COMPUTERS IN
RAILWAYS X

COMPUTER SYSTEM DESIGN AND OPERATION IN THE
RAILWAY AND OTHER TRANSIT SYSTEMS
TENTH INTERNATIONAL CONFERENCE ON COMPUTERS IN RAILWAYS

COMPRAIL X

CONFERENCE CHAIRMEN

J. Allan
Rail Safety and Standards Board, UK

C. A. Brebbia
Wessex Institute of Technology, UK

A. F. Rumsey
Parsons Transportation Group

G. Sciutto
Univertsita di Genova

S. Sone
University of Kogakuin

C. J. Goodman
The University of Birmingham

INTERNATIONAL SCIENTIFIC ADVISORY COMMITTEE

T. Albrecht B. Ning
W. Daamen A. Radtke
J. Esteves J. Rodriguez
I. A. Hansen E. Schmieder
T. Koseki P. Tzieropoulos
N. Moreira A. Yoshimura

Sponsored by
WIT Transactions on the Built Environment
WIT Transactions on The Built Environment

Transactions Editor
Carlos Brebbia
Wessex Institute of Technology
Ashurst Lodge, Ashurst
Southampton SO40 7AA, UK
Email: carlos@wessex.ac.uk

Editorial Board

E Alarcon
Universidad Politecnica de Madrid
Spain

S A Anagnostopoulos
University of Patras
Greece

H Antes
Technische Universität Braunschweig
Germany

D E Beskos
University of Patras
Greece

F Butera
Politecnico di Milano
Italy

J Chilton
University of Nottingham
UK

M C Constantinou
State University of New York at Buffalo
USA

A De Naeyer
Universiteit Gent
Belgium

J Dominguez
University of Seville
Spain

M N Fardis
University of Patras
Greece

L Gaul
Universität Stuttgart
Germany

M Iguchi
Science University of Tokyo
Japan

W Jager
Technical University of Dresden
Germany

C Alessandri
Università di Ferrara
Italy

E Angelino
A.R.P.A. Lombardia
Italy

D Aubry
Ecole Centrale de Paris
France

J J Bommer
Imperial College London
UK

P G Carydis
National Technical University of Athens
Greece

S Clement
Transport System Centre
Australia

G Degrande
Katholieke Universiteit Leuven
Belgium

W P De Wilde
Vrije Universiteit Brussel
Belgium

F P Escrig
University of Seville
Spain

C J Gantes
National Technical University of Athens
Greece

Y Hayashi
Nagoya University
Japan

L Int Panis
VITO Expertisecentrum IMS
Belgium

C M Jefferson
University of the West of England
UK
COMPUTERS IN
RAILWAYS X

COMPUTER SYSTEM DESIGN AND OPERATION IN
THE RAILWAY AND OTHER TRANSIT SYSTEMS

Editors

J. Allan
Rail Safety and Standards Board, UK

C. A. Brebbia
Wessex Institute of Technology, UK

A. F. Rumsey
Parsons Transportation Group

G. Sciutto
Universita di Genova

S. Sone
University of Kogakuin

C. J. Goodman
The University of Birmingham
Preface

COMPRAIL 2006, the tenth in a series of well-established and successful international conferences on Computer System Design and Operation in the Railway and Other Transit Systems, was held in Prague, Czech Republic, in 2006. Since 1987, COMPRAIL has provided a world forum for planners, designers, manufacturers and operators to discuss how they can benefit from computer-based techniques.

This book contains most of the papers presented at COMPRAIL 2006, representing the latest research, from development and application of computers to the management, design, manufacture and operations of railways and other passenger, freight and transit systems.

The Conference attracted a large number of papers, divided into the following sections: Planning; Safety; Passenger interface systems; Decision support systems; Computer techniques; Converting metros to driverless operation; Advanced train control; Train location; Dynamic train regulation; Timetable planning; Operations quality; Communications; Energy management; Power supply; Dynamics and wheel/rail interface; Freight; Condition monitoring.

This book is distributed throughout the world by WIT Press, the publishing arm of the Wessex Institute of Technology. In addition, together with all other COMPRAIL Conferences held from 1994 onwards, the papers are displayed in the electronic library of the Transactions of the Wessex Institute, where they are permanently available to the international scientific community.

The Editors are grateful to all the authors for the excellent papers and to those members of the International Scientific Advisory Committee who participated in the review process. The success of the conference and this book is the result of their significant contribution of time and energy.

The Editors
Prague, 2006
Contents

Section 1: Planning

Choices between stairs, escalators and ramps in stations
W. Daamen, P. H. L. Bovy & S. P. Hoogendoorn ................................................ 3

How is the business case used by stakeholders for making project decisions with PFI/PPP projects?
M. J. Gannon ....................................................................................................... 13

A bilevel model for optimizing station locations along a rail transit line
S. Samanta & M. K. Jha ...................................................................................... 23

Design and implementation of virtual environments for planning and building sustainable railway transit systems
M. Chandramouli, B. Huang, T.-Y. Chou, L. K. Chung & Q. Wu ...................... 33

The network effects of railway investments
S. Hansen, A. Landex & A. H. Kaas ................................................................. 45

Modelling and simulation of the traffic management in a migration phase: example of “Ligne 1” of the Parisian subway

Computer based ex-ante evaluation of the planned railway line between Copenhagen and Ringsted by use of a Decision Support System named COSIMA-DSS
K. B. Salling & A. Landex ................................................................................ 65

Assessing rail transport network performance and reliability
R. Raicu & M. A. P. Taylor ................................................................................ 75

A study on a mathematical model of the track maintenance scheduling problem
Statistical method for the evaluation of railway system modifications
M. Chandesris ........................................................................................................97

Prioritized Rail Corridor Asset Management
T. Selig & J. Kasper ..............................................................................................105

Section 2: Safety

An assessment of hazard probability due to Pentium processor errata in automatic train control applications
C. Bantin ..............................................................................................................115

Role of supervision systems in railway safety
F. Belmonte, J.-L. Boulanger, W. Schön & K. Berkani .......................................129

Automatic train controller safety simulation
R. A. V. Gimenes, J. R. de Almeida Jr. & T. R. Nogueira ....................................139

Common approach for supervising the railway safety performance
E. M. El Koursi & L. Tordai ..............................................................................147

Potential dangerous object detection on railway ballast using digital image processing
P. L. Mazzeo, E. Stella, M. Nitti & A. Distante ....................................................157

Thermal characteristics of novel brake friction materials for light rail transit applications
N. Valliyappan, D. Berhan, M. N. Darius & G. Solomon .....................................167

Section 3: Passenger interface systems

A fast method for estimating railway passenger flow
Y. Nagasaki, M. Asuka & K. Komaya .................................................................179

Route-choice support system for passengers in the face of unexpected disturbance of train operations
R. Tsuchiya, Y. Sugiyama, K. Yamauchi, K. Fujinami, R. Arisawa
& T. Nakagawa .................................................................................................189

A new delay forecasting system for the Passenger Information Control system (PIC) of the Tokaido-Sanyo Shinkansen
K. Fukami, H. Yamamoto, T. Hatanaka & T. Terada .........................................199
Section 4: Decision support systems

Reconstruction of train trajectories from track occupation data to determine the effects of a Driver Information System
T. Albrecht, R. M. P. Goverde, V. A. Weeda & J. van Luipen .............................207

A decision support system for track maintenance
C. Meier-Hirmer, A. Senée, G. Riboulet, F. Sourget & M. Roussignol .................................................................217

The new Shinkansen rescheduling system for drivers and crew

A Decision Support System for railway timetabling (MOM): the Spanish case
F. Barber, P. Tormos, A. Lova, L. Ingolotti, M. A. Salido & M. Abril ...............235

Measurement of train driver’s brain activity by functional near-infrared spectroscopy (fNIRS)
T. Kojima, H. Tsunashima & T. Y. Shiozawa .......................................................245

Methodology for the LCC-Analysis and the optimal migration of the railway operations control on the example of ETCS
M. Obrenovic, B. Jaeger & K. Lemmer ............................................................255

Application of location detection system using active type RFID tags to railways
K. Seki, S. Suzuki, M. Ukai & R. Tsuchiya ................................................................265

A survey on SNCF decision support system tools to supervise and to pilot train traffic in operation
D. Gauyacq ........................................................................................................275

Section 5: Computer techniques

Distributed constraint satisfaction problems to model railway scheduling problems
P. Tormos, M. Abril, M. A. Salido, F. Barber, L. Ingolotti & A. Lova ..........289

Blocking time reduction for level crossings using the genetic algorithm
Y. Noguchi, H. Mochizuki, S. Takahashi, H. Nakamura, S. Kaneko & M. Sakai .................................................................299
Modeling a distributed railway interlocking system with object-oriented Petri nets

Using UML diagrams for system safety and security environment analysis
F. M. Rachel & P. S. Cugnasca ................................................................. 319

System-independent and quality tested availability of railway data across country and system borders by the model driven approach
H. R. Gnägi & N. Stahel................................................................. 329

Formalisation and simulation of operating rules using coloured Petri nets
O. Lahlou, P. Bon & L. Allain ............................................................ 341

From UML to B – a level crossing case study
J.-L. Boulanger, P. Bon & G. Mariano.................................................. 351

Section 6: Converting metros to driverless operation
(special section organised by A. F. Rumsey)

The feasibility case for converting existing heavy metro systems to driverless operation
P. Thomas .................................................................................. 363

Converting existing service to fully automatic operation
F. Fabbian .................................................................................. 373

Re-signaling the Paris Line 1: from driver based to driverless operation
C. Braban & P. Charon .................................................................. 381

Application of communication based Moving Block systems on existing metro lines
L. Lindqvist & R. Jadhav .................................................................. 391

Driverless CBTC – specific requirements for CBTC systems to overcome operation challenges
M. P. Georgescu ........................................................................ 401

Section 7: Advanced train control

CBTC (Communication Based Train Control): system and development
N. Bin, T. Tao, Q. K. Min & G. C. Hai .................................................. 413
An algorithm for braking curve calculations in ERTMS train protection systems
B. Friman ........................................................................................................... 421

ICONIS: the window for URBALIS controlled automatic METRO
P. Noury ............................................................................................................ 431

Automatic train operation system for the high speed Shinkansen train
Y. Yasui.............................................................................................................. 441

Section 8: Train location

Design of experiment for the validation of ATP/ATC odometry algorithms
M. Malvezzi, G. Cocci & A. Tarasconi ............................................................ 449

Location in railway traffic: generation of a digital map for secure applications
F. Böhringer & A. Geistler ............................................................................. 459

Train position detecting system using radio millimeter-waves
T. Maeda, K. Watanabe & M. Ono................................................................. 469

Section 9: Dynamic train regulation

Optimal train control at a junction in the main line rail network using a new object-oriented signalling system model

Optimising train priorities to support the regulation of train services with the assistance of active and deductive databases
C. Sakowitz & E. Wendler................................................................................ 489

Simulation of traffic management with FRISO
A. D. Middelkoop & L. Loeve ................................................................. 501

Influences of station length and inter-station distance on delays and delay propagation on single-track lines with regional rail traffic
O. Lindfeldt .................................................................................................... 511

Simulation of disturbances and modelling of expected train passenger delays
A. Landex & O. A. Nielsen ........................................................................... 521
Running time re-optimization during real-time timetable perturbations
A. D’Ariano & T. Albrecht .................................................................531

ALFa – a software tool for optimal scheduling of demand oriented
train services
S. Scholz & T. Albrecht ................................................................541

An algorithm for train rescheduling using rescheduling pattern
description language R
C. Hirai, N. Tomii, Y. Tashiro, S. Kondou & A. Fujimori ..................551

Section 10: Timetable planning

State-of-the-art of railway operations research
I. A. Hansen ......................................................................................565

Timetable management and operational simulation:
methodology and perspectives
A. Radtke .......................................................................................579

The contribution of state resources in a constraint-based
scheduling model for conflict solving at railway junctions
J. Rodriguez ....................................................................................591

A new idea for train scheduling using ant colony optimization
K. Ghoseiri ....................................................................................601

Joint design standard for running times, dwell times and headway times
V. A. Weeda & P. B. L. Wiggenraad ..............................................611

RTCSIM: an innovative, extendable computation engine
for timetable validation
T. Polzin & R. Gooßmann .................................................................621

Evaluating stochastic train process time distribution models
on the basis of empirical detection data
J. Yuan, R. M. P. Goverde & I. A. Hansen ........................................631

Section 11: Operations quality

Practical use of the UIC 406 capacity leaflet by including
timetable tools in the investigations
A. Landex, A. H. Kaas, B. Schittenhelm & J. Schneider-Tilli .............643
A method to estimate passenger flow with stored data at ticket gates
S. Myojo ...........................................................................................................653

Analysis and optimisation of railway nodes using simulation techniques
A. Kavička, V. Klima & N. Adamko .................................................................663

Section 12: Communications

Model checker for railway signalling communication protocol
J.-G. Hwang, H.-J. Jo & J. H. Lee.................................................................675

A new ground-to-train communication system using
time-space optics technology
H. Kotake, T. Matsuzawa, A. Shimura, S. Haruyama & M. Nakagawa ........683

Communications security concerns in communications based train control
M. Hartong, R. Goel & D. Wijesekera...........................................................693

Ethernet-based network with high reliability for railway signaling systems
H.-J. Jo, J.-G. Hwang & Y.-K. Yoon .................................................................703

Section 13: Energy management

Information system for railway energy management
G. Hribar, B. Dremelj & M. Sekavnik.........................................................713

Impact of train model variables on simulated energy usage
and journey time
P. Lukaszewicz ............................................................................................723

Section 14: Power supply

Investigation into the computational techniques of power system
modelling for a DC railway
A. Finlayson, C. J. Goodman & R. D. White .............................................735

Catenary and autotransformer coupled optimization for 2x25kV systems
planning
E. Pilo, L. Rouco & A. Fernandez.................................................................747

A study of capacity calculation of regenerative inverter for 1500V DC
traction system
C. H. Bae, M. S. Han, Y. K. Kim, S. Y. Kwon & H. J. Park ......................757
Train operation minimizing energy consumption in DC electric railway with on-board energy storage device
K. Matsuda, H. Ko & M. Miyatake ......................................................... 767

Calculations and measurements of harmonic current distributions in the catenary of railways with single-phase A.C.
A. Zynovchenko, J. Xie, S. Jank & F. Klier............................................. 777

A numerical algorithm for run-curve optimization of trains considering a DC feeding circuit
H. Ko & M. Miyatake................................................................................ 787

Railway modelling for power quality analysis
M. Chymera, A. C. Renfrew & M. Barnes................................................ 797

A mixed AC/DC model for railway power systems
J. Muñoz-Riesco, E. Pilo, A. Fernandez & P. Cucala .............................. 805

A user interface for the representation of the dynamic results on the pantograph-catenary interactions
D. Cebrián, T. Rojo, A. Alberto, E. Arias, F. Cuartero & J. Benet .......... 817

Section 15: Dynamics and wheel/rail interface

Dynamic identification of a 1:5 scaled railway bogie on roller rig
N. Bosso, A. Gugliotta & A. Somà ............................................................ 829

On enhanced tilt strategies for tilting trains
B. Kufver & R. Persson ........................................................................ 839

Railway car dynamic response to track transition curve and single standard turnout
J. Droździel & B. Sowiński..................................................................... 849

Optimization of special freight wagons with small wheel diameter
A. Rindi, D. Fioravanti, L. Pugi, M. Rinchi & J. Auciello....................... 859

Design and simulation of railway vehicles braking operation using a scaled roller-rig
N. Bosso, A. Gugliotta & A. Somà ............................................................ 869

Study on vertical dynamic vehicle-track interactions using the TRADYS test facility and computer simulation
M. Miwa & A. Yoshimura ...................................................................... 885
Section 16: Freight

Effect of the distribution of the arrivals and of the intermodal unit sizes on the transit time through freight terminals
G. Malavasi, A. Quattrini & S. Ricci ................................................................. 905

COMPAT: a decision support tool for determining the necessity of rail infrastructure
M. J. Wolbers ................................................................................................... 915

A cost effective solution to manage rail cargo fleets: the final assessment of the F-MAN project
G. Cosulich, A. Derito, M. Giannettoni & S. Savio ........................................... 923

Section 17: Condition monitoring

Methodology for the monitoring, control and warning of defects for preventive maintenance of rails
K. C. Labropoulos, P. Moundoulas & A. Moropoulou ..................................... 935

Onboard measurement method for signaling equipment on Probe Trains
H. Nakamura, S. Takahashi, T. Hiramoto, H. Mochizuki & T. Mizuma ........... 945

Fault detection of railway track by multi-resolution analysis
T. Kojima, H. Tsunashima & A. Matsumoto .................................................... 955

Research on the onboard auto-test system for track circuit compensating capacitors
H. Zhao, Y. Liu & B. Liu ................................................................................ 965

Monitoring wheel defects on a metro line: system description, analysis and results
M. Seco, E. Sanchez & J. Vinolas ................................................................. 973

Author index .................................................................................................. 983