Challenges facing the Road Freight Industry in South Africa and a Performance-Based Standards (PBS) approach to heavy vehicle design

Paul Nordengen
SA RTMS National Steering Committee Research Group Leader: Network Asset Management Systems
CSIR Built Environment
CONTENTS

- Background and problem statement
- The Road Transport Management System – self regulation
- Some observed successes
- PBS approach to vehicle design
- PBS pilot project in South Africa
- Pilot project monitoring results
Road Transport Efficiency & Safety

- High standard of infrastructure (capacity, road surface, road markings, road signs, stopping facilities, road reserve)
- Minimum incidents/crashes including breakdowns
- Compliance with traffic regulations
- Safety & security (effective law enforcement)
- Efficient emergency response
- Seamless cross-border transit
Key Elements in Road Freight Transport

• Road infrastructure: roads, bridges, roadside furniture, signs, road markings, eToll gantries😊
• Vehicles: design, maintenance & operation
• Drivers: skill, health, fatigue
Key Elements in Road Freight Transport

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• Vehicles: design, maintenance & operation

• Drivers: skill, health, fatigue
Key Elements in Road Freight Transport

• Road infrastructure: roads, bridges, roadside furniture, signs, road markings, eToll gantries 😊

• Vehicles: design, maintenance & operation

• Drivers: skill, health, fatigue
Reality Check
Reality Check
Reality Check
Reality Check
Excess heavy vehicle maintenance and repair costs

<table>
<thead>
<tr>
<th>Road condition</th>
<th>Average maintenance and repair cost (R/km)</th>
<th>Average percentage increase in the truck maintenance and repair cost</th>
<th>Average percentage increase in company logistics cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>R 0.96</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fair</td>
<td>R 1.24</td>
<td>30%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Bad</td>
<td>R 2.11</td>
<td>121%</td>
<td>10.4%</td>
</tr>
</tbody>
</table>
Brake & Tyre Watch Results

<table>
<thead>
<tr>
<th>Location</th>
<th>Inspected</th>
<th>Discontinued</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Deep</td>
<td>24</td>
<td>21</td>
<td>88%</td>
</tr>
<tr>
<td>Middelburg</td>
<td>35</td>
<td>24</td>
<td>69%</td>
</tr>
<tr>
<td>Centurion</td>
<td>41</td>
<td>17</td>
<td>42%</td>
</tr>
<tr>
<td>Midway KZN</td>
<td>26</td>
<td>10</td>
<td>38%</td>
</tr>
<tr>
<td>Kroonstad</td>
<td>8</td>
<td>7</td>
<td>92%</td>
</tr>
<tr>
<td>Brackenfell, W. Cape</td>
<td>25</td>
<td>25</td>
<td>100%</td>
</tr>
<tr>
<td>Pietermaritzburg</td>
<td>12</td>
<td>11</td>
<td>92%</td>
</tr>
<tr>
<td>Port Elizabeth</td>
<td>15</td>
<td>6</td>
<td>40%</td>
</tr>
<tr>
<td>Rustenburg</td>
<td>7</td>
<td>5</td>
<td>72%</td>
</tr>
<tr>
<td>Polokwane</td>
<td>11</td>
<td>10</td>
<td>91%</td>
</tr>
<tr>
<td>Midway KZN</td>
<td>24</td>
<td>20</td>
<td>83%</td>
</tr>
<tr>
<td>Bloemfontein</td>
<td>24</td>
<td>20</td>
<td>83%</td>
</tr>
<tr>
<td>Nelspruit/Komati</td>
<td>13</td>
<td>12</td>
<td>92%</td>
</tr>
<tr>
<td><strong>TOTAL (38 events)</strong></td>
<td><strong>723</strong></td>
<td><strong>494</strong></td>
<td><strong>68%</strong></td>
</tr>
</tbody>
</table>

38 B&TW events from Feb. 2006 to date
Heavy Vehicle Fatal Crash Rates

Fatal truck crash per 100 million vehicle kilometres travelled

Source: OECD report, Moving Freight with Better Trucks, 2010
Road Freight Challenges
The Reality: A Culture of Non-compliance

• Inputs
  – Overloading
  – Poor vehicle fitness (servicing & maintenance)
  – Poor driver fitness (fatigue, health, training)
  – Reckless driver behaviour
  – Border post delays
  – Bribery & corruption – impact on compliant and non-compliant operators
  – Inadequate periodic maintenance (roads)

• Outputs
  – Poor road safety
  – High cost of road transport/logistics
  – Deterioration of infrastructure
  – High levels of emissions
Regional Road Transport Issues

**QUALITY OF LIFE**
- Road safety
- Congestion
- Cost of logistics
- Road condition

**GLOBAL COMPETETIVENESS**
- Transport efficiency
- Cost of logistics
- Congestion
- Cross-border delays
- Optimum road maintenance

**HEAVY VEHICLE TRANSPORT**
- “maintaining and preserving natural systems”

**SUSTAINABLE ENVIRONMENT**
- Transport efficiency
- Road crashes
- Road condition
- Congestion
- Energy consumption
- Emissions
Road Safety

Infrastructure Protection

Fair Competition between modes & operators

OVERLOAD CONTROL
National Overload Control Strategy
Implemented by National, Provincial and Local Authorities

Infrastructure & Equipment
- Main routes (major facilities)
- Alternative routes (minor facilities/screening)
- Monitoring (HS-WIM)
- Alternative weighing equipment
- Private weighbridges

Self-regulation
- Road Transport Management System (RTMS)
- Performance-Based Standards (PBS)

Information sharing & Public Awareness
- Overload website
- Overload information booklet

Operations
- Human Resources
- PPP
- Training
- Guideline document for law enforcement

Legislation
- Consignors/Consignees
- 5% Tolerance
- User charges
- Habitual Overloaders
- Public Prosecutors
- Alternative weighing equipment
- AARTO

Co-operation
- Provinces
- Local authorities
- Department of Justice
- Private sector
STANDARDS SOUTH AFRICA

Recommended practice

Road transport management systems

Part 1: Operator requirements — Goods

This document does not have the status of a South African National Standard.
SOUTH AFRICAN NATIONAL STANDARD

Road transport management systems
Part 1: Operator requirements — Goods
RTMS: Overloading trend in forestry
RTMS: Overloading trend in sugar
Benefits: Efficiency Improvements

Fuel Consumption Improved from 17l/100km to 13l/100km
Carbon footprint improved by 24%
Cost savings on fuel =R5.7 Million
Cost savings on repairs and maintenance =R4.2 Million (2016FY)
City of Cape Town: Reduction in Incidents
ZZ2 (Tomato producers): Reduction in Insurance Claims
Vehicle Delivery Services: Reduction in Speed violations
POSITIVE RESULTS AND OUTCOME AFTER IMPLEMENTING RTMS

Weighbridges or weigh mats at all depots:
All trucks are weighed before exiting and any defaults are fixed before trucks leave the yard
• 2013 and before = unknown
• 2014 = 3
• 2015 = 0

Risk of breakdowns/crashes/fines:
Strict daily routine inspections and regular tyre surveys, maintenance checks have improved our downtime, and any issues are repaired before trucks leave.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>FINES</th>
<th>CRASHES</th>
<th>DRIVER ERROR</th>
<th>BREAKDOWNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>218</td>
<td>37</td>
<td>19</td>
<td>57</td>
</tr>
<tr>
<td>2014</td>
<td>232</td>
<td>26</td>
<td>11</td>
<td>46</td>
</tr>
<tr>
<td>2015</td>
<td>56</td>
<td>17</td>
<td>5</td>
<td>33</td>
</tr>
<tr>
<td>2016</td>
<td>28</td>
<td>26</td>
<td>4</td>
<td>20</td>
</tr>
</tbody>
</table>
**Fuel consumption**
Consistent improvement. Fuel monitored on a daily basis and we are running above industry average. Since implementation, fuel consumption has improved by 20%
Primarily as a result of improved driver behaviour – defensive and economical driving, reduction in harsh braking and speeding.

**Speeding occurrences**
2013: Unknown
2014: 60 127 (299/truck/yr)
2015: 8 689 (34/truck/yr)
2016: 4 722 (18/truck/yr)
PBS Pilot Project Objectives

Investigate the Performance-Based Standards approach to heavy vehicles design and operations as researched and implemented specifically in Australia, Canada and New Zealand with a view to improving heavy vehicles operations in South Africa through:

• Reduced road wear (per tonne.km)
• Reduced vehicle trips i.e.
  • Reduced congestion
  • Reduced safety exposure risk
• Improved safety performance
• Improved transport productivity
• Reduced emissions (per tonne.km)
Problem statement
Problem statement
Problem statement
# Performance-Based Standards

<table>
<thead>
<tr>
<th>Prescriptive Standards</th>
<th>Performance-Based Standards</th>
</tr>
</thead>
</table>

## What the vehicle looks like

<table>
<thead>
<tr>
<th>Governs mass and dimensions</th>
<th>Constrains productivity</th>
<th>Constrains innovation</th>
</tr>
</thead>
</table>

## What the vehicle can do

| Governs actual on-road performance | Allows heavier and/or larger vehicles | Promotes innovation |

Images courtesy of the Australian National Transport Commission
Smart Truck Pilot Project: Timeline

**Phase 0 Preparation**
- Go-ahead from DoT
- Refining PBS framework for SA
- Knowledge/skills development

**Phase 1 Proof of concept**
- Get more industries on-board
- Get all provinces on-board
- Monitoring data and research

**Phase 2 Intensive monitoring**
- Implementation strat.

**Phase 3 Formalisation**
- Promulgation
- OR phase out

- Qualification awarded
- Technology output
- South African PBS assessor accredited

Key dates:
- PBS committee established
- 1st PBS vehicles
- 100m km of data collected
- Decision to implement
- Formal adoption

- DoT support granted
- 2 vehicles 1 province
- 245 vehicles 6 provinces

- 2004
- 2007
- 2017
- 2020?
- 2025?
# Performance-Based Standards: Safety

<table>
<thead>
<tr>
<th>Manoeuvre/Test</th>
<th>Performance Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-speed 90° turn (5 km/h)</td>
<td>Low-speed swept path</td>
</tr>
<tr>
<td></td>
<td>Tail swing</td>
</tr>
<tr>
<td></td>
<td>Frontal swing</td>
</tr>
<tr>
<td></td>
<td>Steer-tyre friction demand</td>
</tr>
<tr>
<td>High-speed lane-change (80 km/h)</td>
<td>Rearward amplification</td>
</tr>
<tr>
<td></td>
<td>High-speed transient offtracking</td>
</tr>
<tr>
<td>Rollover</td>
<td>Static rollover threshold</td>
</tr>
<tr>
<td>High-speed pulse steer (80 km/h)</td>
<td>Yaw damping coefficient</td>
</tr>
<tr>
<td>High-speed on uneven road (90 km/h)</td>
<td>Tracking ability on a straight path</td>
</tr>
<tr>
<td>Various (driveability standards)</td>
<td>Startability</td>
</tr>
<tr>
<td></td>
<td>Gradeability A</td>
</tr>
<tr>
<td></td>
<td>Gradeability B</td>
</tr>
<tr>
<td></td>
<td>Acceleration Capability</td>
</tr>
</tbody>
</table>
Low-Speed Offtracking
Low-Speed Offtracking

PATH FOLLOWED BY OUTSIDE TRACTOR TIRE

MAXIMUM WIDTH OF SWEPT PATH

PATH FOLLOWED BY INNERMOST TRAILER TIRE
Low-Speed Offtracking

Standard Semi-Trailer
High Speed Transient Offtracking

PBS Lane Change Manoeuvre (SAE J2179)

Course and test specifications:
- 2.5 second period
- 24.5 m/sec (55mph)
- 61 m (200 ft) maneuvering section
- 1.46 m (4.8 ft) lateral displacement
- 0.15 g peak lateral acceleration

Traffic cone pairs: 4.58 m (15 ft) stripes placed 0.6 m (2 ft) apart*

Initial Straight section, 6.1 m (20 ft) spacing
"Maneuvering" section, 3 m (10 ft) spacing
Exit section, 6.1 m (20 ft) spacing

500 152.5 m
400 122 m
300 91.5 m
200 61 m
100 30.5 m
0 0
-100 -30.5 m
-200 -61 m

* not drawn to scale
High Speed Transient Offtracking

baseline

PBS
Rollover stability: Baseline (legal) vs PBS
Performance-Based Standards: Infrastructure

Infrastructure

Pavements

Pavement Vertical Loading
Pavement Horizontal Loading
Tyre Contact Pressure Distribution

Bridges

Bridge Loading

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Road Wear Performance Standard

![Graph showing Road Wear Performance Standard]

Vehicle description

Baseline-M01, PBS (dual tyres), M01a, M01b, Baseline-M02, PBS-M02, Baseline-M03, PBS-M03, Baseline-M04, PBS-M04, Baseline-M05, PBS (Merc), M05, Baseline-M06, PBS-M06, Baseline-M07, PBS ver 1, M07a, PBS ver 2, M07b.

LEF/ton payload

Baseline, PBS
2 Span Bridge: Max Negative Bending Moment Load Ratio (10% Baseline Overload)

- Timber Logistics Services Baseline Vehicle with 10% overload
- Worst Performing Single Tandem Trailer Vehicle 10%
- Worst Performing Single Tridem Trailer Vehicle 10%
- Worst Performing B-Double Vehicle 10%
- TLS PBS Vehicle
- NBC PBS Vehicle
- Unitrans Fuel Quad
- SAB PBS Vehicle
PBS in Africa ??? ....
PBS Pilot Project in South Africa

PBS MONITORING DATA UP TO JUNE 2017

TOTAL PBS VEHICLES 224

TIMBER
MINING
FUEL
PROCESSED SUGAR
COAL
BUSSES
ALUMINIUM INGOTS
BEER
SUGAR CANE
PAPER REELS

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SMART TRUCK PROGRAMME

RULES FOR THE DEVELOPMENT AND OPERATION OF SMART TRUCKS AS PART OF THE PERFORMANCE-BASED STANDARDS RESEARCH PROGRAMME IN SOUTH AFRICA

April 2017

Compiled by: Smart Truck Committee and CSIR Built Environment
Access: Route assessments
Access: Route assessments
Access: Route compliance
Access: Speed compliance

Location: M13, eThekwini Ward 18, Pinetown, eThekwini Metropolitan Municipality, KwaZulu-Natal, 3610, South Africa

This is an automated message. Please do not reply. For any queries please call Avani Africa on (0)900 4494.
Forestry baseline and PBS vehicles

- 22.0 m, 56.0 tons
- 24.0 m, 64.1 tons
- 27.0 m, 67.5 tons
- 25.8 m, 67.5 tons
- 25.0 m, 70.0 tons
Buhle Betfu Rigid drawbar
Timber Logistics Services Rigid drawbar
Mining side-tipper
Unitrans
BAB Quad
Unitrans B-Triple vs BAB Quad
Mining Road Train: Rearward Amplification
Barloworld Transport Sugar Bottom Dumper
SG Coal B-double
Unitrans Fuel Quad
## Fuel Quad Case Study

### PBS Combination vs Baseline Combination

<table>
<thead>
<tr>
<th>Category</th>
<th>PBS Combination</th>
<th>Baseline Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payload (GCM)</td>
<td>38t</td>
<td>32t</td>
</tr>
<tr>
<td>Payload as % of GCM</td>
<td>68%</td>
<td>58%</td>
</tr>
<tr>
<td>Mass Distribution (GCM)</td>
<td>56t</td>
<td>55t</td>
</tr>
</tbody>
</table>

### Fuel

- **1.2** L/Tonne Payload/100km
- **16.94%** LESS FUEL CONSUMED BY THE PBS VEHICLE

### Trips

- **27** TOTAL RETURN TRIPS
- **R 2 076 323** SAVING PER 1000 Tonne-Payload Transported

### Roadwear

- **0.37** ROADWEAR/Tonne Payload
- **9.5%** LESS ROADWEAR/Tonne-Payload

### Safety

- **1.37** ACCIDENTS/MILLION KM
- **39%** LOWER CRASH RATE FOR PBS VEHICLES
- **R 261 000** ACCIDENT COST SAVING/MILLION KM

### PBS Cost Savings Per 1000 Tonnes

- **R 2 083 370**
Beefmaster B-triple for cattle
SA Breweries PBS combination
## SA Breweries E. Cape PBS combinations: Efficiency improvements

<table>
<thead>
<tr>
<th>Month</th>
<th>Kms Travelled</th>
<th>Kms Saved</th>
<th>Hours on the road</th>
<th>Hours Saved</th>
<th>Fuel Used (ℓ)</th>
<th>Fuel Saved (ℓ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec-16</td>
<td>33 250</td>
<td>13 253</td>
<td>621</td>
<td>248</td>
<td>23 940</td>
<td>3 962</td>
</tr>
<tr>
<td>Jan-17</td>
<td>74 642</td>
<td>29 720</td>
<td>1 477</td>
<td>588</td>
<td>55 059</td>
<td>7 558</td>
</tr>
<tr>
<td>Feb-17</td>
<td>63 854</td>
<td>25 519</td>
<td>1 245</td>
<td>497</td>
<td>46 564</td>
<td>7 060</td>
</tr>
<tr>
<td>Mar-17</td>
<td>82 108</td>
<td>32 349</td>
<td>1 614</td>
<td>636</td>
<td>60 497</td>
<td>8 117</td>
</tr>
<tr>
<td>Total</td>
<td>253 854</td>
<td>100 841</td>
<td>4 957</td>
<td>1 969</td>
<td>186 060</td>
<td>26 697</td>
</tr>
<tr>
<td>% Savings</td>
<td>28.4</td>
<td></td>
<td></td>
<td>28.4</td>
<td></td>
<td>12.5</td>
</tr>
</tbody>
</table>
ZZ2 B-triple for tomatoes
B-double Tautliner Case Study

PBS COMBINATION

- PAYLOAD: 48t
- GCM: 72t
- MASS DISTRIBUTION: 66%

BASELINE COMBINATION

- PAYLOAD: 34t
- GCM: 56t
- MASS DISTRIBUTION: 61%

- 9.39% LESS FUEL CONSUMED BY THE PBS VEHICLE
- TOTAL RETURN TRIPS: 22
- FUEL COST PER TONNE-KM: R 0.15
- FUEL COST % OF TRANSPORTATION COST: 35%
- TOTAL COST PER TONNE-KM: R 0.44
- ROADWEAR/TONNE PAYLOAD: 0.159
- 7.5% LESS ROADWEAR/TONNE-PAYLOAD

- ACCIDENTS/MILLION KM: 1.37
- 39% LOWER CRASH RATE FOR PBS VEHICLES
- R 261 000 ACCIDENT COST SAVING/MILLION KM

PBS COST SAVINGS PER 1000 TONNES: R 642 781

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Overtaking statistics

**COMPARISON OF OVERTAKING TIMES TAKING SPEEDING INTO ACCOUNT**

- 80 km/h
  - **BASELINE/22m PBS**
  - Time: 9.20 s

- 100 km/h
  - **BASELINE**
  - Time: 10.96 s

- 110 km/h
  - **BASELINE**
  - Time: 18.17 s

- 80 km/h
  - **PBS - TIMBER**
  - Time: 9.68 s

- 80 km/h
  - **PBS - TAULINER**
  - Time: 9.95 s

Reduction in overtaking time vs speeding baseline equivalent @ 100 km/h: 226 hours per PBS vehicle per year

Reduction in overtaking time vs speeding baseline equivalent @ 100 km/h: 262 hours per PBS vehicle per year
PBS Bi-articulated Bus
PBS Bi-articulated Bus

Original Vehicle

Modified Vehicle
Car Carriers
## Smart Truck Pilot Project: Impact

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total trips saved per year</td>
<td>74,067 trips</td>
<td>22%</td>
</tr>
<tr>
<td>Total fuel saved per year</td>
<td>R 26.64 M</td>
<td>12%</td>
</tr>
<tr>
<td>Total km saved per year</td>
<td>8,693,848 km</td>
<td>22%</td>
</tr>
<tr>
<td>Greenhouse gas emission</td>
<td>6246 tons CO2 / year</td>
<td>12%</td>
</tr>
<tr>
<td>Roadwear reduction</td>
<td>R 24,448 per vehicle / year</td>
<td>13%</td>
</tr>
<tr>
<td>Accidents per million km</td>
<td>1.37 vs 2.24 for baseline vehicles</td>
<td>39%</td>
</tr>
</tbody>
</table>

Note: Statistics are reported as at June 2017
Estimated Savings in Road Wear for 2017 (PBS vs Baseline):

- **Total:** R 4.7 to R 6.4 million (R 0.3 to R 0.4 LEF/tonne.km)
- **13%** reduction
- **Average R 24 450** per vehicle
- **Average R 0.34** per laden km travelled
Smart Truck monitoring: Crash rates

Crash rate ratio: Smart Truck : Baseline 1:1.63
### Smart Truck monitoring: Cost of crashes

<table>
<thead>
<tr>
<th></th>
<th>Km (million)</th>
<th>Crash Rate (per million km)</th>
<th>Cost/crash</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart Trucks</td>
<td>90.27</td>
<td>1.45</td>
<td>R 300 000</td>
<td>R 39 268 000</td>
</tr>
<tr>
<td>Legal Trucks</td>
<td>132.57</td>
<td>2.25</td>
<td>R 300 000</td>
<td>R 89 483 000</td>
</tr>
<tr>
<td>Cost savings</td>
<td></td>
<td></td>
<td></td>
<td>R 50 215 000</td>
</tr>
</tbody>
</table>

Cost savings: R 50 215 000
Smart Trucks: Way forward

Phase 0: Preparation
- Go-ahead from DoT
- Refining PBS framework for SA
- Knowledge/skills development

Phase 1: Proof of concept
- Get more industries on-board
- Get all provinces on-board
- Monitoring data and research

Phase 2: Intensive monitoring
- Implementation strat.

Phase 3: Formalisation
- Promulgation
- OR phase out

Qualification awarded
Technology output
South African PBS assessor accredited
Smart Trucks: Way forward

• Phase 2
  • Intensive monitoring
  • Increase sample size
  • Involvement of all 9 provinces in the pilot
  • Decision whether to implement or not

• Phase 3
  • Formalise policies and procedures
  • Update legislation
  • Smart Truck portal: administration, monitoring, evaluation
    OR
  • Exit strategy

• Formal adoption
Thank you