

***COMPUTERS IN
RAILWAYS X
COMPUTER SYSTEM DESIGN AND OPERATION IN THE
RAILWAY AND OTHER TRANSIT SYSTEMS***

WIT*PRESS*

WIT Press publishes leading books in Science and Technology.
Visit our website for the current list of titles.
www.witpress.com

WIT*eLibrary*

Home of the Transactions of the Wessex Institute.
Papers presented at COMPRAIL 2006 are archived in the WIT eLibrary in volume 88 of
WIT Transactions on The Built Environment (ISSN 1743-3509).

The WIT electronic-library provides the international scientific community with
immediate and permanent access to individual papers presented at WIT conferences.
<http://library.witpress.com>

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

Universita di Genova

S. Sone

University of Kogakuin

C. J. Goodman

The University of Birmingham

INTERNATIONAL SCIENTIFIC ADVISORY COMMITTEE

T. Albrecht
W. Daamen
J. Esteves
I. A. Hansen
T. Koseki
N. Moreira

B. Ning
A. Radtke
J. Rodriguez
E. Schnieder
P. Tzieropoulos
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 Universitat 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 Ghent
Belgium

J Dominguez
University of Seville
Spain

M N Fardis
University of Patras
Greece

L Gaul
Universitat Stuttgart
Germany

M Iguchi
Science University of Tokyo
Japan

W Jager
Technical University of Dresden
Germany

C Alessandri
Universita 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

- D L Karabalis**
University of Patras
Greece
- W Jager**
Technical University of Dresden
Germany
- W B Kratzig**
Ruhr Universitat Bochum
Germany
- J W S Longhurst**
University of the West of England,
UK
- L Lundqvist**
Unit for Transport and Location Analysis
Sweden
- G D Manolis**
Aristotle University of Thessaloniki
Greece
- F M Mazzolani**
University of Naples "Federico II"
Italy
- G Oliveto**
Universita di Catania
Italy
- A S Papageorgiou**
Rensselaer Polytechnic Institute
USA
- A M Reinhorn**
State University of New York at Buffalo
USA
- C W Roeder**
University of Washington
USA
- M Saiidi**
University of Nevada-Reno
USA
- S A Savidis**
Technische Universitat Berlin
Germany
- Q Shen**
Massachusetts Institute of Technology
USA
- P D Spanos**
Rice University
USA
- H Takemiya**
Okayama University
Japan
- E Taniguchi**
Kyoto University
Japan
- M A P Taylor**
University of South Australia
Australia
- E Kausel**
Massachusetts Institute of Technology
USA
- A N Kounadis**
National Technical University of Athens
Greece
- A A Liolios**
Democritus University of Thrace
Greece
- J E Luco**
University of California at San Diego
USA
- M Majowiecki**
University of Bologna
Italy
- G Mattrisch**
DaimlerChrysler AG
Germany
- K Miura**
Kajima Corporation
Japan
- E Oñate**
Universitat Politecnica de Catalunya
Spain
- G G Penelis**
Aristotle University of Thessaloniki
Greece
- F Robuste**
Universitat Politecnica de Catalunya
Spain
- J M Roesset**
Texas A & M University
USA
- F J Sanchez-Sesma**
Instituto Mexicano del Petroleo
Mexico
- J J Sendra**
University of Seville
Spain
- A C Singhal**
Arizona State University
USA
- C C Spyarakos**
National Technical University of Athens
Greece
- I Takewaki**
Kyoto University
Japan
- J L Tassoulas**
University of Texas at Austin
USA
- R Tremblay**
Ecole Polytechnique
Canada

R van der Heijden

Radboud University
Netherlands

A Yeh

The University of Hong Kong
China

R Zarnic

University of Ljubljana
Slovenia

R van Duin

Delft University of Technology
Netherlands

M Zador

Technical University of Budapest
Hungary

***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

WITPRESS Southampton, Boston



J. Allan
Rail Safety and Standards Board, UK

G. Sciutto
Universita di Genova

C. A. Brebbia
Wessex Institute of Technology, UK

S. Sone
University of Kogakuin

A. F. Rumsey
Parsons Transportation Group

C. J. Goodman
The University of Birmingham

Published by

WIT Press

Ashurst Lodge, Ashurst, Southampton, SO40 7AA, UK
Tel: 44 (0) 238 029 3223; Fax: 44 (0) 238 029 2853
E-Mail: witpress@witpress.com
<http://www.witpress.com>

For USA, Canada and Mexico

Computational Mechanics Inc
25 Bridge Street, Billerica, MA 01821, USA
Tel: 978 667 5841; Fax: 978 667 7582
E-Mail: infousa@witpress.com
<http://www.witpress.com>

British Library Cataloguing-in-Publication Data

A Catalogue record for this book is available
from the British Library

ISBN: 1-84564-177-9
ISSN: 1746-4498

The texts of the papers in this volume were set individually by the authors or under their supervision. Only minor corrections to the text may have been carried out by the publisher.

No responsibility is assumed by the Publisher, the Editors and Authors for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions or ideas contained in the material herein.

© WIT Press 2006.

Printed in Great Britain by Cambridge Printing.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the Publisher.

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 <i>W. Daamen, P. H. L. Bovy & S. P. Hoogendoorn</i>	3
How is the business case used by stakeholders for making project decisions with PFI/PPP projects? <i>M. J. Gannon</i>	13
A bilevel model for optimizing station locations along a rail transit line <i>S. Samanta & M. K. Jha</i>	23
Design and implementation of virtual environments for planning and building sustainable railway transit systems <i>M. Chandramouli, B. Huang, T.-Y. Chou, L. K. Chung & Q. Wu</i>	33
The network effects of railway investments <i>S. Hansen, A. Landex & A. H. Kaas</i>	45
Modelling and simulation of the traffic management in a migration phase: example of “Ligne 1” of the Parisian subway <i>M. Ghantous-Mouawad, W. Schön, J.-L. Boulanger & G. Churchill</i>	55
Computer based ex-ante evaluation of the planned railway line between Copenhagen and Ringsted by use of a Decision Support System named COSIMA-DSS <i>K. B. Salling & A. Landex</i>	65
Assessing rail transport network performance and reliability <i>R. Raicu & M. A. P. Taylor</i>	75
A study on a mathematical model of the track maintenance scheduling problem <i>S. M. Oh, J. H. Lee, B. H. Park, H. U. Lee & S. H. Hong</i>	85

Statistical method for the evaluation of railway system modifications <i>M. Chandesris</i>	97
---	----

Prioritized Rail Corridor Asset Management <i>T. Selig & J. Kasper</i>	105
---	-----

Section 2: Safety

An assessment of hazard probability due to Pentium processor errata in automatic train control applications <i>C. Bantin</i>	115
--	-----

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

Automatic train controller safety simulation <i>R. A. V. Gimenes, J. R. de Almeida Jr. & T. R. Nogueira</i>	139
--	-----

Common approach for supervising the railway safety performance <i>E. M. El Koursi & L. Tordai</i>	147
--	-----

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

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

Section 3: Passenger interface systems

A fast method for estimating railway passenger flow <i>Y. Nagasaki, M. Asuka & K. Komaya</i>	179
---	-----

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

A new delay forecasting system for the Passenger Information Control system (PIC) of the Tokaido-Sanyo Shinkansen <i>K. Fukami, H. Yamamoto, T. Hatanaka & T. Terada</i>	199
--	-----

Section 4: Decision support systems

Reconstruction of train trajectories from track occupation data to determine the effects of a Driver Information System <i>T. Albrecht, R. M. P. Goverde, V. A. Weeda & J. van Luipen</i>	207
A decision support system for track maintenance <i>C. Meier-Hirmer, A. Senée, G. Riboulet, F. Sourget & M. Roussignol</i>	217
The new Shinkansen rescheduling system for drivers and crew <i>H. Shimizu, H. Tanabe, S. Honda & K. Yasura</i>	227
A Decision Support System for railway timetabling (MOM): the Spanish case <i>F. Barber, P. Tormos, A. Lova, L. Ingolotti, M. A. Salido & M. Abril</i>	235
Measurement of train driver's brain activity by functional near-infrared spectroscopy (fNIRS) <i>T. Kojima, H. Tsunashima & T. Y. Shiozawa</i>	245
Methodology for the LCC-Analysis and the optimal migration of the railway operations control on the example of ETCS <i>M. Obrenovic, B. Jaeger & K. Lemmer</i>	255
Application of location detection system using active type RFID tags to railways <i>K. Seki, S. Suzuki, M. Ukai & R. Tsuchiya</i>	265
A survey on SNCF decision support system tools to supervise and to pilot train traffic in operation <i>D. Gauyacq</i>	275

Section 5: Computer techniques

Distributed constraint satisfaction problems to model railway scheduling problems <i>P. Tormos, M. Abril, M. A. Salido, F. Barber, L. Ingolotti & A. Lova</i>	289
Blocking time reduction for level crossings using the genetic algorithm <i>Y. Noguchi, H. Mochizuki, S. Takahashi, H. Nakamura, S. Kaneko & M. Sakai</i>	299

Modeling a distributed railway interlocking system with object-oriented Petri nets <i>X. Hei, H. Mochizuki, S. Takahashi, H. Nakamura, M. Fukuda, K. Iwata & K. Sato</i>	309
Using UML diagrams for system safety and security environment analysis <i>F. M. Rachel & P. S. Cugnasca</i>	319
System-independent and quality tested availability of railway data across country and system borders by the model driven approach <i>H. R. Gnägi & N. Stahel</i>	329
Formalisation and simulation of operating rules using coloured Petri nets <i>O. Lahlou, P. Bon & L. Allain</i>	341
From UML to B – a level crossing case study <i>J.-L. Boulanger, P. Bon & G. Mariano</i>	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 <i>P. Thomas</i>	363
Converting existing service to fully automatic operation <i>F. Fabbian</i>	373
Re-signaling the Paris Line 1: from driver based to driverless operation <i>C. Braban & P. Charon</i>	381
Application of communication based Moving Block systems on existing metro lines <i>L. Lindqvist & R. Jadhav</i>	391
Driverless CBTC – specific requirements for CBTC systems to overcome operation challenges <i>M. P. Georgescu</i>	401

Section 7: Advanced train control

CBTC (Communication Based Train Control): system and development <i>N. Bin, T. Tao, Q. K. Min & G. C. Hai</i>	413
--	-----

An algorithm for braking curve calculations in ERTMS train protection systems <i>B. Friman</i>	421
ICONIS: the window for URBALIS controlled automatic METRO <i>P. Noury</i>	431
Automatic train operation system for the high speed Shinkansen train <i>Y. Yasui</i>	441

Section 8: Train location

Design of experiment for the validation of ATP/ATC odometry algorithms <i>M. Malvezzi, G. Cocci & A. Tarasconi</i>	449
Location in railway traffic: generation of a digital map for secure applications <i>F. Böhringer & A. Geistler</i>	459
Train position detecting system using radio millimeter-waves <i>T. Maeda, K. Watanabe & M. Ono</i>	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 <i>R. Takagi, P. F. Weston, C. J. Goodman, C. Bouch, J. Armstrong, J. Preston & S. Sone</i>	479
Optimising train priorities to support the regulation of train services with the assistance of active and deductive databases <i>C. Sakowitz & E. Wendler</i>	489
Simulation of traffic management with FRISO <i>A. D. Middelkoop & L. Loeve</i>	501
Influences of station length and inter-station distance on delays and delay propagation on single-track lines with regional rail traffic <i>O. Lindfeldt</i>	511
Simulation of disturbances and modelling of expected train passenger delays <i>A. Landex & O. A. Nielsen</i>	521

Running time re-optimization during real-time timetable perturbations <i>A. D'Ariano & T. Albrecht</i>	531
ALFa – a software tool for optimal scheduling of demand oriented train services <i>S. Scholz & T. Albrecht</i>	541
An algorithm for train rescheduling using rescheduling pattern description language R <i>C. Hirai, N. Tomii, Y. Tashiro, S. Kondou & A. Fujimori</i>	551

Section 10: Timetable planning

State-of-the-art of railway operations research <i>I. A. Hansen</i>	565
Timetable management and operational simulation: methodology and perspectives <i>A. Radtke</i>	579
The contribution of state resources in a constraint-based scheduling model for conflict solving at railway junctions <i>J. Rodriguez</i>	591
A new idea for train scheduling using ant colony optimization <i>K. Ghoseiri</i>	601
Joint design standard for running times, dwell times and headway times <i>V. A. Weeda & P. B. L. Wiggenraad</i>	611
RTCSIM: an innovative, extendable computation engine for timetable validation <i>T. Polzin & R. Goßmann</i>	621
Evaluating stochastic train process time distribution models on the basis of empirical detection data <i>J. Yuan, R. M. P. Goverde & I. A. Hansen</i>	631

Section 11: Operations quality

Practical use of the UIC 406 capacity leaflet by including timetable tools in the investigations <i>A. Landex, A. H. Kaas, B. Schittenhelm & J. Schneider-Tilli</i>	643
---	-----

A method to estimate passenger flow with stored data at ticket gates
S. Myojo653

Analysis and optimisation of railway nodes using simulation techniques
A. Kavička, V. Klima & N. Adamko663

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
free-space optics technology
H. Kotake, T. Matsuzawa, A. Shimura, S. Haruyama & M. Nakagawa683

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. Sekavčnik.....713

Impact of train model variables on simulated energy usage
and journey time
P. Lukaszewicz723

Section 14: Power supply

Investigation into the computational techniques of power system
modelling for a DC railway
A. Finlayson, C. J. Goodman & R. D. White735

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 <i>K. Matsuda, H. Ko & M. Miyatake</i>	767
Calculations and measurements of harmonic current distributions in the catenary of railways with single-phase A.C. <i>A. Zynovchenko, J. Xie, S. Jank & F. Klier</i>	777
A numerical algorithm for run-curve optimization of trains considering a DC feeding circuit <i>H. Ko & M. Miyatake</i>	787
Railway modelling for power quality analysis <i>M. Chymera, A. C. Renfrew & M. Barnes</i>	797
A mixed AC/DC model for railway power systems <i>J. Muñoz-Riesco, E. Pilo, A. Fernandez & P. Cucala</i>	805
A user interface for the representation of the dynamic results on the pantograph-catenary interactions <i>D. Cebrián, T. Rojo, A. Alberto, E. Arias, F. Cuartero & J. Benet</i>	817

Section 15: Dynamics and wheel/rail interface

Dynamic identification of a 1:5 scaled railway bogie on roller rig <i>N. Bosso, A. Gugliotta & A. Somà</i>	829
On enhanced tilt strategies for tilting trains <i>B. Kufver & R. Persson</i>	839
Railway car dynamic response to track transition curve and single standard turnout <i>J. Drożdźiel & B. Sowiński</i>	849
Optimization of special freight wagons with small wheel diameter <i>A. Rindi, D. Fioravanti, L. Pugi, M. Rinchi & J. Auciello</i>	859
Design and simulation of railway vehicles braking operation using a scaled roller-rig <i>N. Bosso, A. Gugliotta & A. Somà</i>	869
Study on vertical dynamic vehicle-track interactions using the TRADYS test facility and computer simulation <i>M. Miwa & A. Yoshimura</i>	885

The study of design on the urban track transportation vibration prevention: floating slab track in the bored tunnel at Taipei <i>Sy. Chang, K. Y. Chang, K. H. Cheng & R. J. T. Chen</i>	895
--	-----

Section 16: Freight

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

COMPAT: a decision support tool for determining the necessity of rail infrastructure <i>M. J. Wolbers</i>	915
---	-----

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

Section 17: Condition monitoring

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

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

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

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

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

Author index	983
---------------------------	-----