Determination of MDF fiber size distribution: Requirements and innovative solution

Benthien JT, Hasener J, Pieper O, Tackmann O, Bähnisch C, Heldner S, Ohlmeyer M

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Abstract

For all wood particle-based composite panels, particle size distribution and morphology are classified as crucial factors for the industrial production process and the resulting product properties. Currently, particle size measurement of fibers for MDF production is still just done by skilled personnel (haptic and visual), based on fiber mat density and an evaluating comparison of the actual produced MDF surface with samples of target quality. Such approaches seem to be limited in reproducibility and not optimal for process control. Due to the large spectrum of particle size and the need of fiber separation for its determination, available fiber dimension detecting systems, e.g., from pulp and paper industry, cannot be applied adequately for the characterization of MDF fibers.

To determine the requirements of MDF manufacturers regarding fiber quality management, a survey was realized. All major companies worldwide were asked about their opinion on the effect of fiber size on panel quality and economic efficiency, as well as their demand regarding fiber size measurement. These results will be discussed in this conference contribution.

Furthermore, the current state of an image analyzing based approach to measure the dimensions of dry-applied fibers will be presented. The system´s efficiency will be shown in detail. Based on the characteristics of each individually analyzed particle, property profiles of three differently defibrated MDF fibers will be presented.

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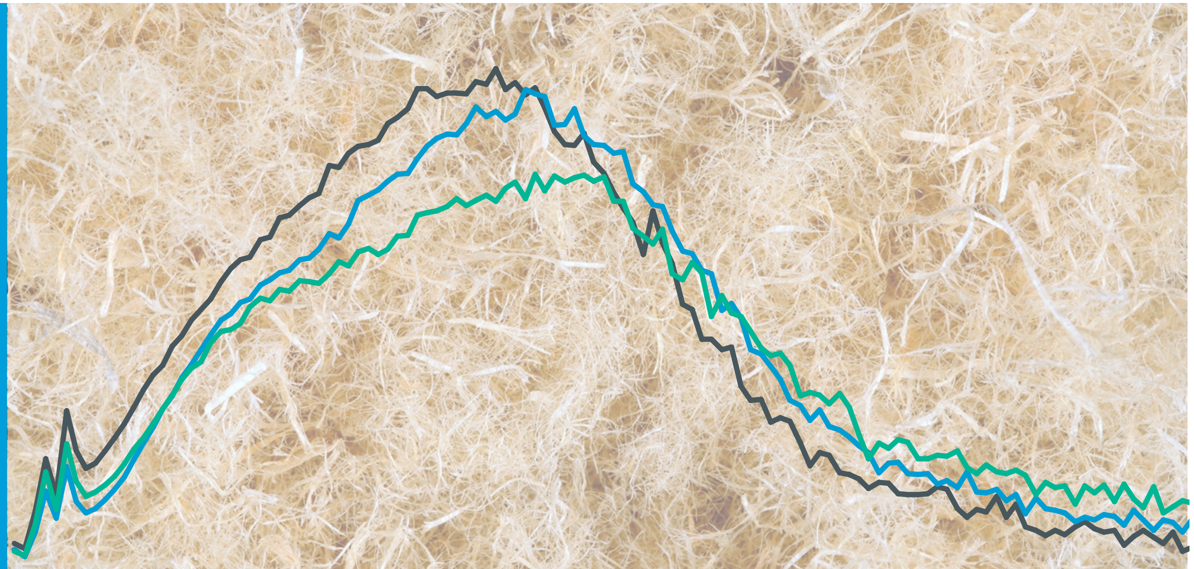

Seattle,
03. April 2013

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1. Fiber quality survey
Motivation and Results

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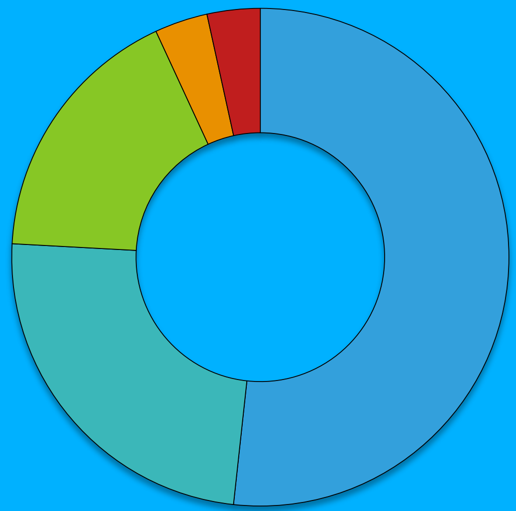

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Fiber quality survey

Aim

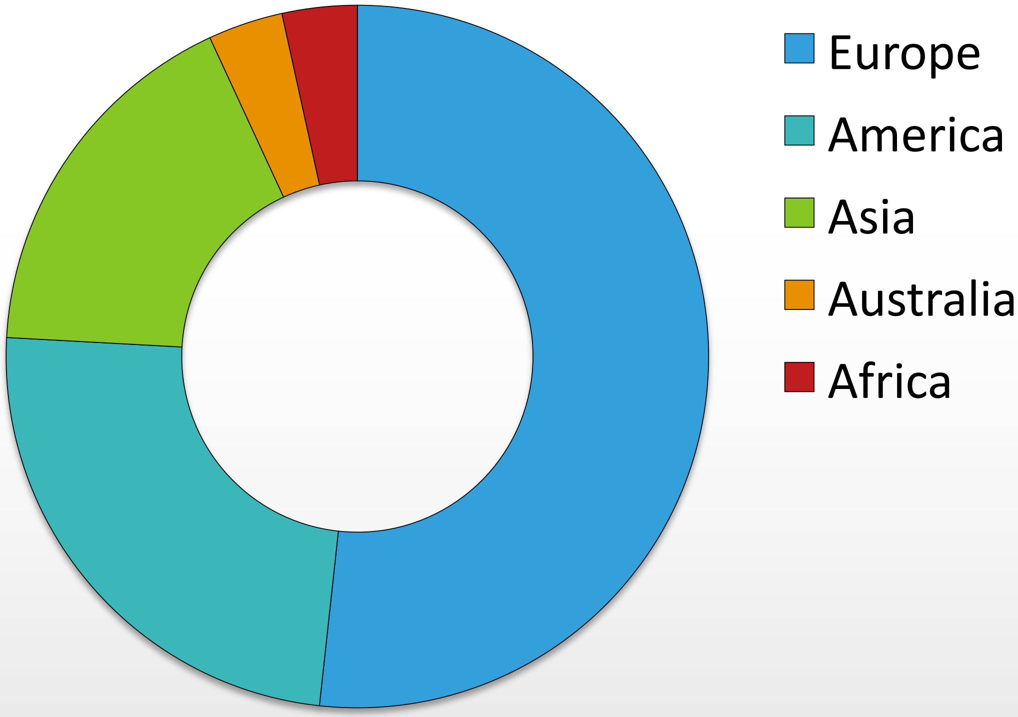
- Relevance of fiber quality for MDF production?
- State of the art in quality control?

Approach

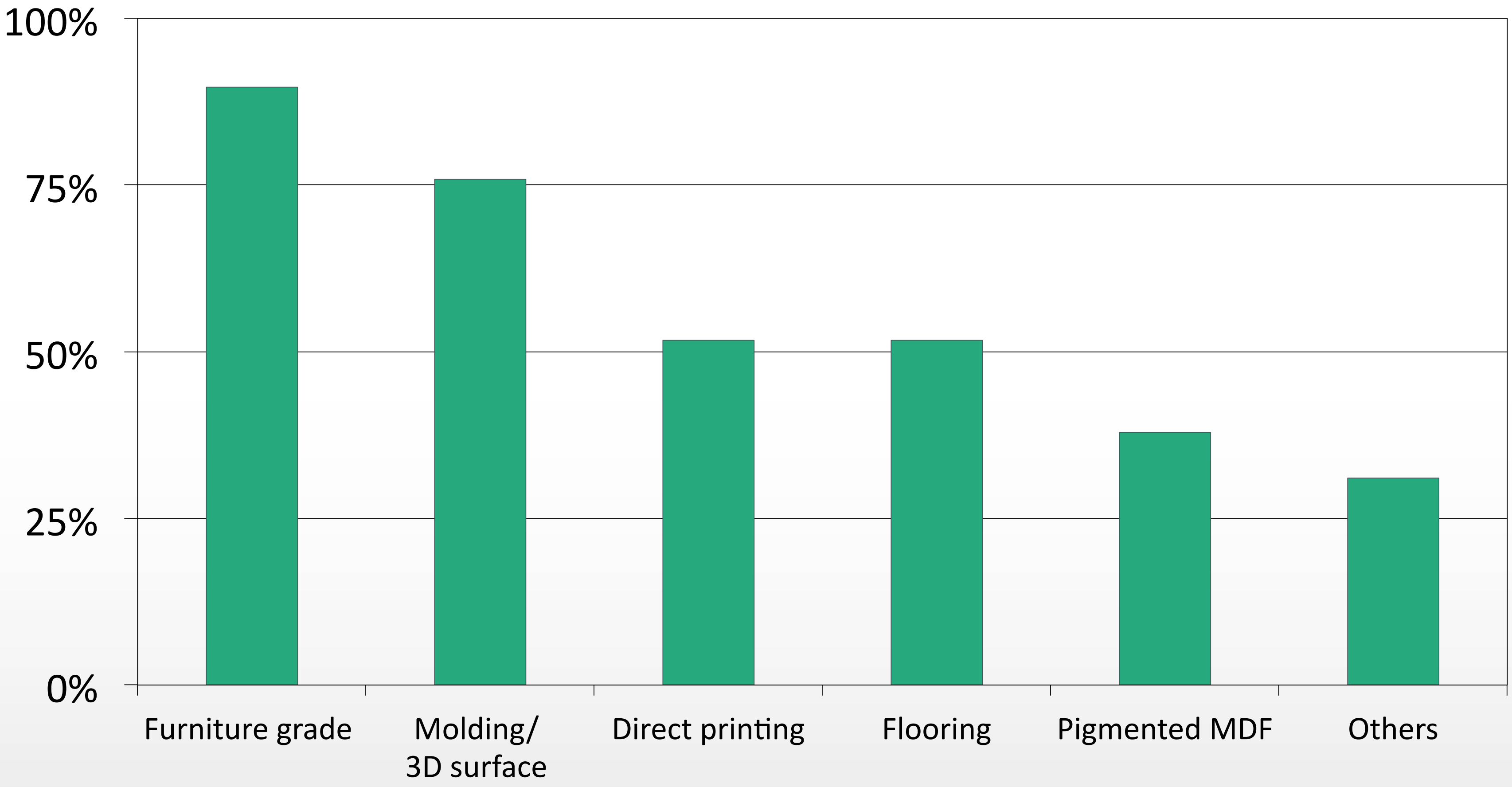
- Worldwide survey in 2011

Response rate

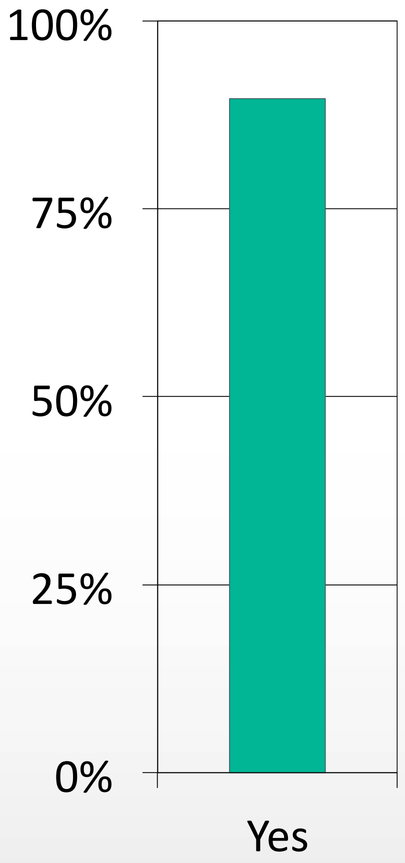
- 300 questionnaires
- Response rate 10%
- n = 29



Which type of fiberboard do you produce?



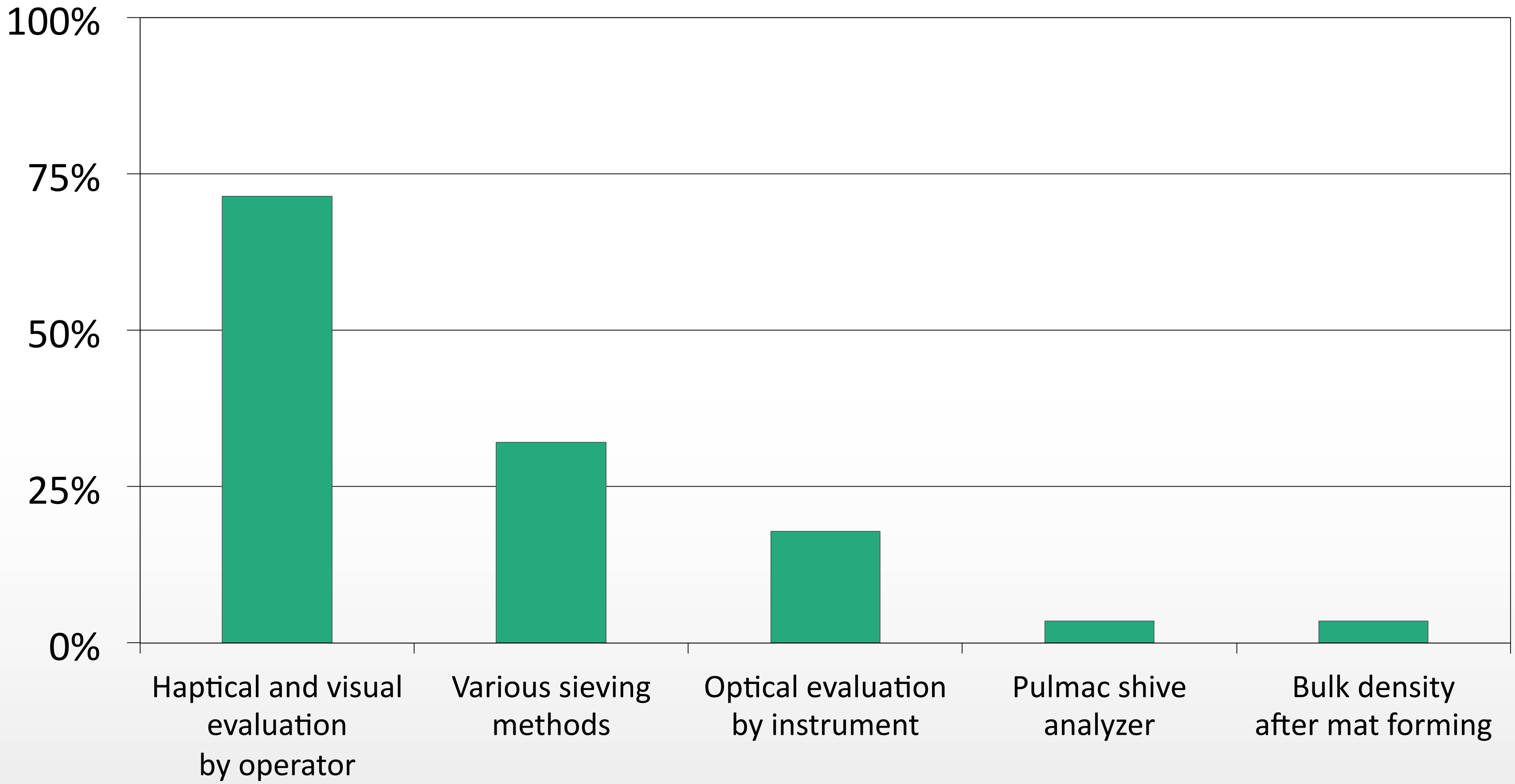
Fiber quality survey



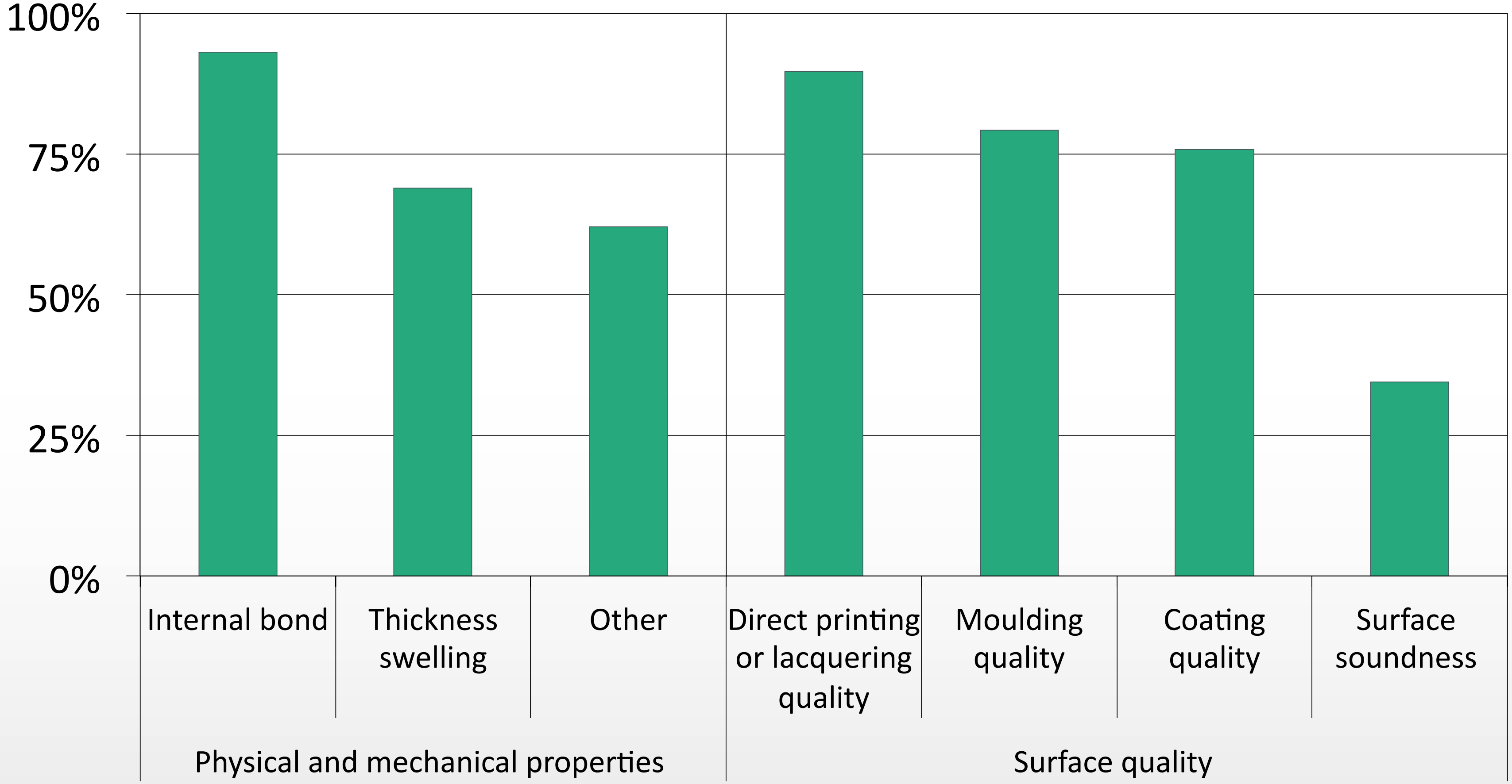
Q: **Is fiber quality a crucial factor in your process?**
A: **Yes** (90%)

Q: **Do you asses fiber quality for QC?**
A: **Yes** (90%)

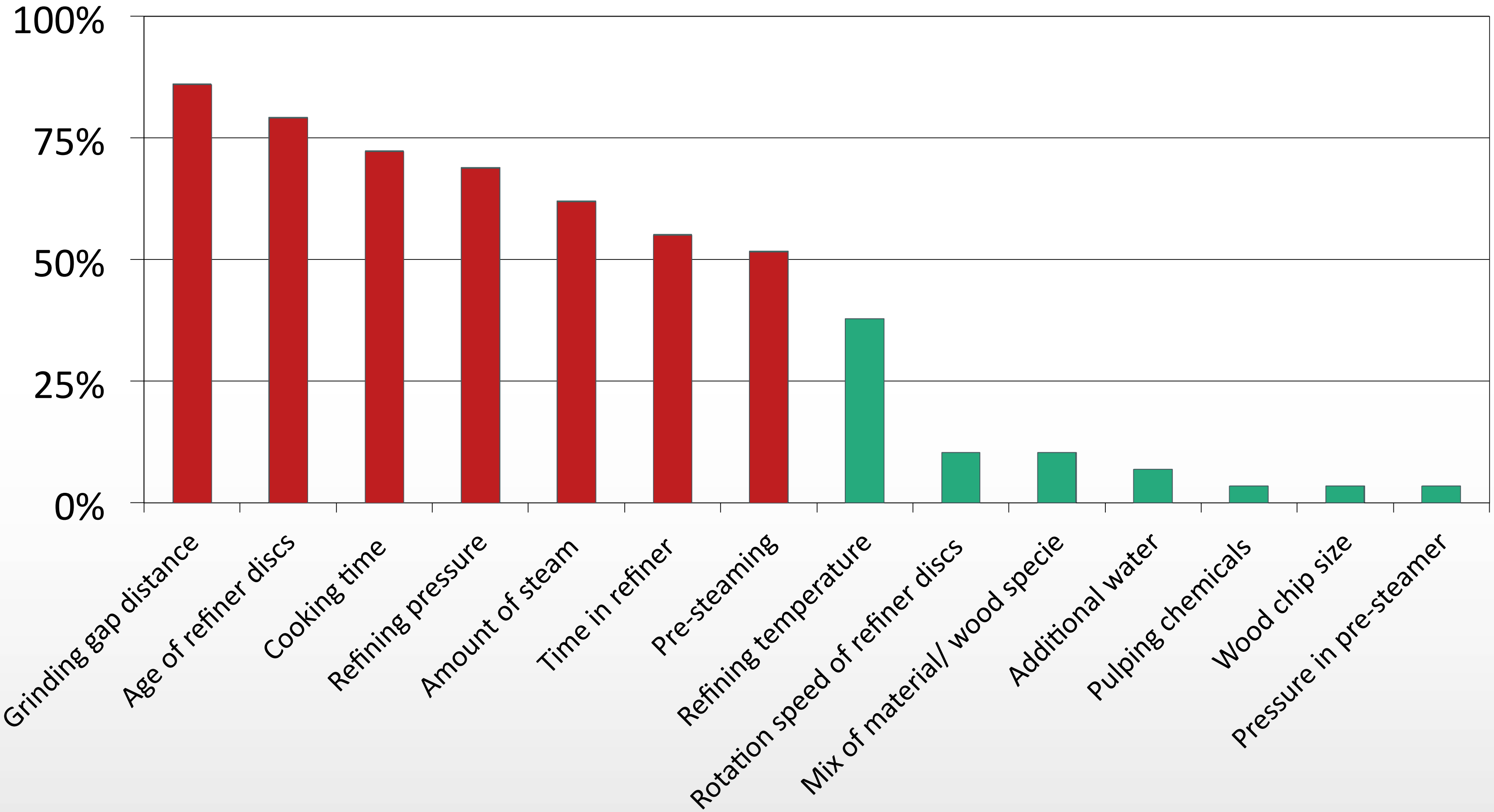
Which method is applied to evaluate fiber quality?



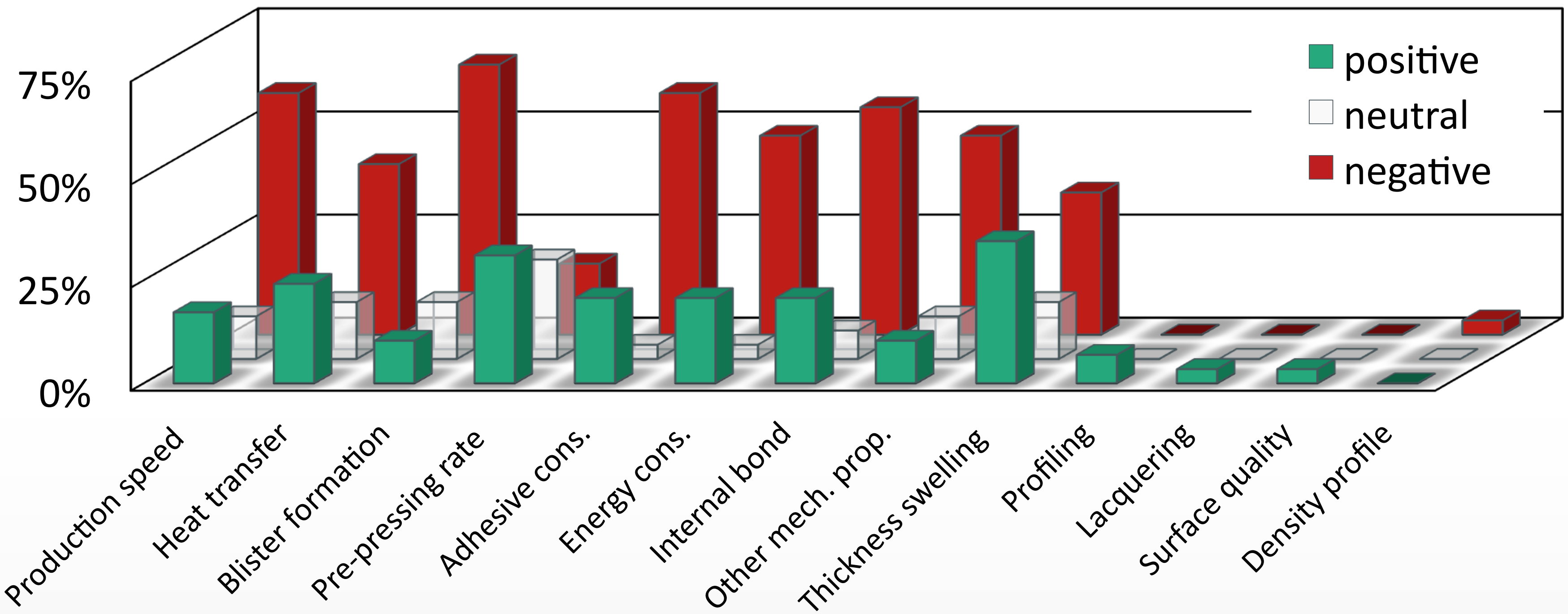
Which board properties are affected by fiber quality?



How is the fiber quality adjusted during production?



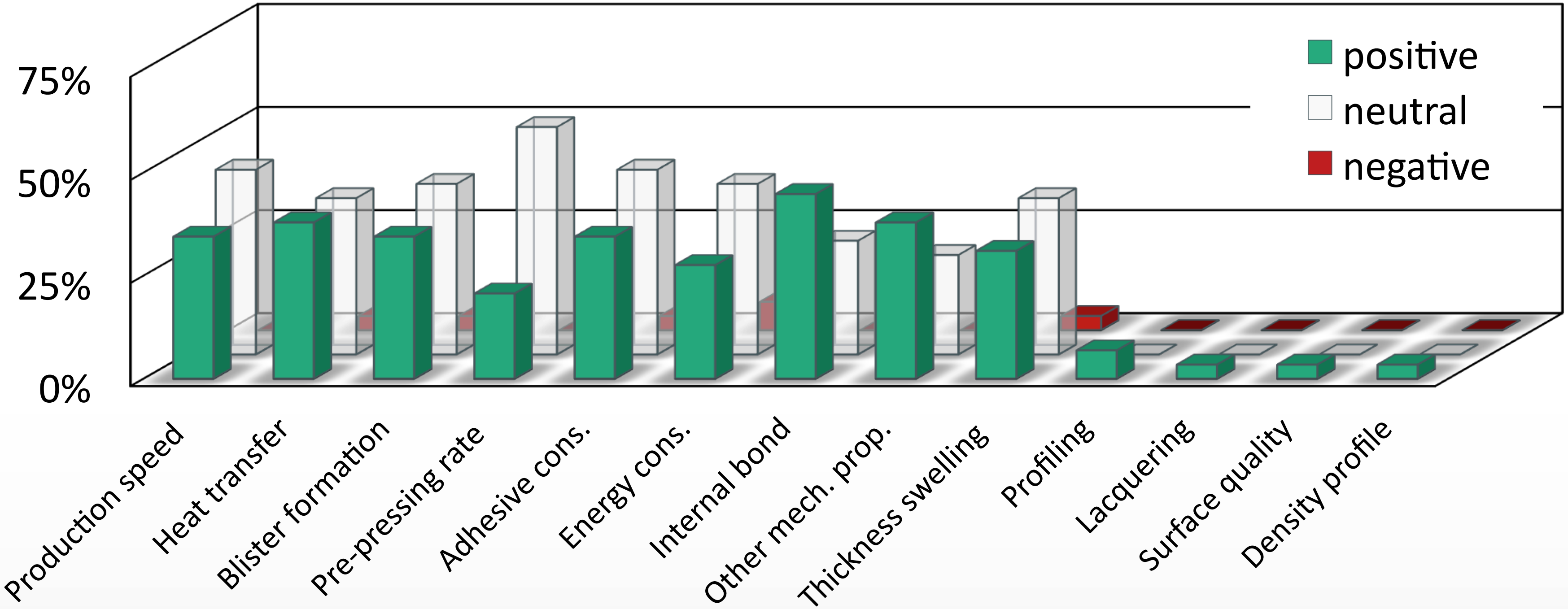
How does the fines content affect the process?



Note

- The fines content was mostly classified to affect the process negatively

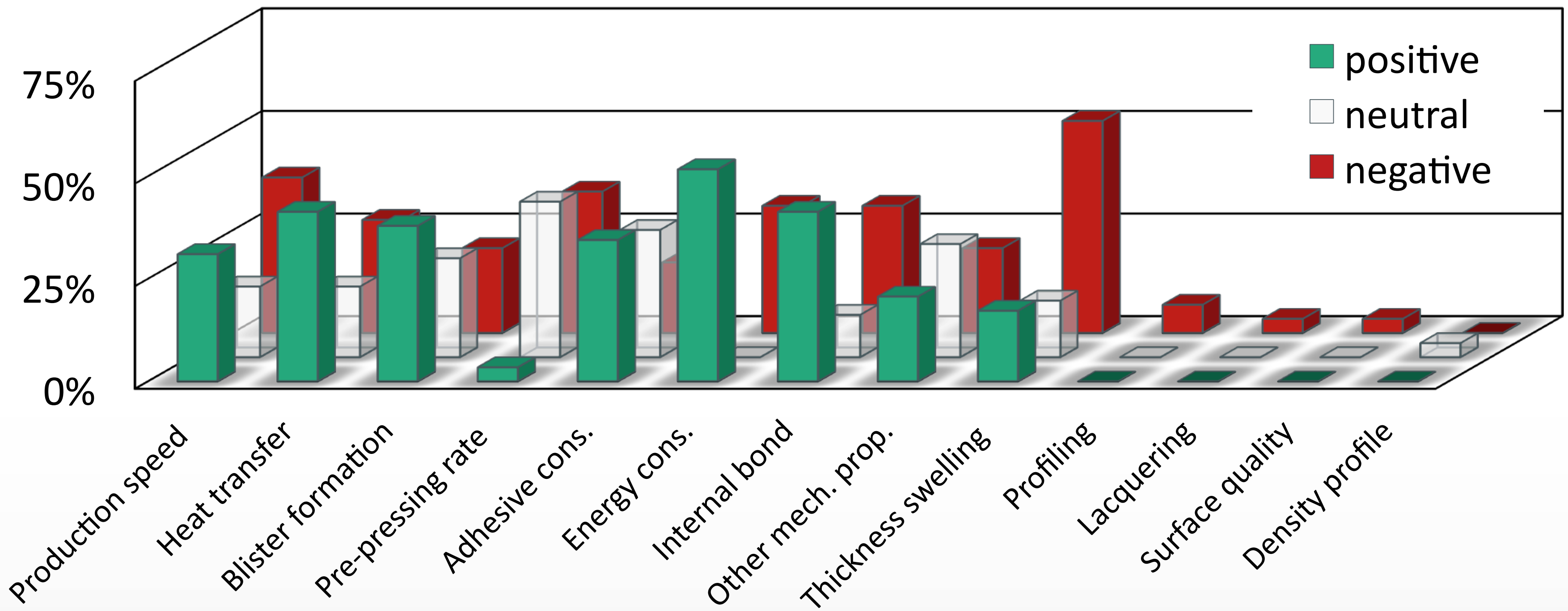
How does the fiber content affect the process?



Note

- The fibers content was nearly always classified to have a positive or no effect on the process.

How do shives affect the process?



Note

- Beside some clear cases, the effect of shives was classified to be negative and positive on the process at the same time.

Fiber quality survey

Summary

- Fiber quality is of worldwide interest for MDF production
- MDF properties are affected by fiber quality
- In practice, fiber quality is adjusted by various process parameters
- Fibers are the most wanted structures
- The acceptable amount of fines and shives depends on the intended MDF type

Conclusion

- A measuring device is needed, which allows an individual characterization of MDF fibers for process control

2. MDF fiber characterization
Operation principals and test results

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Limitations of currently available fiber analyzers

Problem

- MDF fiber composition spreads from small dust particles up to several centimeter-sized fiber bundles

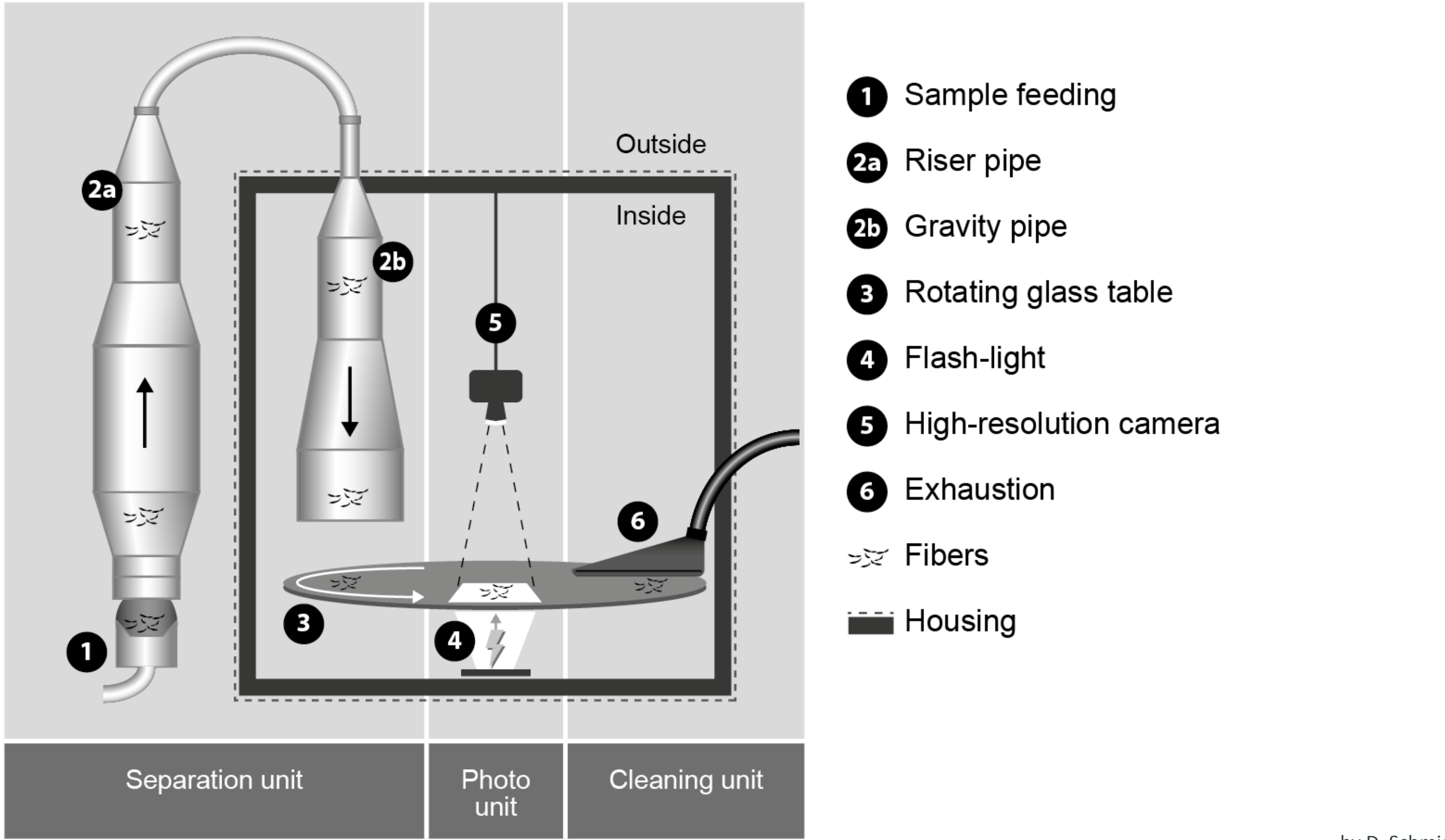
Current limitations

- Low sample size; fiber bundles may block the system
- Sieve analysis capture fiber width only
- Limited reproducibility

Solution

- Image analyzing system, based on dry-separated fibers
- Developed by the Thünen Institute and Grecon

Operation Principal

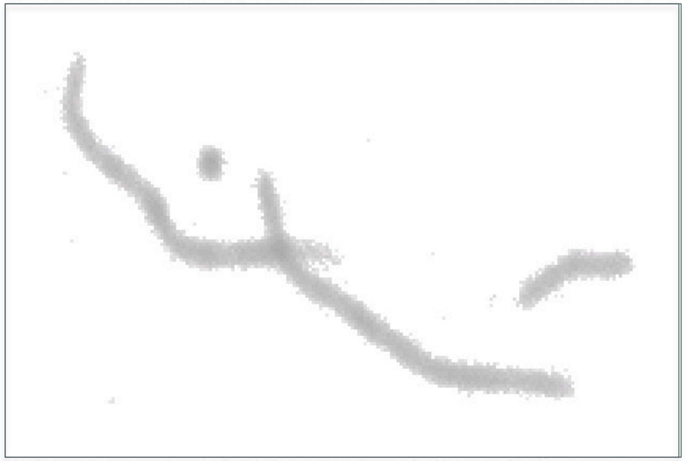


by D. Schmidt

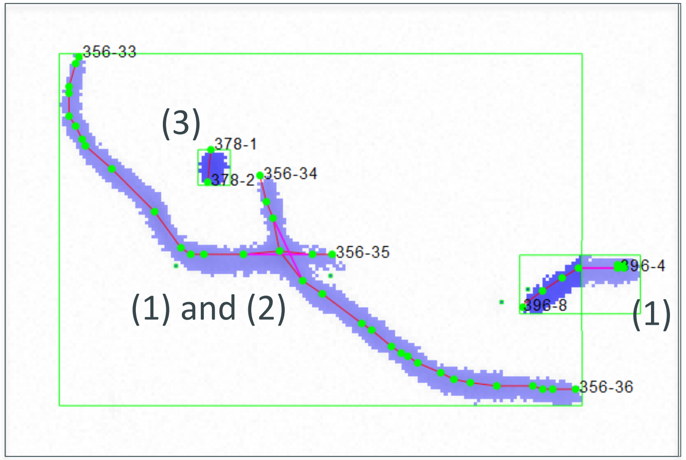
Measuring Device

- 0.5 g fibers
- 82 images per minute
- Image size: 93 x 62 mm
- Pixel size 23.2 µm
- 1094 dpi (ppi)
- 8 minutes per run
- 650 images per run
- 250,000 fibers per run
- 3 replications per fiber

Image analysis



Gray scale image



Processed image

Image processing

- Flow line tracing (1) and
  separation of overlapping fiber (2)
- Image moment method (3)
- Special treatment, if (1) and (3) are not applicable

Fiber material

Fiber A

- High temperature/ long time
- 16 bar (200 °C)/ 8 min

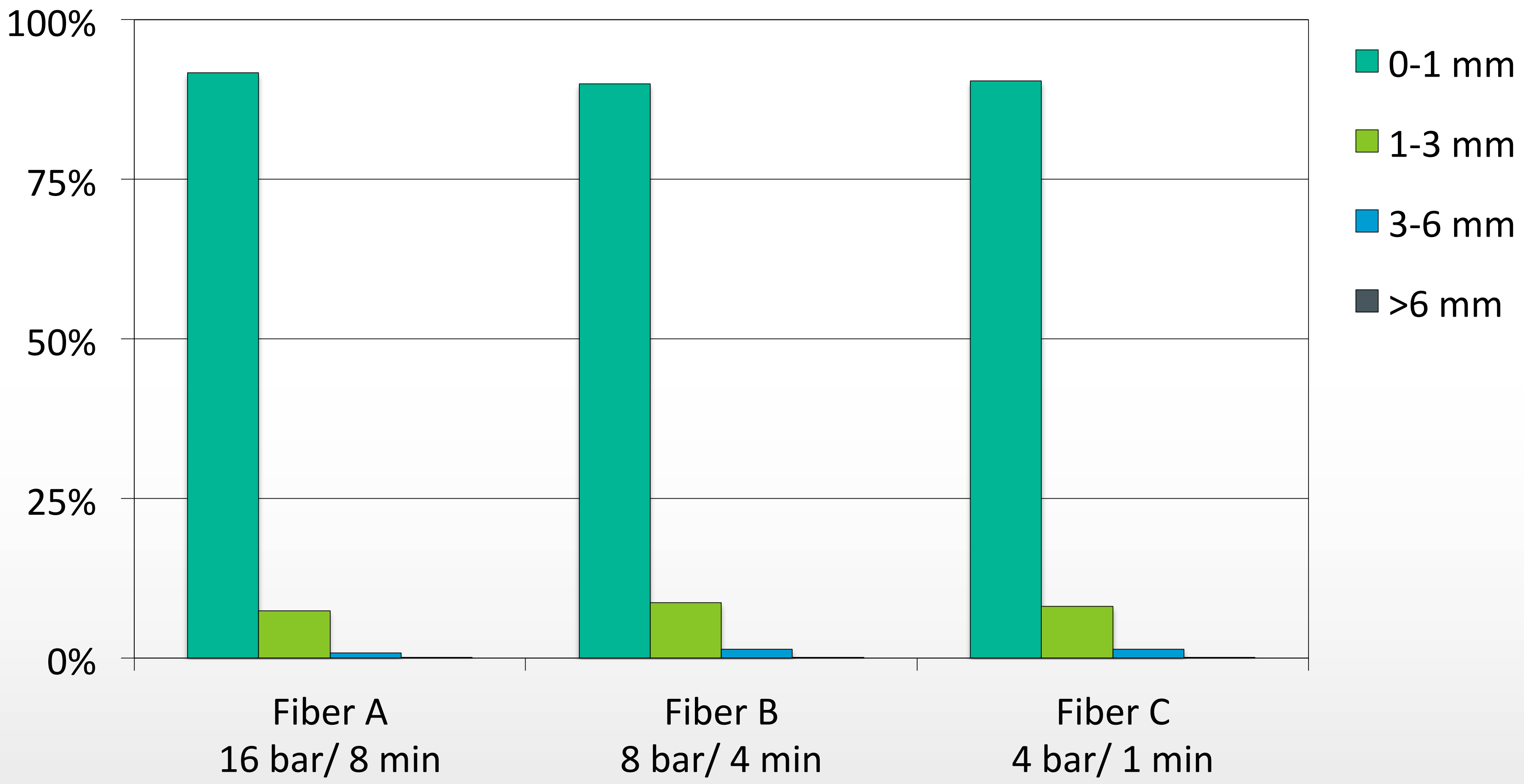
Fiber B

- “Standard“
- 8 bar (170 °C)/ 4 min

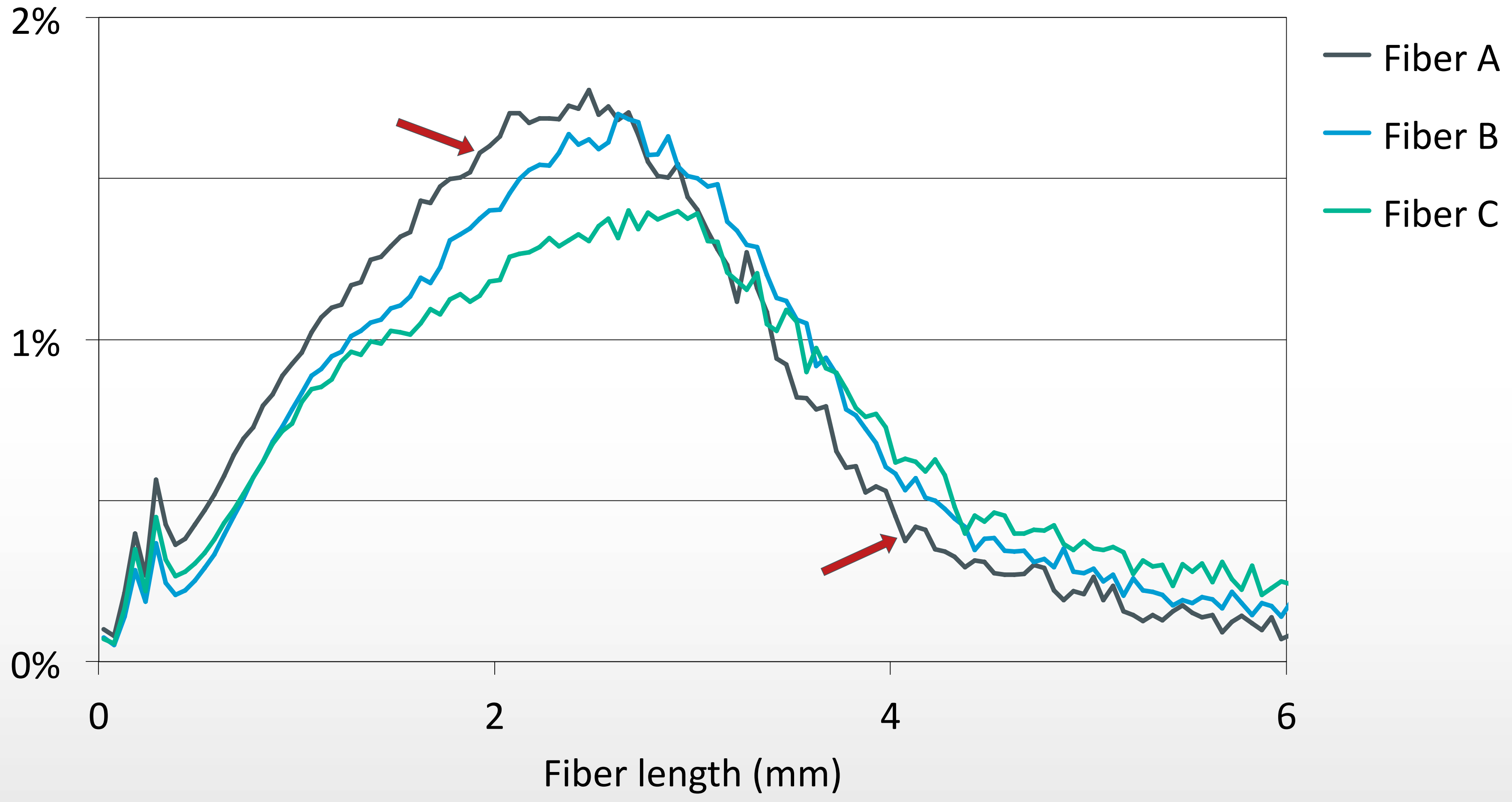
Fiber C

- Low temperature/ short time
- 4 bar (143 °C)/ 1 min

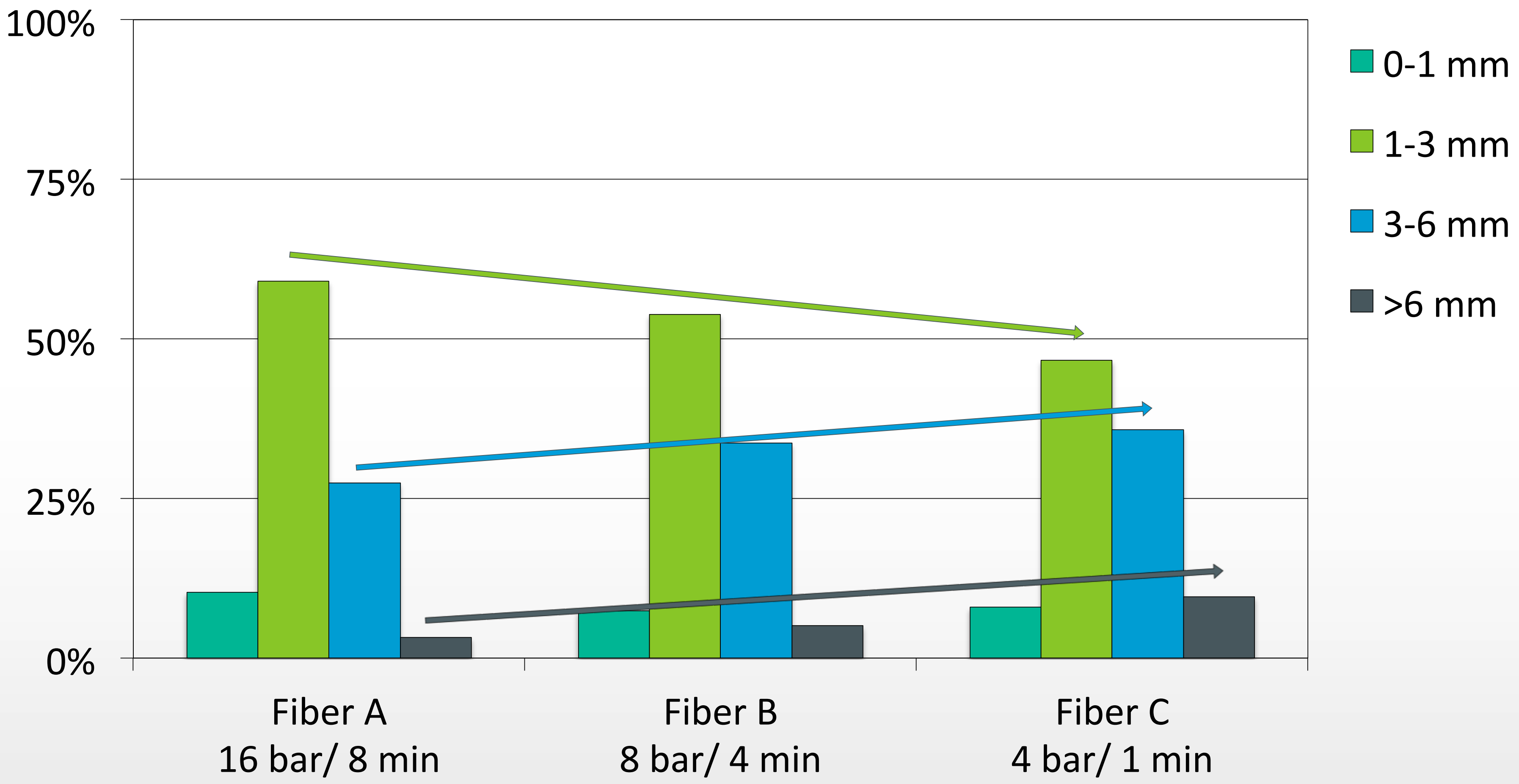
Relative frequency



Double length-weighted relative frequency



Double length-weighted relative frequency



Characteristic values

Fiber		A	B	C
Cooking conditions		16 bar/ 8 min	8 bar/ 4 min	4 bar/ 1 min
Double length-weighted relative frequency	0-1 mm	10.3%	7.4%	7.9%
	0-3 mm	59.0%	53.9%	46.7%
	3-6 mm	27.5%	33.7%	35.7%
	> 6 mm	3.2%	5.1%	9.6%
Double length-weighted fiber length		2.6 mm	2.9 mm	3.3 mm
Longest detected fiber		16.3 mm	18.4 mm	32.8 mm

Data treatment

Line chart

- 655 length classes (width: 0.05 mm)
- Weighting number of fibers two times by the fiber length average of each length class ($n*l^2$)
- Calculation of the (double length-weighted) relative frequency

Characteristic values and bar chart

- 4 length classes (width: 0-1 mm; 1-3 mm; 3-6 mm; >6 mm)
- Further procedure like for graph painting

Double length-weighted fiber length

- Data from characteristic value calculation
- $L_w = \sum n*l^3 / \sum n*l^2$

Conclusion and outlook

Conclusion

- A new approach for MDF fiber characterization is needed
- The presented measuring device fulfills the requirements for MDF fiber characterization
- The effect of varying cooking temperature and time on the fiber quality was shown

Outlook

- Characterization of differently manufactured MDF fibers (Grinding gap distance, wood specie,…)
- Correlation of fiber characteristics and fiberboard properties

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