Increase of Material Yield in Plywood Production with New Veneer Processing Technologies

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- Economic potential for plywood production in Germany
- Potential for technical improvements
- Simulation of Clipping strategies and yield estimation

Plywood Production in Germany

High discrepancy between the plywood production and the plywood demand in Germany:

- Production decreased from 83,000 m³ in 2002 to 30,000 m³ in 2005
- At the same time the imports increased from 823,000 m³ to 975,000 m³
- High raw material and especially high production costs seem to inhibit a profitable plywood fabrication in Germany
- Otherwise high stocks of large-dimension beech timber and "low density hardwood" (LDH: birch, alder, poplar, etc.) are available in German forests
- In other European countries a profitable plywood production was established by technological improvements and by the enlargement of the raw material basis
Forest Management and Plywood Production in Germany 1

Shift of forest area (%) in Germany (1987-2002)

- Oak: 0.7%
- Beech: 1.9%
- LDH: 0.6%
- Spruce: -0.3%
- Pine: -1.9%
- Larch: -0.7%

Forest Management and Plywood Production in Germany 2

Beech timber stocks in German forests (2002)

- 0-20: 7 Mio. m³
- 21-40: 8 Mio. m³
- 41-60: 10 Mio. m³
- 61-80: 12 Mio. m³
- 81-100: 14 Mio. m³
- 101-120: 16 Mio. m³
- 121-140: 18 Mio. m³
- 141-160: 20 Mio. m³
- > 160: 22 Mio. m³

40% Utilization
Potential for Technical Improvements

Requirements for a economic large-scale production of plywood in Germany:

- Reduce veneer losses
- Sawing (10%)
- Peeling (12.5%) and defect clipping (15%)
- Drying (11%)
- Pressing (10%)
- Trimming (10%)
- ...  
- Automate production, use alternative cutting schemes  
- Simulation of clipping strategies and yield estimation

State of the Art in Veneer Clipping

Today:

- Veneer defects are detected by cameras and image processing  
- Defective parts of the veneer are cut out  
  - High amount of data  
  - Detailed defect information is not logged  
  - Only basic defect statistics are recorded:  
    - Yield  
    - Percentage of defect classes
Effects of new Production Strategies

Today several questions remain unanswered:

- Could the yield be increased by alternative cutting schemes?
- If we change the definition of a defect or of defect classes, how would this affect the yield?
- Is it worthwhile ...
  - to buy a faster clipper?
  - to use cheaper but lower-graded logs?
  - to handle smaller strips?
  - to join pieces in fibre direction into an endless ribbon?
  - to repair defects?

Aim of Clipping Simulation

Procedure:

- Acquire a complete image from the veneer sheet
- Apply (simplified) defect detection algorithms
- Get detailed defect information
  - Size
  - Position
- Advantage:
  - Yield can be calculated as a function of defect definition
  - Cutting schemes can be optimized (virtual cutting)
Experiment 1 – Test Peelings with Beech Logs

Test peelings at Blomberger Holzindustrie (Delignit), Blomberg

Experiment 2 – Test Peelings with Spruce Logs

Test peelings at Moralt Tischlerplatten, Bad Tölz
Experiment 3 – Image Acquisition and Processing

Recording the complete veneer sheet in the production flow using a line camera between peeler and clipper

- Production speed: 60 … 100 m/min
- Resolution in fibre direction approx. 1 mm (2048 Pixel)
- Resolution perpendicular to fibre direction: better than 1 mm (line frequency: 20 kHz)
- Raw image data stored in partial images
- Approx. 100 to 300 MB data per peeling roll
- Overall 60 GB

Evaluation of Veneer Images 1

Post-processing of image data:

- Correct inhomogeneous illumination
- Adjust scale to increase contrast
- Stitch partial images
- Reduce data amount
- Detect defects by grey value thresholds
- Calculate defect size (area of surrounding rectangle)
- Extract defect statistics
Evaluation of Veneer Images 2

Part of a veneer surface

Image of the complete veneer surface

Evaluation of Veneer Images 3

Detail of veneer surface

Defects:
- Crack
- Hole
- Knot bigger than min. size
Evaluation of Veneer Images 4

Detail of veneer surface

Useable (no defect, minimum area exceeded)

Clipping Simulation 1

Procedure:

- Definition of material quality
  - Percentage of total defect area
  - (Theoretical) upper limit for yield
  - Real yield is smaller, depending on clipping scheme
- Real world:
  - Defects are clipped out perpendicular
  - Clipped area is discarded completely
  - Good pieces can be used only if they exceed a minimum length
  - Distance between two cuts cannot exceed a minimum value - limited by speed of cutting machine
Clipping Simulation 2

- Theoretical yield: Percentage of clear veneer area - to be achieved if
  - Defects could be clipped out exactly

- Realistic yield: Percentage of defect-free veneer area if
  - Defects are clipped out,
    but with a min. strip width of (e.g.) 50 mm

- More realistic yield: Percentage of defect-free veneer area if
  - Defects are clipped out,
    but with a min. strip width of (e.g.) 200 mm,
    and a min. distance between cuts 50 mm

Clipping Simulation 3

- Example for theoretical yield:
  - Defects are clipped out exactly
Clipping Simulation 4

- Example for realistic yield:
- Defects are clipped out with a certain min. width

Clipping Simulation 5

- Example for more realistic yield:
- Defects are clipped out with a certain min. width and cut distance
Clipping Simulation 6

Example: Spruce
Good and bad peeling roll
Results for theoretical and practical cases

Clipping yield and log quality - Spruce

Yield

100%
91%
82%
58%

52%

Roll 47446_2:
Grade A
32,4 m

Roll 47453_2:
Grade C
23,6 m

Defect clipping
min. 150 mm

min. 150 mm, real clipper

Clipping simulation 7

Example: Beech
Good and bad peeling roll
Results for theoretical and practical cases

Clipping yield and log quality - Beech

Yield

100%
87%
70%
65%

80%
68%

Roll 47567_1:
Grade B/C
109 m

Roll 47571_1:
Grade B/C
54 m

Defect clipping
min. 200 mm

min. 200 mm, real clipper
Results of Peeling Experiments

Quality indices considering real-world cutting scheme:

- For beech and spruce: Reflect visual log grades
- For beech and spruce: Reflect grades of peel rolls achieved by visual post-grading
- For beech: Reflect that best peel rolls are in the middle of the stem
- For spruce: Reflect that peel roll quality increases to the top of stem

Simulation of Processing Methods 1

Objective:

- Comparison of yield for alternative cutting strategies like
  - (a) variable defect clipping
  - (b) clipping of fixed sheet lengths + visual/automatic post-grading

Method:

- Simulated clipping of the veneer into fixed sheet lengths
- Simulated grading runs according to defect area or –size
- Statistic evaluation of grade distribution for stems or peel rolls
Simulation of Processing Methods 2

- Veneer sheet with marked defects
- Grading by defect area
- Grade distribution for peel roll

Conclusions

- Plywood production in Germany has a potential due to availability of wood resources
- Technological improvements are necessary but also realistic
- Methods to estimate yield potential of raw material and and/or new processing strategies are available