Modelling of Service Reliability Using OpenTrack

IT 08 Closing the Loop - Capacity and Quality of Railway Systems January 2008

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Corporate Background

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Plateway Capability

• Financial Assessment of Railway Operations and Projects
  – Project economic evaluations and cost/benefit analysis
  – Value management studies
  – Due diligence

• Railway Service Design
  – Single train simulation using OpenTrack
  – Railway network simulation using OpenTrack
  – Timetable design using Viriato
  – Haulage system capacity

• Management System Development
  – Development of Railway Safety Management Systems
  – Railway safety audits
  – Risk assessments
Plateway Capability

• Railway Management Service
  – Project management
  – Tendering and estimating
  – Contract management
  – Contract strategy selection
  – Contract performance assessment

• Railway Engineering
  – Technical standards and requirements assessments
  – Reliability analysis
  – Asset condition and assessment
  – Work program development
  – Infrastructure and rollingstock acceptance testing
  – Terminal design
Reliability – Why Bother?

- Cost base – infrastructure, rollingstock.
- Asset utilisation.
- Market share particularly for high value time sensitive freight.
- Network Connectivity
Reliability Modelling with OpenTrack

- System View (Monte Carlo Function)
  - Good approach for testing timetable when you do not care what is driving the causes of poor reliability.
  - Useful for evaluating whether a service design on a given infrastructure can meet the required level of on time running performance.
  - Historical data set does not discriminate between cause and consequence.
• Incidents View
  – Test the impact of a discrete data set.
  – Quite often the railways engineering data set (rollingstock failures, TSR records, signal failure records align better with this view).
  – Historical data set does discriminate between cause and consequence.
Basic Premise

• We can describe system happening on a railway mathematically using a series of probability distributions which describe the probability of failure of an element (such as signals, terminal despatch of trains).
• These are generated randomly.
• Entered into OpenTrack as incidents.
Basic Premise

- OpenTrack software can calculate the consequences on a network wide basis for each total incident data set.
- These can be calibrated against the historical data set.
- Consequences should correlate with the historical data set.
- Variable analysis can be used to test the impact of changing each chosen distribution and the resulting benefits to the rail service.
Australian Railway Network

Trans Australian Railway
Australian Railway Network

- Interstate Network is Around 9,400km in length.
- Connects all state capital cities with a uniform gauge (1,435mm).
- Started in 1912 (first major section opened in 1917) and completed in 1995 (or 2004 if Darwin is included).
Australian Railway Network

- Maximum train speed of 115km/h (parts up to 160km/h).
- Maximum train length of 1,800m.
- Maximum axle load of 25 tonnes.
- West of Adelaide/Parkes double stacking permitted.
• Open Access managed by four major access providers.

• Currently one large freight operator, several small freight operators and state based passenger services.

• Volume of rail traffic varies along the east west corridor from 5MGT p.a. to 22MGT p.a.

• Other portions include sections of up to 120MGT p.a.
OpenTrack the “Virtual Railway”

- Pacific National OpenTrack model was started in 2003 and covers all of the Interstate Rail Network (excl. Tarcoola – Darwin), with a total route length of in excess of 9,000km.
- The model is populated from an access seekers perspective using data provided by the network owner to all access seekers.
- Originally developed to test the benefits of funding proposals generally in ‘single train’ mode.
OpenTrack the “Virtual Railway”

- Single Train Simulations
  - Time benefits of main south infrastructure upgrades.
  - Capability of North – South route options (for DOTARS study).
OpenTrack the “Virtual Railway”
OpenTrack the “Virtual Railway”

- Multi Train Simulations
  - Moss Vale – Unanderra & Illawarra Bulk Terminal.
  - South Sydney Freight Line & Metropolitan Goods Line.
  - North Coast loop extensions (both 1,500m & 1,800m).
  - Reliability modelling Adelaide – Parkeston.
East West Study

• Railway Line runs through an uninhabited landscape.
• Fuelling at Cook and Parkeston acts as capacity limiters.
• Historically a section with high reliability assets.
• Timetabled Transit Time Adelaide – Parkeston:
  – Express Freight  24:15
  – Passenger        24:20
  – Standard Freight 40:15
East West Study

• Market Demand creates flights of trains heading west or east.
• Between those flights the corridor has surplus capacity.
• Market growth causes additional trains to be added to a given sequence of flights (i.e. the number of flighted trains increases).
### East West Study

**CUSTOMER COMMITTED CAPACITY GRAPH**

**as at 9th JULY 2006**

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- Contracted Service
- Non Contracted Service

Locations where flights of trains cross

Source ARTC Website
East West Impact of Growth

- Additional train services.
- Train Services have a higher loading and are longer.
- Less available maintenance windows.
- Trains no longer originate from the same terminals.
- Trains no longer all fuel at Cook and Parkeston.
East West Model

- Trains run over 11 days of simulation
  - 173 Courses, with individual train consists
- Typical Incident Data Set
  - 70 - 100 Incidents

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<tr>
<th>Section</th>
<th>Route Km</th>
<th>Crossing / Block Locations</th>
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<tr>
<td>Adelaide - Parkeston</td>
<td>1900</td>
<td>55 + 22 km of double line</td>
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<tr>
<td>Crystal Brook – Broken Hill</td>
<td>373</td>
<td>14</td>
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Model Structure

Source Data
- Track Related Delay Data
  - TSR
  - Incidents
  - Wind
- Consist Related Delay Data
  - Departure
  - Equipment
  - Operational

Rules & Assumptions
- Sampling Rules
  - Average Level
  - Distribution
- Network Rules
- Driving Style & Train Handling Rules

Model Input Data
- Delay Data Sets
  - TSR
  - Incidents
  - Wind
- Train Priority Rules
- Train Handling Data
- Sampling Rules
  - Average Level
  - Interdependencies

Model Train Operations
- Opentrack

Individual Run Data
- Train Performance Data

Accumulated Run Data
- Corridor Performance Database
- Task Usage Data
  - Loop Occupancy

Existing

Outcomes

• Model Outputs are consistent with historical data set.
• Identification of the benefits to the service of changes to:
  – Temporary speed restrictions;
  – Below rail incidents;
  – Rollingstock reliability;
  – Terminal performance; and
  – Rollingstock performance by adding locomotives.
Impact of Incidents

Simulation with Temporary Speed Restrictions Only
Impact of Incidents

Simulation with Temporary Speed Restrictions Plus Incidents
Outcomes

• Trains ‘bunch’.
• Extended waiting time in crossing loops.
• Reliability Drivers:
  – Some factors driving reliability affect every train such as:
    • Climatic effects (these can be described mathematically); and
    • Condition related temporary speed restrictions.
  – Others are random events.
Outcomes

• Improvement in factors affecting every train (higher power to weight ratio & less TSRs) costly but allow system to ‘recover’.

• Improvement in random events:
  – May be difficult to achieve is a sustained manner;
  – Will always leave a small population of random events; and
  – Requires system re-engineering.
Commercial Issues

- Who “owns” the recovery time and ability to recover in the schedule? The operator or Network Access Provider?
- How are investments to improve reliability across the system funded?
- What is the Network Access providers role in optimising the system?
Acknowledgements

Pacific National/Asciano Corporate Group

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