More Productive Truck Configurations and Designs
Recent Developments in Canadian Forest Transport
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Overview

- History of W&D in Canada
- Why larger trucks?
- Approach
- Recent Initiatives
Why W&D regulations?

- Protection of people
  - Vehicle safety & security
  - Road fit
  - Interaction with the public

- Protection of infrastructure
  - Roads
  - Bridges
  - Overpasses, etc.
Canada at a glance

- **Canada is a vast country**
  - Nearly 10 million km$^2$ in size

- **With a vast road network**
  - Over 1 million km of roads

- **Spread across 10 provinces & 3 territories**

- **Road transport, including vehicle weights & dimensions, falls mainly at the provincial level**
  - Which has led to a high degree of variability in W&D regulations between jurisdictions
History of Weights & Dimensions in Canada

- Strong desire for more uniformity in regulation led to the initiation of a W&D Study
  - A clear goal of the study was to base any recommendations upon **sound, proven, rational performance criteria**
    - Especially focused on vehicle stability & pavement response
    - Also focusing on economics, interaction with other traffic, bridges, & the role of the driver
History of Weights & Dimensions in Canada

- Led to Canada adopting a national MOU on VWD in 1988
  - With W&D based upon performance-based standards (PBS)
    - Becoming the 1st country to adopt PBS
  - The MOU has been revised many times since
    - Added more configurations and the latest technologies & research
History of Weights & Dimensions in Canada

- Each jurisdiction:
  - Permits vehicles that comply with the MOU to travel on a designated system of highways in their jurisdiction
  - Continues to retain authority to allow more liberal weights & dimensions, or different types of vehicle configurations

- The MOU has been key in the development & adoption of new, larger, safer configurations
  - As long as the performance standards are met
Why Larger Trucks?

- Truck transport is a cornerstone of the Canadian economy & the forest industry
- Forest transportation represents 35-50% of raw materials costs
- Maximizing payload is key to improving efficiency & reducing costs
  - ~$7k/yr profit per tonne of payload
Why Larger Trucks?

- Larger trucks can also be safer than the older, smaller trucks they are replacing
  - Held to a higher performance standard than configurations developed before the MOU
  - More axles plus more brakes often means better stability and braking
  - More payload per truck means less trucks on the road

- The use of PBS ensures that safety related issues are identified & dealt with prior to adoption of any new configuration
  - They must operate safely on all road networks
Why Larger Trucks?

- Larger trucks are better for the environment
  - Productivity gains translate directly to significant reductions in:
    - Fuel consumption
    - GHG emissions

<table>
<thead>
<tr>
<th>No. of Axles</th>
<th>Fuel Consumption (L/100km)</th>
<th>Payload (tonne)</th>
<th>Fuel Intensity (L/t100km)</th>
<th>Savings per 1 million km (L)</th>
<th>Savings per 1 million km (tonne CO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>50.9</td>
<td>32</td>
<td>1.59</td>
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<td>7</td>
<td>56.6</td>
<td>37</td>
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<tr>
<td>8</td>
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<td>43</td>
<td>1.51</td>
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<tr>
<td>9</td>
<td>75.0</td>
<td>51</td>
<td>1.47</td>
<td>68,400</td>
<td>185</td>
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<tr>
<td>10</td>
<td>77.0</td>
<td>57</td>
<td>1.35</td>
<td>136,600</td>
<td>369</td>
</tr>
</tbody>
</table>
Provincial Focus

- Looking at new configurations, the route to adoption is (initially) usually found at the provincial level
  - Each province has their own unique needs
  - However, the PBS developed for the MOU allows provinces to evaluate their own region-specific configurations in the same light
  - And, the MOU provides the mechanism to adopt nationally, once enough interest is expressed
    - e.g. tridem drive
Approach

- New configuration concepts are typically driven by industrial need
- Developing solutions: from concept, through evaluations, to approval is a very time-consuming process
  - Typically 2-4 years (the bigger the change, the longer it takes)
- Solutions are best achieved through a collaborative effort
Vehicle Dynamics

- A proposed configuration’s dynamic performance can be analyzed using computer simulation models
- Performance measures focused on:
  - Stability & control
  - Off-tracking
- Must meet MOU PBS
Vehicle Dynamics

Performance Measures (typical)
- Static Rollover Threshold (SRT)
- Under-steer Coefficient @ 0.25g (USC)
- Load Transfer Ratio (LTR)
- Rearward Amplification (RA)
- Friction Demand (FD)
- Lateral Friction Utilization (LFU)
- Low–speed Off-tracking (LSOT)
- High-speed steady state off-tracking (HSOT)
- Transient Off-tracking (TOT)
Vehicle Dynamics

- Performance Measures (extra)
  - Front Out-swing (FO)
  - Rear Out-swing (RO)
  - Braking Capacity (BC)
  - Braking Efficiency (BE)
  - Additional Handling Measures (NRC 3 Point Handling Measure)
Vehicle Dynamics

- The simulation models have been validated for all typical Canadian configurations, for a wide range of conditions (weights, dimensions, etc.)
Vehicle Dynamics

- New technologies & configurations can require further real-world testing to further validate the models.
Infrastructure Requirements

- Evaluating how the vehicles will affect the road & bridge infrastructure.
  - Are the bridges built strong enough for the higher loads?
  - Will they increase or decrease damage to the road network?

![Evaluation of simple span bridge force effects from new BC log truck configuration](chart1.png)

![Comparison of gravel road impacts from four large log truck configurations](chart2.png)
Road Space Requirements

- Evaluating how the vehicles will fit on the roadway
  - How will the vehicle interact with other traffic?
  - What changes to road geometry may be required to accommodate the vehicle?
New configurations in Alberta

8-axle tractor/semi-trailer:
Versatile configuration, can haul both TL & CTL

10-axle B-train:
Up to 50% payload increase compared to an 8-axle B-train
Winter Weight Increases in Alberta

- The AB FIAT Task Force initiated a review of forest configurations to evaluate whether any weight increases were safely possible
  - Evaluations conducted over a 3 year period
  - Were able to safely recommend maximum GVW increases, for most configurations, of from 3 up to 10 tonnes during the Winter Weight period
  - Average payload capacity increase of 10%

- Estimated Fuel Consumption / GHG reduction of 5% to 6%
## Winter Weight Increases in Alberta

<table>
<thead>
<tr>
<th>Configuration</th>
<th>new GCW</th>
<th>Payload Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-axle B-train (tandem drive)</td>
<td>74 t</td>
<td>9 t</td>
</tr>
<tr>
<td>8-axle B-train (tridem drive)</td>
<td>76 t</td>
<td>11 t</td>
</tr>
<tr>
<td>9-axle B-train (tandem drive)</td>
<td>77 t</td>
<td>6.5 t</td>
</tr>
<tr>
<td>9-axle B-train (tridem drive)</td>
<td>79 t</td>
<td>7.7 t</td>
</tr>
<tr>
<td>10-axle B-train</td>
<td>88 t</td>
<td>9.7 t</td>
</tr>
</tbody>
</table>
## Winter Weight Increases in Alberta

<table>
<thead>
<tr>
<th>Configuration</th>
<th>new GCW</th>
<th>Payload Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tridem drive tractor/quadaxle semi-trailer</td>
<td>68 t</td>
<td>3 t</td>
</tr>
<tr>
<td>Tandem drive/tandem jeep/tridem pole trailer</td>
<td>69 t</td>
<td>4 t</td>
</tr>
<tr>
<td>Tandem drive/tandem jeep/tridem semi-trailer</td>
<td>74 t</td>
<td>9 t</td>
</tr>
</tbody>
</table>
Winter Weight Increases in Alberta

Estimated Savings ($/m$^3$) vs. Additional Payload (tonnes)

- $2.00
- $1.50
- $1.00
- $0.50
- $0.00

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Winter Weight Increases in Alberta

- Not everyone is able to take advantage of the increased Winter Weight allowances
  - Maximum bridge capacity is the main limiting factor
    - Especially with the larger 9- & 10-axle b-trains

- Engineering evaluations of problem bridges & routes continue
  - Some routes have now been approved for the higher weights
New Configurations in BC

- MoT released a new Reducible Load Overweight Policy
  - Sets out conditions for approval of heavier/larger configurations
  - Approval is route specific
  - Configuration & route must both be evaluated
    - Vehicle dynamics
    - Infrastructure capacities
    - Route road fit analysis
  - Monitoring programs required
9-axle B-trains in BC

- A 4-year collaboration of FPI, BC MoT, BC MoFLNRO, & industry has led to the approval of the first tridem drive 9-axle route in BC
  - Further route approvals for this configuration, as well as tandem drive approval, are currently underway
  - Potential to reduce transportation costs by from $2/m³ to $4/m³, saving the BC forest sector over $34 million/yr
9-axle B-trains in BC

- Approval is currently for one route only
- ‘Road Map’ document is under development
  - To specify the steps required for industry to apply for additional route approvals
  - Covering both separate MoT & MoFLNRO approval processes
9-axle B-trains in BC

- A guide book has been developed to assist industry with evaluating the safe use of 9-axle configurations on resource roads
- Will be available soon
10-axle Chip Van in BC

- An FPI, government, & industry collaboration is underway to develop a chip van in BC
  - The initiative has been ongoing for many years
  - Focused on 10 axles (not 9) for better load balance
  - Many more engineering hurdles to overcome (compared to 9 axles)
  - Potential to save BC forest industry $20 million/yr
2-Container Hauler

- Long-term initiative to develop a configuration that can carry 2 40-ft ocean containers
  - Strong interest from industrial locations with poor or no rail service
    - Can reduce or eliminate costly trans-loading costs
  - The extreme length of the configuration will likely limit the road networks on which this could operate
  - Innovative self-steering axles on the trailers are being evaluated to improve performance
Thank you

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