

**Automatic scaling? Yes - and soon also  
automatic grading**

**Longview / Kelso, October 2007**

***Lars Björklund, The Swedish Timber  
Measurement Council***

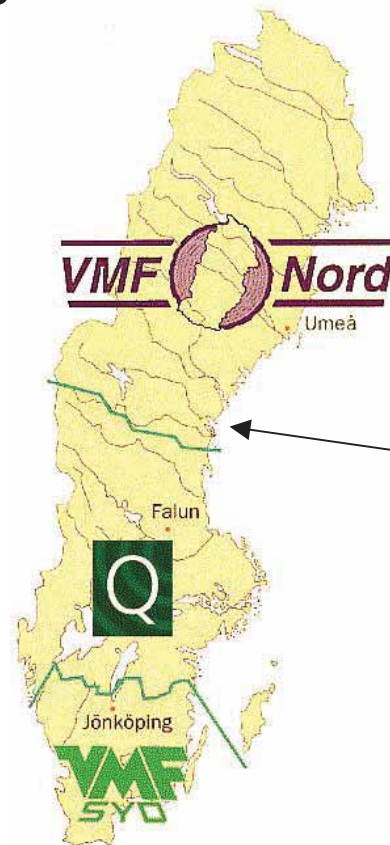
# Organisation of wood measurement in Sweden

**Three regional  
Scaling and Grading  
Associations**

**VMF Nord**  
**Umeå**  
280 Employees

**VMF Qbera**  
**Falun**  
375 Employees

**VMF Syd**  
**Jönköping**  
315 Employees



*Four closely collaborating,  
private, non-profit  
companies.*

**SDC – the IT company  
for the Swedish forestry  
sector**

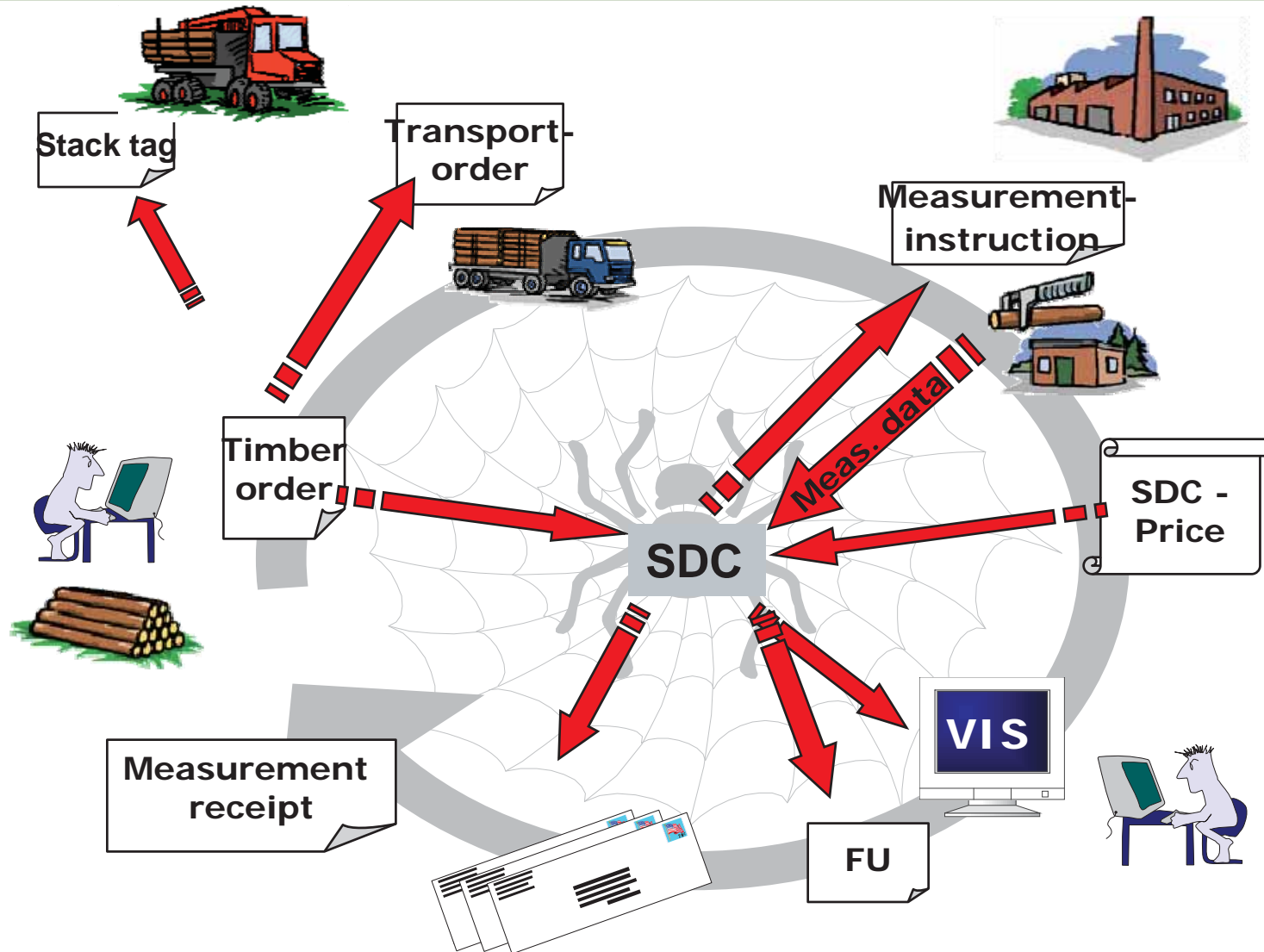
*Sundsvall*

**VMR The Swedish Timber  
Measurement Council**

The Swedish Timber Measurement Council



# SDC is the spider in our information web

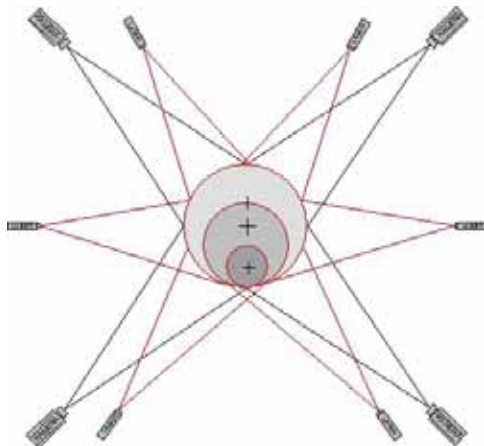


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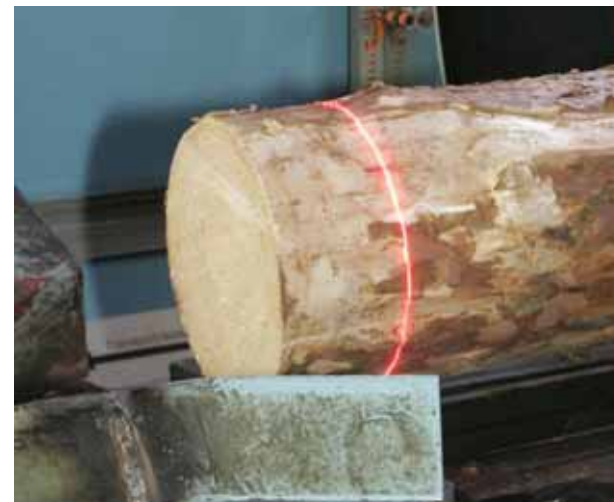
# Scanning logs since around 1970

All new installations are 3D-scanners based on laser lines and cameras

(Old) profile scanner



3D with six lasers and four cameras



The Swedish Timber Measurement Council

# Does this mean automatic scaling?

*A modern measurement station. 3D scanner before or after the inspection table.*

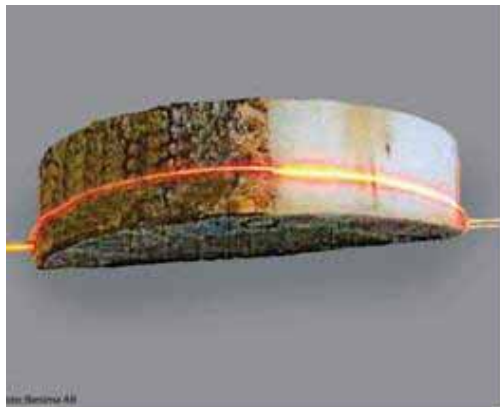


The scaler presses buttons for:

- Bark thickness class
- Grade
- Species

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# Diameter under bark – now possible in 3D-scanners



The laser light reflects differently on wood and bark

A log with some bark missing



Estimation of  $D_{ob}$  and  $D_{ub}$



Diameter under bark can be calculated

—— *Measurement*

----- *Estimation*

Now being introduced but problems with snow and sprinkled logs



# Our goal for sawlog grading

**Sawlog grading will be conducted by automatic measurement of wood properties that are important for the final product.**

**The grading instructions will be adjusted when new measurement techniques are introduced.**

*(The Timber Measurement Council, May 2004)*

# Grading and sorting simultaneously

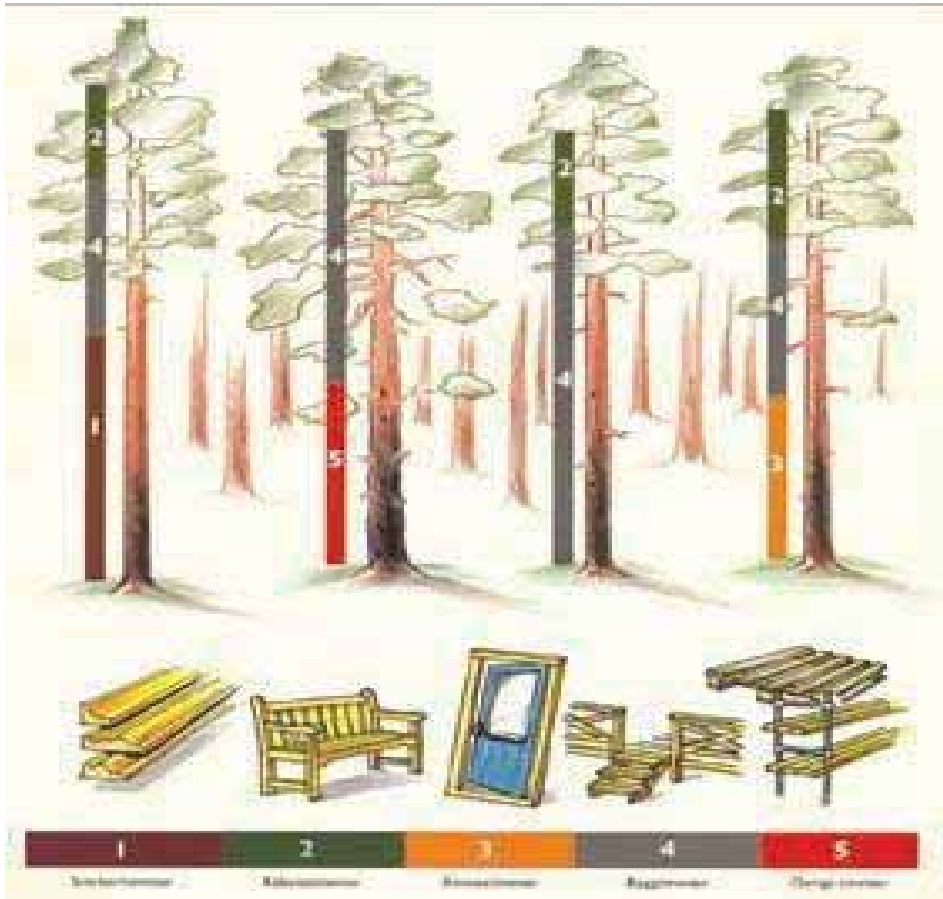
**Grading for payment: Must be identical where the instruction is used.**

**Sorting: Every sawmill sorts for highest possible product value.**

**Grading and sorting by the VMF personnel.**



# Grading of pine sawlogs



**Present instruction 10 years old.**

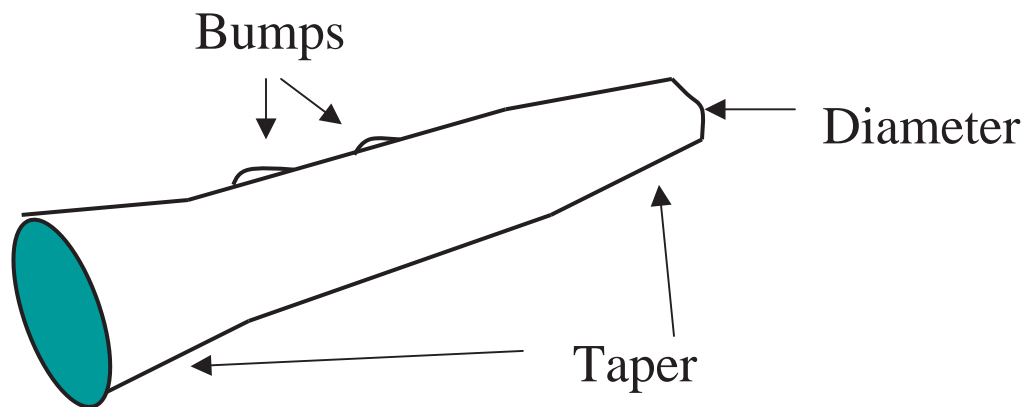
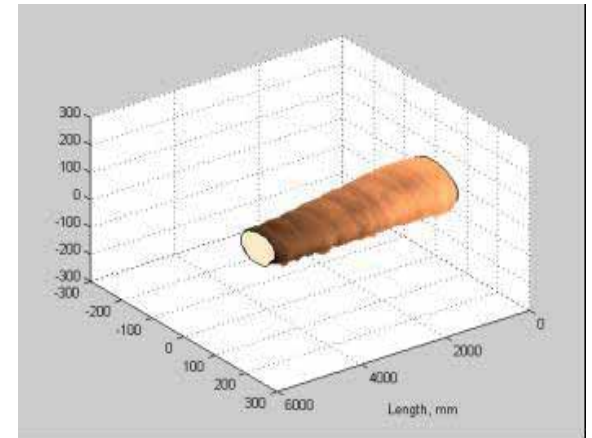
**Five grades based on presumed final products.**

**Detailed instruction.**

# First attempt for automatic grading

Grading in the five grades based on the shape of the log, primarily taper and bumps.

Result: not good enough.



# What to do to make automatic grading possible?

**Simplify the instruction**

**Consider available techniques when choosing grading criteria.**

**Study more techniques than log shape**

# Pine grades from 1 January 2008

	Grade			
	1	2	3	4
Log type	Butt log	Not butt log	All logs	All logs
Knots	Max 20 mm. Max 5 knots	Sound knot 120 mm. Other knots 60 mm.	Sound knot 120 mm. Other knots 60 mm.	Spike knot max 120 mm. Other knots unlimited.
Knots within 15,0 dm from butt end		Minimum two distinct whorls or one sound knot		
Knot swelling	Max 5			
Growth rings 2-8 cm from pith	Min 20		Min 12	
Straightness	Max 20 cm loss of saw yield			Max 120 cm loss of saw yield
"Old broken top"	Not permitted			Permitted
Blue stain	Not permitted			Permitted
Forest rot	Not permitted			Max 5 % of end surface

# Straightness instead of compression wood

	Grade			
	1	2	3	4
Log type	Butt log	Not butt log	All logs	All logs
Knots	Max 20 mm. Max 5 knots	Sound knot 120 mm. Other knots 60 mm.	Sound knot 120 mm. Other knots 60 mm.	Spike knot max 120 mm. Other knots unlimited.
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- Today detailed rules concerning compression wood.
- The new rules do not mention compression wood.
- The straightness rule should "punish" for loss of saw yield, disturbance in the production and compression wood.

# Straightness vs compression wood

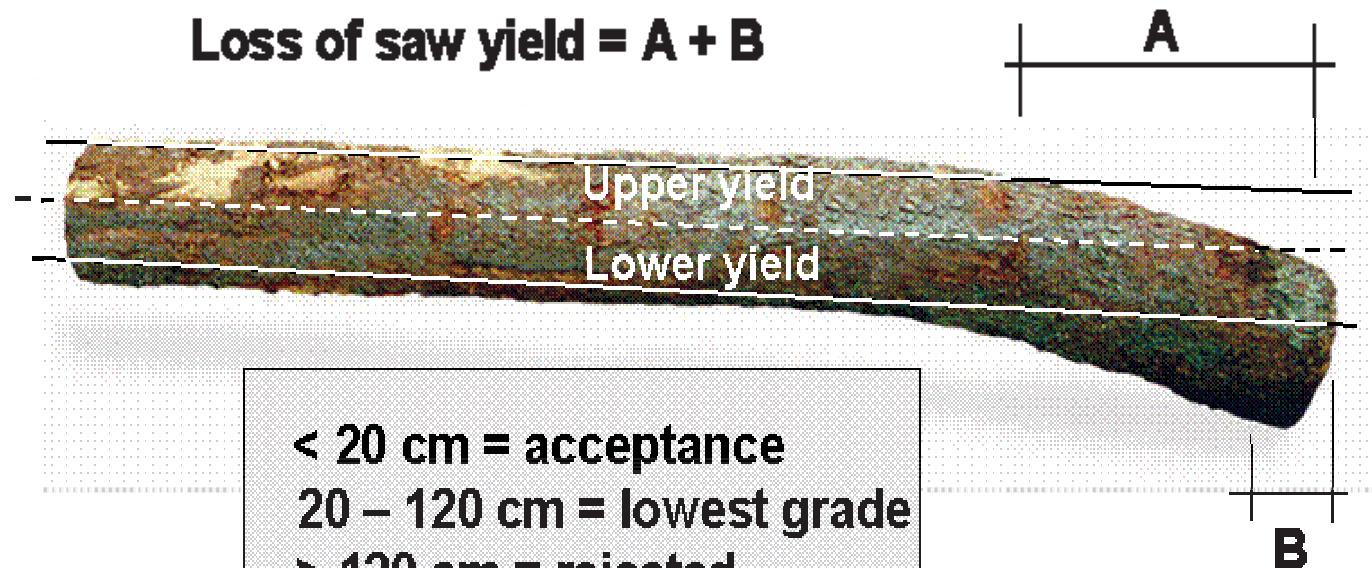
Compression wood as it looks to the scaler



And at a fresh cut

*Straightness can be measured in 3D-scanners and has a strong correlation to occurrence of compression wood*

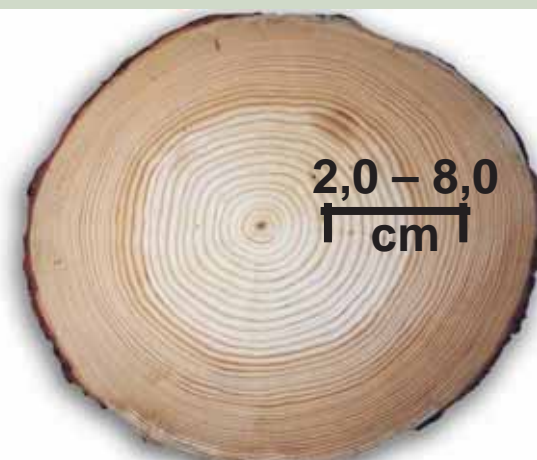
**Loss of saw yield = A + B**



< 20 cm = acceptance  
20 – 120 cm = lowest grade  
> 120 cm = rejected

# Detection of growth ring width

## Essential for the grading



	Grade			
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Grade 1	Grade 4
< 3 mm	> 5 mm
More knot free wood	Bigger knots
High heartwood content	Lower strength
Resistant as window frames	

# Image analysis of end surfaces

- A PhD-student at the Center for Image Analysis in Uppsala.





# Pith detection is the first step

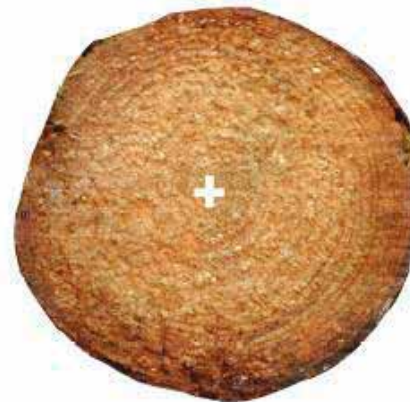
**Easy!**



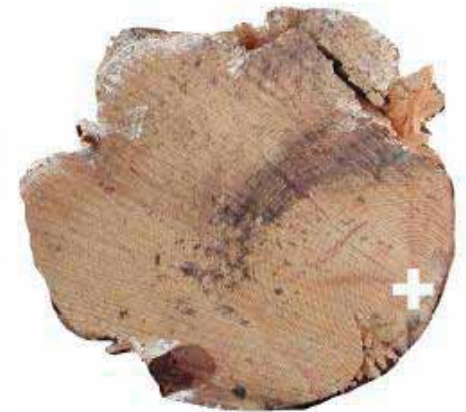
**Works**



**Works**



**Works**



**Warning**



**Rot – stop !**



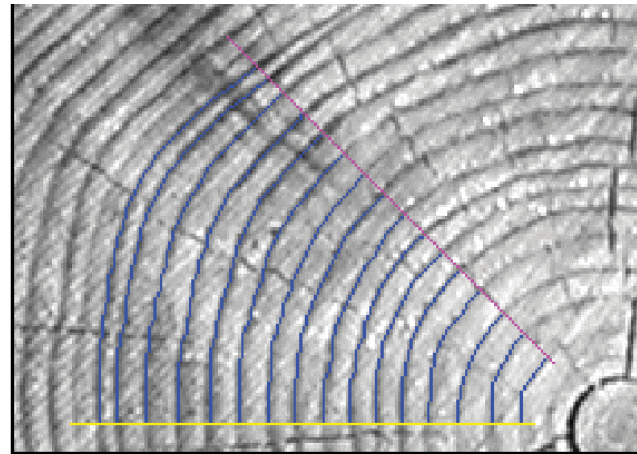
*Images: Kristin Norell,  
Centre for Image Analysis*

# Growth ring detection

## Installation of camera and light



## Grey Weighted Polar Distance Transform for Outlining Circular and Approximately Circular Objects



(c) The shortest path to each of the 16 end pixels in the object.

**The research approach seems justified**

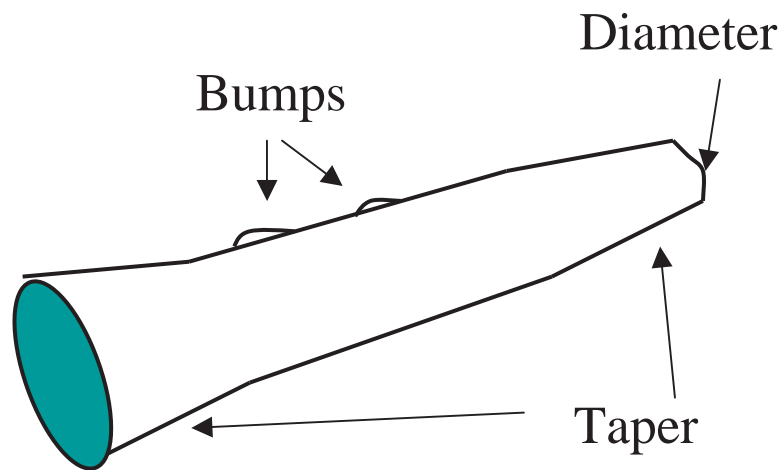
# Knots and log type by automatic means

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*This can be combinations of three techniques:*

- Log shape by 3D-scanner
- X-ray
- Image analysis of log surface

# The new pine grading better correlated to log shape



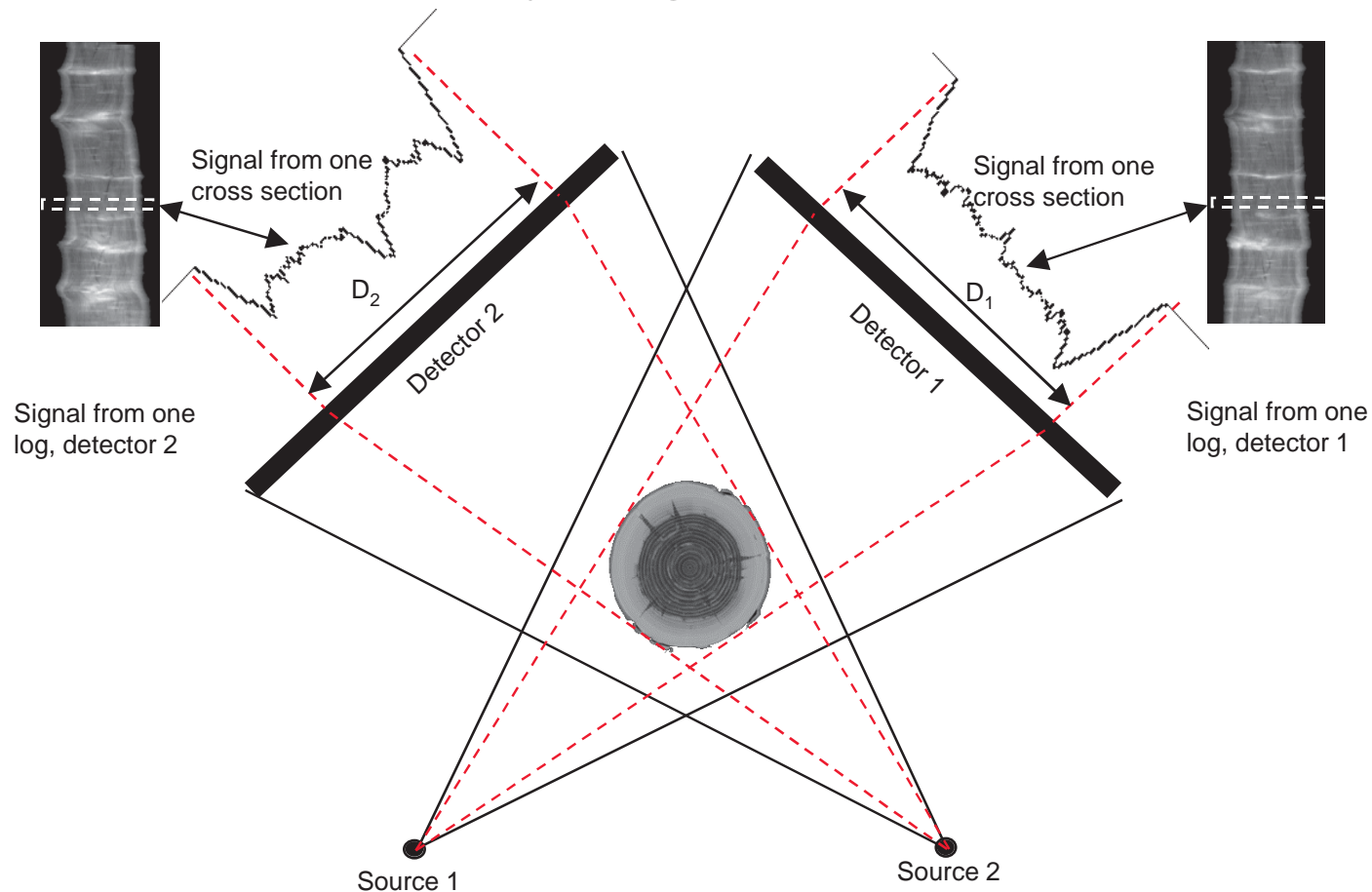
*Data from 3D-scanners gives good indications of:*

- Butt log vs top log
- Knot size



# Research on X-ray in Skellefteå, northern Sweden

## X-ray LogScanner



# X-ray has a great potential

*X-ray can provide estimations of*

- **Knot parameters at whorl level (volume, distance)**
- **Species**
- **Diameter under bark**
- **Heartwood**
- **Density**
- **(Growth ring width)**
- **(Strength)**

**Two-direction X-ray**



**Spruce**



**Pine**



# Image analysis of log surface

**There are commercial image analysis systems for board inspection that detect knots and defects.**

**Could something similar be developed for logs?**



## Some more in the sawlog grading instruction

<i><b>Defect</b></i>	<i><b>Automatic detection</b></i>
Sharp bend (old broken top)	Shape of the log
Blue stain	Image analysis
Forest rot	Image analysis



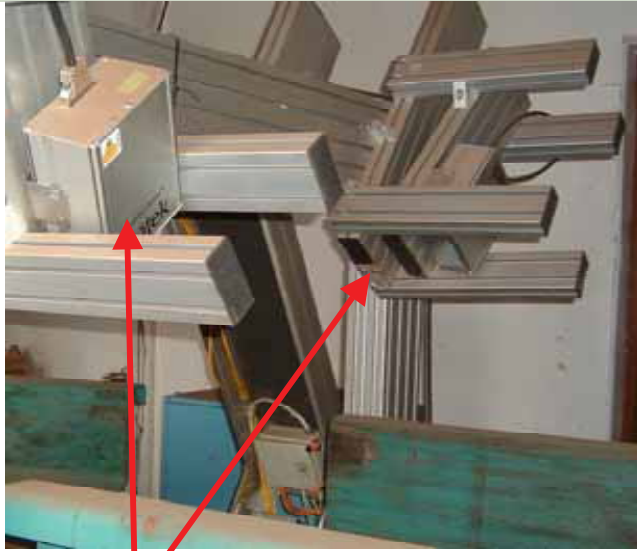


# Our way forward

- We will gradually introduce new techniques.
- The scaler will be less tied to his (her) chair.
- In today's manual grading approx 70 % of the logs are given the same grade as in the control measurement.
- Automatic grading will hopefully increase this percentage and minimize differences between scaling stations.
- Faster and cheaper. Today up to 8000 logs per shift and scaler.
- Grading for payment combined with measurements for sorting and process control.

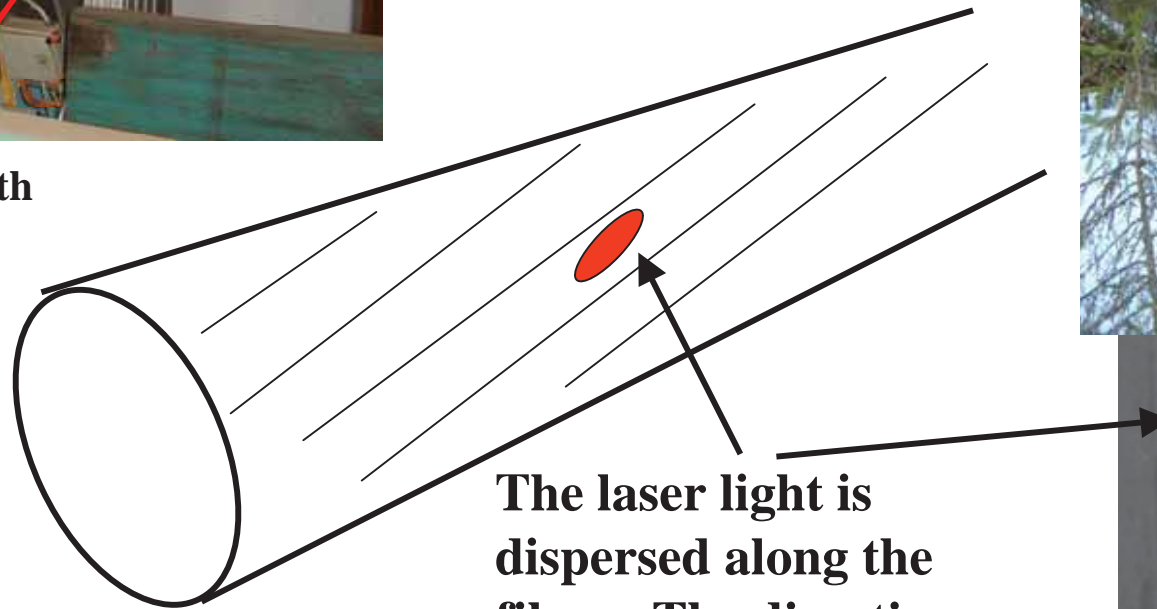


# Measuring spiral grain on barked logs



Prototype with four lasers

Measuring spiral grain by point lasers and cameras



The laser light is dispersed along the fibers. The direction can be detected.

Pine with extreme spiral grain



# Acoustic testing for strength

***Several tests have been done. We now look forward to the first installation in a Swedish sawmill.***

Sweet music for the sawmills



**In the harvester**



**Manual**



**On-line**



# Avoid this (sports arena in Denmark)

Inaugurated  
november  
2001

Broke down  
january  
2003

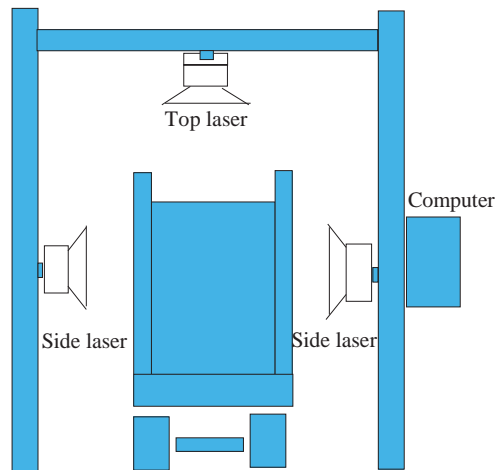


# And now some words about pulpwood

***Most pulpwood is measured by two-phase sampling systems. First step is often manual measurement of piles on trucks or railway.***

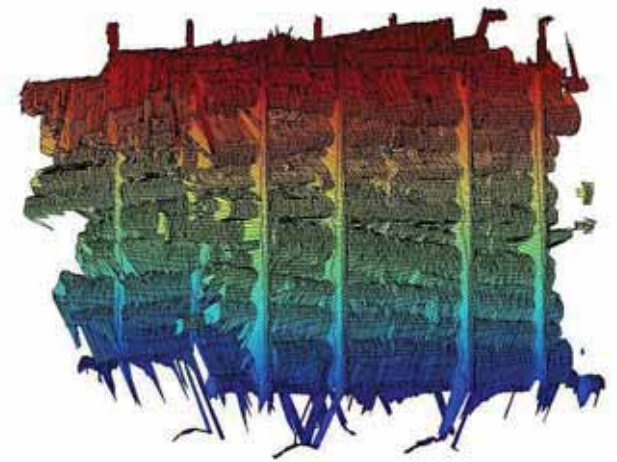


# Finnish laser measurement system for truckloads of pulpwood



## *Modus 2000*

Measured by three lasers while passing the frame.



**The first installation in Sweden.**

**Many installations in Finland, one in Sweden, one in Norway.**

The Swedish Timber Measurement Council

# Manual log measurement of pulpwood

*Second phase includes sampling of piles and manual log measurement. Cost-efficient as a whole but manual measurement very expensive.*



# Mobile equipment for automatic log-by-log measurement of pulpwood



**Measurement by  
Rema 9001, one  
direction**

**One truck pile in  
20-30 min**

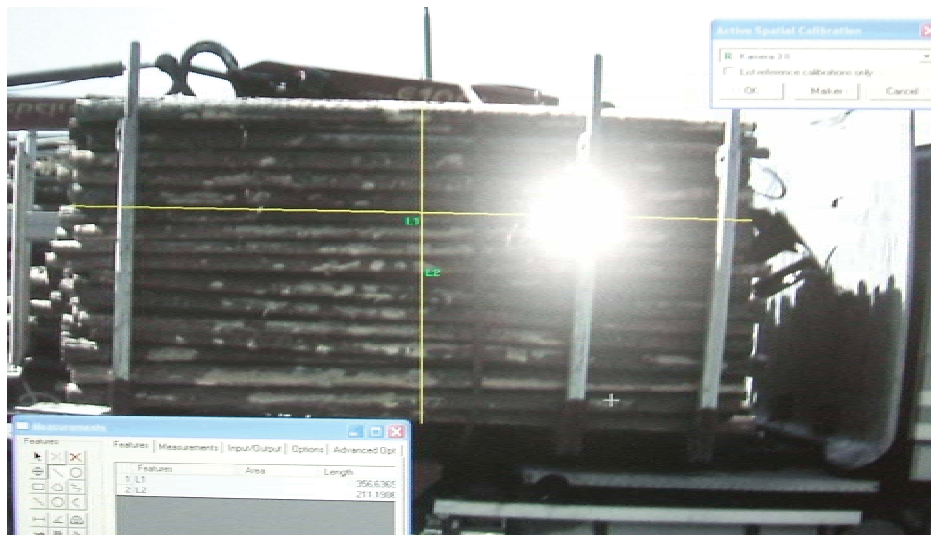
**Will serve approx  
six industries**



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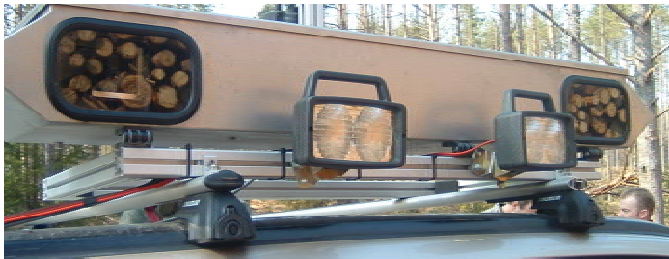
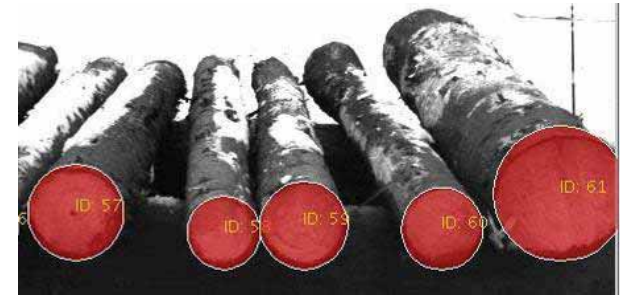
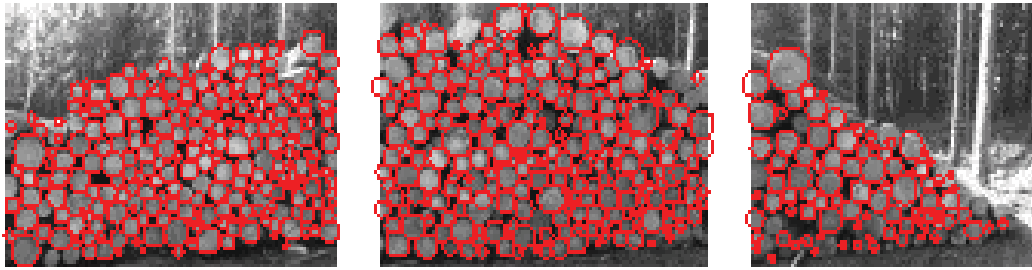
# Also in our pipe-line. Camera-surveillance or image analysis



Photos from Elverum, Norway

The Swedish Timber Measurement Council

# Image analysis can become an important tool



Rot ?

Growth rings ?



Both wide-angle and zoom cameras ?

Dralle Ltd, Denmark

The Swedish Timber Measurement Council

# Dry matter content sampling with NIR-probe



The probe can be freely positioned within the container

**BESTWOOD**

# The installation at a measurement station for biofuels



Connection to computer

**BESTWOOD**

# Measurement by the harvester



Measurement by:

- The machine
- The operator
- Third-party revision

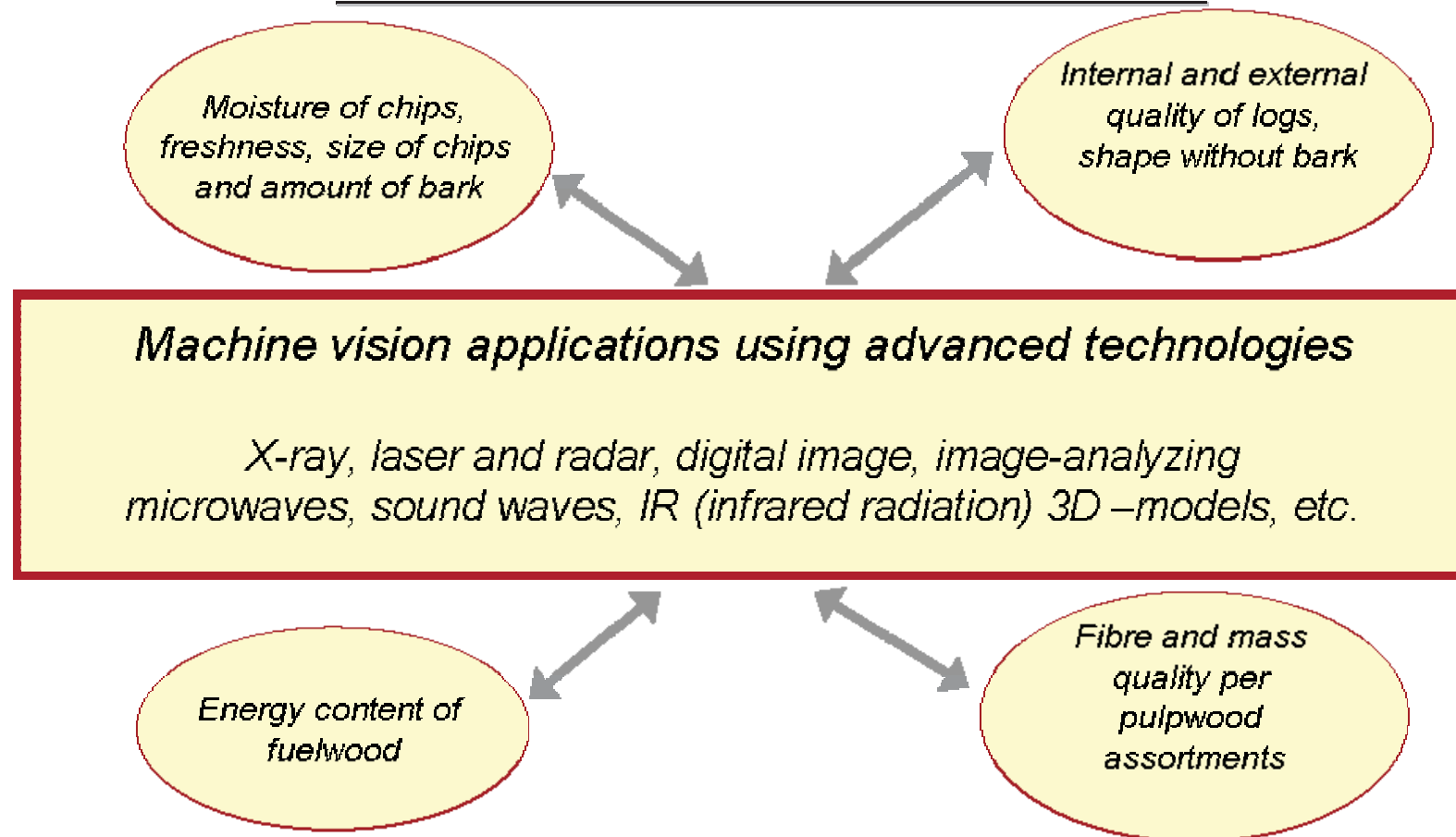


Larmlista	Larm-nivå	Totalt	Utfall 309	Utfall 310	Utfall 311	Utfall 312
Diameteravvikelse (mm)	+/-3 mm	1,3	2,2	2,5	-0,6	-1,1
Diameterandel (% +/- 4)	50 %	55	51	57	67	56
Längdavvikelse (cm)	+/- 2 cm	0,0	0,9	0,4	-0,2	-0,3
Längdandel inom (% +/-2)	60 %	76	74	92	61	94
Volymsavvikelse (%)	+/- 3 %	1,0	1,8	1,8	-1,0	-1,3

Follow-up of four machines. Length, diameter, volume.

# Very similar thinking in Finland

## Timber measurement vision 2010



# Flow of information = customer satisfaction



**New techniques to measure, accumulate and combine information open new possibilities.**

**That´s all for today**

**We believe we have an exciting future  
ahead of us!**

**Thanks for inviting us!**