Wood Transportation Planning 4.0

FORMEC 2019

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Transportation Model

1. Forest → Truck

2. Terminal (multimodal) → Train

3. Industry (unimodal)
Terminal Operations

0. drive to landing, load wood, transport wood
1. access terminal
2. remove safety belts
3. load wagon
4. secure wagon load
5. clean loading platform
6. complete delivery note
Case Study Terminal

- 4 forest districts directly supply the terminal
- 3 regional carriers transport 2000 m³ wood per month (up to 30 000 after wind throws)
- Once (twice) a day a locomotive picks up the wagons
- 9 wagons can be loaded simultaneously
- Stockyard for 10 000 m³ wood
2 Simulation Model

<table>
<thead>
<tr>
<th>Animation</th>
<th>Scenarios</th>
<th>Statistics</th>
<th>Logic Supply Chain</th>
<th>Logic Terminal</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck Garage</td>
<td></td>
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<tr>
<td>Forrest 1, Landing 1</td>
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<td>Forrest 2, Landing 2</td>
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<td>Forrest 3, Landing 3</td>
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<td>Forrest 4, Landing 4</td>
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<td>Forrest 5, Landing 5</td>
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<td>Forrest 6, Landing 6</td>
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<td>Forrest 7, Landing 7</td>
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<tr>
<td>Industry</td>
<td></td>
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</tbody>
</table>

Trucks at Terminal: 9
Loaded Wagons: 0
Parameterization

MultiStrat Simulator Version 50 - Workshop Edition

Control Method
- Manually
- Plans
- Excel
- Workshop

Train Pickups
- 1
- 2
- Multimodal
- Unimodal

Transport priority
- Largest Stock
- Oldest Wood

Runtime (pause simulation)
- Year
- Month
- Week
- Day
- Train Pickup

Transport Module
- Triangular time distributions in minutes
  - Drive to landing
  - Load truck
  - Transport to terminal
  - Truck transport to industry
  - Train transport

- Triangular capacity distribution in solid cubic meters
  - Truckload

Costs
- Truck transport per solid cubic meter
  - Average costs to Terminal
  - Average costs to Industry
  - Train transport per solid cubic meter

Terminal Module
- Triangular time distributions in minutes
  - Remove Bets
  - Load Wagon
  - Secure Wagon Load
  - Clean Loading Platform
  - Complete Delivery Note
  - Unload at Terminal Stockyard
  - Unloading Truck at the Industry

- Maximum capacity in truck loads

Plan
- D1, D2, D3
- D4, D5
- D6, D7
- D8, D9

- District 1
- District 2
- District 8
- District 9

- Wagon per week
- Truck per week

blue: amount of provided wood for transport in every district in solid cubic meters (per week)
grey: number of trucks (in this week, MAX 50)
green: number of wagons (per pickup in this week, MAX 9)
Management Cockpit
Transport strategies

- BOTH: multimodal and unimodal transport
- MULTI: only multimodal (truck + train) transport
- UNI: only unimodal (truck) transport
3 Scenarios

- **BAU**  average yearly production volume based on historical data
- **SNOW**  reduced production in the first quarter of the year
- **STORM**  increased production in the third quarter of the year
## Results

<table>
<thead>
<tr>
<th>Scenario</th>
<th>BAU</th>
<th>SNOW</th>
<th>STORM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategy / KPI</strong></td>
<td>BOTH</td>
<td>MULTI</td>
<td>UNI</td>
</tr>
<tr>
<td>Transported (m³)</td>
<td>41,581</td>
<td>37,563</td>
<td>39,771</td>
</tr>
<tr>
<td>Stockyard (Truckloads)</td>
<td>66</td>
<td>225</td>
<td>158</td>
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<tr>
<td>Delivery Quota</td>
<td>1.12</td>
<td>1.11</td>
<td>1.04</td>
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<tr>
<td>Full Loaded Wagons</td>
<td>437</td>
<td>819</td>
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<tr>
<td>Half Loaded Wagons</td>
<td>85</td>
<td>92</td>
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</tr>
<tr>
<td>Empty Wagons</td>
<td>77</td>
<td>119</td>
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<tr>
<td>Fulfillment Level (%)</td>
<td>96</td>
<td>98</td>
<td>81</td>
</tr>
<tr>
<td>CO₂ Equivalents (Mio.)</td>
<td>719</td>
<td>579</td>
<td>762</td>
</tr>
<tr>
<td>Truck Utilization (%)</td>
<td>80</td>
<td>80</td>
<td>97</td>
</tr>
<tr>
<td>Queuing Time (Min.)</td>
<td>13.21</td>
<td>24.38</td>
<td>-</td>
</tr>
<tr>
<td>Transport Costs per m³</td>
<td>16.01</td>
<td>17.91</td>
<td>14.11</td>
</tr>
</tbody>
</table>
4 Workshop Edition

- For managers, scientists and students
- Different challenges / scenario settings
- Team ranking and strategy discussion
Conclusions

- BOTH proves to be resilient and outperforms other strategies by avoiding both bottlenecks and ill-timed plans and by reducing CO₂ emissions.

- Weaknesses (e.g. waiting times, lead time) and threats (e.g. natural disturbances, wagon/truck availability)

- Standalone workshop edition works well to teach students, inform colleagues and discover potential for improvement with industry experts.
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