Can information technology help rail play a greater role in preventing climate change?

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Agenda

1. Introduction: IT and Railway Potential
2. The Problem
3. Information Technology in the Railway Industry
4. Three key types of IT Applications
   - Scheduling and timetable planning;
   - Operations management and dispatching;
   - Simulation (infrastructure planning);
5. Upcoming Conferences
6. Conclusions and Recommendations
Introduction

• Research Goal:
  
  *Identify opportunities for using information technology to improve railway operations and service.*

• Research based on results presented at IT08.rail conference supplemented by literature review.

• Presentation Goal: Highlight upcoming conferences and encourage participation from interested railway professionals:
  
  – Rail Zurich 2009 - IAROR Conference - February 11 - 13, 2009
  – IT10.rail conference - Zurich - January 21 - 23, 2010
Rail’s Potential for Helping Address Climate Change

• “The railway will be the 21st Century’s preferred mode of transport – if it can survive the 20th Century.”

• Railways could help reduce energy consumption, improve the environment and reduce climate change.

• But, potential customers value the independence and high quality service provided by automobiles, trucks and airplanes.

• Railways have a window of opportunity – but they must use new technologies including IT to create:
  – New production processes,
  – New products and
  – New services
  ... tailored for 21st Century customers.
The Problem

• Rail is an attractive and efficient means of transport in many market segments, including:
  – Bulk freight (e.g. coal)
  – High density passenger routes (e.g. HSR)

• But: while volumes have been growing, mode share is generally falling. Why?
  – Capacity constraints
  – Demand for higher quality service by passengers & freight

• In some markets, e.g. European freight corridors, California Capitol Corridor, where institutional barriers have been reduced, real partnerships have been created and new products introduced, rail has been particularly successful.

• These successes highlight rail’s strong potential.
Compounding the Problem: More Trains = Lower Quality

- Rail capacity is a function of:
  - infrastructure quality
  - type of operations
  - scheduling assumptions

- Railway service quality:
  - punctuality
  - reliability
  - comfort/security
  - price

- As demand increases quality decreases, first slowly, then sharply.
- Timetable and dispatching improvements can increase the number of trains operated while maintaining the same quality of service.
Solving the Problem:
Improving Quality and Increasing Capacity

1. Add infrastructure
   - Expensive
   - Difficult (especially where capacity is often most needed!)
2. Revise schedules (timetables and organizing principles)
3. Improve operations management (e.g. dispatching)

Best: do all three! But …
- How do you decide what to do?
- How do you set priorities?
- How do you operate in the meantime?

*Information technology plays an important and growing role in answering these questions.*
• Key benefit of rail IT applications is their ability to test many different alternatives quickly and accurately, enabling planners and operators to make better decisions.

• The main types of rail planning IT applications parallel the three main types of capacity/quality improvements above:
  1. Scheduling and timetable planning;
  2. Operations management and dispatching;
  3. Simulation (infrastructure planning);

• An important element of current rail IT research is linking applications and adding more automated analysis functions.

• These planning applications are also being more closely linked with ‘administrative’ rail IT applications (e.g. staff scheduling).
1. Timetable Planning

- The timetable is a railway’s central organizing element;
- Therefore … it forms an important basis for many rail information technology applications.
Timetable Planning Strategies

• Rail timetables need to be both:
  – Stable: able to recover quickly from service disturbances and delays, and
  – Robust: able to function despite service disturbances and failures.

• IT applications developed for planning timetables use conceptual scheduling principles including:
  – Stable and simple service concepts (e.g. Taktfahrplan);
  – Optimization of train connection relationships;
  – Achievable (realistic) conflict-free train paths;
  – Resource planning (e.g. staffing); and
  – Real time slot access and pricing.
Slot pricing is a fundamental element in creating a more effective and efficient rail system.

Slot pricing is complex and prone to charges of favoritism and discrimination.

IT timetable planning systems can be used to e.g.:
- Identify opportunities for adding trains to heavily used networks;
- Create a systematic approach for setting slot prices and priorities;
- Explore opportunities for real-time slot pricing strategies (e.g. auctions in the case of delays);

Focus is on linking different applications and creating more transparency in the system.
Three ideas for using IT to optimize rail operations:

1. Improved dispatching systems (next slides);

2. Improved train control systems:
   - Combine real time dispatching information with driver-machine interfaces to more precisely implement timetables;

3. Improved travel information systems:
   - Customers expect high quality real time information (automobile GPS, freight delivery);
   - Use ability to re-direct passengers (and trains) to provide more customer-friendly delay/incident recovery plans.
Example Rail Operations: Improved Dispatching Systems

- **Dispatching IT:**
  - *Today* = monitoring and conflict detection;
  - *Tomorrow* = provide solutions and consider more variables (e.g. energy use).

- **Key issues:**
  - Problem complexity;
  - Can machines ‘anticipate’ problems (like an experienced dispatcher) or simply ‘react’?
  - Data acquisition (data is out there, but where?);
  - How do you measure success?
  - Human factors (will dispatchers accept the help? Generational issue: T-Rex vs. PacMan vs. iPod?).
Puls90 - addresses complexity by dividing network into zones with excess capacity (compensation zones) and zones operating at capacity (condensation zones).

Two main principles of Puls90 are:

- Automated real-time rescheduling in case of delays or disturbances
- Driver-Machine-Interface with real-time data to adjust driving behavior
3. Railway Simulation and Infrastructure Planning

- ‘Classical’ application of information technology to railway planning and operations.
- Planners can develop and test many different combinations of:
  - Infrastructure
  - Rolling stock
  - Schedules/operating strategies
- Especially effective at identifying the most cost effective solutions;
- Future: more interfaces with other rail IT applications and more automated problem analysis.
Railway Information Technology Conferences

**IT08 RAIL**

Closing the Loop - Capacity and Quality of Railway Systems
24 - 26 January 2008 in Zurich

- **RailZurich2009: IAROR Conference**
  - February 11 - 13, 2009
  - 3rd International Seminar on Railway Operations Modeling and Analysis - Engineering and Optimization Approaches

- **International Association of Railway Operations Research (IAROR)**
  - [www.iaror.org](http://www.iaror.org)

- **IT10.rail Conference:**
  - 21 - 23 January 2010
  - ETH Zurich
  - [www.it10rail.ch](http://www.it10rail.ch) - details forthcoming!
Day 1: User Workshops
  - Viriato timetable development and analysis application
  - OpenTrack rail simulation application

Atelier - Automatic Train Traffic Control Systems of the Future - group workshops discussing ideas and problems;

Day 2: Technical Symposium (next slide);

Day 3: Excursion - Lötschberg Basis Tunnel and BLS tunnel control center.
Stability and Reserves
- Dagmar Haase, DB Netz AG - The relationship between stability and reserves
- Prof. Leo Kroon, Erasmus University Rotterdam - Robust timetables: Determination of reserves in the planning process

New Methods in Dispatching
- Dr. Felix Laube, SBB AG - Puls 90 – A new method to deal with reserves from strategic planning up to operations
- Prof. Eckehard Schnieder, TU Braunschweig - What is the state of the art of current dispatching systems? What are the most promising approaches?

Route Management and Open Access
- Jean-Michel Dancoisne, CEO Thalys - Planning of top-quality international HS routes
- Roland Hartkopf, Railion Germany - Challenges and opportunities with Open Access for a freight operator

Incident Management and Quality Assurance
- Martin Wyss, BLS AG - The human dispatcher in the complex control technology environment
- Prof. Ingo Hansen, TU Delft - Quality assurance: Analysis of operational data as input to the planning process of future timetables
- Prof. Dr. Ulrich Weidmann, ETH Zurich - Conclusions: The reserve as an adjusting lever in the over-all process of planning, operations and quality
### Conclusions

- Railways could carry a greater share of freight and passenger trips thereby helping reduce energy use and climate change;
- Rail IT applications are already helping railways increase capacity and improve service quality ... but
- To succeed railways must combine these new technologies with institutional change to create new products and services tailored to meet the demands of 21st Century customers;
- Two important areas for further research are:
  - Technical innovation to help improve rail IT applications;
  - Socio-institutional research on how new technologies can be applied within an old business model to create truly innovative new products.
Thank you very much for your attention!

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