Heavy Hauling: A Worldwide Update and Highlights from IHHA2015
Agenda

• A snapshot of the heaviest haulers
• One example: Daqin China
• One example: Fortescue Australia
• Heavy Haul Best Practice
• Technologies highlighted at IHHA2015
• Headwinds highlighted at IHHA2015
• Some conclusions from IHHA2015
<table>
<thead>
<tr>
<th>IHHA Member Country</th>
<th>Axle Load (tons)</th>
<th>Standard Train Length (cars)</th>
<th>Future standard train length (cars)/axle loads (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA and Canada</td>
<td>36</td>
<td>129-170 cars</td>
<td>39 tons, 190-250 cars</td>
</tr>
<tr>
<td>Australia (Pilbara iron ore)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• BHPBilliton</td>
<td>41</td>
<td>204 cars</td>
<td>333 cars Going to 50 ton axle loads</td>
</tr>
<tr>
<td>• Rio Tinto</td>
<td>40</td>
<td>236</td>
<td></td>
</tr>
<tr>
<td>• FMG</td>
<td>44</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td>33</td>
<td>216 cars</td>
<td>342 cars</td>
</tr>
<tr>
<td>• Iron ore</td>
<td>29</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>• Coal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>36</td>
<td>330 cars</td>
<td>42 tons</td>
</tr>
<tr>
<td>• Vale iron ore</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>28</td>
<td>210 cars</td>
<td>40 tons</td>
</tr>
<tr>
<td>• Daqin</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Shuohuang</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td>20</td>
<td></td>
<td>33 tons</td>
</tr>
<tr>
<td>Sweden</td>
<td>30</td>
<td>68 cars</td>
<td>36 tons going to 44 tons</td>
</tr>
<tr>
<td>• LKAB Iron Ore</td>
<td></td>
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</tr>
</tbody>
</table>
China’s Daqin Line

- 653 km electrified double track
- 375 million gross tons/year
- Mountainous terrain with many tunnels up to 5 mi. long
- Two 30 mi. long grades in downward direction
Innovations for Chinese Heavy Haul

- 10,000 kW (13,400 HP) electric locos
- Elastic rubber drawgears to reduce longitudinal forces
- Locotrol with GSM-R integration, for locos in 3-4 positions in 22,000 ton trains
- ECP Braking
- Aluminum/SS carbody coal gons
- Gons permanently coupled in sets of 3 with rotary couplers
Mechanical Inspection of Trains

- Acoustic bearing detectors and hot wheel and bearing detectors
- Car inspectors review images gathered from 5 cameras
- Inbound train inspection time reduced from 1 hour to 14 minutes
Fortescue Railway
In the Pilbara
Track Construction
Achievements

- 288km of track constructed in < 9 months
- 35 mtpa rate operation within 12 months of start up
- Proved 40 tonne axle load operation
- Readily expandable to 200 mtpa

288km of track, 19,584 tonnes of rail, 427,000 sleepers and 7 million cubic metres of earth
Highlights

- Trains started running on 5 April 2008
- 1,100 trains delivering 26 million tonnes to date
- Driver only operations – 240 car trains
- Train control in Perth 1,600 km away
- 4 x 240 car train sets (55 mtpa)
- Cycle time <20 hours
Rollingstock
Basis of design

- Proven locomotives modified for Pilbara conditions
- Ore cars designed for 40 tonne axle load
- Ore car wheel improved AAR standard ≤1mm FBH defect allowed (Maanshan Iron & Steel)
- Ore car castings of higher quality and strength than AAR standards
- Wheel profile design specifically for Fortescue to match rail head profile
- Mainline train speed of 80 km/h loaded
- Ore cars married pair with single brake controller
- AAR plate “C” clearance outline
- ECP brake system (Knorr-Bremse)
Locomotives (manufactured by GE)
15 x 44CW GE Dash – 9 (4,400HP)
Ore cars (manufactured by CYR)
976 of the world’s heaviest haul ore cars

Ore car workshop is highly automated
Ore car bogie

- Metalastic primary suspension
- Cross braced bogie (minimise wheel flange wear)
- Improved casting strength of bolsters and sideframes for 40 tonne axle load
- 2 stage secondary suspension for improved empty ride performance
Heavy Haul Best Practice

- 40,000t trains with distributed power in up to 4 locations
- Axle loads up to 44 tons
- ECP braking
- Single driver, with fuel and train dynamics analyzers
- Control devices for longitudinal forces
- Increased payload to tare ratios
- Wayside and onboard diagnostics
Heavy Haul Best Practice

- Managed friction
- Wheel/rail profile matching
- Micro-alloyed wheels and rails
- All welds are flash butt
- Concrete sleepers and reinforced concrete bridges
- Scheduled precision railroading
- Condition-based maintenance with wear and defect trending
- Bogie tracking diagnostics and 2 mm wheel tread hollow spec.
Technologies Highlighted at IHHA2015

• Phased array ultrasonic testing
• New models of stress analysis, dynamic simulation and fracture mechanics
• Expansion of automated asset health monitoring, and shift to condition based maintenance guided by rules engines and trending
• Continued growth in strength of materials through microalloying, lighter weight stainless steel in wagons
Technologies Highlighted at IHHA2015

- Evolution in the practice and use of ECP braking
- Elastic pads under concrete ties and turnouts
- Greater use and carry down of friction modifiers and further evidence they lower the stress state
- New designs of couplers, yokes and draft gear
- Green technologies for motive power
- Communication-based train control as a boost to network capacity
- The growth of autonomous instrumented freight cars doing frequent, performance-based track inspections
Headwinds Highlighted at IHHA2015

• The transformation to a rolling contact fatigue regime with increases in axle loads beyond 33 tonnes
• The onset of rail weld failures as rail lives continue to increase with better metallurgy and maintenance practices
• The high cost of operational variances like low train speeds of under-powered trains, tread hollowed wheels, bad actor cars, poor track drainage and high impact wheels
Some Conclusions from IHHA2015

• No heavy haul railway has been successful without learning wheel/rail interface basics.
• Longer trains can be both more productive and less destructive.
• Heavier axle loads bring on a stress-based regime, but can be managed.
• Maintenance can be proactive and preventive
• ECP braking is here to stay and will only improve.
• There is much scope to support train drivers and inspectors with technology. Automation?
See you in Cape Town!