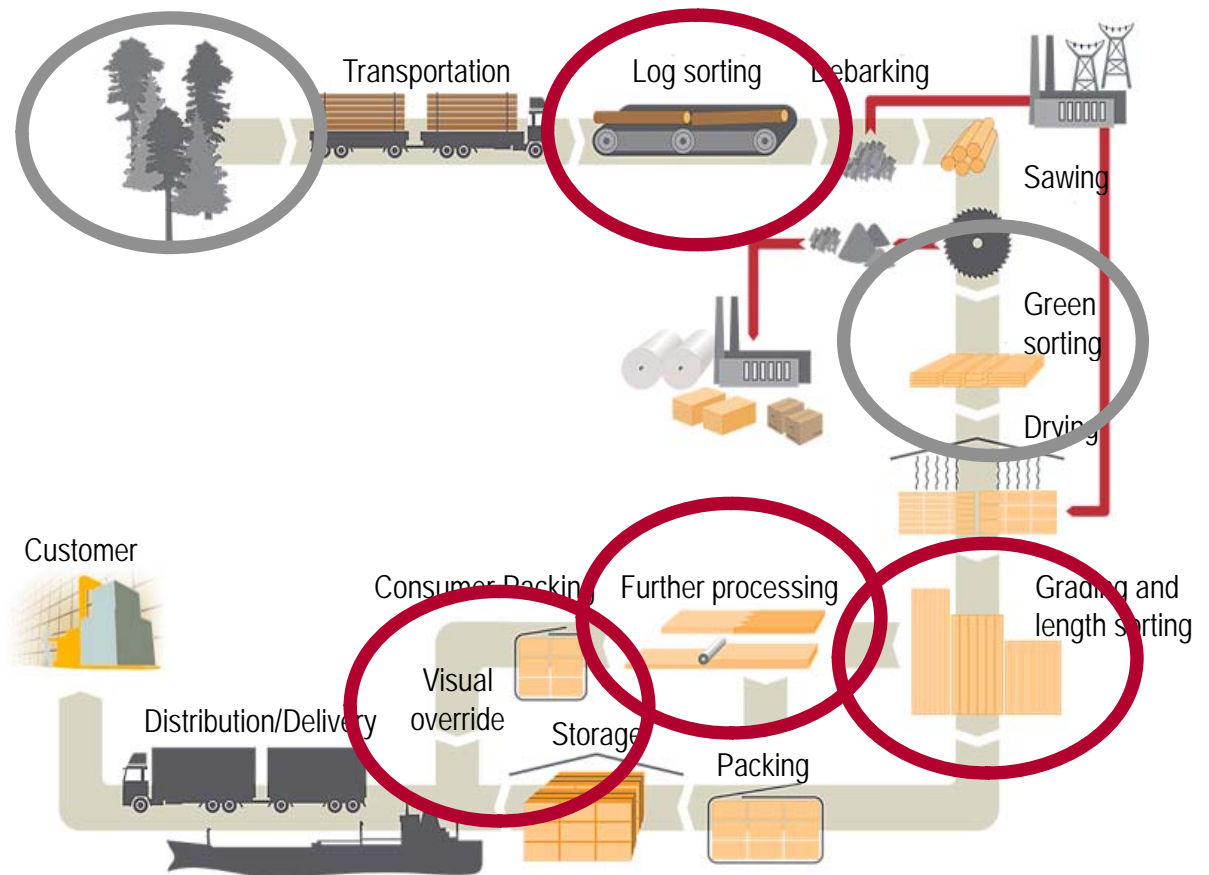
- *Integrated strength grading*
- *Mattias Brännström*
- *<http://pure.ltu.se/>*



Integrated strength grading

Process including sub-processes

- Harvesting
- Log grading (LG)
 - Pregrading
 - Machine control
- Green sorting
- Dry-grading (DG)
 - Pregrading
 - Machine control
- Machine grading (MG)
 - Machine control
- Visual override



Materials & Methods

Some of the equipments used

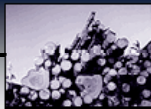
Visual colour scanner

= “Dry grading” DG

Using cameras for the visual spectra to detect knots, defects and deformation of all sides of a board



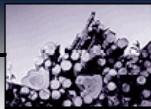
Article V



Materials & Methods – Equipments used

Outer shape scanner
“**3D-scanner**”

Measure the shape of the log by laser triangulation



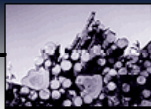
Materials & Methods – Equipments used

Grain angle scanner

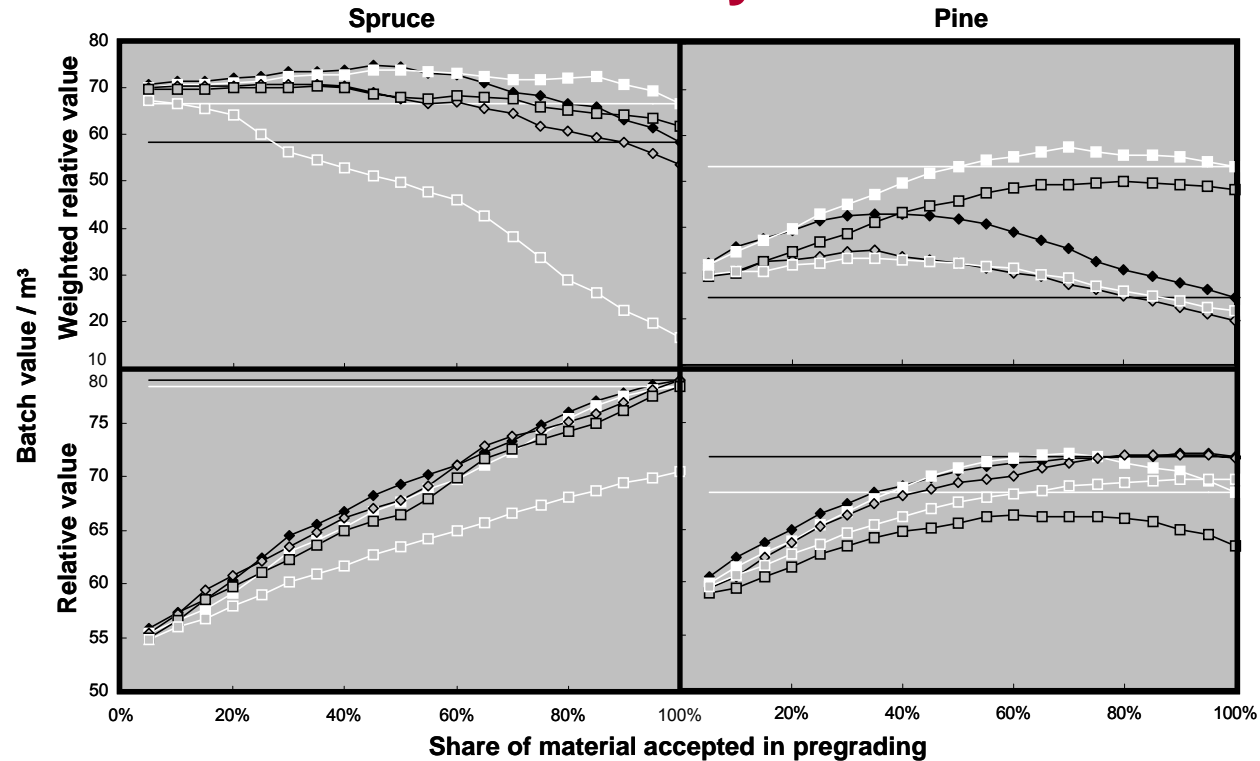
Using the tracheid effect to detect median spiral grain angle



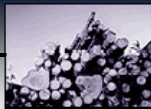
Article III



Miscellaneous – Profitability



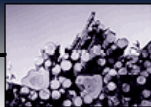
- Case C. No pregrading. MG C40 combination.
- Case C. No pregrading. MG C30 combination.
- ◆ Case D. Pregrading by LG. Accept to C grades, MG C40 combination. Reject to Nordic timber.
- Case D. Pregrading by LG. Accept to C grades, MG C30 combination. Reject to Nordic timber.
- ◇ Case E. Pregrading by DG. Accept to C grades, MG C40 combination. Reject to Nordic timber.
- Case E. Pregrading by DG. Accept to C grades, MG C30 combination. Reject to Nordic timber.
- Case F. Pregrading by LG. Accept to C grades, DG C30 combination. Reject to Nordic timber.



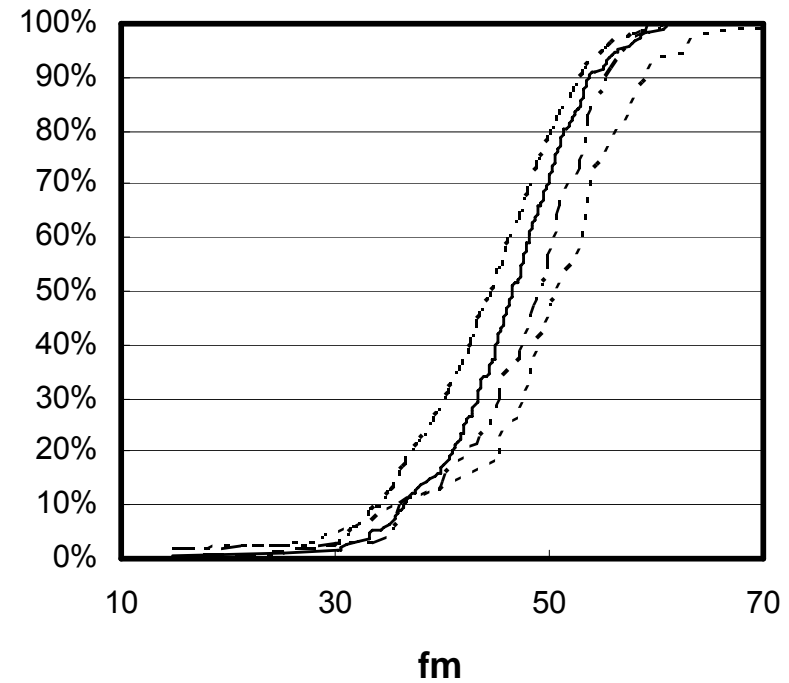
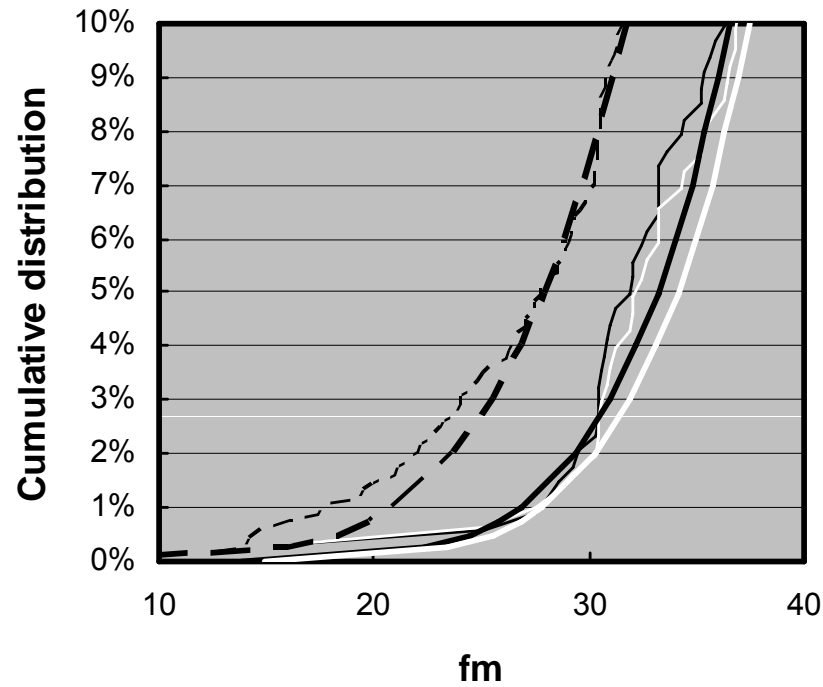
Miscellaneous – Visual qualities

Pine

Pieces	Visual grade				
	A	B	C	D	Reject
C40	36	33	47	17	1
C30	38	85	70	18	0
C18	18	206	242	59	0
Reject	0	8	18	2	0



Miscellaneous – Quality aspect



- - - - LG C30 ——— DG C30 ——— (LG+DG) C30
 - - - - LG Fit N ——— DG Fit N ——— (LG+DG) C30 Fit N

- - - - MG C30
 ——— LG >C30 + DG C30 + MG C30
 - · - · - LG >C30 + MG C30
 ····· LG C30

